GUERNSEY HORTICULTURAL SOCIETY

Guernsey Horticultural Society.

NEW RULES FOR THE LIBRARY.

In consequence of several valuable Works being missing from the Library, the following Amended Rules have been unanimously adopted, and the Fines modified, in order to their being strictly enforced in future:—

I.

The Library to be open to Members only, for reading and reference, every day, except Sundays.

II.

New Books to remain on the Table, from fourteen days to one month, according to size, before being circulated. All Periodicals to remain there one month.

III.

Books to be taken out, renewed, or returned every Wednesday and Saturday, from nine to two o'clock only; and, in no case, without the presence of the Clerk, under a fine of *5s.*; and not more than One Volume to be taken at the same time, under a fine of *2s. 6d.*

IV.

Any Books kept out longer than one week, to pay *6d.* for the first week, and *1s.* for each ensuing week beyond the time allowed.

V.

Any Members lending a Work belonging to the Society to a non-Subscriber, to forfeit *5s.* for each offence.

VI.

Any Member losing a Work or Volume belonging to the Society, shall be bound to replace it within a month under a fine of *10s.* beyond the value of the Book lost; and if the Volume should belong to a series, the whole Work must be replaced, unless the missing Volume be procured within the time above stated.

VII.

Any Member who shall appear to have wilfully or carelessly injured or defaced any Book belonging to the Library shall be fined one-third of its value.

HARRY DOBREE, Jun., Treasurer.

AN

ENCYCLOPÆDIA

OF

AGRICULTURE:

COMPRISING THE

THEORY AND PRACTICE

OF THE VALUATION, TRANSFER, LAYING OUT, IMPROVEMENT, AND MANAGEMENT OF

LANDED PROPERTY;

AND THE CULTIVATION AND ECONOMY OF

THE ANIMAL AND VEGETABLE PRODUCTIONS

OF AGRICULTURE,

INCLUDING

All the latest Improvements;

A GENERAL HISTORY OF AGRICULTURE IN ALL COUNTRIES;

AND A STATISTICAL VIEW OF ITS PRESENT STATE,

WITH SUGGESTIONS FOR ITS FUTURE PROGRESS IN THE BRITISH ISLES.

By J. C. LOUDON, F. L. G. Z. & H.S. &c.

AUTHOR OF THE ENCYCLOPÆDIA OF GARDENING,

AND CONDUCTOR OF THE GARDENER'S MAGAZINE, AND OF THE MAGAZINE OF NATURAL HISTORY.

SECOND EDITION.

ILLUSTRATED WITH

UPWARDS OF ELEVEN HUNDRED ENGRAVINGS ON WOOD BY BRANSTON.

LONDON:

PRINTED FOR

LONGMAN, REES, ORME, BROWN, AND GREEN,

PATERNOSTER-ROW.

1831.

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PREFACE.

The subject of Agriculture admits of two grand divisions; the improvement and general management of landed property, which may be termed *Territorial Economy;* and the cultivation and treatment of its more useful animal and vegetable productions, which are called *Husbandry*, or *Agriculture* in a more limited sense of the term. Numerous as have been the publications on rural matters during the last twenty years, there are but two or three of them whose titles might lead to a supposition that they embraced both of these departments. That none of them did embrace both, however, previously to the appearance of this Encyclopædia, may be confidently affirmed.

This work, which is termed an *Encyclopædia of Agriculture,* on account of its superior comprehensiveness, though in part an original composition from the author's practical experience and observation, is yet chiefly a compilation from books. It professes to embrace every part of the subject; and, what has never hitherto been attempted, to give a general History of Agriculture in all countries; and a condensed survey of its present state in every county of the British Isles. A systematic arrangement is adopted as by far the best for instruction, and also as best admitting of compression. At the same time, a copious General Index is supplied, to render the whole work of the easiest access as a book of reference. So much information as is here given could only be compressed into one volume by the use of a very small type, and by the liberal employment of engravings. By means of the latter, much verbal description is avoided; a knowledge of implements and operations is more forcibly conveyed to the reader; and such a body of useful matter is brought together, as, by the system of detached copper-plate engravings, and ordinary letter-press, would have occupied half a dozen volumes.

Throughout this work, we have kept in view the following objects: in Part I., to depict what may be termed Universal Agriculture, by giving a historical view of that of all countries; in Part II., to exhibit the principles on which the operations and results of the Agriculture of all countries are founded; and, in Parts III. and IV., to apply these principles to that particular Agriculture which is practised in Britain, and adapted to similar climates. In pursuing these objects, we have aimed at language sufficiently free from provincial or obscure technology to be understood by all classes of readers. In describing the Agriculture of Britain, we have held up to view that of the northern counties of Northumberland, Berwickshire, and East Lothian, as examples, in most things, to the other parts of the empire. In addressing landlords, superior agents, valuers of land, and patrons, we have pointed out the advantages of equitable and liberal conduct to their tenants and dependants: in discussing the duties of land stewards, bailiffs, and other serving agriculturists, we have recommended habits of order, vigilance, and economy: and, finally, we have submitted to all classes of readers, the advantages of enlightening the minds and ameliorating the condition of the working classes of rural society, by facilitating the attainment of instruction; by pointing out the evils of their entering too early into the marriage state; by increasing the comfort and improving the appearance of their cottages and gardens; and, especially, by repaying the labour of farm servants to a certain extent in productions calculated for their chief support. (See § 7834. 7862. and § 7953. to 7980.) For, in our opinion, the main comfort of all those engaged in agriculture as a profession, from the labourer to the gentleman farmer, will ever consist more in *the possession within themselves of the essential means of comfortable existence,* than in the power of accumulating fortunes, such as manufacturers and commercial men frequently acquire.

As much of the value of a work of this kind will depend on the knowledge it conveys of the modern improvements in implements and buildings, particular attention has been paid to these subjects. Many of the latest improvements in implements and buildings have not found their way into any books, and for them we have had recourse to the originals, and to the most eminent agricultural mechanics and manufacturers of implements. Our thanks, in this respect, are particularly due to the proprietors of Weir's Agricultural Repository, Oxford Street, London, for permitting us to take sketches from their extensive collection, and more particularly of those implements and machines which the late Mr. Weir invented or greatly improved. Our best thanks are also due to Mr. Morton, Leith Walk, Edinburgh, who is equally eminent as an agricultural mechanist in Scotland; to Messrs. Cottam and Hallen, of Winsley Street, Oxford Street, manufacturers of agricultural implements and machines in iron; and to Mr. Wilkie, of Uddistone, near Glasgow, a scientific mechanist, and an eminent manufacturer of agricultural implements both in timber and iron. There is no implement or machine mentioned in this work which will not be found on sale, or may not be made to order, in the establishments of these gentlemen, in the best manner, and at an equitable charge.

For important assistance in the Veterinary Part of this work, our best thanks are due to an eminent professor. Through the kind assistance of this gentleman we have been enabled to bring together a body of useful information on the anatomy, physiology, pathology, breeding, rearing, and general treatment of the horse, the ox, the sheep, and other domestic animals, even to dogs and poultry, such as we can safely assert is not to be found in any other single volume on Agriculture.

It may be necessary to mention, as a key to this work, that such technical terms as are used in a more definite sense than usual, or such as practical readers in the country, or mere general readers, may be supposed not familiar with, are explained in a Glossarial Index (p. 1241.); and that the abridged titles of books are given at length in an appropriate catalogue. (p. viii.) The systematic nomenclature of plants adopted is that of our *Hórtus Británnicus*, with some exceptions which are noted where they occur. In the specific names of the more common animals, we have followed Turton's edition of the *Systèma Natùræ* of Linnæus; in those of insects, we have followed modern authors: such chemical, mineralogical, and geological terms as occur, are those used by Sir H. Davy in his *Agricultural Chemistry*, and by Professor Brande in his *Geology:* the weights and measures are always according to the standard of Britain, and the temperature to that of Fahrenheit's thermometer, unless otherwise expressed. Systematic names of animals, vegetables, and minerals are accented, and their derivations indicated, in the manner adopted in the *Gardener's Magazine* and in the *Magazine of Natural History*, as explained in a separate article. (p. vii.)

The recent changes which have taken place in the market value of currency, render price a criterion of much too temporary a nature to be employed in any work which aims at general and permanent utility. For this reason we have in this Encyclopædia generally avoided money calculations, preferring to indicate the value of objects or operations by the quantity of materials and labour requisite to produce them, or by stating their cost relatively to the cost of other articles.

We have also avoided entering on the subject of state policy, as to the relative protection of agriculture and manufactures, or of the protection of the home against the foreign grower of corn. Natural prices will always be safer for the farmer than artificial ones; and with low prices the farmer has the chance of deriving a greater benefit on an extraordinary rise, and sustaining less loss on an extraordinary fall. If the prices of corn were one half lower than they are, neither farmers nor proprietors would find their comforts diminished; for the value of manufactures and importations would fall in proportion to that of agricultural produce. Price, it is true, is not always value; but they are never materially different for any length of time.

The first edition of this work was written in the autumn and winter of 1822–3, and published in June, 1825. In this second edition, commenced in January, 1828, and completed in January, 1831, will be found very considerable additions and improvements, including nearly 500 new engravings. Of these engravings nearly 200 are more useful figures, substituted for others considered less so; and the remainder, consisting of nearly 300 are entirely additional. A catalogue of all the engravings in the work arranged systematically is also given (p. xxxii.), for more convenient reference, when the purpose of the reader is a choice of implements or machines.

The principal additions to the letter-press of this edition have been made at the suggestion of our much esteemed friend Mr. Cleghorn, of Edinburgh, late editor of the *Farmer's Magazine*, formerly published in that city; and, in consequence of the assistance procured by the Proprietors, on our recommendation, from Mr. Swainson, the eminent naturalist. The former gentleman perused an interleaved copy of the Encyclopædia, and suggested on the blank pages whatever he thought wanting; indicating at the same time the books or other sources which might be consulted for the purpose of supplying these wants. Mr. Swainson most obligingly took the trouble of writing some paragraphs in the Agricultural History of South America (p. 200.), and the whole of the article on Insects (from p. 1112. to p. 1121.), with some other sentences and paragraphs in different parts of the work, not always considered of sufficient importance to be marked with his signature. Dr. Trail, of Liverpool, on our suggestion to the Proprietors, examined the chemical and geological departments of Part II. Book III., and was good enough to send us some corrections and additions, most of which are indicated by the letter T. With the exception of the additional engravings of implements before mentioned, Mr. Swainson's article on Insects is by far the most valuable addition which the Encyclopædia has received; and it is but doing justice to him to state, that he is the only gentleman among the List of Contributors (p. vi.), who took the trouble to write out his additions in such a manner as to accommodate them to the portions of the work for which they were intended. The amalgamation of the information sent by the other contributors, and the selection and description of the engravings, are of course our own; together with what we have been able to collect ourselves, not only from books and correspondence, but also from the personal observations we made, during a tour in France and Germany undertaken in 1828–9 on purpose for this work.

In consequence of repeated invitations given on the cover of the *Gardener's Magazine*, a considerable number of corrections, additions, and suggestions, have been sent us by the anonymous and other correspondents enumerated in the list (p. vi.) before referred to. The essence of the greater part of these communications was inserted in the *Gardener's Magazine* at the time they were received, and the whole of these are either given, quoted, or referred to, in this edition of the Encyclopædia, in the proper places; but some which arrived too late for being used in the body of the work are given in the Supplement. (p. 1279.) Similar Supplements are intended to be published occasionally, perhaps every two years, and sold separately at the lowest possible price. To every supplementary paragraph will be prefixed the number of the paragraph in the body of the work to which the additional information belongs; and every future impression of the body of the work will contain references from the proper paragraphs to the additions to these paragraphs given in the different Supplements: the manner is exemplified in p. 1138., viz. by the star (*) placed before § 7790., which signifies that an addition to that paragraph will be found in the Supplement given in the present edition after the General Index. (p. 1279.) Where the supplementary matter contains figures, similar references will be made from the Systematic List of Engravings, as in (p. xxxii.), where the star (*) prefixed to Threshing Machines indicates that the Supplement contains a figure or figures of one or more kinds of threshing machines. This improvement in the manner of rendering supplementary information available to a work already in type, and, considered in all its bearings, a very great one it is, can only be effected in consecutive editions of a stereotyped book, in the plates of which stars or other marks can at any time be easily introduced It is calculated to save the reader much trouble that would otherwise be unavoidable in referring to numerous Supplements at random; to prevent any additional information from escaping his attention; and to render it unnecessary on the part of the Proprietors to publish, or on that of the possessors of the work to purchase, a new edition for several years to come.

We have stated above that the essence of most of the improvements contained in this edition, and many of the new engravings, have been given from time to time in the published volumes of the *Gardener's Magazine;* into which they have been introduced in conformity with that object of the work indicated in the titlepage by the expression "Register of Rural and Domestic Improvement." We think it right here to repeat, what we stated in the Prospectus and Introduction to that Periodical (see vol. i.), that though chiefly intended as a perpetual Supplement to the *Encyclopædia of Gardening*, it is also meant to be a perpetual Supplement to the *Encyclopædia of Agriculture* in all matters of vegetable culture, implements, buildings, and territorial improvements, with a view to farm bailiffs and land stewards. Temporary agriculture and statistics, and matters connected with live stock and other things which more immediately interest the commercial farmer, we leave to journals and newspapers wholly agricultural.

In order to show how much we are indebted to contributors for the improvements contained in this second edition, as well as to simplify the duty of thanking them, we have placed their names or signatures in the following alphabetical list; and we beg leave, on the part of the Proprietors and ourselves, to return them sincere thanks. We have earnestly to request that these contributors and all our readers will examine the present work with a scrutinising eye, and send us whatever they think will contribute to its farther improvement. Our ardent wish is, by means of frequent Supplements, to keep it at all times on a pace with the rapidly advancing state of agricultural knowledge and practice; and we are well aware that this can only be done by the extensive cooperation of scientific and practical men.

By referring to the Calendarial Index (p. 1233.), those parts of this work which treat of Farm and Forest Culture and Management may be consulted monthly, as the operations require to be performed; by recurring to the General Index (p. 1248.), any particular subject may be traced alphabetically, through all its ramifications of history, theory, practice, and statistics; and, by turning to the Glossarial Index (p. 1241.), the meaning of all words not familiar to general readers may be found. Thus we have here combined an Agricultural Treatise, embracing every part of the subject, a Husbandman's Calendar, a Dictionary of Rural Affairs, and a Glossary of Agricultural Terms.

J. C. L.

Bayswater, January, 1831.

LIST OF CONTRIBUTORS

TO THE SECOND EDITION OF THE ENCYCLOPÆDIA OF AGRICULTURE.

An Amateur Naturalist, &c.; *Anon.*, Coleshill, Warwickshire; *a Reader of the Gardener's Magazine* from its commencement; *a Subscriber to the Magazine of Natural History*.
Suggestions, corrections and hints.

Anderson, John, 49. Park Street, Grosvenor Square, London, agricultural engineer; formerly an extensive farmer in Northumberland; afterwards draughtsman and manager at E. Weir's agricultural repository, Oxford Street.
Various elaborate drawings of machines, particularly of the bone-mill, and of the very excellent machine for threshing and other purposes erected at Bagshot Park, Berkshire.

B., a retired veterinary surgeon of eminence, author of various works.
The greater part of the article on the horse, p. 949., and the veterinary part of the subsequent articles on agricultural and domestic animals.

Bell, the Rev. *Patrick*, of Mid Lioch, Auchter House, near Dundee, inventor of a greatly improved reaping-machine.
Drawings and an elaborate description of his excellent invention, p. 422.

Booth and Co., distillers, Brentford, Middlesex.
The details of their establishment for fattening cattle, furnished to us on the spot, p. 1025.

Burnes, —, Farm manager to the Duke of Gloucester, at Bagshot Park.
Various hints, and permission to publish plans of his machine, &c.

Cleghorn, James, Accountant, Edinburgh; editor of the latter volumes of the Farmer's Magazine, till that work was discontinued; characterised by the late Professor Coventry to us, in 1822, as the first agricultural writer in Scotland. Author of the article Agriculture in the Supplement to the Encyc. Brit. and of other works.
A general examination of the whole work, with numerous corrections, various suggestions for improvements, and references to works where the requisite information might be obtained.

Cottam and Hallen, agricultural implement manufacturers, chiefly in iron, Winsley Street, Oxford Street.
Corrections, additions, and every assistance in delineating some new implements and machines.

Dickson, W. formerly a farmer near Edinburgh, now of Kidbrook, in Kent.
Various details respecting his farm when inspected by us, in April, 1829.

Dombasle, C. J. A. Mathieu de, director of the agricultural establishment at Roville, near Nancy, in France, and author of various agricultural works.
Various information respecting the agriculture of France, and the inspection of all the details of the establishment at Roville.

Eichthal, M. le Baron *de*, an extensive proprietor in Bavaria, who has resided some time in Britain, and especially in Scotland; studied our agriculture; and introduced it on his Bavarian estates by means of Scotch farmers.
Various information respecting the agriculture and state of property in Bavaria, in London in 1826, and at Munich and Eichthal in 1828.

Forsyth, William, F.H.S. &c., Nottingham Place, London.
Various corrections and additions, more especially to the bibliography, p. 1206.

F. and *W.*, the latter a Scotch farmer of experience both in Fifeshire and Middlesex.
Notes on the agriculture of France and Italy, from a tour made there in 1828.

Gibbs and Co., Messrs., nursery and seedsmen, London.
Lists of hardy fruits suitable for a field orchard in the midland counties of England, p. 667, and information respecting the Serradilla, p. 886.

Gibbs, M. sen., late nurseryman at Inverness; afterwards superintendent of a British colony attempted to be established at Caraccas.
Information respecting the agricultural capabilities of some parts of North and South America.

Gladstone, M., engineer, Chester.
Drawings of several of his late father's inventions; among others, of the bean reaping-machine, p. 427., and water-furrowing plough, p. 397.

Gorrie, Archibald, F.H.S., &c., Annat Gardens, Errol, Perthshire.
Various corrections and additions, as to the wheat-fly and other matters.

Gossier, M. l' Abbé *de*, of Rouen, late president of the Agricultural Society there.
Information respecting the state of agriculture in Normandy.

Graham, James, formerly a farmer in Perthshire; afterwards in Middlesex; and latterly in the neighbourhood of Sydney, in Australia.
Some notices respecting Australia.

Hazzi, M., president of the Agricultural Society of Bavaria, and the father of improved agriculture in that country; author and editor of various works.
Various corrections and additions relative to the agriculture of Bavaria.

Headrick, the Rev. *J.*, author of the Survey of Forfarshire, and of various chemical and agricultural works.
Various additions and corrections to the statistics.

J. C., near Alnwick, Northumberland, a very extensive farmer, and an enlightened political economist.
Various corrections and additions.

J. W. L.
Corrections and additions to the statistical departments, and especially to Worcestershire and Warwickshire.

Laycock, M., Islington.
The details of his dairy establishment, from which we drew up the account, p. 1029.

Lindley, John, F.R.S. L.S. &c., professor of botany in the University of London.
Botanical corrections.

M., an extensive proprietor, who cultivates a part of his own estate in Suffolk.
A general examination of the whole work, and various corrections, suggestions, and additions.

Main, James, A.L.S., &c., editor of the British Farmer's Magazine; author of the Cottage Florist's Directory, and other works.
General corrections and additions.

Masclet, M. le Chevalier *de*, late French consul at Edinburgh, and then a writer in the Farmer's Magazine and other periodicals; now residing in Paris.
Various corrections and additions relative to the agriculture of France and Flanders.

Menteath, C. G., stuart of Closeburn, Dumfriesshire.
An account of his limekilns, waggons, and mode of improving grass lands, p. 626. *et seq.*

Morton and Co., Leith Walk, Edinburgh, agricultural implement manufacturers, chiefly in wood.
Various information respecting agricultural implements, and several drawings of some new ploughs, drill-machines, &c.

Pearson and Co., Messrs., nurserymen, Chilwell, near Nottingham.
Lists of hardy fruits suitable for a field orchard in the northern counties of England, p. 668.

R. M. of Devonshire.
Additions to the dairy department.

Ransome and Co., agricultural implement makers, Ipswich.
Drawings of ploughs and other implements.

Rhodes and Co., Islington.
The details of their dairy establishment, from which we drew up the account, p. 1028.

Ronalds and Sons, Messrs., nurserymen, Brentford.
Lists of hardy fruits suitable for a field orchard in the midland counties of England, p. 668.

Sherriff, Patrick, of Mungo's Wells, near Haddington.
Several important suggestions, and various corrections.

Sinclair, George, F.L.S., H.S., &c. of the firm of

Cormack, Sons, and Sinclair, nursery and seedsmen, Newcross, London.
Various corrections and suggestions.
Snowden and Co., agricultural implement manufacturers, Oxford Street, London.
Drawings of the leaf-gathering machine, and other implements.
Swainson, William, F.R.S., L.S., &c., author of various important works on natural history.
Various corrections and additions; more especially the entire article on insects injurious to agriculture, p. 1112.
Taylor, R. C., F.G.S., &c.
Geological and statistical corrections, and information from North America.
Taylor, Samuel, F.R.S., &c., late editor of the agricultural department of the Country Times newspaper.
Various corrections and additions.
Trail, Dr., of Liverpool.
Geological and chemical corrections.
Tredgold, Thomas, civil engineer, author of various works, who died in 1829.
Some hints as to the subject of the application of steam to agriculture.
T. W. H., agricultural pupil with a farmer near Woo'er in Northumberland.
Information and corrections.
Vilmorin, M., of the firm of Vilmorin and Co., seedsmen, Paris.
Various corrections as to the agriculture of France, and additions to the forage plants and Cereàlia.
W., proprietor of the Metropolitan Dairy establishment, in the Edgeware Road, London.
The details of his dairy establishment, from which we drew up the account, p. 1029.
Weir and Co., Oxford Street, London, agricultural implement manufacturers, chiefly in wood.
Corrections, additions, and every assistance in making drawings and descriptions of a great variety of new implements, machines, and utensils.
Wilkie, J., of Uddistone, near Glasgow, agricultural implement maker, both of wood and iron.
Various drawings and descriptions; especially of his new plough, p. 392., and cultivator, p. 405.

INDICATIONS AND ACCENTUATION OF SYSTEMATIC NAMES.

The systematic names employed in the sciences are for the greater part derived from the Greek or Latin, as being dead, and consequently fixed, languages; and partly also as being languages more or less understood by men of science throughout the world. The Greek language is preferred to the Latin, as being more copious and flexible. In general, family or generic names are composed of two or more Greek words, indicating some quality common to the family or genus; and specific or individual names, of Latin words indicative of some quality in the individual or species. A number of names, however, are formed by giving Greek or Latin terminations to aboriginal names, or by aboriginal words unchanged; not a few names, generic and specific, are given in honour of individuals; and some, more especially specific names, point to countries, towns, or other places connected with the history of the plants.

All systematic names, whether generic or specific, which Greek or Roman authors have applied to the same class of beings as the moderns, and which on this account are called classical names, are indicated by the first letter being put in Italic when the remainder of the word is in Roman, or in Roman when the remainder of the word is in Italic; as, *E*quus, the horse; *P*ìnus, the pine tree; *M*ármor, marble: *or*, E*quus, the horse*; P*ìnus, the pine tree;* M*ármor, marble.*

Names, whether generic or specific, formed from aboriginal words by altering the termination of the aboriginal word, or by adopting the aboriginal word without altering its termination, and names of uncertain derivation, are distinguished by all the letters being in Italic when the preceding and following words are in Roman, and in Roman when the preceding and following words are in Italic; as, *Glàma* (Camèlus *Glàma*), the lama; *Tabàcum* (Nico*tiàna Tabàcum*), tobacco; and *Tùfa* (Ceméntum *Tùfa*), volcanic earth: *or*, Glàma (*Camèlus* Glàma), *the lama;* Tabàcum (*Nico*tiàna Tabàcum), *tobacco; and* Tùfa (*Ceméntum* Tùfa), *volcanic earth.*

Names, generic or specific, commemorative of individuals, are indicated by putting the letters added to the name of the person, or the final letter if none are added, in Italic when the preceding and following words are in Roman, and in Roman when the preceding and following words are in Italic; as, *C*ýgnus Yarrèll*i*, Yarrell's Swan; *L*ýcium Sháw*ii*, Shaw's Lycium, and Olivìnus Wernèr*i*, the Olivine of Werner: *or*, *Cýgnus Yarréll*i, *Yarrell's Swan;* L*ýcium Sháw*ii, *Shaw's Lycium; and Olivìnus Wernèr*i, *the Olivine of Werner.*

RULES FOR PRONOUNCING SYSTEMATIC NAMES.

SYLLABLES.

In classical words *there are as many syllables as there are vowels;* except when *u* with any other vowel follows *g*, *q*, or *s*, and when two vowels unite to form a diphthong. The diphthongs are *æ*, *œ*, *ai*, *ei*, *oi*, *ui*, *au*, *eu*, and *ou*. These seldom coalesce in final syllables. *oo*, *ee*, *ea*, and other combinations which never occur as diphthongs in classical words, follow, in commemorative names, the pronunciation of their primitives, as Tēēd*ia*, Wōōds*ia*.

VOWELS.

In this work the sounds of the accented vowels are indicated by the mark placed over each; the long sound by a grave accent (`), and the short by an acute (´), as Màry, Mártha.

In addition to the primary accent, every word of more than three syllables contains a *secondary accent*, which is regulated by the same rules. The secondary accent must always be at least two syllables before the primary accent, as in *C*hélidònium; for its place the ear is a sufficient guide, and even were it entirely omitted, still, however inharmonious, the pronunciation would not be incorrect.

CONSONANTS.

C and *g* are hard before *a*, *o*, and *u*, as *C*órnus, *G*àlium; soft before *e*, *i*, and *y*, as Cetrària, *C*ìtrus.

T, *s*, and *c*, before *ia*, *ie*, *ii*, *io*, *iu*, and *eu*, when preceded by the accent, change their sounds, *t* and *c* into *sh*, as Blèt*ia*, *V*ìcia; and *s* into *zh*, as Blàs*ia*: but, when the accent is on the first diphthongal vowel, the preceding consonant preserves its sound, as aurantìacum.

Ch, before a vowel, is pronounced like *k*, as *C*helidònium (*kel*), *C*ólchicum (*kolckum*); but in commemorative names it follows their primitives, as Richardsòn*ia*, in which the *ch* is soft.

Cm, *cn*, *ct*, *gm*, *gn*, *mn*, *tm*, *ps*, *pt*, and other incombinable consonants, when they begin a word, are pronounced with the first letter mute, as *Pt*èris (*teris*), *C*nìcus (*nikus*), Gmelìna (*melina*), Gnídia (*nidia*); in the middle of a word they separate as in English, as *L*ap-sàna, *L*ém-na.

Ph, followed by a mute, is not sounded; but, followed by a vowel or a liquid, sounds like *f*, as *P*hlèum (*fleum*).

Sch sounds like *sk*, as Schœ̀nus (*skenus*); in *tl* and *zm* both letters are heard.

S, at the end of a word, has its pure hissing sound, as *D*áctylis; except when preceded by *e*, *r*, or *n*, when it sounds like *z*, as *Ribes* (*ez*).

X, at the beginning of a word, sounds like *z*, as Xánthium; in any other situation it retains its own sound, as *T*áxus, *T*ámarix. (*Gardener's Magazine*, vol. v. p. 232.)

LIST OF BOOKS REFERRED TO,

THE TITLES OF WHICH ARE ABRIDGED IN THE TEXT.

*Of those marked * some further account, or some notice of their authors, will be found in the Agricultural Bibliography, p.* 1206.

ACCOUNT of the Shetland Sheep, by Thos. Johnson, page 1052. Report on the subject of Shetland Wool. Lond. 1790. 8vo. 2*s.*

Advt. by Cormack, Son, and Sinclair, p. 894. A few pages printed and given away by Cormack, Son, and Sinclair, seedsmen, New Cross. Lond. 8vo. 1830.

* Agriculture appliquée, &c. p. 321. See Chaptal.

Agriculture appliquée à Chimie, p. 322. See Chaptal.

Agr. Chim. app. p. 895. See Chaptal.

* Agricultural buildings, p. 741. See Waistell's Agricultural Buildings.

Agr. Rep. of Cheshire, p. 713. See Holland.

Agr. Mem., p. 306. Agricultural Memoirs; or, History of the Dishley System, in answer to Sir John Sebright. Lond. 1812. 8vo.

Agricultural Memoirs, &c., p. 305. See Agr. Mem.

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American Farmer, 1090. New York. 4to.

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Q.

Quarterly Journal of Agric., p. 316. The Quarterly Journal of Agriculture: and the Prize Essays and Transactions of the Highland Society of Scotland. Edin. 1828. In 8vo numbers, quarterly.
Quar. Jour. Science, p. 602. The Quarterly Journal of Science. Edited at the Royal Institution of Great Britain. In 8vo numbers, quarterly. In October, 1830, it was given up, and the Journal of the Royal Institution of Great Britain substituted.
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Scotland	Wheat Firlot	2197·3	1·022	36·005	7·827
	Barley Firlot	3205·5	1·490	52·525	5·369
France	Setier	9519·5	4·427	156·000	1·807
	Hectolitre	6102	2·837	100·000	2·819
	Boisseau Usuel	762·7	0·354	12·500	22·598
Amsterdam	Mudde	6788	3·157	111·256	2·534
Berlin	Scheffel	3180	1·479	52·107	5·409
Bourdeaux	Boisseau	4682	2·177	76·708	3·674
Cadiz	Fanega	3439	1·599	56·351	5·003
Copenhagen	Toende	8488	3·947	139,084	2·026
Constantinople	Killow	2023	0·941	33·148	8·501
Elbing	Scheffel	2965	1·378	48·584	5·805
Florence	Stajo	1486	0·691	24·369	11·577
Frankfort	Malter	6590	3·064	107·984	2·611
Hamburg	Scheffel	6426	2·988	105·296	2.677
Munich	Scheffel	22130	10·290	362·622	0.777
Netherlands	Mudde	6102	2·837	100·000	2·819
Poland	Korzee	3120·8	1·451	51·137	5·513
Russia	Chetwert	12800	5·952	209·740	1·344
Sicily	Salma grossa	21014	9·771	34·433	0·818
	Salma generale	16886	7·851	27·667	1·019
Spain	Fanega	3439	1·599	56·351	5·003
Sweden	Tunna of 32 Kappar	8940	4·157	146·490	1·924
	Kann	159·6	0·0742	2·615	107·816
Vienna	Metzen	3753	1·745	61·496	4·584
Zealand	Sack	4556	2·119	74·660	3·775

FRENCH WEIGHTS AND MEASURES.

What is called a standard in weights and measures is merely an authority; and this in rude ages is founded on custom, or some arbitrary quantity; while, in the progress of improvement, a standard is derived from nature. Among the various natural standards, the two following may be considered the best:—

1. The length of a pendulum that vibrates seconds of mean solar time.
2. The length of an arc or portion of a meridional circle.

From the measurement of a meridional arc in France; the length of the quadrantal arc was computed; and the ten-millionth part of this quadrant is the metre, which is the standard unit for all French measures.

The standard unit for all weights is the gramme, which is the weight of a cubic vessel of water of the greatest condensation and purity; the side of such cube being the hundredth part of the metre.

From these two units the other measures are derived by decimal division or multiplication, and hence this system is generally called.

THE METRICAL OR DECIMAL SYSTEM.

In order to express the decimal proportion, the following vocabulary of names has been adopted, in which the terms for multiplying are Greek, and those for dividing are Latin :—

For multipliers, the word

Deca prefixed means	10 times.
Hecto	100 times.
Kilo	1000 times.
Myria	10,000 times.

On the contrary, for divisors, the

word *Deci* expresses the	10th part.
Centi	100th part.
Milli	1000th part.

Thus, *Decametre* means 10 metres.

Decimetre .... the 10th part of a metre.
Kilogramme .... 1000 grammes, &c.

The *are* is the element of square measure, and is a square decametre, equal to 3·955 English perches.

The *stere* is the element of cube measure, and contains 35.317 cubic feet English.

The *litre* is the element of all measures of capacity. It is a cubic decimetre, and equals 2·1135 English pints. 100 litres make the hectolitre, which equals 26·419 English gallons, or 2·838 Winchester bushels.

The decimal Weights and Measures of France, compared with the Weights and Measures at present considered the National Measures of Britain.

Long Measures.

Decimal System.	British arbitrary System.
Millimetre	0·03937 inches.
Centimetre	0·39371 inches.
Decimetre	3·93710 inches.
Metre	39·37100 inches.
Decametre	32·80916 feet.
Hectometre	328·09167 feet.
Kilometre	1093·6389 yards.
Myriametre	10936·38900 yards, or 6 miles, 1 furlong, 28 poles.

Superficial Measures.

Centiare	1·1960 square yards.
Are (a square decametre)	119·6046 square yards.
Decare	1196·0460 square yards.
Hectare	11660·4604 square yards, or 2 acres, 1 rood, 35 perches.

Measures of Capacity.

Millitre	0·06103 cubic inches.
Centilitre	0·61028 cubic inches.
Decilitre	6·10280 cubic inches.
Litre (a cubic decimetre)	61·02802 cubic inches, or 2·1135 wine pints.
Decalitre	610·28028 cubic inches, or 2·642 wine gallons.

Decimal System.	British arbitrary System.
Hectolitre	3·5317 cubic feet, or 26·419 wine gallons, 22 Imperial gallons, or 2·839 Winchester bushels.
Kilolitre	35·3171 cubic feet, or 1 tun and 12 wine gallons.
Myrialitre	353·17146 cubic feet.

Solid Measures.

Decistere	3·5317 cubic feet.
Stere (a cubic metre)	35·3174 cubic feet.
Decastere	353·1714 cubic feet.

Weights.

Milligramme	0·0154 grains.
Centigramme	0·1543 grains.
Decigramme	1·5434 grains.
Gramme	15·4340 grains.
Decagramme	154·3402 grains, or 5·64 drams avoirdupois.
Hectogramme	3·2154 oz. troy, or 3·527 oz. avoirdupois.
Kilogramme	2 lb. 8 oz. 3 dwt. 2 gr. troy, or 2 lb. 3 oz. 4.428 drams avoirdupois.
Myriagramme	26·795 pounds troy, or 22·0485 avoirdupois
Quintal	1 cwt. 3 qrs. 25 lb. nearly.
Millier, or Bar	9 tons 16 cwt. 3 qrs. 12 lb.

THE FRENCH SYSTÈME USUEL.

The *Système Usuel* has the metrical standards for its basis ; but their divisions are binary ; and instead of the new nomenclature, the names of the ancient weights and measures are used, annexing the term *usuel* to each : thus, the half kilogramme is called the *livre usuelle*, and the double metre, the *toise usuelle*, &c.

This system was legalised by an imperial decree in 1812, for the use of retail traders, and the decimal system was continued for all other kinds of business and measurement : but as the law was left optional, it led to many difficulties, insomuch that in 1816 the *système usuel* was enforced by a royal decree, in which the use of weights or measures decimally divided is absolutely prohibited in shops or any departments of trade connected with retail business, while the decimal system is confirmed for all other purposes.

As the *système usuel* has the metre and gramme for its basis, any of its divisions may be easily computed from the foregoing tables. The following, however, are the contents of its principal units in English measure :—

The *toise usuelle* of 2 metres equals 6 feet $6\frac{3}{4}$ inches English.

The *pied usuel* equals $\frac{1}{6}$ of the toise, and the inch $\frac{1}{12}$ of the foot.

The *aune usuelle* equals 3 feet $11\frac{1}{4}$ inches English, with all its divisions in proportion.

The long measures are also divided into thirds, sixths, and twelfths, which are easily computed from the foregoing dimensions of the toise and aune.

The *boisseau usuel* is $\frac{1}{8}$ of the hectolitre, and equals 0·35474 English bushels, with halves, quarters, &c. in proportion.

The *litron usuel* equals 1·074 Paris pints, with halves, quarters, &c. in proportion.

Apothecaries have adopted the *systeme usuel* in compounding medicines ; which weight, in small quantities, scarcely differs from the poids de marc.

Diamonds are still weighed by carats of 4 grains each ; but these grains differ from the foregoing : thus, 1 carat equals 3.876 grains poids de marc, or 3·798 grains usuels, and also answers to 2·01 decigrammes, or $3\frac{1}{10}$ English grains.

The *livre usuelle* = 500 grammes = 9413·575 grains poids de marc, or 7717 English grains ; and all its divisions and multiples in proportion. Hence the common pound of France equals 1 lb. 11 oz. $10\frac{1}{5}$ drams avoirdupois ; and therefore the *quintal métrique* of 100 kilogrammes answers to 220·486 lb. avoirdupois, or 1 cwt. 3 qrs. $24\frac{1}{2}$ lb., which is 1000 grains less than has been hitherto reckoned, on account of the undue proportion allowed to the French weight. (*Kelly's Cambisl*, vol. i. p. 140)

The Système Usuel of the French, compared with the British System.

Comparison of Weight.

	Troy Weight.					Avoirdupois.		
	Grammes.	lb.	oz.	dwt.	gr.	lb.	oz.	dr.
Kilogramme	1000	2	8	3	2	2	3	$4\frac{1}{2}$
Livre usuelle	500	1	4	1	13	1	1	$10\frac{1}{4}$
Half	250		8	0	18·5		8	$13\frac{1}{8}$
Quarter	125		4	0	9·25		4	$6\frac{1}{2}$
Eighth	62·5		2	0	4·5		2	$3\frac{1}{4}$
Once	31·3		1	0	2·25		1	$1\frac{1}{4}$
Half	15·6			10	1·125			$8\frac{7}{8}$
Quarter	7·8			5	0·5			$4\frac{1}{2}$
Gross	3·9			2	12·25			$2\frac{1}{4}$

Comparison of Linear Measures.

Mesures usuelles.	Metres.	Feet.	Inches.	Parts.
Toise usuelle	2	6	6	9
Pied, or Foot	$0\frac{1}{6}$	1	1	$1\frac{1}{2}$
Inch	$0\frac{1}{72}$	0	1	$1\frac{1}{8}$
Aune	$1\frac{1}{5}$	3	11	3
Half	$0\frac{3}{5}$	1	11	$7\frac{1}{2}$
Quarter	$0\frac{3}{10}$	0	11	$9\frac{3}{4}$
Eighth	$0\frac{3}{20}$	0	5	$10\frac{7}{8}$
Sixteenth	$0\frac{3}{40}$	0	2	$11\frac{7}{16}$
One third of an aune	$0\frac{2}{5}$	1	3	9
Sixth	$0\frac{1}{5}$	0	7	$10\frac{1}{2}$
Twelfth	$0\frac{1}{10}$	0	3	$11\frac{1}{4}$

(Feet, Inches and Parts: English Measures.)

Comparison of Measures of Capacity.

	Litres.	English bushels.
Bolsseau usuel	12·5	0·35474

With halves and quarters in proportion.

	Paris pinte.	English pint.
Litron usuel	1·074	$2\frac{1}{9}$

With halves and quarters in proportion.

ENGLISH WEIGHTS AND MEASURES.

The following Tables show the state of English weights and measures as long established ; but a new law has lately passed, which proposes the following alteration in measures of capacity, that is to say, both in liquid and dry measures, from the 1st of January, 1826. Thus, instead of the three different gallons heretofore used, viz. the wine, ale, and corn gallons, one measure only is to be adopted, called the imperial gallon, with its divisions and multiples, which are to be as heretofore for wine measure. But for corn or other dry goods not heaped, the divisions and multiples are to be as in corn measure.

The imperial gallon is to measure 277·274 cubic inches, and to weigh 10 lb. avoirdupois of water at the temperature of 62 degrees of Fahrenheit's thermometer, the barometer being at thirty inches.

The imperial bushel is to measure and weigh eight times the above, and all the other multiples and divisions of the imperial gallon are to be in proportion.

All new measures in future are to be constructed on the imperial plan ; but the old measures may continue to be used, provided their contents be marked on them, that is, the proportion which they may be found to bear to imperial measure.

The following Table shows the contents of the different Gallons, both in Measure and Weight.

	Cubic Inches.	Avoirdup. Weight. lb.	oz.	dr.	Troy Weight. lb.	oz.	dwt.	gr.
Imperial gallon	277·274	10	0	0	12	1	16	16
Corn gallon	268·8	9	10	$1\frac{3}{4}$	11	9	7	12
Wine gallon	231	8	5	$6\frac{1}{4}$	10	1	9	22
Ale gallon	282	10	2	$11\frac{1}{2}$	12	4	6	8

The above Table will be found useful in comparing different vessels where gauging cannot be relied on.

Rules for converting the Old Measures to the New, and the contrary.

1. *Wine Measure* multiplied by 5 and divided by 6 will give imperial measure, and the contrary.
2. *Corn Measure* multiplied by 31 and divided by 32 will give imperial measure, and the contrary.
3. *Ale Measure* multiplied by 59 and divided by 60 will give imperial measure, and the contrary.

The coal measure is scarcely changed by the new law, and therefore will probably remain unaltered in practice.

Tables of English Weights and Measures, compared with those of France.

TROY WEIGHT.

		French grammes.
	1 grain	0·0648
24 grains	1 pennyweight	1·5552
20 pennyweights	1 ounce	31·1027
12 ounces	1 pound	373·2330

The grain troy is divided into 20 mites, the mite into 24 doits, the doits into 20 periots, and the periot into 24 blanks. These divisions are imaginary; but there are real weights of decimal divisions to the thousandth part of a grain.

APOTHECARIES' WEIGHT.

		Fr. gram.
	1 grain	0·0648
20 grains	1 scruple	1·295
3 scruples	1 dram	3·888
8 drams	1 ounce	31·102
12 ounces	1 pound	373·233

This weight is essentially the same as troy weight, but differently divided. It is chiefly used for medical prescriptions ; but drugs are mostly bought and sold by avoirdupois weight.

AVOIRDUPOIS WEIGHT.

		French gram.
	1 dram	1·771
16 drams	1 ounce	28·346
16 ounces	1 pound	453·544
28 pounds	1 quarter	12·699 kilog.
4 quarters	1 hundred wt.	50·796
20 hundred wt.	1 ton	1015·920

The dram is subdivided into three scruples, and each scruple into ten grains ; the pound or 7680 grains avoirdupois, equals 7000 grains troy, and hence one grain troy equals 1.097 grains avoirdupois.

Hence also	144 lb. avoird.		175 lb. troy.
and	192 oz. ditto		175 oz. do.

The stone is generally 14 lb. avoirdupois, but for butcher's meat or fish it is 8 lb. Hence the hundred equals 8 stone of 14 lb. or 14 stone of 8 lb.

A stone of glass is 5 lb. A seam of glass 24 stone, or 120 lb.

Hay and straw are sold by the load of 36 trusses.

The truss of hay weighs 56 lb. and of straw 36 lb. The truss of new hay is 60 lb. until the 1st of September. The hay is by that time become dry, and the same quantity weighs less.

The custom of allowing more than 16 ounces to the pound of butter is very general in several parts of the country.

Other customary Weights, &c.

CHEESE AND BUTTER.

8 pounds	1 clove.
32 cloves	1 wey in Essex.
42 ditto	1 ditto in Suffolk
56 pounds	1 firkin of butter.

BEEF, MUTTON, &c.

8 pounds	1 stone of beef, mutton, &c.
64 pounds of soap	1 firkin.
30 pounds of anchovies	1 barrel.
112 pounds of gunpowder	1 ditto.
112 pounds of raisins	1 ditto.
120 pounds of prunes	1 puncheon.
$7\frac{1}{2}$ pounds of oil	1 gallon.
8 pounds of vinegar	1 ditto.
36 pounds of straw	1 truss.
60 pounds of new hay	1 ditto.
56 pounds of old hay	1 ditto.
36 trusses of hay or straw	1 load.
7 pounds of salt	1 gallon.
56 pounds or 8 gallons	1 bushel.

WOOL WEIGHT.

Wool, like all other common articles, is weighed by avoirdupois, but the divisions differ : thus,

		Kilogram.
7 pounds	1 clove	3.1748
2 cloves	1 stone	6.3496

		Kilogram.
2 stone	1 tod	12·6992
6½ tods	1 wey	82·543
2 weys	1 sack	165·087
12 sacks	1 last	1981·044

LONG MEASURE.

		Fr. metres.
3 barleycorns	1 inch	0·0254
12 inches	1 foot	0·3048
3 feet	1 yard	0·9144
5½ yards	1 pole or rod	5·0291
40 poles	1 furlong	201·1632
8 furlongs	1 mile	1609·3059
3 miles	1 league	4827·9179
60 geographical, or $69\frac{1}{9}$ English miles	1 degree	11120.7442

Besides the above, there are the palm, which equals 3 inches; the hand, 4 inches; the span, 9 inches; and the fathom, 6 feet.

SQUARE MEASURE.

		Fr. sq. metres.
144 inches	1 square foot	0·0929
9 square feet	1 square yard	0·8361
30¼ square yards	1 square pole	25·2916
40 square poles	1 rood	1011·6662
4 roods	1 acre	4064·6648

The inch is generally divided, on scales, into tenths, or decimal parts; but in squaring the dimensions of artificer's work, the duodecimal system is adopted; — thus, the inch is divided into 12 parts or lines, each part into 12 seconds, and each second into 12 thirds.

In land measure there are (besides the above pole of 16½ feet, which is called statute measure) the woodland pole of 18 feet, the plantation pole of 21 feet, the Cheshire pole of 24 feet, and the Sherwood Forest pole of 25 feet. A rope in some kinds of measurement is reckoned 20 feet, 30 acres is called a yard of land, 100 acres a hide of land, and 640 acres a mile of land.

Land is usually measured by a chain of 4 poles, or 22 yards, which is divided into 100 links. 10 chains in length and 1 in breadth make an acre, which equals 160 square perches, or 4840 square yards.

CUBIC OR SOLID MEASURE.

		Fr. cubic metres.
1728 cubic inches	1 cubic foot	·0283
27 cubic feet	1 cubic yard	·7645
40 ft. of rough timber or 50 ft. hewn ditto	1 load or ton	1·1326 1·4157
42 cubic feet	1 ton of shipping	1·1892

By cubic measure marble, stone, timber, masonry, and all artificers' works of length, breadth, and thickness, are measured, and also the contents of all measures of capacity, both liquid and dry.

DRY MEASURE.

		cub. in.	Fr. litres.
4 gills	1 pint	33.6	0·55053
2 pints	1 quart	67.2	1·10107
2 quarts	1 pottle	134.4	2·20214
2 pottles	1 gallon	268.8	4·40428
2 gallons	1 peck	537.6	8·80856
4 pecks	1 bushel	2150.42	35·23430
4 bushs.	1 coom	4 977 feet	140·93721
2 cooms	1 quarter	9.954 ditto	281·87443
5 qrs.	1 wey or load	49.770 ditto	1409·37216
2 weys	1 last	99.540 ditto	2818·74432

The Winchester bushel, which is the legal measure for corn and seeds, should be 18½ inches wide, and 8 inches deep. Its contents are therefore, as above, 2150·42 inches. Corn and seeds are measured in the port of London by striking the bushel from the brim, with a round piece of light wood, about 2 inches in diameter and of equal thickness from one end to the other. All other dry goods are heaped.

There are two other bushels of different shapes, but containing the same quantity; the one, called the drum bushel, generally used for the London granaries, is 13 inches in diameter, and 16.2 inches in depth; and the other, called the farmer's bushel, is chiefly used in the country, its diameter is 15.375, and depth 11·589 inches. These shapes are chosen for the convenience of working and loading; but the shallow vessel or standard, to avoid the effects of pressure in filling, which depth might cause.

The dimensions of the imperial standard bushel are as follows: — The outer diameter 19½ inches, and the inner diameter 18½. The depth is 8¼, and the height of the cone, for heaped measure, is 6 inches. Hence the contents of the stricken imperial bushel are 2218·192 cubic inches, and it is to weigh 80 lb. avoirdupois of water. The contents of the imperial heaped bushel are 2815·4887 cubic inches. The subdivisions and multiples of this measure are of course in the same proportion.

In some markets corn is sold by weight, which is the fairest mode of dealing, but not the most convenient in practice. Even where measures are used, it is customary to weigh certain quantities or proportions, and to regulate the prices accordingly. The average bushel of wheat is generally reckoned at 60 lb. — of barley 49 lb. — of oats 38 lb. — peas 64, beans 63, clover 68, rye and canary 53, and rape 48 lb. In some places a load of corn, for a man, is reckoned five bushels, and a cart load 40 bushels.

COAL MEASURE.

Coals are generally sold by the chaldron, which bears a certain proportion to Winchester measure.

4 pecks	1 bushel.
3 bushels	1 sack.
3 sacks	1 vat.
4 vats	1 chaldron.
21 chaldron	1 score.

The coal bushel holds one Winchester quart more than the Winchester bushel; it therefore contains 2217·62 cubic inches. This bushel must be 19½ inches wide from outside to outside, and 8 inches deep. In measuring coals, it is to be heaped up in the form of a cone, at the height of at least 6 inches above the brim (according to a regulation passed at Guildhall in 1806). The outside of the bushel must be the extremity of the cone, and thus the bushel should contain at least 2814·9 cubic inches, which is nearly equal to the imperial heaped bushel. Hence the chaldron should measure 58.64 cubic feet.

The chaldron of coals at Newcastle is not a measure, but a weight of 53 cwt., which is found sometimes to equal two London chaldrons; but the common reckoning is, that the keel, which is 8 Newcastle chaldrons, equals 15½ London chaldrons. In such comparisons, however, there can be no certainty, as coals not only differ in their specific gravity, but even those of the same quality weigh more, measure for measure, when large, than when broken into smaller parts. — (*Mortimer's Commercial Dictionary*, art. *Weights and Measures.*)

UNIFORMITY OF WEIGHTS AND MEASURES IN BRITAIN.

The act for this purpose, which came into force in 1826, contains the following clauses which more immediately concern the agriculturist: —

Standard yard defined as the measure of length. — The straight line or distance between the centres of the two points in the gold studs in the straight brass rod, now in the custody of the clerk of the House of Commons, whereon the words and figures "STANDARD YARD, 1760," are engraved, shall be the original and genuine standard of that measure of length or lineal extension called a yard; and the same straight line or distance between the centres of the said two points in the said gold studs in the said brass rod, the brass being of the temperature of sixty-two degrees by Fahrenheit's thermometer, shall be and is hereby denominated the "IMPERIAL STANDARD YARD," and shall be the unit or only standard measure of extension, wherefrom or whereby all other measures of extension whatsoever, whether the same be lineal, superficial, or solid, shall be derived, computed, and ascertained. s. 1.

Standard pound defined weight. — The standard brass weight of *one pound troy weight*, made in the year 1758, now in the custody of the clerk of the House of Commons, shall be declared to be the original and genuine standard measure of weight, and such brass weight shall be denominated the imperial standard troy pound, and shall be the unit or only stardard measure of weight from which all other weights shall be derived, computed, or ascertained. s. 4.

Standard gallon to be the measure of capacity. — The standard measure of capacity, as well for liquids as for dry goods not measured by heaped measure, shall be THE GALLON, containing ten pounds avoirdupois of distilled water weighed in air, at the temperature of sixty-two degrees of Fahrenheit's thermometer, the barometer being at thirty inches; and *a measure shall be forthwith made of brass, of such contents as aforesaid*, under the directions of the commissioners of his majesty's treasury; and such brass measure shall be the imperial standard gallon, and shall be the unit and only standard measure of capacity, from which all other measures of capacity to be used, as well for wine, beer, ale, spirits, and all sorts of liquids, as for dry goods, not measured by heap measure, shall be derived, computed, and ascertained; and all measures shall be taken in parts or multiples or certain proportions of the said imperial standard gallon, and the quart shall be the fourth part of such standard gallon, and the pint shall be one eighth of such standard gallon, and two such gallons shall be a peck, and eight such gallons shall be a bushel, and eight such bushels a quarter of corn or other dry goods not measured by heaped measure. s. 6.

Standard for heaped measure. — The standard measure of capacity for *coals, culm, lime, fish, potatoes, or fruit, and all other goods and things commonly sold by heaped measure*, shall be the aforesaid bushel, containing eighty pounds avoirdupois of water as aforesaid, the same being made round with a plain and even bottom, and being nineteen inches and a half from outside to outside of such standard measure as aforesaid. s. 7.

In making use of such bushel, all coals and other goods and things commonly sold by heaped measure, shall be duly heaped up in such bushel, in the form of a cone, such cone to be of the height of at least six inches, and the outside of the bushel to be the extremity of the base of such cone; and that three bushels shall be a sack, and that twelve such sacks shall be a chaldron. s. 8.

Measure of weight, or heaped measure, to be used for wheat. — Provided always that any contracts, bargains, sales, and dealings, made or had for or with respect to any coals, culm, lime, fish, potatoes, or fruit, and all other goods and things commonly sold by heaped measure, sold, delivered, done, or agreed for, or to be sold, delivered, done, or agreed for by weight or measure, shall and may be either according to the said standard of weight, or the said standard for heaped measure; but all contracts, bargains, sales, and dealings, made or had for any other goods, wares, or merchandise, or other thing done or agreed for, or to be sold, delivered, done, or agreed for by weight or measure, shall be made and had according to the said standard of weight, or to the said gallon, or the parts, multiples, or proportions thereof; and in using the same the measures shall not be heaped, but shall be stricken with a round stick or roller, straight, and of the same diameter from end to end. s. 9.

Weight in Ireland. — But nothing herein shall authorise the selling in Ireland, by measure, of any articles, matters, or things, which by any law in force in Ireland are required to be sold by weight only. s. 10.

Contracts for sale, &c. by weight or measure. — All contracts, bargains, sales, and dealings, which shall be made or had within any part of the United Kingdom, for any work to be done, or for any goods, wares, merchandise, or other thing to be sold, delivered, done, or agreed for by weight or measure, where no special agreement shall be made to the contrary, shall be deemed to be made and had according to the standard weights and measures, ascertained by this act; and in all cases where any special agreement shall be made, with reference to any weight or measure established by local custom, the ratio or proportion which every such local weight or measure shall bear to any of the said standard weights or measures, shall be expressed, declared, and specified in such agreement, or otherwise such agreement shall be null and void. s. 15.

Existing weights and measures may be used, being marked. — And as it is expedient that persons should be allowed to use the several weights and measures which they may have in their possession, although such weights and measures may not be in conformity with the standard weights and measures established by this act; it is therefore enacted, that it shall be lawful for any person or persons to buy and sell goods and merchandise by any weights or measures established either by local custom, or founded on special agreement: provided that in order that the ratio or proportion which all such measures and weights shall bear to the standard weights and measures established by this act, shall be and become a matter of common notoriety, the ratio or proportion which all such customary measures and weights shall bear to the said standard weights and measures shall be painted or marked upon all such customary weights and measures respectively; but nothing herein contained shall extend to permit any maker of weights or measures, or any person or persons whomsoever, to make any weight or measure at any time after the 1st day of May, 1825, except in conformity with the standard weights and measures established under this act. s. 16.

American Weights. — The several European colonies make use of the weights of the states or kingdoms of Europe they belong to. For, as to the aroue of Peru, which weighs twenty-seven pounds, it is evidently no other than the Spanish arroba, with a little difference in the name.

African Weights — As to the weights of Africa, there are few places that have any, except Egypt, and the countries bordering on the Mediterranean, whose weights have been already enumerated among those of the ports of the Levant. The island of Madagascar, indeed, has weights, but none that exceed the drachm, nor are they used for any thing but gold and silver.

The above information is taken from an elaborate quarto volumes of Dr. Kelly, and the very useful Commercial Dictionary of Mortimer. It is impossible to turn over the leaves of such a book as Kelly's, without lamenting the time which every commercial man must lose in acquiring, and in practising, the art of overcoming the obstacles which not only impede the intercourse of nations, but open a fertile source for deception and chicanery. How easy it would be for one nation to become acquainted with another, even if they spoke different languages, provided their weights, measures, monies, and all that was done by figures, were the same! How easy for the three leading powers of the world, France, Britain, and America, to effect this! Naturalists in every part of the world use the same language, and the same names for natural objects, and they accordingly form but one family, every member of which, however remotely situated, holds ready communication with all the others. How easy for the great powers alluded to, by prospective measures, which would occasion no inconvenience to any one, not only to render one description of weights, measures, and monies, universal, but one language! The establishment in one nation after another of *Parochial Institutions*, such as those already existing in Wirtemberg and Bavaria, and obliging some one language to be taught to every one in addition to that which was the native tongue, would have the complete effect in two generations. But legislators, at least in Europe, have hitherto been too much occupied with the concerns of their own day and generation to think of futurity; and the policy has too generally been to devise measures which should isolate nations, and separate their interests, rather than unite them in one common intercourse, commercial and intellectual.

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ENCYCLOPÆDIA

OF

AGRICULTURE.

THE first want of man is food, and his first resource for it the ground. Whether herbs or fruits were resorted to, must have depended on their relative abundance in the country where man found himself; but the latter would probably be preferred, till the use of fire was discovered in the preparation of the former. The first care and labour of man would thus be bestowed on fruit trees, and hence gardening may be said to be the art of earliest invention. But man is also a carnivorous animal, and this propensity of his nature would soon induce him to attempt domesticating such beasts of the earth as he found most useful in affording milk, clothing, or food, or in performing labour. Hence the origin of pasturage, and the management of live stock. The invention of tillage would be coeval with the discovery of the use of the cereal grasses, and may be considered as the last grand step in the invention of husbandry, and the most important, as leading to the establishment of property in territorial surface.

In the earlier stages of civilisation, these branches of economy, in common with all the arts of life, would be practised by every family for itself; but the advantages of separating occupations would soon present themselves, and the result of this principle in regard to rural culture and management, the *res rustica* of the Romans and husbandry of old English authors, is, that all their operations are now classed under the two designations of agriculture and gardening.

Agriculture, the art to which we here confine ourselves, as compared to gardening, is the culture and management of certain plants and animals for the food and service of man; but, relatively to the present improved state of the art, it may be defined, the cultivation and management of territorial surface on an extended scale, by manual and animal labour, for the production of objects and materials used for the food and service of man, and for various important purposes in arts, manufactures, and civilised life.

The importance of agriculture is obvious, not only by its affording the direct supply of our greatest wants, but as the parent of manufactures and commerce. Without agriculture there can be neither civilisation nor population. Hence it is not only the most universal of arts, but that which requires the greatest number of operators: the main body of the population in every country is employed in the pursuit of agriculture; and the most powerful individuals, in almost all nations, derive their wealth and consequence from their property in land.

In the earliest ages of mankind, before tillage was invented, the surface of the earth would be common to all the inhabitants, and every family would pasture its flock, and pitch its tent, or erect its hut, where it thought fit: but when tillage came in use, it became necessary to assign to each family a portion of territory, and of this portion that family became the proprietor and cultivator, and the consumer of the product.

Hence the invention of property in land, and progressively of purchased cultivators, or slaves; of hired cultivators, or labourers; of commercial agriculturists, or farmers; and of the various laws and customs in regard to the proprietorship and occupation of landed property.

The practice of agriculture, however rude in early times or in countries still comparatively uncivilised, assumes a very different character among the most advanced nations. Not to mention the peculiarities of implements, machines, and domestic animals, and the different kinds of culture and management requisite for the different countries and climates of the world, the local variations requisite even in Britain are so considerable, that an agriculturist whose experience and observation had been confined to one district, may be comparatively unfit to exercise his profession in another. The sheep farming of the North Highlands, the dairy farming of Gloucestershire, the hop culture of Kent, the woodlands of Buckinghamshire, and the hay management of Middlesex, have given rise to commercial agriculturists of very distinct varieties from the common corn farmer. The previous preparation of land for culture, by enclosure, drainage, embanking, road-making, &c., demands considerable science; and has given rise to artist agriculturists, known as land-surveyors and land-engineers. The relative changes as to rent and occupancy which take place between land-owners and farmers, and the valuation and transfer of landed property among monied men, have produced land-valuators and land-agents; from the direction of extensive estates, and the management of small concerns and farms, have originated the serving agriculturists, known as land-stewards and bailiffs; and the operators are shepherds, herdsmen, ploughmen, carters, spadesmen, and hands of all work.

The practice of agriculture, from having been chiefly confined to men of humble station, who pursued it as a matter of business or profit, has of late years been engaged in by men of rank, and other opulent or amateur practitioners, as matter of taste and recreation. The contrast between the simple and healthy pursuits of the country, and such as require intense application, and confine men chiefly to towns and cities, gives them a peculiar charm to the industrious and active citizen, while the idle and the opulent find relief in it from the weariness of inaction or a frivolous waste of time. Some magnificent displays of the art have thus been made by great landed proprietors on their demesne or home farms; and very neat and tasteful specimens of culture, by retired citizens and other possessors of villas, farms, and *fermes ornées.* These circumstances may be said to have raised the pursuit of agriculture to a comparatively dignified state, with reference to that in which it was formerly held; while the political advantages which are enjoyed by all classes in a free and commercial country, have improved the circumstances of agriculturists of every grade, and tended to raise them in the scale of society.

The recent discoveries in chemistry and physiology, have led to the most important improvements in the culture of plants, and the breeding and rearing of animals; agriculture is, in consequence, no longer an art of labour, but of science; hence the advantage of scientific knowledge to agriculturists, and the susceptibility, in the art, of progressive advancement. "Agriculture," Marshall observes, "is a subject, which, viewed in all its branches and to their fullest extent, is not only the most important and the most difficult in rural economies, but in the circle of human arts and sciences."

For the purpose of agricultural improvement, societies have been established in every country of Europe, and in almost every county of Britain. Most of these, as well as several eminent individuals, have stimulated cultivators and breeders to exertion, by the offer of premiums, and other honorary rewards. Professorships of rural economy have also been instituted in some colleges; and other independent georgical institutions have been established for public instruction, especially on the Continent: to which we may add, the publication of numerous books on the subject of agriculture and territorial improvement.

Such are the origin, the extent, the importance, and the interest of the subject of agriculture; from which it cannot be surprising that a varied and voluminous mass of knowledge has been accumulated on the subject, and is consequently more or less necessary to every one who would practise the art with success himself, or understand when it is well practised for him by others. To combine as far as practicable the whole of this knowledge, and arrange it in a systematic form, adapted both for study and reference, are the objects of the present work. The sources from which we have selected, are the modern British authors of decided reputation and merit; sometimes we have recurred to ancient and to Continental authors, and occasionally, though rarely, to our own observation and experience: *observation* chiefly in Britain, but partly also on the Continent; and *experience* in Scotland, under the paternal roof, during our early years, — during some years' occupancy of two extensive farms in England, — and, in the engineering and surveying departments, during our practice for upwards of twenty years as a landscape-gardener.

With this purpose in view, Agriculture is here considered, in

Part	Book
I. As to its origin, progress, and present state,	1. Among ancient and modern nations.
	2. Under different geographical, physical, and political circumstances.
II. As a science founded on	1. The study of the vegetable kingdom.
	2. The study of the animal kingdom.
	3. The study of the mineral kingdom and the atmosphere.
	4. The study of the mechanical agents employed in agriculture.
	5. The study of the operations of agriculture.
III. As an art comprehending	1. The valuation, purchase, and transfer of landed property.
	2. The laying out, or general arrangement, of landed property.
	3. The improvement of culturable lands.
	4. The management of landed estates.
	5. The selection, hiring, and stocking of farms.
	6. The culture of farm lands.
	7. The economy of live stock, and the dairy.
IV. Statistically in Britain,	1. As to its present state.
	2. As to its future progress.

A Calendarial Index to those parts of the work which treat of culture and management, points out the operations as they are to be performed, in the order of time and of season : and

A General Index explains the technical terms of agriculture, the abbreviations here made use of, and presents an analysis of the whole work in alphabetical, as the Table of Contents does in systematic, order.

PART I.

AGRICULTURE CONSIDERED AS TO ITS ORIGIN, PROGRESS, AND PRESENT STATE AMONG DIFFERENT NATIONS, GOVERNMENTS, AND CLIMATES.

1. *The history of agriculture* may be considered chronologically, or in connection with that of the different nations who have successively flourished in various parts of the world; politically, as influenced by the different forms of government which have prevailed; geographically, as affected by different climates; and physically, as influenced by the characters of the earth's surface. The first kind of history is useful, by displaying the relative situation of different countries as to agriculture; instructive, as enabling us to contrast our present situation with that of other nations and former times; and curious, as discovering the route by which agriculture has passed from primitive ages and countries to our own. The political and geographical histories of the art, derive their value from pointing out causes favourable and unfavourable to improvement, and countries and climates favourable or unfavourable to particular kinds of cultivation and management.

BOOK I.

HISTORY OF AGRICULTURE AMONG ANCIENT AND MODERN NATIONS.

2. *Traditional history* traces man back to the time of the deluge. After that catastrophe, of which the greater part of the earth's surface bears evidence, man seems to have recovered himself (in our hemisphere at least) in the central parts of Asia, and to have first attained to eminence in arts and government on the alluvial plains of the Nile. Egypt colonised Greece, Carthage, and some other places on the Mediterranean sea; and thus the Greeks received their arts from the Egyptians, afterwards the Romans from the Greeks, and finally the rest of Europe from the Romans. Such is the route by which agriculture is traced to our part of the world: how it may have reached the eastern countries of India and China is less certain; though, from the great antiquity of their inhabitants and governments, it appears highly probable that arts and civilisation were either coeval there, or, if not, that they travelled to the east much more rapidly than they did to the west.

3. *The early history of man in America* rests on very indistinct traditions: there arts and civilisation do not seem of such antiquity as in Asia; in North America they are of very recent introduction; but of the agriculture of either division of that continent, and of India and China, we shall attempt little more than some sketches of the modern history, and its present state.

4. *The history of agriculture, among the nations of what may be called classic antiquity,* is involved in impenetrable obscurity. Very few facts are recorded on the subject previously to the time of the Romans. That enterprising people considerably improved the art, and extended its practice with their conquests. After the fall of their empire, it declined throughout Europe; and, during the dark ages, was chiefly preserved on the estates of the church. With the general revival of arts and letters, which took place during the sixteenth century, agriculture also revived; first in Italy, and then in France and Germany; but it flourished most in Switzerland and Holland; and finally, in recent times, has attained its highest degree of perfection in Britain. The modern agriculture of America is copied from that of Europe; and the same may be said of the agriculture of European colonies established in different parts of the world. The agriculture of China, and the native agriculture of India, seem to have undergone no change for many ages. — Such is the outline which we now proceed to fill up by details, and we shall adopt the usual division of time, into the ages of antiquity, the middle ages, and the modern times.

Chap. I.

Of the History of Agriculture in the Ages of Antiquity; or from the Deluge to the Establishment of the Roman Empire, in the Century preceding the vulgar Æra.

5. *The world, as known to the ancients,* consisted of not more than half of Asia, and of a small part of Africa and Europe. During the inundation of the deluge, a remnant of man, and of other animals, is related to have been saved on the top of the high mountain of Ararat, near the Caspian sea (*fig.* 1.), and, when the waters sub-

1

sided, to have descended and multiplied in the plains of Assyria. As they increased in numbers they are related to have separated, and, after an unknown length of time, to have formed several nations and governments. Of these the principal are those of the Assyrian empire, known as Babylonians, Assyrians, Medes, and Persians, in Asia; of the Jews and the Egyptians, chiefly in Africa; and of the Grecians, chiefly in Europe. Least is known of the nations which composed the Assyrian empire; of the Jews, more is known of their gardening and domestic economy, than of their field culture; the Egyptians may be considered the parent nation of arts and civilisation, and are supposed to have excelled in agriculture; and something is known of that art among the Greeks.

6. *The authors whose writings relate to the period under consideration* are few, and the relations of some of them very contradictory. The earliest is Moses, who flourished B. C. 1600; Herodotus and Diodorus Siculus, who wrote more particularly on the history and geography of Egypt, lived, the former in the fifth, and the latter in the sixth, century B. C.; and Hesiod, the ancient Greek writer on husbandry, in the tenth century preceding our æra.

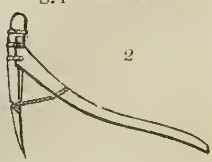
7. *Estimating the value of the writers of antiquity* on these principles, they may be considered as reaching back to a period 1600 years before our æra, or nearly 3500 years from the present time; and it is truly remarkable, that, in the Eastern countries, the state of agriculture and other arts, and even of machinery, at that period, does not appear to have been materially different from what it is in the same countries at the present day.

Property in land was recognised, the same grains cultivated, and the same domestic animals reared or employed: some led a wandering life and dwelt in tents like the Arabs; and others dwelt in towns or cities, and pursued agriculture and commerce like the fixed nations. It is reasonable indeed, and consistent with received opinions, that this should be the case; for, admitting the human race to have been nearly exterminated at the deluge, those who survived that catastrophe would possess the more useful arts, and general habits of life, of the antediluvian world. Noah, accordingly, is styled a husbandman, and is said to have cultivated the vine and to have made wine. In little more than three centuries afterwards, Abraham is stated to have had extensive flocks and herds, slaves of both sexes, silver and gold, and to have purchased a family sepulchre with a portion of territory around it. Isaac his son, during his residence in Palestine, is said to have sown and reaped a hundred fold. Corn seems to have been grown in abundance in Egypt; for Abraham, and afterwards Jacob, had recourse to that country during times of famine. Irrigation was also extensively practised there, for it is said (*Gen.*, xiii. 10.) that the plain of Jordan was watered everywhere, even as the garden of the Lord, like the land of Egypt. Such is the amount of agricultural information contained in the writings of Moses, from which the general conclusion is, that agriculture, in the East, has been practised in all or most of its branches from time immemorial. The traditions of other countries, however, as recorded by various writers, ascribe its invention to certain fabulous personages; as the Egyptians to Osiris; the Greeks to Ceres and Triptolemus; the Latins to Janus; and the Chinese to Chin-hong, successor of Fo-hi.

Sect. I. *Of the Agriculture of Egypt.*

8. *The origin of agriculture* has been sought by modern philosophers in natural circumstances. Man in his rudest state, they consider, would first live on fruits or roots, afterwards by hunting or fishing, next by the pasturage of animals, and lastly, to all of these he would add the raising of corn. Tillage, or the culture of the soil for this purpose, is supposed to have been first practised in imitation of the effects produced by the sand and mud left by the inundations of rivers. These take place more or less in every country, and their effects on the herbage which spontaneously springs up among the deposited sand and mud must at a very early period have excited the attention of the countryman. This hypothesis seems supported by the traditions and natural circumstances of Egypt, a country overflowed by a river, civilised from time immemorial, and so abundant in corn as to be called the granary of the adjoining states. Sir Isaac Newton and Stillingfleet, accordingly, considered that corn was first cultivated on the banks of the Nile. Sir Isaac fixes on Lower Egypt; but, as Herodotus and other ancient Greek writers assert that that country was once a marsh, and as Major Rennel in his work on the geography of Herodotus is of the same opinion, Stillingfleet (*Works*, vol. ii. 524.) considers it more probable that the cultivation of land was invented in Upper Egypt, and proceeded downwards according to the course of the Nile.

9. *The situation and natural phenomena of Upper Egypt*, Stillingfleet considers, rendered it fitter for *the invention of cultivation* than the low country; "for, while Lower Egypt was a marsh, formed by the depositions of the Nile, the principal part of Upper Egypt was a valley a few leagues broad, bounded by mountains, and on both sides declining to the river. Hence it was overflowed only for a certain time and season; the waters rapidly declined, and the ground, enriched by the mud, was soon dry, and in a state fit to receive seed. The process of cultivation in this country was also most obvious and natural; for the ground being every year covered with mud brought by the Nile, and plants springing up spontaneously after its recess, must have given the hint, that nothing more was necessary than to scatter the seeds, and they would vegetate. Secondly, the ground was prepared by nature for receiving the seed, and required only stirring sufficient to cover it. From this phenomenon the surrounding nations learned two things: first, that the ground before sowing should be prepared, and cleared from plants; and secondly, that the mixture of rich mould and sand would produce fertility. What is here stated may appear without foundation as to Upper Egypt; because at present, in the vicinity of Thebes, water is raised by art. But this objection is obviated by the testimony of Dr. Pococke, who is of opinion that formerly Upper Egypt was overflowed, in the same manner as Lower Egypt was afterwards, and is to this day." (*Stillingfleet's Life and Works*, ii. 524.)



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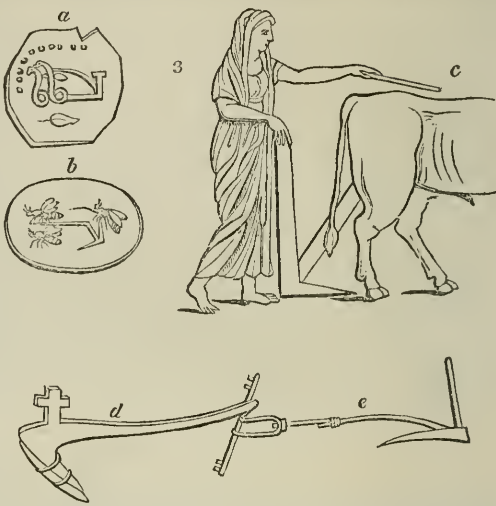
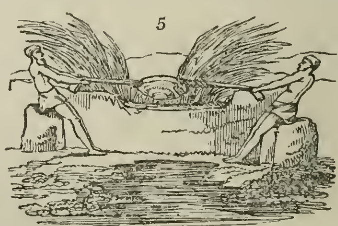
10. *The invention of agricultural implements* must have been coeval with the invention of aration; and, accordingly, they are supposed to have originated in Egypt. Antiquarians are agreed, that the primeval implement used in cultivating the soil, must have been of the pick kind. (*fig.* 2.) A medal of the greatest antiquity, dug up at Syracuse, contained an impression of such an instrument (*Encyc. of Gard.*, fig. 77.): and its pro-

gress till it became a plough has been recognised in a cameo, published by Menestrier, on which a pick-like plough is drawn by two serpents (*fig.* 3. *a*): it may be also seen on a medal from the village of Enna, in Sicily, published by Combe (*b*); in a figure given by Spon, as found on an antique tomb (*c*); in an Etruscan plough, copied from a fragment in the Roman college at Rome, by Lasteyrie (*d*); and as we still see in the instrument depicted by Niebuhr, as used for ploughing in Egypt and Arabia at the present day (*e*). What seems to confirm these conjectures is, that the image of Osiris is sculptured with a similar plough in each hand (*fig.* 4. *a b c d*), and with a harrow (*e*) suspended by a cord (*f*) over the left shoulder. This plough there can be little doubt was used in war as well as in agriculture, and seems to have been of that kind with which the Israelites fought against their enemies the Philistines (1 *Sam.*, xiii. 19. 23.): it is thought, by some, to be the archetype of the letter alpha (the hieralpha of Kircher); and, by others, the sounds necessary to conduct the processes of culture are thought to have founded the origin of language. Thus it is that agriculture is considered by some antiquarians, as not only the parent of all other arts, but also of language and literature.



11. *Whether the culture of corn were invented in Egypt or not*, all testimonies concur that cultivation was carried to a higher degree of perfection there than in any other country of antiquity. The canals and banks which still remain in Lower Egypt, and especially in the Delta, are evidences of the extent to which embanking, irrigation, and drainage have been carried. These works are said to have been greatly increased by Sesostris, in the 17th or 18th century B. C. Many of the canals and drains have been long obliterated; but there are still reckoned eighty canals, like rivers, all excavated by manual labour, several of which are twenty, thirty, and forty leagues in length. These receive the inundations of the Nile, and circulate the waters through the country, which before was wholly overflown by them. The large lakes of Mœris, Behire, and Mareotis, formed vast reservoirs for containing the superfluous waters, from which they were conducted by the canals over the adjacent plains. Upon the elevated ridges, and even on the sides of the hills which form the boundary to the flat alluvial grounds, the water was raised by wheels turned by oxen; and by a succession of wheels, and gradations of aqueducts, it is said, some hills, and even mountains, were watered to their summits. All the towns at some distance from the Nile were surrounded with reservoirs for the supply of the inhabitants, and for watering the gardens. For this last purpose the water was raised in a very simple manner, by a man walking on a plank with raised edges, or on a bamboo or other tube, which, it is observed in Calmet's Bible, is the machine alluded to by Moses, when he speaks of sowing the seed and watering it "with the foot." (*Deut.*, xi. 10.) They also raised water by swinging it up in baskets (*fig.* 5.); a mode which, like the others, remains in use at the present day. The water is lifted in a basket lined with leather. "Two men, holding the basket between them, by a cord in each end fastened to the edge



of it, lower it into the Nile, and then swing it between them, till it acquires a velocity sufficient to enable them to throw the water over a bank into a canal. They work stark naked, or, if in summer, only with a slight blue cotton shirt or belt." (*Clarke's Travels.*)

12. *Of these immense embankments,* some of which served to keep in the river, and others to oppose the torrents of sand which occasionally were blown from the Great Desert, and which threatened to cover the country as effectually as the waters of the Nile, the ruins still remain. But, in spite of these remains, the sand is accumulating, and the limits of cultivated Egypt have been annually decreasing for the last 1200 years; the barbarous nations, to which the banks of the Nile have been subject during this period, having paid no attention to cultivation, or to the preservation of these noble works of antiquity.

13. *Landed property,* in ancient Egypt, it would appear, was the absolute right of the owners, till by the procurement of Joseph, in the eighteenth century B.C., the paramount or allodial property of the whole was transferred to the government. The king, however, made no other use of that right, than to place the former occupiers in the situation of tenants *in capite;* bound to pay a rent or land-tax of one fifth of the produce. This, Moses says, continued to be the law of Egypt down to his time; and the same thing is confirmed by the testimony of Herodotus and Strabo.

14. *The soil of Egypt* is compared by Pliny to that of the Leontines, formerly regarded as the most fertile in Sicily. There, he says, corn yields a hundred for one; but Cicero, as Gouguet observes, has proved this to be an exaggeration, and that the ordinary increase in that part of Sicily is eight for one. Granger (*Relat. du Voy. fait. en Egypte,* 1730.), who paid much attention to this subject, says that the lands nearest to the Nile, which during the inundation were covered with water forty days, did not, in the most favourable seasons, yield more than ten for one; and that those lands which the water covered only five days, seldom gave more than four for one. This, however, is probably owing to their present neglected state.

15. *Of the animal or vegetable products of Egyptian agriculture* very little is known. The ox seems to have been the chief animal of labour from the earliest period; and rice at all times the principal grain in cultivation. By a painting discovered in the ancient Elethia (*fig.* 6.), it would appear that the operation of reaping was performed much in the same way as at present, the ears being cropped by a hook, and the principal part of the straw left as stubble. Herodotus mentions that, in his time, wheat was not cultivated, and that the bread made from it was despised, and reckoned not fit to be eaten; beans were also held in abhorrence by the ancient inhabitants: but it is highly probable, that in latter times, when they began to have commerce with other nations, they laid aside these and other prejudices, and cultivated what they found best suited to the foreign market.

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16. *Agriculture was, no doubt, the chief occupation of the Egyptians:* and though they are said to have held the profession of shepherd in abhorrence, yet it appears that Pharaoh not only had considerable flocks and herds in his own possession, but was desirous of introducing any improvement which might be made in their management; for when Jacob, in answer to his questions, told him that he and his family had been brought up to the care of live stock from their youth, he expressed a wish to Joseph to have a Jewish bailiff for the superintendence of his grazing farm: "If thou knowest any men of activity among them, then make them rulers over my cattle." (*Gen.,* xlvii. 6.)

Sect. II. *Of the Agriculture of the Jews, and other Nations of Antiquity.*

17. *Of the agriculture of the nations contemporary with the Egyptians and Greeks* nothing is distinctly known; but, assuming it as most probable that agriculture was first brought into notice in Egypt, it may be concluded that most other countries, as well as Greece, would begin by imitating the practices of that country.

18. *On the agriculture of the Jews,* we find there are various incidental remarks in the books of the Old Testament. On the conquest of Canaan, it appears that the different tribes had their territory assigned them by lot; that it was equally divided among the heads of families, and by them and their posterity held by absolute right and impartial succession. Thus every family had originally the same extent of territory; but, as it became customary afterwards to borrow money on its security, and as some families became indolent and were obliged to sell, and others extinct by death without issue, landed estates soon varied in point of extent. In the time of Nehemiah a famine occurred, on which account many had "mortgaged their lands, their vineyards, and houses, that they might buy corn for their sons and daughters; and to enable them to pay the king's tribute." (*Nehem.,* v. 2.) Some were unable to redeem their lands otherwise than by selling their children as slaves, and thereby "bringing the sons and daugh-

ters of God into bondage." Boaz came into three estates by inheritance, and also a wife, after much curious ceremony. (*Ruth*, iv. 8—12.) Large estates, however, were not approved of. Isaiah pronounces a curse on those "that join house to house, that lay field to field, till there be no place, that they may be placed alone in the midst." While some portions of land near the towns were enclosed, the greater part was in common, or in alternate proprietorship and occupation, as in our common fields. This appears both from the laws and regulations laid down by Moses as to herds and flocks; and from the beautiful rural story of Ruth, who, to procure sustenance for herself and her widowed mother-in-law Naomi, "came and gleaned in the field after the reapers, and her hap was to light on a *part of the field* [that is, of the common field] belonging unto Boaz." (*Ruth*, ii. 3.)

19. *It would appear that every proprietor cultivated his own lands*, however extensive; and that agriculture was held in high esteem even by their princes. The crown-lands in King David's time, were managed by seven officers: one was over the storehouses, one over the work of the field and tillage of the ground, one over the vineyards and wine-cellars, one over the olive and oil-stores and sycamore (*Fìcus Sycómorus Linn.*) plantations, one over the herds, one over the camels and asses, and one over the flocks. (1 *Chron.*, xxvii. 25.) King Uzziah "built towers in the desert, and digged many wells; for he had much cattle both in the low country and in the plains; husbandmen also and vine-dressers in the mountains, and in Carmel, for he loved husbandry." (2 *Chron.*, xxvi. 10.) Even private individuals cultivated to a great extent, and attended to the practical part of the business themselves. Elijah found Elisha in the field, with twelve yoke of oxen before him, and himself with the twelfth. Job had five hundred yoke of oxen, and five hundred she-asses, seven thousand sheep, and three thousand camels. Both asses and oxen were used in ploughing; for Moses forbade the Jews to yoke an ass with an ox, their step or progress being different, and of course their labours unequal.

20. *Among the operations of agriculture* are mentioned watering by machinery, ploughing, digging, reaping, threshing, &c. "Doth the ploughman ploughe all day to sow? doth he open and break the clods of his ground? When he hath made plain the face thereof, doth he not cast abroad the fitches, and scatter the cummin [*Cumìnum Cymìnum Linn.*], and cast in the principal wheat, and the appointed barley, and the rye, in their place?" (*Isaiah*, xxviii. 24, 25.) The plough was probably a clumsy instrument, requiring the most vigilant attention from the ploughman; for Luke (ch. ix. 62.) uses the figure of a man at the plough looking back, as one of utter worthlessness. Covered threshing-floors were in use; and, as appears from the case of Boaz and Ruth, it was no uncommon thing to sleep in them during the harvest. Corn was threshed in different ways. "The fitches," says Isaiah, "are not threshed with a threshing instrument, neither is a cart-wheel turned about upon the cummin; but the fitches are beaten out with a staff, and the cummin with a rod [flail]. Bread corn is bruised, because he will not ever be threshing it, nor break it with the wheel of his cart, nor bruise it with his horsemen." (Ch. xxviii. 27, 28.) The bread corn here mentioned was probably the *far* of the Romans (maize, *Zèa Mays* L.), which was commonly separated by hand-mills, or hand-picking, or beating, as is still the case in Italy and other countries where this corn is grown. Corn was "winnowed with the shovel and with the fan." (*Id.*, xxx. 24.) Sieves were also in use, for Amos says, "I will sift the house of Israel, as corn is sifted in a sieve" (Ch. ix. 9.); and Christ is represented by St. Luke as saying, "Simon, Simon, Satan hath desired to have you, that he may sift you as wheat." Isaiah mentions (vii. 25.) the "*digging of hills with the mattock*:" to which implement the original pick (*fig.* 2.) would gradually arrive, first, by having the head put on at right angles, and pointed (*fig.* 7. *a*); next, by having it flattened, sharpened, and shod with iron (*b c*); and lastly, by forming the head entirely of metal, and forked (*d*), such probably as we see it in use in Judea, and the land of Canaan, at the present day.

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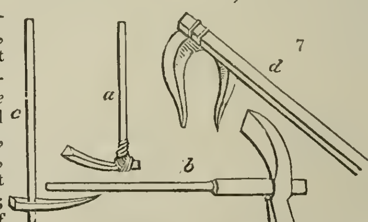

21. *Vineyards* were planted on rising grounds, fenced round, the soil well prepared, and a vintage-house and watch-tower built in a central situation (*Isaiah*, v. 2.), as is still done in European Turkey and Italy. Moses gives directions to the Jews for cultivating the vine and other fruit trees; the three first years after planting, the fruit is not to be eaten; the fourth it is to be given to the Lord; and it is not till the fifth year that they are "to eat of the fruit thereof." (*Levit.*, xix. 25.) The intention of these precepts was, to prevent the trees from being exhausted by bearing, before they had acquired sufficient strength and establishment in the soil.

22. *Of other agricultural operations and customs*, it may be observed with Dr. Brown,

(*Antiq. of the Jews*, vol. ii. part xii. sect. 5, 6.) that they differed very little from the existing practices in the same countries, as described by modern travellers.

23. *The agricultural produce of the Jews* was the same as among the Egyptians; corn, wine, oil, fruits, milk, honey, sheep, and cattle, but not swine. The camel then, as now, was the beast of burden and long journeys (*fig.* 8.); and the horse, the animal of war and

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luxury. The fruit of the sycamore-fig was abundant, and in general use; and grapes attained an astonishing size, both of berry and bunch; the melon and gourd tribes were common. The returns of corn were in general good; but as neither public stores, nor corn monopolisers, seem to have existed, dearths, and their attendant miseries, happened occasionally. A number of these are mentioned in Scripture, and some of extraordinary severity.

Sect. III. *Of the Agriculture of the Greeks.*

24. *The Aboriginal Greeks, or Pelasgi,* were civilised by colonies from Egypt, and received from that country their agriculture, in common with other arts and customs. Some of the ancient Greeks pretend that the culture of corn was taught them by Ceres; but Herodotus, and most of the ancients, concur in considering this divinity as the same with the Egyptian Isis. There is no particular evidence that the Greeks were much attached to, or greatly improved, agriculture; though Homer gives us a picture of old King Laertes, divested of wealth, power, and grandeur, and living happy on a little farm, the fields of which were well cultivated. (*Odyssey*, lib. xxiv.) On another occasion, he represents a king standing amongst the reapers, and giving them directions by pointing with his sceptre. (*Ibid.*, v. 550.) Xenophon highly commends the art; but the practical instances he refers to, as examples, are of Persian kings.

25. *What we know of the agriculture of Greece* is chiefly derived from the poem of Hesiod, entitled *Works and Days*. Some incidental remarks on the subject may be found in the writings of Herodotus, Xenophon, Theophrastus, and others. Varro, a Roman, writing in the century preceding the commencement of our æra, informs us, that there were more than fifty authors, who might at that time be consulted on the subject of agriculture, all of whom were ancient Greeks, except Mago the Carthaginian. Among them he includes Democritus, Xenophon, Aristotle, Theophrastus, and Hesiod. The works of the other writers he enumerates have been lost; and indeed all that remain of Democritus are only a few extracts preserved in the *Geoponika*, an agricultural treatise published at Constantinople by the Greeks of the fourth or fifth centuries of our æra. Xenophon, Aristotle, Homer, and others, touch on our subject but very slightly. Xenophon, after his banishment to Scillus, is said to have spent his time in literary pursuits, and in improving and decorating his estate; he wrote a treatise expressly on rural and domestic affairs, the third book of which is devoted to agriculture, entitled *Œconomics*, in the form of a dialogue, and he is even said to have given lessons on the subject. Of his treatise, Harte (*Essays*, p. 201.) says, "I take it to be one of the plainest and most sensible performances amongst the writings of the ancients." Theophrastus, a disciple of Aristotle, wrote on natural history, and his history of plants possesses an astonishing degree of merit, for the age in which it was written. He is justly considered the father of botany, and his work contains some curious observations on soils and manures, and on various parts of agriculture and gardening.

26. *But the writings of Hesiod are the chief resource for details as to Grecian agriculture.* This author flourished in the tenth century B. C., and was therefore contemporary with Homer. He lived at Askra, a village at the foot of Mount Helicon, in Bœotia. There he kept a flock, and cultivated a soil which he describes as "bad in winter, hard in summer, and never good," probably a stiff clay. As a poet who had written on various subjects, Hesiod was held in great veneration; and Aristotle states, that when the Thesprotians destroyed the village of Askra, and the Orchomenians received the fugitives who escaped, the oracle ordered them to send for the remains of the poet who had given celebrity to the place.

27. *The Works*, which constitute the first parts of his *Poem*, are not merely details of agricultural labours, but comprise directions for the whole business of family economy in the country. The poem sets out by describing the state of the world, past and present, for the purpose of exemplifying the condition of human nature. This condition entails on man the necessity of exertion to preserve the goods of life, and leaves him no alternative but honest industry or unjust violence; of which the good and evil

consequences are respectively illustrated. Dissension and emulation are represented as two principles actively at work; much is said of the corruption of judges, and the evils of litigation; contentment is apostrophised as the true secret of happiness; virtue and industry strongly recommended. The poet now proceeds to describe the prognostics of the seasons of agricultural labour, and gives directions for providing a house, wife, slaves, and two steers; how and when to cut down timber; to construct carts and ploughs, and make clothes and shoes; when to sow, reap, dress the vine, and make wine. He then treats of navigation, and gives cautions against risking every thing in one voyage: he describes the fit seasons for the coasting trade, and advises taking great care of the vessel at such time as she is not in use, and hanging up the rudder and other tackle in the smoke of the chimney. He concludes the Works with some desultory precepts of religion, personal propriety, and decorum; and enjoins some curious superstitious observances relative to family matters. The *Days* contain a division of the lunar month into holy, auspicious, and inauspicious, mixed and intermediary days, the latter being such as are entitled to no particular observance.

28. *Property in land,* among the Greeks, seems to have been absolute in the owner, or what we would term freehold. The manner of inheritance seems to have been that of gavelkind; the sons dividing the patrimony in equal portions. One of Solon's laws forbade that men should purchase as much land as they desired. An estate containing water, either in springs or otherwise, was highly valued, especially in Attica: and there a law existed relating to the depth of wells; the distance they were to be dug from other men's grounds; what was to be done when no water was found; and other matters to prevent contentions as to water. Lands were enclosed, probably with a ring-fence, or boundary-mark; or, most likely, the enclosed lands were such as surrounded the villages, and were in constant cultivation; the great breadth of country being, it may be presumed, in common pasture. Solon decrees, that "he who digs a ditch, or makes a trench, nigh another's land, shall leave so much distance from his neighbour, as the ditch or trench is deep. If any one makes a hedge near his neighbour's ground, let him not pass his neighbour's landmark: if he builds a wall, he is to leave one foot between him and his neighbour; if a house, two feet. A man building a house in his field, must place it a bowshot from his neighbour's." (*Potter's Antiq.*)

29. *The surface of Greece* was, and is, irregular and hilly, with rich vales, and some rocky places and mountains: the soil is various; clayey in some places, but most generally light and sandy, on a calcareous subsoil.

30. *The operations of culture,* as appears by Hesiod, required to be adapted to the season: summer fallows were in use, and the ground received three ploughings, one in autumn, another in spring, and a third immediately before sowing the seed. Manures were applied: in Homer, an old king is found manuring his fields with his own hands; and the invention of manures is ascribed by Pliny to the Grecian king Augeas. Theophrastus enumerates six different species of manures; and adds, that a mixture of soils produces the same effects as manure. Clay, he says, should be mixed with sand, and sand with clay. The seed was sown by hand, and covered with a rake. Corn was reaped with a sickle; bound in sheaves; carted to a well-prepared threshing-floor, in an airy situation, where it might be threshed and fanned by the wind, as is still practised in modern Greece, Italy, and other countries of the Continent. Afterwards it was laid up in bins, chests, or granaries, and taken out as wanted by the family, to be pounded in mortars or quern-mills, into meal. Thorns and other plants for hedges were procured from the woods, as we find from a passage in Homer, in which he represents Ulysses as finding Laertes digging and preparing to plant a row of quicksets. (*Odyss.*, lib. xxiv.)

31. *The implements* enumerated by Hesiod are, a plough, of which he recommends two to be provided in case of accident; and a cart ten spans (seven feet six inches) in width, with two low wheels. The plough consisted of three parts; the share-beam, the draught-pole, and the plough-tail. The share-beam is to be made of oak, and the other parts of elm or bay: they are to be joined firmly with nails. Antiquarians are not agreed as to the exact form of this implement. Gouguet conjectures it may not have been unlike one still in use in the same countries, and in the south of France; others, with greater probability, refer to the more simple plough still in use in Magna Græcia and Sicily (*fig.* 9.), originally Greek colonies. The rake, sickle, and ox-goad are mentioned; but nothing said of their construction, or of spades or other manual implements.

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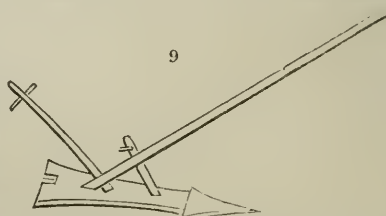

32. *The beasts of labour* mentioned are oxen and mules: the former were more common; and it would appear, from a passage in Homer (*Il.*, lib. xiii. v. 704.), were yoked by the

horns. Oxen of four years and a half old are recommended to be purchased, as most serviceable. In winter, both oxen and mules were fed under cover, on hay and straw, mast, and the leaves of vines and various trees.

33. *The most desirable age for a ploughman* is forty. He must be well fed, go naked in summer, rise and go to work very early, and have a sort of annual feast, proper rest, good food, and clothing consisting of coats of kid skins, worsted socks, and half boots of ox hides in winter. He must not let his eye wander about while at the plough, but cut a straight furrow; nor be absent in mind when sowing the seed, lest he sow the same furrow twice. The vine is to be pruned and stalked in due season; the vintage made in fine weather, and the grapes left a few days to dry, and then carried to the press.

34. *The products of Grecian agriculture* were, the grains and legumes at present in cultivation, with the vine, fig, olive, apple, date, and other fruits: the live stock consisted of sheep, goats, swine, cattle, mules, asses, and horses. It does not appear that artificial grasses or herbage plants were in use; but recourse was had, in times of scarcity, to the mistletoe and the cytisus: what plant is meant by the latter designation is not agreed on; some consider it the Medicàgo arbòrea *L.*, and others the common lucerne. Hay was, in all probability, obtained from the meadows and pastures, which were used in common; flax, and probably hemp, were grown. Wood for fuel, and timber for construction, were obtained from the natural forests, which, in Solon's time, abounded with wolves. Nothing is said of the olive or fig by Hesiod; but they were cultivated in the fields for oil and food, as well as the vine for wine. One of Solon's laws directs that olive and fig trees must be planted nine feet from a neighbour's ground, on account of their spreading roots; other trees might be planted within five feet.

35. *In Hesiod's time almost every citizen was a husbandman,* and had a portion of land which he cultivated himself, with the aid of his family, and perhaps of one or two slaves; and the produce, whether for food or clothing, appears to have been manufactured at home. The progress of society would, no doubt, introduce the usual division of labour and of arts; and commercial cultivators, or such as raised produce for the purpose of exchange, would in consequence arise; but when this state of things occurred, and to what extent it was carried at the time Greece became a Roman province (B. C. 100), the ancient writers afford us no means of ascertaining.

Sect. IV. *Of the Agriculture of the Persians, Carthaginians, and other Nations of Antiquity.*

36. *Of the agriculture of the other civilised and stationary nations* of this period, scarcely any thing is known. According to Herodotus, the soil of *Babylon* was rich, well cultivated, and yielded two or three hundred for one. Xenophon, in his book of *Œconomics,* bestows due encomiums on a Persian king, who examined, with his own eyes, the state of agriculture throughout his dominions; and in all such excursions, as occasion required, bountifully rewarded the industrious, and severely discountenanced the slothful. In another place he observes, that when Cyrus distributed premiums with his own hand to diligent cultivators, it was his custom to say, "My friends, I have a like title with yourselves to the same honours and remuneration from the public; I give you no more than I have deserved in my own person; having made the selfsame attempts with equal diligence and success." (*Œconom.*, c. iv. sect. 16.) The same author elsewhere remarks, that a truly great prince ought to hold the arts of war and agriculture in the highest esteem; for by such means he will be enabled to cultivate his territories effectually, and protect them when cultivated. (*Harte's Essays*, p. 19.)

37. *Phœnicia,* a country of Asia, at the east of the Mediterranean, has the reputation of having been cultivated at an early period, and of having colonised and introduced agriculture at Carthage, Marseilles, and other places. The Phœnicians are said to have been the original occupiers of the adjoining country of Canaan; and when driven out by the Jews, to have settled in Tyre and Sidon (now Sur and Saida), in the fifteenth century B. C. They were naturally industrious; and their manufactures acquired such a superiority over those of other nations, that, among the ancients, whatever was elegant, great, or pleasing, either in apparel or domestic utensils, was called Sidonian; but of their agriculture it can only be conjectured that it was Egyptian, as far as local circumstances would permit.

38. *The republic of Carthage* included Spain, Sicily, and Sardinia, and flourished for upwards of seven centuries previous to the second century B. C. Agriculture was practised at an early period in Sicily; and, according to some, Greece received that art from this island. It must have been also considerably advanced in Spain, and in the Carthaginian territory, since they had books on the subject. In 147 B. C., when Carthage was destroyed by Scipio, and the contents of the libraries were given in presents to the princes, allies of the Romans, the senate only reserved the twenty-eight books on agriculture of the Carthaginian general Magon, which Decius Syllanus was directed to translate, and of which the Romans preserved, for a long time, the original and the translation. (*Encyc. Méthodique*, art. *Agriculture.*)

39. *Italy, and a part of the south of France*, would probably be partially cultivated, from the influence of the Carthaginians in Sicily and Marseilles; but the north of France, and the rest of Europe, appear to have been chiefly, if not entirely, in a wild state, and the scene of the pastoral and hunting employments of the nomadic nations, the Kelts or Celts, the Goths, and the Slaves.

40. *The Indian and Chinese nations* appear to be of equal antiquity with the Egyptians. Joseph de Guignes, an eminent French Oriental scholar, who died in the first year of the present century, has written a memoir (in 1759, 12mo), to prove that the Chinese were a colony from Egypt; and M. de Guignes, a French resident in China, who published at Paris a Chinese dictionary in 1813, is of the same opinion. The histories of the Oriental nations, however, are not yet sufficiently developed from the original sources, to enable us to avail ourselves of the information they may contain, as to the agriculture of so remote a period as that now under consideration.

41. With respect to *the American* nations, during this period, there are no facts on record to prove either their existence or their civilisation, though Bishop Huet and the Abbé Clavigero think that they also are descendants of Noah, who, while in a nomadic state, arrived in the western world, through the northern parts of the eastern continent.

Chap. II.

History of Agriculture among the Romans, or from the Second Century B. C. to the Fifth Century of our Æra.

42. We have now arrived at a period of our history where *certainty supplies the place of conjecture*, and which may be considered as not only entertaining but instructive. The attention of the Romans to agriculture is well known. The greatest men amongst them applied themselves to the study and practice of it, not only in the first ages of the state, but after they had carried their arms into every country of Europe, and into many countries of Asia and Africa. Some of their most learned men and one of their greatest poets wrote on it; and all were attached to the things of the country. Varro, speaking of the farms of C. Tremellius Scrofa, says, "they are to many, on account of their culture, a more agreeable spectacle than the royally ornamented edifices of others." (*Var. de R. R.*, lib. i. cap. 2.) In ancient times, Pliny observes, the lands were cultivated by the hands even of generals, and the earth delighted to be ploughed with a share adorned with laurels, and by a ploughman who had been honoured with a triumph. (*Nat. Hist.*, lib. xviii. c. 3.) The Romans spread their arts with their conquests; and their agriculture became that of all Europe at an early period of our æra.

43. *The sources from which we have drawn our information* being first related, we shall review, in succession, the proprietorship, occupancy, soil, culture, and produce of Roman agriculture.

Sect. I. *Of the Roman Agricultural Writers.*

44. *The Roman authors* on agriculture, whose works have reached the present age, are Cato, Varro, Virgil, Columella, Pliny, and Palladius; there were many more, whose writings are lost. The compilation of Constantine Poligonat, or, as others consider, of Cassius Bassus, entitled *Geoponika*, already mentioned (18.), is also to be considered as a Roman production, though published in the Greek language at Constantinople, after the removal thither of the seat of government.

45. M. Porcius *Cato*, called the Censor, and the father of the Roman rustic writers, lived in the seventh century of the republic, and died at an extreme old age, B. C. 150. He recommended himself, at the age of seventeen, by his valour in a battle against Annibal; and afterwards rose to all the honours of the state. He particularly distinguished himself as a censor, by his impartiality and opposition to all luxury and dissipation; and was remarkably strict in his morals. He wrote several works, of which only some fragments remain, under the titles of *Origines* and *De Re Rustica*. The latter is the oldest Roman work on agriculture: it is much mutilated, and more curious for the account it contains of Roman customs and sacrifices, than valuable for its georgical information.

46. M. Terentius *Varro* died B. C. 28, in the 88th year of his age. He was a learned writer, a distinguished soldier both by sea and land, and a consul. He was a grammarian, a philosopher, a historian, and an astronomer; and is thought to have written five hundred volumes on different subjects, all of which are lost, except his treatise *De Re Rustic*

This is a complete system of directions in three books, on the times proper for, and the different kinds of, rural labour; it treats also of live stock, and of the villa and offices. As Varro was for some time lieutenant-general in Spain and Africa, and afterwards retired and cultivated his own estate in Italy, his experience and observation must have been very considerable.

47. Publius *Virgilius* Maro, called the prince of the Latin poets, was born at a village near Mantua in Lombardy about 70 B. C., and died B. C. 19, aged 51. He cultivated his own estate till he was thirty years old, and spent the rest of his life chiefly at the court of Augustus. His works are the *Bucolics*, *Georgics*, and *Æneid*. The *Georgics* is to be considered as a poetical compendium of agriculture, taken from the Greek and Roman writers then extant, but especially from Varro.

48. Luc. Jun. Moderatus *Columella* was a native of Gades, now Cadiz, in Spain, but passed most of his time in Italy. The time of his birth and death are not known, but he is supposed to have lived under Claudius in the first century. His work *De Re Rustica*, in twelve books, of which the tenth is still extant, was a complete treatise on rural affairs, including field operations, timber trees, and gardens.

49. *C. Plinius Secundus*, surnamed the elder, was born at Verona in Lombardy, and suffocated at the destruction of Pompeii in his 56th year, A. D. 79. He was of a noble family; distinguished himself in the field and in the fleet; was governor of Spain; and was a great naturalist, and an extensive writer. Of the works which he composed none are extant but his *Natural History* in thirty-seven books; a work full of the erudition of the time, accompanied with much erroneous, useless, and frivolous matter. It treats of the stars and the heavens, of wind, rain, hail, minerals, trees, flowers, and plants; gives an account of all living animals; a geographical description of every place on the globe; and a history of commerce and navigation, and of every art and science, with their rise, progress, and several improvements. His work may be considered as a compendium of all preceding writers on these subjects, with considerable additions from his personal experience and observation.

50. Rutilius Taurus Emilianus *Palladius* is by some supposed to have lived under Antoninus Pius, in the second century, though others place him in the fourth. His work *De Re Rustica* is a poem in fourteen books, and is little more than a compendium of those works which preceded it on the same subject. The editor of the article Agriculture, in the *Encyclopédie Méthodique*, says it is too dull to be read as a poem, and too concise to be useful as a didactic work.

51. These works have been rendered accessible to all by *translations;* and *a judicious and instructive treatise composed from them* by Adam Dickson, a Scotch clergyman, was published in 1788, under the title of *The Husbandry of the Ancients*. To this latter work we are indebted for the greater part of what we have to submit on Roman agriculture.

52. *The Roman authors*, as Rozier has observed (*Dict. de l'Agr.*, art. *Hist.*), *do not enable us to trace the rise and progress of agriculture*, either in Italy or in any other country under their dominion. What they contain is a picture of their rural economy in its most perfect state, delivered in precepts, generally founded on experience, though sometimes on superstition; never, however, on theory or hypothesis. For, as the Rev. Adam Dickson states, " instead of schemes produced by a lively imagination, which we receive but too frequently from authors of genius unacquainted with the practice of agriculture, we have good reason to believe that they deliver, in their writings, a genuine account of the most approved practices; practices, too, the goodness of which they had themselves experienced." (*Husb. of the Anc.*, p. 16.) He adds, that if in the knowledge of the theory of agriculture, the Roman cultivators are inferior to our modern improvers; yet in attention to circumstances and exactness of execution, and in economical management, they are greatly superior.

Sect. II. *Of the Proprietorship, Occupancy, and General Management of Landed Property among the Romans.*

53. *The Roman nation originated from a company of robbers and runaway slaves*, who placed themselves under their leader Romulus. This chief having conquered a small part of Italy divided the land among his followers, and by what is called the Agrarian Law, allowed 2 jugera or 1⅓ acre to every citizen. After the expulsion of the kings in the 6th century B. C., 7 yoke, or 3⅔ acres were allotted. The custom of distributing the conquered lands, by giving 7 jugera to every citizen, continued to be observed in latter times; but when each soldier had received his share, the remainder was sold in lots of various sizes, even to 50 jugera; and no person was prevented from acquiring as large a landed estate as he could, till a law passed by Stolo, the second plebeian consul, B. C. 377, that no one should possess more than 500 jugera. This law appears to have remained in force during the greater period of the Roman power. Whatever might be the size of the estate, it was held by the proprietor as an absolute right, without acknowledgment to

any superior power; and passed to his successors, agreeably to testament, if he made one; or if not, by common law to his nearest relations.

54. *In the first ages of the commonwealth, the lands were occupied and cultivated by the proprietors themselves;* and as this state of things continued for four or five centuries, it was probably the chief cause of the agricultural eminence of the Romans. When a person has only a small portion of land assigned to him, and the maintenance of his family depends entirely upon its productions, it is natural to suppose that the culture of it employs his whole attention. A person who has been accustomed to regular and systematic habits of action, such as those of a military life, will naturally carry those habits into whatever he undertakes. Hence, it is probable, a degree of industrious application, exactness, and order in performing operations, in a soldier-agriculturist, which would not be displayed by men who had never been trained to any regular habits of action. The observation of Pliny confirms this supposition: he asserts that the Roman citizens, in early times, "ploughed their fields with the same diligence that they pitched their camps, and sowed their corn with the same care that they formed their armies for battle." (*Nat. Hist.*, lib. xviii. c. 3.) Corn, he says, was then both abundant and cheap.

55. *Afterwards, when Rome extended her conquests, and acquired large territories, rich individuals purchased large estates;* the culture of these fell into different hands, and was carried on by bailiffs and farmers much in the same way as in modern times. Columella informs us that it was so in his time, stating, that "the men employed in agriculture are either farmers or servants; the last being divided into free servants and slaves." (*Col.*, lib. i. cap. 7.) It was a common practice to cultivate land by slaves during the time of the elder Pliny; but his nephew and successor let his estates to farmers.

56. *In the time of Cato the Censor*, the author of *The Husbandry of the Ancients* observes, though the operations of agriculture were generally performed by servants, yet the great men among the Romans continued to give particular attention to it, studied its improvement, and were very careful and exact in the management of all their country affairs. This appears from the directions given them by this most attentive farmer. Those great men had both houses in town, and *villas* in the country; and, as they resided frequently in town, the management of their country affairs was committed to a bailiff or overseer. Now their attention to the culture of their lands and to every other branch of husbandry, appears, from the directions given them how to behave upon their arrival from the city at their *villas*. "After the landlord," says Cato, "has come to the villa, and performed his devotions, he ought that very day, if possible, to go through his farm; if not that day, at least the next. When he has considered in what manner his fields should be cultivated, what work should be done, and what not; next day he ought to call the bailiff, and enquire what of the work is done, and what remains; whether the labouring is far enough advanced for the season, and whether the things that remain might have been finished; and what is done about the wine, corn, and all other things. When he has made himself acquainted with all these, he ought to take an account of the workmen and working days. If a sufficiency of work does not appear, the bailiff will say that he was very diligent, but that the servants were not well; that there were violent storms; that the slaves had run away; and that they were employed in some public work. When he has given these and many other excuses, call him again to the account of the work and the workmen. When there have been storms, enquire for how many days, and consider what work might be done in rain; casks ought to have been washed and mended, the villa cleaned, corn carried away, dung carried out, a dunghill made, seed cleaned, old ropes mended, new ones made, and the servant's clothes mended. On holidays, old ditches may have been scoured, a highway repaired, briars cut, the garden digged, meadows cleared from weeds, twigs bound up, thorns pulled, far (bread-corn, maize) pounded, all things made clean. When the servants have been sick, the ordinary quantity of meat ought not to have been given them. When he is fully satisfied in all these things, and has given orders that the work that remains be finished, he should inspect the bailiff's accounts, his account of money, of corn, fodder, wine, oil, what has been sold, what exacted, what remains, what of this may be sold, whether there is good security for what is owing. He should inspect the things that remain, buy what is wanting for the year, and let out what is necessary to be employed in this manner. He should give orders concerning the works he would have executed, and the things he is inclined to let out, and leave his orders in writing. He should inspect his flocks, make a sale, sell the superfluous oil, wine, and corn; if they are giving a proper price, sell the old oxen, the refuse of the cattle and sheep, wool, hides, the old carts, old iron tools, and old and diseased slaves. Whatever is superfluous he ought to sell; a farmer should be a seller, not a buyer." (*Cat.*, cap. ii.)

57. *The landlord is thus supposed by Cato to be perfectly acquainted with every kind of work proper on his farm,* and the seasons for performing it, and also to be a perfect judge how much work, both without and within doors, ought to be performed by any number of servants and cattle in a given time; the knowledge of which is highly useful to a farmer, and what very few perfectly acquire. It may be observed, likewise, that the landlord is here supposed to enquire into all circumstances, with a minuteness of which there is scarcely even an actual farmer in this age who has any conception.

58. *Varro* complains that, in his time, the same attention to agriculture was not given as in former times; that the great men resided too much within the walls of the city, and employed themselves more in the theatre and circus, than in the corn fields and vineyards. (*Var. de R. R.*, lib. i. præf.)

59. *Columella* complains that, in his time, agriculture was almost entirely neglected. However, from the directions which he gives to the proprietors of land, it appears that there were still a few who continued to pay a regard to it; for, after mentioning some things, which he says, by the justice and care of the landlord, contribute much to improve his estate, he adds, "But he should likewise remember, when he returns from the city, immediately after paying his devotions, if he has time, if not, next day, to view his

marches, inspect every part of his farm, and observe whether in his absence any part of discipline or watchfulness has been dispensed with; and whether any vine, any other tree, or any fruits are missing. Then likewise he ought to review the cattle and servants, all the instruments of husbandry, and the household furniture. If he continue to do all these things for some years, he will find a habit of discipline established when he is old; and at no age will he be so much impaired with years as to be despised by his servants." (*Col.*, lib. i. cap. 9.)

60. *The earliest farmers among the Romans* seem not to have been upon the same footing as in Britain. The stock on the farm belonged to the landlord, and the farmer received a certain proportion of the produce for his labour. The farmer, who possessed a farm upon these terms, was called *politor* or *polintor*, from his business, being the dresser of the land; and *partuarius*, from his being in a kind of copartnership with his landlord, and his receiving a part of the produce of the farm for his labour. Cato takes notice of this kind of farmers only, and it is probable that there were no others in his time. "The terms," says he, "upon which land ought to be let to a *politor:* in the good land of Casinum and Venafrum, he receives the eighth basket; in the second kind of land he receives the seventh; in the third kind he receives the sixth. In this last kind, when the grain is divided by the *modius*, he receives the fifth part; in the very best kind of land about Venafrum, when divided by the basket, he receives only the ninth.... If the landlord and *politor* husk the *far* in common, the *politor* receives the same proportion after as before; of barley and beans divided by the *modius*, he receives a fifth." (Ch. xl. xli.) The small proportion of the produce that the *politor* received, makes it evident that he was at no expense in cultivating the land, and that he received his proportion clear of all deductions.

61. *The coloni or farmers mentioned by Columella*, seem to have paid rent for their farms in the same manner as is done by the farmers in Britain. The directions given by this author to landlords, concerning the mode of treating them, are curious as well as important. A landlord, he says, "ought to treat his tenants with gentleness, should show himself not difficult to please, and be more vigorous in exacting culture than rent, because this is less severe, and upon the whole more advantageous. For, where a field is carefully cultivated, it for the most part brings profit, never loss, except when assaulted by a storm or pillagers; and therefore the farmer cannot have the assurance to ask any ease of his rent. Neither should the landlord be very tenacious of his right in every thing to which the farmer is bound, particularly as to days of payment, and demanding the wood and other small things which he is obliged to, besides paying his rent, the care of which is a greater trouble than expense to the rustics. Nor is every penalty in our power to be exacted, for our ancestors were of opinion, that the rigour of the law is the greatest oppression. On the other, the landlord ought not to be entirely negligent in this matter; because it is certainly true, what Alpheus the usurer used to say, that good debts become bad ones, by being not called for," &c. (*Col.*, lib. i. cap. 7.)

62. *These directions are valuable even with reference to the present times;* and they instruct us respecting the general management of landed property among the Romans. It appears that the landlord was considered as understanding every thing respecting the husbandry of his estate himself; and that there was no agent, or intermediate person, between him and the farmer. The farmers paid rent for the use of their farms, and were bound to a particular kind of culture, according to the conditions of their lease; but they were perfectly free and independent of their landlords; so much so, as sometimes to enter into lawsuits with them. On the whole, they seem to have been upon the same footing as the farmers of Britain in modern times.

Sect. III. *Of the Surface, Soil, Climate, and other Agricultural Circumstances of Italy, during the Time of the Romans.*

63. *The agriculture of any country must necessarily take its character from the nature of that country.* The extent and manner of cultivating the soil, and the kind of plants cultivated, or animals reared, must necessarily be regulated by the surface of the soil, the natural productions, the climate, the artificial state, and the habits of the people.

64. *The climate of Italy* is regular, dry, clear, and considerably warmer than that of Britain. At the bottoms of the mountains, it is subject to severe storms of hail in summer, and snow in winter, which often do considerable damage; but these are only accidental disadvantages; and in the champaign lands and gentle declivities, the vine, the fig, and the olive, ripened anciently, as now, in open plantations, from one extremity of Italy to the other.

65. *The surface of Italy* is very irregular. A ridge of hills, and mountains passes through its whole length, forming numerous valleys of different degrees of extent; some elevated and narrow, others low and watered by a river, a stream, or by lakes. The immense plain of the Po constitutes a capital feature towards the north-east; the sandy plain of Calabria towards the south; and the marshy plain of Terracino, and

the rocky coast of Genoa, towards the western shore. Columella and Palladius agree in stating, that the best situation for lands is, not so much on a level as to make the water stagnate, nor so steep as to make it run off with violence; nor so low as to be buried in the bottom of a valley, nor so exposed as to feel the violence of storms and heats; for in these a mediocrity is always best: but champaign lands exposed, and whose declivity affords the rain a free passage; or a hill whose sides gently decline; or a valley not too much confined, and into which the air has easy access; or a mountain defended by a higher top, and thereby secured from the winds that are most pernicious, or, if high and rugged, at the same time covered with trees and grass. (*Col.*, lib. ii. cap. 2.; *Pallad.*, lib. i. cap. 5.) The situation of lands which Cato reckons the best, is at the foot of a mountain with a south exposure. Varro and Pliny concur in this opinion, and the latter states that the best lands in Italy are so situated.

66. *The soil of Italy is as varied as the surface.* About Genoa a yellow marly clay forms a base to schistous cliffs and hilly slopes; a blue clay containing sulphur and alum on the west coast between Florence and Venice; volcanic earth about Rome and Naples; sand about Florence, and at the estuaries of most of the rivers; rich black loam in the central parts of Tuscany; and rich, deep, soft, moist earth, and mild marly clay, in Lombardy. Columella divides the soils of Italy into six kinds; fat and lean, free and stiff, wet and dry: these mixed with one another, he says, make great varieties. In common with all the other writers, he prefers a free soil.

67. *The native productions of Italy*, in an agricultural point of view, are, timber on the mountains, pastures on the hill sides, and meadow or very luxuriant grass-lands in the alluvial plains. The rich, low, and yet dry lands do not produce a close pasture, but a rough herbage, unless they are covered with trees; the sandy soils produce little of any thing; and the fens and marshes reeds and other coarse aquatics. Such were the productions of Italy antecedent to culture.

68. *The artificial state of the country*, in respect to agriculture, during the time of the Romans, seems to have differed less from its present state than will be imagined. The cultivated lands were open, and enclosures only to be seen near the villas. These were of small size, and chiefly gardens and orchards, except in the case of parks for game, formed by the wealthy, which never were very numerous. With the exception of part of Tuscany and Lombardy, this is still the case; and the landscape, as Daniel Malthus has observed (*Introd. to Girardin's Essay*), which Pliny observes as seen from his villas, does not appear to have been different two thousand years ago, from what it is at this day. But the roads, canals, markets, and artificial water-courses for the irrigation both of arable and grass-lands, are undoubtedly greatly increased since the time of the Romans: though they also practised irrigation.

69. *The habits of a people* take their rise, in a great degree, from the climate in which they live, and the native or cultivated productions with which the country abounds. As respects agriculture, it may be sufficient to mention, that the great heat of the climate, by relaxing the frame, naturally produces indolence in many, and leads to a life of plunder in some. Hence then, as now, the danger from thieves and robbers in that country; and hence, also, the custom of performing field labours early in the morning, and in the evening, and resting during the mid-day heat. The general use of oil and wine as food and drink, and also of the fig as an article of nourishment, are habits which arise immediately from the circumstance of these articles being the artificial produce of the country; but are ultimately, like most other habits, to be referred to the climate.

70. *These hints respecting the natural and agricultural geography of Italy*, during the time of the Romans, are confessedly *too scanty* to be of more use than to recal to the reader's recollection the information on the same subject with which his mind is already stored; and by this means to enable him to form a due estimate of the nature and merits of the agriculture which we are about to describe.

Sect. IV. *Of the Culture and Farm Management of the Romans.*

71. *The Roman authors are much more copious in describing farm culture and economy*, than in relating the state of landed property as to extent and proprietorship. Their directions, being founded on experience, are in great part applicable at the present day: they are remarkable for their minuteness; but we can only give a very brief compendium, beginning with some account of the farm and the villa, or farmery, and taking in succession the servants, beasts of labour, implements, operations, crops cultivated, animals reared, and profit produced.

Subsect. 1. *Of the Choice of a Farm, and of the Villa or Farmery.*

72. *In the choice of a farm*, Cato recommends a situation where there are plenty of artificers and good water; which has a fortified town in its neighbourhood; is near the sea or a navigable river, or where the roads are easy and good. (*Cat.*, cap. 1.) To these requisites Varro adds, a proper market for buying and selling, security from thieves and

robbers, and the boundaries planted with useful trees. The interior of the farm was not subdivided by enclosures, which were seldom used but for their gardens, and to form parks in the villas of the wealthy.

73. *The soil* preferred by Columella and all the Roman authors is the fat and free, as producing the greatest crops, and requiring the least culture; next, fat stiff soil; then stiff and lean soil, that can be watered; and, last of all, lean dry soil.

74. *The state of a farm* preferred by Cato and some other writers is that of pasture, meadow, and watered grass-lands, as yielding produce at least expense; and lands under vines and olives, as producing the greatest profit according to the expense. The opinions of the Roman agriculturalists, however, seem to disagree on the subject of meadows, apparently from confounding a profitable way of management, with a capacity of yielding great profit with superior management, and none without.

75. *The word Villa originally denoted a farm-house and its appurtenances.* In the first age of the commonwealth, these were very plain and small, suitable to the plain manners of the people, and adapted to the small size of their farms: but, when the Romans had extended their empire, when they had become rich and luxurious, and particular persons were possessed of large landed estates, then the villas became large and magnificent. In the time of Valerius Maximus, there were villas that covered more ground than was in the estates of some of the ancient nobles. " Now," says he, " those think themselves very much confined, whose houses are not more extensive than the fields of Cincinnatus." (*Val. Max.*, lib. iv. cap. 4. sect. 7.) In the days of Cato, it is probable that they had begun to extend their villas considerably, which makes him give a caution to the proprietors of land not to be rash in building. He recommends to them to sow and plant in their youth, but not to build till somewhat advanced in years. His words are remarkable: " A landholder," says he, " should apply himself to the planting of his fields early in his youth; but he ought to think long before he builds. He ought not to think about planting; but he ought to do it. When he is about thirty-six years of age, he may build, provided his fields are planted." (*Cat.*, cap. 3.)

76. *Men should plant in their youth, and not build till their fields are planted;* and even then ought " not to be in a hurry, but take time to consider. It is best, according to the proverb, to profit by the folly of others." (*Plin. Nat. Hist.*, lib. xviii. cap. 5.) The reason why these authors recommend greater attention to planting than building is, that the labouring oxen in Italy, in the time of the Romans, were fed, for several months in the year, with leaves and mast; and the vine, the fig, the olive, and other trees, were cultivated for their fruit.

77. *Build in such a manner that your villa may not be too small for your farm, nor your farm too small for your villa.* (*Cat.*, cap. 3.) Varro assigns proper reasons for this. " In not attending," says he, " to the measure of the farm, many have gone wrong. Some have made the villa much smaller, and others much larger than the farm required. One of these is contrary to a man's interest, and the other hurtful to the produce of his lands. For we both build and repair the larger buildings at a greater expense than is necessary; and, when the buildings are less than what the farm requires, the fruits are in danger of being destroyed." (*Var. de R. R.*, lib. i. cap. 11.) Columella expresses himself to the same purpose, and mentions two persons in particular who had fallen into each of the extremes. " I remember," says he, " that many have erred in this point, as these most excellent men did, L. Lucullus and Q. Scævola, one of whom built a villa much larger, and the other much less than the farm required." (*Col.*, lib. i. cap. 4.)

78. *Pliny, noticing the above remark of Cato's*, observes that Lucullus had thereby rendered himself liable to the chastisement of the censors, having less occasion to plough his lands than to clean his house. " In this case," says he, " to plough less than to sweep, was a foundation for the chastisement of the censors." (*Plin. Nat. Hist.*, lib. xviii. cap. 6.)

79. *Proportion the expense of the building to the rent, or the profits arising from the farm.* " An edifice should be built according to the value of the farm and fortune of the master, which, immoderately undertaken, it is commonly more difficult to support than to build. The largeness of it should be so estimated, that, if any thing shall happen to destroy it, it may be rebuilt by one, or at most by two years' rent or profits of the farm in which it is placed." (*Pal.*, lib. i. tit. 8.)

80. *The position of the villa, and the situation of its different parts,* are also noticed by some of these authors. " Some art," says Pliny, " is required in this. C. Marius, of a very mean family, seven times consul, placed a villa in the lands of Misenum, with such skill in the contrivance, that Sylla Felix said, that all others in this respect were blind, when compared to him." (*Plin. Nat. Hist.*, lib. xviii. cap. 7.) All of them advise that it shall not be placed near a marsh, nor fronting a river. Pliny cites the authority of Homer for this. Varo says, that such a situation is cold in winter and unhealthful in summer; that, in such a place, there are many small insects which, though invisible, enter the body at the mouth and nostrils, and occasion diseases. (*Var. de R. R.*, lib. i. tit. 12.) Palladius gives reasons of the same kind. (*Pal.*, lib. i. tit. 7.) Besides this, Varro

directs, that, if possible, it shall be placed at the foot of a mountain covered with woods, in such a manner as to be exposed to the most healthful winds, and to enjoy the sun in winter and the shade in summer. An east exposure, he thinks, is the best for this purpose, (*Var. de R. R.*, lib. i. cap. 12.) Palladius proposes that, for the same purpose, the villa shall front the south-east; that the *prætorium*, or master's house, shall be a little higher than the rest of the villa, both to secure the foundations, and to have a more agreeable prospect. (*Pal.*, lib. i. tit. 8.) It is probable that both these authors have Italy particularly in view. But Pliny extends his views further; for he says, that the villa in warm climates ought to front the north, in cold climates the south, and in temperate climates the east. (*Plin. Nat. Hist.*, lib. xviii. cap. 7.) Columella is more particular than any of the other authors, both in giving directions as to the situation of the villa, and giving reasons for the situation he recommends. (*Col.*, lib. i. cap. 5.)

81. *The villa is divided into three parts, the urbana, the rustica, and the fructuaria.* All the particulars of these, Columella says, ought to be properly placed with respect to each other. The *urbana* contained the apartments of the landlord; the *rustica* contained the kitchen, the houses of the labouring servants, the stables, piggeries, and poultry houses, ponds for water, dunghills, on which, says Varro, some persons place necessary conveniences for the family. (§ xii.) Adjoining the villa rustica, in the residence of opulent Romans, were placed the aviary, apiary, a place for dormice, a warren for hares and rabbits, a place for snails, and a large enclosure or park of fifty acres or more for retaining live deer and wild beasts taken in the chase. The *fructuaria* contained the oil and wine cellars, the places for the oil and wine presses, the corn-yards, barns, granaries, store-houses, repositories for roots and fruits, &c.

82. Both Columella and Palladius give directions *how all these parts should be situated and constructed;* but, though minute, they are not so explicit as to enable any one to delineate their ground plan. The same may be said as to the directions given by these author , and by Pliny (*Nat. Hist.*, lib. xviii.), respecting the laying out of the villa urbana, and the apartments for summer and winter. The subject of designing villas for the opulent belongs no doubt more to architecture than to agriculture; and therefore we shall refer, for details, to the plans given by Castel (*fig.* 10.) and other modern authors, who have attempted to embody the descriptions of the ancient writers.

83. *Castel's general arrangement of a grand Roman villa and its environs,* is as follows: —

1, Prætorium.
2, Farm-house and offices.
3, Canal, parting the farm from the prætorium.
4, Stone-banks to the canal.
5, Bridges.
6, Museum.
7, River Vinius.
8, Part of the island surrounded by that river.
9, The other river.
10, Walk on the bank of that river.
11, Ornithon of Varro.
12, Vivarium, or park for wild beasts.
13, Small woody islands for peacocks.
14, Place for turkeys (!!), rather swans, and their keepers: turkeys being natives of America, and consequently unknown to the Romans.
15, For geese and their keeper.
16, Cochlearium.
17, Dormice.
18, Apiary.
19, Threshing floor and barn.
20, Mill driven by water.
21, Temple of Ceres.
22, Corn-fields.
23, Vineyards.
24, Olive grounds.
25, Meadows.
26, Orchard.
27, Garden.
28, Osier ground.
29, Woods, &c.
30, Coppices.

84. It is remarkable that *no directions are given as to the materials* of which the villa should be built. These would, in all probability, depend on local circumstances; rammed earth, timber, brick burned or only dried in the sun, or stone, would be taken according to convenience. The remains of villas which have reached modern times, are chiefly of brick stuccoed over. Pliny mentions walls in Africa and Spain, called formacii, the formation of which, by cramming the earth between two boards, exactly agrees with the French mode of building mud walls, called *en pise.* He also mentions walls of unburnt brick, of mud, of turf, and frames filled up with bricks and mud. (*Nat. Hist.*, lib. xxxv. cap. 14.)

Subsect. 2. *Of the Servants employed in Roman Agriculture.*

85. *The servants employed in Roman agriculture* were of two sorts, freemen and slaves. When the proprietor or farmer lived on the farm and directed its culture, these were directly under his management; in other cases there was a bailiff or overseer, to whom all the other servants were subordinate. This was the case so early as Cato's time, who is very particular in his directions respecting the care a bailiff ought to take of the servants, the cattle, the labouring utensils, and in executing his master's orders.

86. *The bailiff was generally a person who had received some education,* and could write and keep accounts; and it was expected that he should be careful, apt to learn, and capable to execute his master's orders with a proper attention to situations and circumstances. Columella, however, says that "the bailiff may do his business very well, though he is illiterate." Cornelius Celsus says that "such a bailiff will bring money to his master oftener than his book; because, being ignorant of letters, he is the less capable to contrive accounts, and is afraid to trust another, being conscious of fraud." (*Col.*, lib. i. cap. 8.) There are some other things mentioned by this author, with respect to the bailiff, that are very proper, and show particularly the attention of the Romans. "He

ought not," says he, "to trade on his own account, nor employ his master's money in purchasing cattle or any other goods ; for this trading takes off his attention, and prevents

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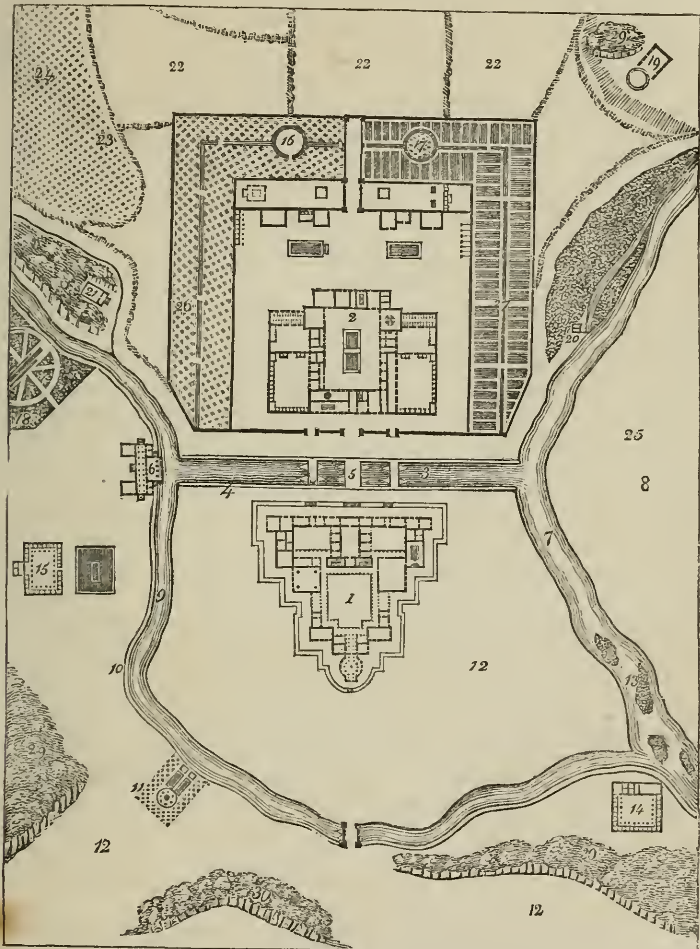


him from keeping square accounts with his master. But when he is required to settle them, he shows his goods in the place of money. This, above all, he should be careful of, not to think he knows any thing he does not know ; and always to be ready to learn what he is ignorant of. For as it is of great advantage to do a thing well, so it is most hurtful to have it ill done. This one thing holds true in all rustic work, to do but once what the manner of culture requires ; because, when imprudence or negligence in working is to be set to rights, the time for the work is already wasted ; nor are the effects of the amendment such as to make up the lost labour, and balance the advantages that might have been gained by improving the season that is past." (*Col.*, lib i. cap. 8.)

87. *The qualities of the other villa servants* are represented by the same author in this manner : "The careful and industrious," says he, "should be appointed masters of the works ; these qualities are more necessary for this business than stature or strength of body, for this service requires diligent care and art." Of the ploughman he says,

88. *In the ploughman*, though a degree of genius is necessary, yet it is not enough. "There should be joined to it a harshness of voice and manner, to terrify the cattle : but he should temper strength with clemency ; because he ought to be more terrible than cruel, that so the oxen may obey his commands, and continue the longer at their work, not being spent, at the same time, both with the severity of labour and stripes. But what the offices of masters of works and of ploughman are, I shall mention in

their proper places. It is sufficient at present to observe, that tallness and strength are of great use in the one, and of very little in the other; for we should make, as I have said, the tallest man a ploughman, both for the reason I have already mentioned, and because there is no rustic work by which a tall man is less fatigued than by ploughing; because, when employed in this, walking almost upright, he may lean upon the handle of the plough." Of the common labourer he says, " The common labourer may be of any size, provided he is able to endure fatigue." And of the vine-dresser, " Vineyards do not require such tall men, provided they are thick and brawny; for this constitution of body is most proper for digging, pruning, and the other culture necessary for them. In this work diligence is less necessary than in the other works of husbandry; because the vine-dresser ought to perform his work in company and under the eye of a director. Commonly wicked men are of a quicker genius, which this kind of work requires; and, as it requires not only a stout servant, but one of an active contrivance, vineyards are commonly cultivated by slaves in chains." (*Col.*, lib. i. cap. 9.) Thus we see, that, among the Romans, labourers were appointed to the different works of husbandry, according to their strength, size, and genius.

89. With respect to *the wages of agricultural labour among the Romas*, very little benefit can be derived from knowing the absolute sum of money paid for any article, unless it can be compared with the price of other commodities. The price of a slave in Cato's time, was about 50*l.*; in the time of Columella it had risen to 60*l.*; or to the price of eight acres of good land. A good vine-dresser cost 66*l.* 13*s.* 4*d.*, and a good ploughman or labourer not less than 60*l.* The interest of money at this time was 6*l.* per cent per annum; therefore, in stating the expense of farm labour, a slave must be rated at not less than 12*l.* per cent, as being a perishable commodity; so that one who cost 60*l.* would fall to be charged at the rate of 7*l.* 4*s.* per annum, besides his maintenance and clothing. This may give some idea of the wages that would be paid to a free servant who hired himself by the year; of which, however, there appears to have been no great number, their wages not being stated.

90. *All the servants were maintained and clothed by the farmer or proprietor;* and as may be supposed, it was the interest of the latter that this should be done in a good and sufficient manner. Columella mentions what he calls an old maxim, concerning the bailiff: " That he should not eat but in the sight of all the servants, nor of any other thing but what was given for the rest." He mentions the reason of this: " For thus," says he, " shall he take care that both the bread be well baked, and the other things prepared in a wholesome manner." (*Col.*, lib. i. cap. 8.) The same author mentions the treatment that masters ought to give their slaves: " So much the more attentive," says he, " ought the master to be in his enquiry concerning this kind of servants, that they may not be injured in their clothes and other things afforded them, inasmuch as they are subject to many, such as bailiffs, masters of works, and gaolers; and the more they are liable to receive injuries, and the more they are hurt through cruelty or avarice, the more they are to be feared. Therefore a diligent master ought to enquire, both at themselves, and likewise the free servants in whom he may put greater confidence, whether they receive the full of what is allowed them; he himself ought likewise to try, by tasting the goodness of the bread and drink, and examine their clothes, mittens, and shoes." (*Col.*, lib. i. cap. 8.) In another place, he says, " That the bailiff should have the family dressed and clothed rather usefully than nicely, and carefully fortified against the wind, cold, and rain; all which they will be secured from, by sleeved leathern coats, old *centones* (thick patchwork as bed-quilts) for defending their heads; or cloaks with hoods. If the labourers are clothed with these, no day is so stormy as to prevent them from working without doors. (*Col.*, lib. i. cap. 8.) Cato likewise makes particular mention of the clothes of the slaves: " The vestments of the family," says he, " a coat and a gown three feet and a half long should be given once in two years; whenever you give a coat or a gown, first receive the old one; of these make *centones*. Good shoes should be given once in two years." (*Cat.*, cap. 59.)

91. Cato informs us *what quality of bread and wine, and what other kinds of meat, were given to labourers.* Of bread, he says, each labourer was allowed at the rate of three pounds avoirdupois, or of three pounds twelve ounces avoirdupois in the day, according to the severity of his labour. " During the winter," says he, " the bailiff should have four *modii* of wheat each month, and during the summer four *modii* and a half; and the housekeeper, or the bailiff's wife, and the shepherd, should have three. During the winter, the slaves should have four pounds of bread each in the day; from the time that they begin to dig the vineyard, to the ripening of the figs, they should have five pounds each; after which they should return again to four." (*Cat.*, cap. 56.) To this bread, there was a daily allowance of wine; during the three months that immediately followed the vintage, the servants drank a weak kind of wine called *lora*. The manner in which this liquor was made, is described both by Pliny and Columella; and from the description given by them, it may well be supposed to be as good as the small beer given to servants in Britain. (*Plin. Nat. Hist.*, lib. xiv. cap. 10.) It does not appear that the Roman slaves were much restricted in the quantity; Cato mentions no measure; he only says, that they have this to drink for three months after the vintage; he proceeds in this manner: " In the fourth month, each should get a *hemina* of wine in the day, which is at the rate of two and a half *congii* in the month; in the fifth, sixth, seventh, and eighth months, each a *sextary* in the day, which is five *congii* in the month; in the ninth, tenth, and eleventh, each three *heminæ* in the day, which is an *amphora* in the month. More than this, at the *saturnalia* and *compitalia*, to each man was given a *congius*. The quantity of wine for each man in the year is eight quadrantals; however, as addition must be made according to the work in which the slaves are employed, it is not too much for each of them to drink ten quadrantals in the year." This allowance of wine, it must be acknowledged, was not inconsiderable, being at least seventy-four gallons in the year, or at an average 1·62 parts of a pint in the day.

92. *Besides bread and wine, the slaves got what was called pulmentarium,* which answers to what in some parts of the country is called kitchen dripping or fat. (*Plin. Nat. Hist.*, lib. xviii. cap. 8.) For this purpose Cato recommends the laying up as

many fallen olives as can be gathered ; afterwards the early olives from which the smallest quantity of oil is expected ; at the same time observing that these must be given sparingly, that they may last the longer. When the olives are finished, he desires salt fish and vinegar to be given, and besides, to each man a *sextarius* of oil in the month, and a *modius* of salt in the year. (*Cat.*, cap. 18.) Columella, for this purpose, directs apples, pears, and figs, to be laid up : he adds, if there is a great quantity of these, the rustics are secured in no small part of their meat during the winter, for they serve for dripping or fat. (*Col.*, lib. xii. cap. 14.)

Subsect. 3. *Of the Beasts of Labour used by the Romans.*

93. *The labouring cattle used by the Romans,* as well as by all the ancient nations, were chiefly the ox, the ass sometimes, the mule for burdens, and but very rarely the horse. The horse, however, was reared ; but almost exclusively for the saddle, the chase, or for war. The respect for the ox which existed among the Egyptians, Jews, and Greeks, was continued among the Romans, so much so that Varro, and after him Columella and Pliny, adduce an instance of a man having been indicted and condemned, for killing one to please a boy who longed for a dish of tripe.

94. *The breeding, breaking, feeding, and working of the ox* are very particularly treated of by the ancient authors.

95. *Bulls,* says Palladius, " should be tall, with huge members, of a middle age, rather young than old, of a stern countenance, small horns, a brawny and vast neck, and a confined belly." (*Pal.*, lib. iv. sect. 11.)

96. *The cows* Columella " most approves of, are of a tall make, long, with very large belly, very broad forehead, eyes black and open, horns graceful, smooth, and black, hairy ears, strait jaws, very large dewlap and tail, and moderate hoofs and legs." (*Col.*, lib. vi. cap. 21.)

97. *Breeders both of horses and cows,* Virgil observes, should attend principally to the make of the female. " If any one," says he, " fond of the prize at the Olympic games, breeds horses ; or if any one breeds stout bullocks for the plough, he chiefly attends to the make of the mother, who ought to be large in all her parts." (*Georg.*, iii. v. 49.) The same maxim is enforced scientifically by Cline. (*Commun. to Board of Ag.*, vol. iv.)

98. *For breaking and training cattle to the yoke,* Varro and Columella give very particular directions. " To break bullocks," says Varro, " put their necks between forked stakes ; set up one for each bullock, and give them meat from the hand ; they will become tractable in a few days : then, in order that by degrees they may become accustomed to the yoke, let an unbroken one be joined with a veteran, whom he will imitate ; then let them go upon even ground without a plough ; then yoked to a light plough in a sandy soil. That they may be trained for carriages, they should first be put to empty carts, and driven, if convenient, through a village or town ; the habit of hearing frequent noise, and seeing a variety of objects, will soon make them fit for use. (*Var.*, lib. i. cap. 20.)

99. *Training* commences with the calf state ; and " calves," says Virgil, " which you intend for country labour, should be instructed while their youthful minds are tractable, and their age manageable : first bind round their necks wide wreaths of tender twigs ; then, when their free necks have been accustomed to servitude, put real collars upon them ; join bullocks of equal strength, and make them step together ; at first let them frequently be employed in drawing along the ground wheels without any carriage upon them, so that they may print their steps only upon the top of the dust ; afterwards let the beechen axle groan under the heavy load, and the pole draw the wheels joined to the weighty carriage." (*Georg.*, iii. v. 163.)

100. *Labouring oxen were fed* with the mast or nuts of the beech or sweet chestnut, grape stones and husks after being pressed, hay, wheat and barley straw, bean vetch and lupine chaff, all parts of corn and pulse, grass, green forage, and leaves. The leaves used were those of the holm oak, ivy, elm (considered the best), the vine, the poplar, &c. The poplar leaves were mixed with the elm leaves to make them hold out, and when there were no elm leaves, then oak and fig leaves were used. (*Cat.*, cap. 54.) The food pre ferred before all others by Columella, is good pasturage in summer, and hay and corn in winter ; but he says the food and manner of feeding differ in different countries.

101. *Oxen were worked in pairs abreast* both with the cart and plough, and stood in the stables also in pairs, in *bubilia* or stalls formed on purpose. They were carefully matched, in order that the stronger might not wear out the weaker. They were yoked either by the horn or neck ; but the latter mode was greatly preferred.

102. *Yoking by the horns,* Columella observes, " is condemned by almost all who have written on husbandry ; because cattle can exert more strength from the neck and breast, than the horns ; as in the one way, they press with the whole weight and bulk of their bodies ; whereas in the other way, they are tormented with having their heads drawn back and turned up, and with difficulty stir the surface of the earth with a light plough." (*Col.*, lib. ii. cap. 11. 22.)

103. *Oxen, when in the plough,* were not allowed to go a great way without turning ; one hundred and twenty feet was the length fixed upon, and further than this it was thought improper for them to pull hard without stopping. The Reverend A. Dickson thinks it probable, that " the breaks or plats for the different kinds of corn and pulse

were laid out nearly of this length and breadth" (*Husb. of the Anc.*, ii. 452.); and there appear grounds for concluding that the case was the same among the Jews and Greeks. It was thought proper that oxen, in ploughing, should be allowed to stop a little at the turning, and when they stopped, that the ploughman should put the yoke a little forward, that so their necks might cool. "Unless their necks are carefully and regularly cooled," says Columella, "they will soon become inflamed, and swellings and ulcers will arise." The same author directs that "the ploughman, when he has unyoked his oxen, must rub them after they are tied up, press their backs with his hands, pull up their hides, and not suffer them to stick to their bodies; for this is a disease that is very destructive to working cattle." No food must be given them till they have ceased from sweating and high breathing, and then by degrees, in portions as eaten; and afterwards they are to be led to the water, and encouraged by whistling." (*Col.*, lib. ii. cap. 3.)

104. *In purchasing working oxen*, Varro directs to choose such as have "spacious horns, rather black than otherwise, a broad forehead, wide nostrils, a broad chest, and thick dewlap." (Lib. i. cap. 20.) All the Roman authors agree that the best colour of the body is red or dark brown; that the black are hardier, but not so valuable; that the hair should be short and thick, and the whole skin very soft to the touch; the body in general very long and deep, or, as Columella and Palladius express it, compact and square. The particular parts they also describe at length in terms such as would for the most part be approved by experienced breeders of cattle; making due allowance for the difference between choice for working, and choice for fatting. They all concur in recommending farmers to rear at home what oxen they want, as those brought from a distance often disagree with the change of soil and climate.

105. *The ass was the animal next in general use*. Varro says they were chiefly used for carrying burdens, or for the mill, or for ploughing where the land was light, and that they were most common in the south of Italy, especially in Campania. (Lib. ii. cap. 6.) He gives directions for breeding and rearing them; and states that the female should not be allowed to work when in an advanced state of pregnancy, but that the male does not improve by indulgence in labour. The foal is removed from the dam a year after being foaled, and broken for labour in the third year.

106. *Mules*, Columella says, "are very proper both for the road and the plough, provided they are not too dear, and the stiff lands do not require the strength of the ox." "Mules and hinni," Varro observes, "are of two kinds; the first being the offspring of a mare and an ass, and the second of a horse and an ass. A hinnus is less than an ass in the body, commonly of a brighter colour; his ears, mane, and tail like those of the horse. The mule is larger than the ass, but has more of the character of that animal in its parts than the hinnus. To breed mules, a joung jackass is put under a mare when he is foaled, and being reared with her is admitted to her the third year; nor does he despise the mare on account of former habits. If you admit him younger he soon gets old, and his offspring is less valuable. Persons who have not an ass which they have brought up under a mare, and who wish to have an ass for admission, choose the largest and the handsomest they can find, from a good breed." (*Varro*, lib. ii. cap. 8.) Mules are fed like the ass, on spray, leaves, herbage, hay, chaff, and corn.

107. *The horse was scarcely, if at all, used in Roman agriculture*, but was reared for the saddle and the army, by some farmers. Varro and Columella are particular in their directions as to the choice of mares, and breeding and rearing their young; but as these contain nothing very remarkable, we shall merely remark that the signs of future merit in a colt are said to be a small head, well formed limbs, and contending with other colts or horses for superiority in running, or in any other thing.

108. *The dog is a valuable animal in every unenclosed country*, and was kept by the Roman farmers for its use in assisting the shepherd, and also for watching. Varro mentions two kinds: one for hunting, which belongs to fierce and savage beasts; and one for the shepherd and the watch-box. The latter are not to be bought from hunters or butchers, because these are either lazy, or will follow a stag rather than a sheep. The best colour is white, because it is most discernible in the dark. They must be fed in the kitchen with bread and milk; or broth with bruised bones, but never with animal food, and never allowed to suffer from hunger, lest they attack the flock. That they may not be wounded by other beasts, they wear a collar made of strong leather set with nails, the inward extremities of which are covered with soft leather, that the hardness of the iron may not hurt their necks. If a wolf or any other beast is wounded by these, it makes other dogs that have not the collar remain secure. (*Varr.*, lib. ii. cap. 9.)

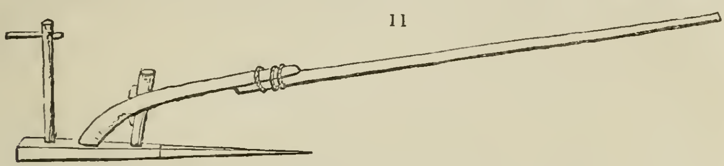
Subsect. 4. *Of the Agricultural Implements of the Romans.*

109. *The Romans used a great many instruments* in their culture and farm management; but their particular forms and uses are so imperfectly described, that very little is known concerning them.

110. *The plough*, the most important instrument in agriculture, is mentioned by Cato as

of two kinds, one for strong, and the other for light, soils. Varro mentions one with two mould boards, with which, he says, "when they plough after sowing the seed, they are said to ridge." Pliny mentions a plough with one mould board for the same purpose, and others with a coulter, of which, he says, there are many kinds. It is probable indeed, as the Rev. A. Dickson has remarked, that the ancients had many kinds of ploughs, though, perhaps, not so scientifically constructed as those of modern times. "They had ploughs," he says, "with mould boards, and without mould boards; with and without coulters; with and without wheels; with broad and narrow pointed shares; and with shares not only with sharp sides and points, but also with high-raised cutting tops." (*Husb. of the An.*, ii. 388.) But amidst all this variety of ploughs, no one has been able to depict the simplest form of that implement in use among the Romans. Professor John Martyn, in his notes to Virgil's *Georgics*, gives a figure of a modern Italian plough to illustrate Virgil's description. Rosier says the Roman plough was the same as is still used in the south of France (*fig.* 11.) Some authors have made fanciful representations

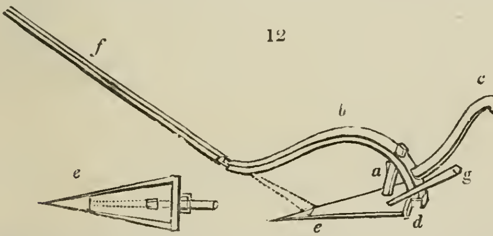
11



of it of the rudest construction; others have exhibited more refined pieces of mechanism, but most improbable as portraits.

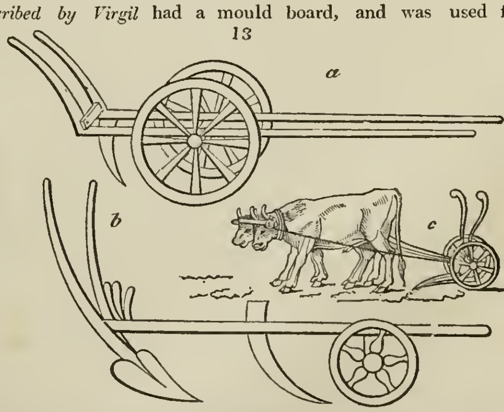
111. *From the different parts of the plough* mentioned by the Roman authors, a figure has been imagined and described by the author of the *Husbandry of the Ancients*, which, from his practical knowledge of agriculture, and considerable classical attainments, it is to be regretted he did not live to see delineated. A plough in use from time immemorial in Valentia (*fig.* 12.), is supposed to come the nearest to the common Roman implement. In it we have the buris or head (*a*); the temo, or beam (*b*); the stiva, or handle (*c*); the dentale, or share head (*d*); and the vomer or share (*e*). The other parts, the aura or mould board, and the culter or coulter, composed no part of the simplest form of Roman plough; the plough-staff, or paddle, was a detached part; and the manicula, or part which the ploughman took hold of, was a short bar fixed across, or into the handle, and the draught pole (*f*) was that part to which the oxen were attached.

12



112. *The plough described by Virgil* had a mould board, and was used for covering seed and ridging; but that which we have depicted, was the common form used in stirring the soil. To supply the place of our mould boards, this plough required either a sort of diverging stick (*g*), inserted in the share head, or to be held obliquely and sloping towards the side to which the earth was to be turned. The Romans did not plough their fields in beds, by circumvolving furrows, as we do; but the cattle returned always on the same side, as in ploughing with a turnwrest plough.

13



113 *Wheel ploughs,* Lasteyrie thinks, were invented in or not long before the time of Pliny, who attributes the invention to the inhabitants of Cisalpine Gaul. Virgil seems

to have known such ploughs, and refers to them in his *Georgics*. In the Greek monuments of antiquity are only four or five examples of these. Lasteyrie has given figures of three wheel ploughs from Caylus's *Collection of Antiquities* (*fig.* 13. *a* and *b*), and from a Sicilian medal (*c*).

114 *The urpex, or irpex*, seems to have been a plank with several teeth, used as our brake or cultivator, to break rough ground, and tear out roots and weeds.

14

115. *The crates* seems to have been a kind of harrow;

116. *The rastrum*, a rake used in manual labour;

117. *The sarculum*, a hand hoe, similar to our draw hoe; and

118. *The marra*, a hand hoe of smaller size.

119. *The bidens* (bi-dens) seems to have been a two-pronged hoe of large size, with a hammer at the other end used to break clods. These were used chiefly in cultivating vineyards.

120 *The ligo* seems to have been a spade (*fig.* 14.), and the *pala* a shovel or sort of spade, or probably a synonym. The ligo and pala were made of wood only, of oak shod with iron, or with the blade entirely of iron.

121. *The securis* seems to have been an axe, and the same term was applied to the blade of the pruning knife, which was formed like a crescent.

122. *The dolabra* was a kind of adze for cutting roots in tree culture.

123. *The reaping hook* seems to have been the same as that in modern use: some were used for cutting off the ears of far or maize, and these, it may be presumed, were not serrated like our sickles; others for cutting wheat and barley near the ground, like our reaping hooks. In the south of Gaul, Pliny informs us, they had invented a reaping machine: from his description this machine must have borne a considerable resemblance to that used in Suffolk, for cropping the heads off clover left for seed, and not unlike other modern attempts at an engine of this description. (See *fig.* 16.)

15

124. *There were threshing implements* for manual labour, and for being drawn by horses; and some for striking off the ears of corn (*fig.* 15.), like what are called rippling combs, for combing off the capsules of newly pulled flax.

125. *A variety of other instruments* for cleaning corn, and for the wine and oil press, are mentioned; but too obscurely to admit of exact description.

Subsect. 5. *Of the Agricultural Operations of the Romans.*

126. *Of simple* agricultural operations, the most important are ploughing, sowing, and reaping; and of such as are compound, or involve various simple operations, fallowing, manuring, weeding, and field-watering.

127. *Ploughing* is universally allowed to be the most important operation of agriculture. "What," says Cato, "is the best culture of land? Good ploughing. What is the second? Ploughing in the ordinary way. What is the third? Laying on manure." (Cap. lxi.) The season for ploughing was any time when land was not wet: in the performance, the furrow is directed to be kept equal in breadth throughout, one furrow equal to another; and straight furrows. The usual depth is not mentioned, but it was probably considerable, as Cato says corn land should be of good quality for two feet in depth. No scamni or balks (hard unmoved soil) were to be left, and to ascertain that this was properly attended to, the farmer is directed, when inspecting the work done, to push a pole into the ploughed land in a variety of places. The plough was generally drawn by one pair of oxen, which were guided by the ploughman without the aid of a driver. In breaking up stiff land he was expected to plough half an acre, in free land an acre, and in light land an acre and a half, each day. Land, as already noticed (103.), was ploughed in square plots of 120 feet to the side, two of which made a jugerum or acre. A similar practice seems to have existed among the Eastern nations, and is probably alluded to in the book of Samuel (chap. xiv. 5. 14.), where Jonathan and his armour-bearer are said to have slain about twenty men within half an acre, or literally "half a furrow of an acre of land."

128. *Fallowing was a universal practice among the Romans.* In most cases, a crop and a year's fallow succeeded each other; though, when manure could be got, two crops or more were taken in succession; and on certain rich soils, which Pliny describes as favourable for barley, a crop was taken every year. In fallowing, the lands were first ploughed after the crop was removed, generally in August; they were again cross-ploughed in spring, and at least a third time before sowing, whether spring corn or winter corn was the crop. There was, however, no limit to the number of ploughings and sarclings, and, when occasioned required, manual operations; the object being, as

Theophrastus observes, "to let the earth feel the cold of winter, and the sun of summer, to invert the soil, and render it free, light, and clear of weeds, so that it can most easily afford nourishment." (*Theo. de Caus. Plant.*, lib. iii. cap. 25.)

129. *Manuring* was held in such high esteem by the Romans, that immortality was given to Sterculius for the invention. They collected it from every source which has been thought of by the moderns, vegetable, animal, and mineral, territorial, aquatic, and marine. Animal dung was divided into three kinds, that produced by birds, that by men, and that by cattle. Pigeon-dung was preferred to all, and next human ordure and urine. Pigeon-dung was used as a top-dressing; and human dung, mixed with cleanings of the villa, and with urine, was applied to the roots of the vine and the olive. "M. Varro," says Pliny, "extols the dung of thrushes from the aviaries, as food for swine and oxen, and asserts that there is no food that fattens them more quickly." Varro prefers it also as a manure; on which Pliny observes, "we may have a good opinion of the manners of our times, if our ancestors had such large aviaries, as to procure from them dung to their fields." (*Nat. Hist.*, lib. xvii. cap. 9.) Dunghills were directed to be placed near the villa, their bottoms hollowed out to retain the moisture, and their sides and top defended from the sun by twigs and leaves. Dung usually remained in the heap a year, and was laid on in autumn and spring, the two sowing seasons. No more was to be spread than could be ploughed in the same day. Crops that were sickly were revived by sowing over them the dust of dung, especially that of birds, that is, by what is now called a top-dressing. Frequent and moderate dungings are recommended as preferable to occasional and very abundant supplies. Green crops, especially lupines, were sown, and before they came into pod ploughed in as manures: they were also cut and buried at the roots of fruit trees for the same purpose. Trees, twigs, stubble, &c., were burned for manure. Cato says, "If you cannot sell wood and twigs, and have no stone that will burn into lime, make charcoal of the wood, and burn in the corn fields the twigs and small branches that remain." Palladius says that "lands which have been manured by ashes of trees will not require manure for five years." (Lib. i. 6.) Stubble was very generally burned, as it was also among the Jews. Lime was used as a manure, especially for vines and olives. Cato gives particular directions how to form the kiln and burn it. He prefers a truncated cone, ten feet in diameter at the bottom, twenty feet high, and three feet in diameter at the top. The grate covers the whole bottom; there is a pit below for the ashes, and two furnace-doors, one for drawing out the burnt stone, and the other for admitting air to the fire. The fuel used was wood or charcoal. (Cap. 38.)

130. *Marl* was known to the earlier Roman authors, but not used in Italy. It is mentioned by Pliny as having been "found out in Britain and Gaul. ...... It is a certain richness of earth," he says, "like the kernels in animal bodies that are increased by fatness." Marl, he says, was known to the Greeks, "for is there any thing," he adds, "that has not been tried by them? They call the marl-like white clay *leucargillon*, which they use in the lands of Megara, but only where they are moist and cold." (*Nat. Hist.*, lib. xvii. cap. 5. 8.) But though the Romans did not use marl, because they had not discovered it in Italy, they were aware, as Varro and others inform us, of its use. "When I marched an army," says Varro, "to the Rhine, in Transalpine Gaul, I passed through some countries where I saw the fields manured with white fossil clay." (Lib. i. cap. 7.) This must have been either marl or chalk.

131. *Sowing* was performed by hand from a basket, as in modern times; the hand, as Pliny observes, moving with the step, and always with the right foot. The corns and leguminous seeds were covered with the plough, and sometimes so as to rise in drills; the smaller seeds with the hoe and rake.

132. *In reaping corn*, it was a maxim, that it is "better to reap two days too soon than two days too late." Varro mentions three modes of performing the operation: cutting close to the ground with hooks, a handful at a time; cutting off their ears with a curved stick, and a saw attached; and cutting the stalks in the middle, leaving the lower part or stubble to be cut afterwards. Columella says, "Many cut the stalks by the middle, with drag-hooks, and these either beaked or toothed: many gather the ears with *mergæ*, and others with combs. This method does very well where the crop is thin; but it is very troublesome where the corn is thick. If, in reaping with hooks, a part of the straw is cut off with the ears, it is immediately gathered into a heap, or into the nubilarium, and after being dried, by being exposed to the sun, is threshed. But if the ears only are cut off, they are carried directly to the granary, and threshed during the winter." (*Col.*, lib. ii. cap. 21.) To these modes Pliny adds that of pulling up by the roots; and remarks, generally, that, "where they cover their houses with stubble, they cut high, to preserve this of as great a length as possible; when there is a scarcity of hay, they cut low, that straw may be added to the chaff." (*Nat. Hist.*, lib. xviii. cap. 30.)

133. *A reaping machine* used in the plains of Gaul, is mentioned both by Pliny and Palladius, which is thus described by the latter: — "In the plains of Gaul, they use this quick way of reaping, and, without

reapers, cut large fields with an ox in one day. For this purpose a machine is made, carried upon two wheels; the square surface has boards erected at the side, which, sloping outwards, make a wider space above; the board on the fore part is lower than the others; upon it there are a great many small teeth, wide set in a row, answering to the height of the ears of the corn, and turned upwards at the ends; on the back part of this machine two short shafts are fixed, like the poles of a litter; to these an ox is yoked, with his head to the machine, and the yoke and traces likewise turned the contrary way: he is well trained, and does not go faster than he is driven. When this machine is pushed through the standing corn, all the ears are comprehended by the teeth, and heaped up in the hollow part of it, being cut off from the straw, which is left behind; the driver setting it higher or lower, as he finds it necessary; and thus, by a few goings and returnings, the whole field is reaped. This machine does very well in plain and smooth fields, and in places where there is no necessity for feeding with straw." (*Pal.*, lib. vii. tit. 2.) A conjectural delineation of this machine (*fig.* 16.) is given by Lasteyrie, in his *Collection des Machines, &c.*

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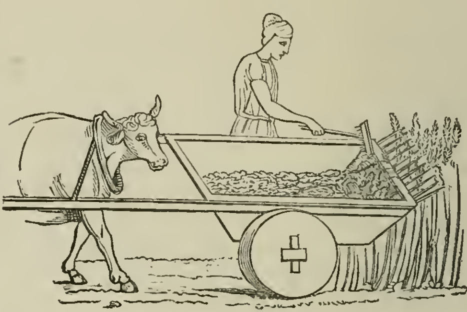

134. *The Romans did not bind their corn into sheaves,* as is customary in northern climates. When cut it was in general sent directly to the area to be threshed; or, if the ears only were cropped, sent in baskets to the barn. Among the Jews, Egyptians, and Greeks, the corn was bound in sheaves; or at least some kinds were so treated, as appears from the story of Ruth "gleaning among the sheaves;" of Joseph's dream, in which his "sheaf arose;" and from the harvest represented by Homer, on one of the compartments of Achilles's shield. (*Il.*, lib. xviii. 550.) Reapers were set in bands on the opposite sides of the field or plot, and worked towards the centre. As the land was ploughed in the same manner from the sides to the middle, there was an open furrow left there, to which the reapers hastened in the way of competition. A reaper was expected to cut down a jugerum of wheat in a day and a half; of barley, legumes, and medica or clover, in one day; and of flax in three days.

135. *Threshing was performed in the area or threshing floor,* a circular space of from 40 to 60 feet in diameter, in the open air, with a smooth hard surface. The floor was generally made of well wrought clay mixed with *amurca* or the lees of oil; sometimes it was paved. It was generally placed near the *nubilarium* or barn, in order that when a sudden shower happened, during the process of threshing, the ears might be carried in there out of the rain. Sometimes also the ears or unthreshed corn of the whole farm were first put in this barn and carried out to the area afterwards. Varro and Columella recommended that the situation of the area should be high and airy, and within sight of the farmer or bailiff's house, to prevent fraud; distant from gardens and orchards, because, though dung and straw are beneficial to the roots of vegetables, they are destructive when they fall on their leaves." (*Var.*, lib. i. cap. 51.)

136. *The corn being spread over the area* a foot or two in thickness, was threshed or beaten out by the hoofs of cattle, or horses driven round it, or dragging a machine over it. This machine, Varro informs us, was "made of a board, rough with stones or iron, with a driver or great weight placed on it." A machine composed of rollers studded with iron knobs, and furnished with a seat for the driver (*fig.* 17.), was used in the Carthaginian territory. Sometimes also they threshed with rods or flails. Far, or Indian corn (*Zèa Màys* L.), was generally hand-picked, or passed through a handmill.

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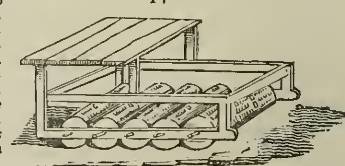


137. *Corn was cleansed or winnowed by throwing it from one part of the floor to another* (in the wind when there was any), with a kind of shovel called *ventilabrum;* another implement, called a van, probably a kind of sieve, was used when there was no wind. After being dressed, the corn was laid in the granary, and the straw either laid aside for litter, or, what is not a little remarkable, "sprinkled with brine; then, when dried, rolled up in bundles, and so given to the oxen for hay." (*Plin. Nat. Hist.*, lib. xviii. cap. 30.)

138. *Hay-making among the Romans* was performed much in the same way as in modern times. The meadows were mown when the flowers of the grass began to fade; "as it dries," says Varro, "it is turned with forks; it is then tied up in bundles of four pounds each, and carried home, and what is left strewed upon the meadow is raked together, and added to the crop." "A good mower," Columella informs us, "cuts a jugerum of meadow, and binds twelve hundred bundles of hay." It is probable that this quantity, which is nearly two tons, was the produce per acre of a good crop. A second crop was cut, called *cordum,* and was chiefly used for feeding sheep in winter. Hay

was also made of leafy twigs for the same purpose. Cato directs the bailiff to "cut down poplar, elm, and oak spray, and put them up in time, not over dry, for fodder for the sheep." (Cap. 5.)

139. *Weeding and stirring the soil* were performed, the first by cutting with a hook, or pulling the weeds up with the hand; and the second by sarcling or hoeing. Beans were hoed three times, and corn twice: the first time they were earthed up, but not the second or third; "for," says Columella, "when the corn ceases to tiller, it rots if covered with earth." Lupines were not sarcled at all, "because so far from being infested with weeds, they destroy them." Horse-hoeing was also practised, the origin of which is thus given by Pliny: — "We must not omit," says he, "a particular method of ploughing, at this time practised in Italy beyond the Po, and introduced by the injuries of war. The Salassi, when they ravaged the lands lying under the Alps, tried likewise to destroy the panic and millet that had just come above ground. Finding that the situation of the crop prevented them from destroying it in the ordinary way, they ploughed the fields; but the crop at harvest being double what it used to be, taught the farmer to plough amongst the corn." This operation, he informs us, was performed, either when the stalk was beginning to appear, or when the plant had put forth two or three leaves. The corn being generally sown in drills, or covered with the plough, so as to come up in rows, readily admitted this practice.

140. *Pasturing and harrowing corn,* when too luxuriant, were practised. Virgil says, "What commendation shall I give to him, who, lest his corn should lodge, pastures it while young, as soon as the blade equals the furrow." (*Geor.*, i. 111.) Pliny directs to comb the corn with a harrow before it is pastured, and sarcle it afterwards.

141. *Watering* on a large scale was applied both to arable and grass lands. Virgil advises to "bring down the waters of a river upon the sown corn, and when the field is parched, and the plants dying, convey it from the brow of a hill in channels. (*Geor.*, i. 106.) Pliny mentions the practice, and observes that the water destroys the weeds, nourishes the corn, and serves in place of sarcling. Watering grass lands was practised wherever an opportunity offered. "As much as in your power," says Cato, "make watered meadows." Land that is naturally rich and in good heart, says Columella, "does not need to have water set over it, because the hay produced in a juicy soil is better than that excited by water; when the poverty of the soil requires it, however, water may be set over it." The same author likewise describes, very particularly, the position of the land most proper for water meadows. "Neither a low field," says he, "with hollows, nor a field broken with steep rising grounds, are proper. The first, because it contains too long the water collected in the hollows; the last, because it makes the water to run too quickly over it. A field, however, that has a moderate descent, may be made a meadow, whether it is rich or poor, if so situated as to be watered. But the best situation is, where the surface is smooth, and the descent so gentle, as to prevent either showers, or the rivers that overflow it, from remaining long; and, on the other hand, to allow the water that comes over it gently to glide off. Therefore, if in any part of a field intended for a meadow, a pool of water should stand, it must be let off by drains; for the loss is equal, either from too much water or too little grass." (*Col.*, lib. ii. cap. 17.)

142. *Old water meadows were renewed by breaking up and sowing them with corn* for three years; the third year they were laid down with vetches and grass seeds, and then watered again, but "not with a great force of water, till the ground had become firm and bound together with turf." (*Col.*, lib. ii. cap. 18.) Watering, Pliny informs us, was commenced immediately after the equinox, and restrained when the grass sent up flower stalks; it was recommenced in mowing grounds, after the hay season, and in pasture lands at intervals.

143. *Draining*, though an operation of an opposite nature to watering, is yet essential to its success. It was particularly attended to by the Romans, both to remove surface water, and to intercept and carry off under the surface the water of springs. Cato gives directions for opening the furrows of sown fields, and clearing them so as the water might find its way readily to the ditches: and for wet-bottomed lands he directs to make drains three feet broad at top, four feet deep, and a foot and a quarter wide at the bottom; to lay them with stones, or, if these cannot be got, with willow rods placed contrariwise, or twigs tied together. (Cap. 43.) Columella directs both open and covered drains to be made sloping at the sides, and in addition to what Cato says respecting the water-ways of covered drains, directs to make the bottom narrow, and fit a rope made of twigs to it, pressing the rope firmly down, and putting some leaves or pine branches over it before throwing in the earth. Pliny says the ropes may be made of straw, and that flint or gravel may be used to form the water-way, filling the excavation half full, or to within eighteen inches of the top.

144. *Fencing* was performed by the Romans, but only to a limited extent. Varro says "the limits of a farm should be fenced (rendered obvious) by planting trees, that families may not quarrel with their neighbours, and that the limits may not want the

decision of a judge." (Lib. i. 15.) Palladius directs to enclose meadows, and gardens, and orchards. Columella mentions folds for enclosing the cattle in the night-time; but the chief fences of his time were the enclosures called parks for preserving wild beasts, and forming agreeable prospects from the villas of the wealthy. Pliny mentions these, and says they were the invention of Fulvius Lupinus. (*Nat. Hist.*, lib. viii.) Varro describes fences raised by planting briars or thorns, and training them into a hedge; and these, he says, have the advantage of not being in danger from the burning torch of the wanton passenger; fences of stalks, interwoven with twigs, ditches with earthen dykes, and walls of stone or brick, or rammed earth and gravel. (Lib. i. cap. 14.)

145. *Trees* were pruned and felled at different times, according to the object in view. The olive was little cut; the vine had a winter dressing, and one or two summer dressings. Green branches or spray, of which the leaves were used as food for oxen and sheep, were cut at the end of summer; copse wood for fuel, in winter; and timber trees generally in that season. Cato, however, directs that trees which are to be felled for timber should be cut down at different times, according to their natures: such as ripen seeds, when the seed is ripe; such as do not produce seeds, when the leaves drop; such as produce both flowers and seeds at the same time, also when the leaves drop; but if they are evergreens, such as the cypress and pine, they may be felled at any time.

146. *Fruits were gathered by hand.* The ripest grapes were cut first; such as were selected for eating were carried home and hung up; and those for the press were put in baskets, and carried to the wine-press to be picked and then pressed. Olives were plucked by hand, and some selected for eating; the rest were laid up in lofts for future bruising, or they were immediately pressed. Such as could not be reached by ladders, Varro directs to be "struck with a reed rather than with a rod, for a deep wound requires a physician." It does not appear that green olives were pickled and used as food as in modern times.

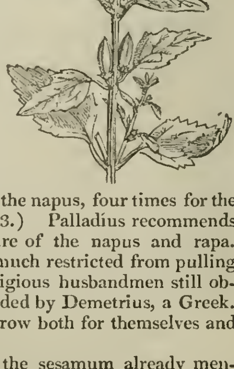
147. *Such are the chief agricultural operations of the Romans,* of which it cannot fail to be observed as most remarkable, that they differ little from what we know of the rural operations of the Jews and Greeks on the one hand, and from the practices of modern times on the other.

Subsect. 6. *Of the Crops cultivated, and Animals reared by the Romans.*

148. *The cereal grasses* cultivated by the Romans were chiefly the *triticum* or wheat, the *far*, or Indian corn (Zèa), and the *hordeum* or barley: but they sowed also the *siligo* or rye, the *holcus* or millet, the panic grass (*P*ánicum *m*iliàceum), and the *avena* or oat.

149. *Of legumes* they cultivated the *faba* or bean, the *pisum* or pea, the *lupinus* or lupine, the *ervum* or tare, the *lens* or flat tare (*L*áthyrus *C*ícera), the chickling vetch (*L*áthyrus satìvus), the chick or mouse pea (*C*ìcer arietìnum), and the kidneybean (*P*haseolus). The bean was used as food for the servants or slaves, the others were grown principally for food to the labouring cattle.

18



150. *The sesamum,* or oily grain (*S*ésamum orientàle *L.*) (*fig.* 18.), was cultivated for the seeds, from which an oil was expressed, and used as a substitute for that of olives, as it still is in India and China, and as the oil of the poppy is in Holland, that of the walnut in Savoy, and that of the hemp in Russia.

151. *The herbage plants* were chiefly the *trifolium* or clover, the medic or lucern, and the *cytisus*. What the latter plant is, has not been distinctly ascertained. They cultivated also the *ocymum* and *fœnum græcum*, with several others, which from the descriptions left of them cannot now be identified. The *napus* or turnip, and *rapa* or rape, were much esteemed and carefully cultivated. Pliny says "they require a dry soil; that the rapa will grow almost any where; that it is nourished by mists, hoar-frosts, and cold; and that he has seen some of them upwards of forty pounds' weight. The napus," he says, "delights equally in colds, which make it both sweeter and larger, while by heat they grow to leaves." He adds, "the more diligent husbandmen plough five times for the napus, four times for the rapa, and apply dung to both." (*Nat. Hist.*, lib. xviii. cap. 13.) Palladius recommends soot and oil as a remedy against flies and snails, in the culture of the napus and rapa. While the turnips were growing, it appears, persons were not much restricted from pulling them. Columella observes that, in his time, the more religious husbandmen still observed an ancient custom, mentioned by Varro as being recorded by Demetrius, a Greek. This was, that while sowing them they prayed they might grow both for themselves and neighbours. Pliny says the sower was naked.

152. *Of crops used in the arts* may be mentioned the flax, the sesamum already mentioned, and the poppy; the two latter were grown for their seeds, which were bruised for oil.

153. *The ligneous crops* were willows, both for basketmaking, and as ties and poles for olives and vines. Copse wood was grown in some places for fuel; but chiefly in natural woods, which were periodically cut. Timber was also procured from the natural forests, which were abundant in oak, elm, beech, pine, and larix.

19

154. *The fruit trees* cultivated extensively were the vine and the olive. The fig was grown in gardens and orchards, and also the pear; and in the gardens of the wealthy were found most fruits in present use, with the exception of the pine-apple, the gooseberry, and perhaps the orange, though the lemon seems to have been known in Palladius's time. The vine was supported by elms or poplars (*fig.* 19.), or tied to different sorts of trellises (*fig.* 20.), as in Italy at the present day.

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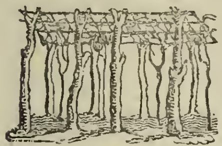


155. *Such are the principal field crops of Roman agriculture* from which, and from the list of cultivated vegetables given by Pliny, it appears that they had most plants and trees now in use, with the exception of the potato, and one or two others of less consequence.

156. *Of animals reared,* the quadrupeds were of the same kinds as at present; and to the common sorts of poultry they added thrushes, larks, peacocks, and turtle doves; they also reared snails, dormice, bees, and fish. The care of the poultry was chiefly committed to the wife of the farmer or bailiff; and it was principally near Rome and Naples that the more delicate birds were extensively reared. When Rome was at her greatest height, in the time of the Cæsars, the minor articles of farm produce bore a very high price. Varro informs us that "fat birds, such as thrushes, blackbirds, &c., were sold at two shillings, and sometimes 5000 of them were sold in a year from one farm. (*Var.*, lib. iii. cap. 2.) Pea-fowls were sold at 1*l.* 13*s.* 4*d.*; an egg was sold at 3*s.* 4*d.* A farm produced sometimes as many of these fowls as to sell at 500*l.* (*Var.*, lib. iii. cap. 6.) A pair of fine doves were commonly of the same price with a peacock, 1*l.* 13*s.* 4*d.* If very pretty, they were much higher in the price, no less than 8*l.* 6*s.* 8*d.* L. Anius, a Roman knight, refused to sell a pair under 13*l.* 6*s.* 8*d.*" (*Var.*, lib. iii. cap. 7.) Some kinds of fishes were very highly valued among the Romans in the time of Varro. Hortensius, whom Varro used frequently to visit, would sooner have parted with a pair of his best coach-mules, than with a bearded mullet. (*Var.*, lib. iii. cap. 17.) Herrius's fishponds, on account of the quantity of fish, were sold for 33,333*l.* 6*s.* 8*d.* (*Plin. Nat. Hist.*, lib. ix. cap. 55.); Lucullus's, likewise, for the same price. (*Id.*, lib. ix. cap. 54.)

Subsect. 7. *Of the general Maxims of Farm Management among the Romans.*

157. *In every art which has been long practised, there are maxims of management which have been handed down from one generation to another;* and in no art are there more of these than in agriculture. Maxims of this sort were held among the Romans in the greatest estimation, and their writers have recorded a number derived from the lost Greek writers, and from their own traditionary or experimental knowledge. A few of these shall be noticed, as characteristic of Roman economy, and not without their use in modern times.

158. *To sow less and plough better* was a maxim indicating that the extent of farms ought to be kept in their proper bounds. Pliny and Virgil consider large farms as prejudicial, and Columella says, one of the seven wise men has pronounced that there should be limits and measures in all things. "You may admire a large farm, but cultivate a small one;" and the Carthaginian saying, that "the land ought to be weaker than the husbandman," were maxims to the same effect.

159. *The importance of the master's presence* in every operation of farming, was inculcated by many maxims. "Whoever would buy a field ought to sell his house, lest he delight more in the town than in the country," was a saying of Mago. "Wherever the eyes of the master most frequently approach," says Columella, "there is the greatest increase." It is justly remarked by the Rev. A. Dickson, that though "every person knows that the presence and attention of the master is of great importance in every business; yet every person does not know, that in no business are they so important as in farming." (*Husb. of the An.*, i. 206.)

160. *That more is to be gained by cultivating a small spot well than a large space indifferently,* is illustrated by many sayings and stories. "A vine-dresser had two daughters and a vineyard; when his eldest daughter was married, he gave her a third of his vineyard for a portion; notwithstanding which, he had the same quantity of fruit as formerly. When his younger daughter was married he gave her the half of what remained, and still the produce of his vineyard was not diminished." (*Col.*, lib. iv. cap. 3.) Pliny mentions a freedman, who having much larger crops than his neighbours, was accused of witchcraft

and brought to trial. He produced in the forum a stout daughter, and his excellently constructed iron spades, shears, and other tools, with his oxen, and said, " These, Romans, are my charms." He was acquitted. (*Nat. Hist.*, lib. xviii. cap. 6.)

161. *Ostentatious or profuse culture* is not less condemned than imperfect culture. " The ancients," says Pliny, " assert that nothing turns to less account than to give land a great deal of culture. To cultivate well is necessary, to cultivate in an extraordinary manner is hurtful. In what manner, then," he asks, " are lands to be cultivated to the best advantage ?" To this he answers, " In the cheapest manner, if it is good ;" or " by good bad things," which, he says, were the words in which the ancients used to express this maxim.

162. *Industry* is recommended by numerous maxims. " The ancients," says Pliny, " considered him a bad husbandman who buys what his farm can produce to him ; a bad master of a family, who does in the day-time what he may do at night, except in the time of a storm ; a worse, who does on common days what is lawful on holidays ; the worst of all, who on a good day is employed more within doors than in the fields." (*Nat. Hist.*, lib. xviii. cap. 6.)

163. *Kindness and humanity to servants and slaves* is strongly recommended. " Slaves," says Varro, " must not be timid nor petulant. They who preside must have some de ree of learning and education ; they must be frugal, older than the workmen, for the latter are more attentive to the directions of these, than they are to those of younger men. Besides, it must be most eligible that they should preside, who are experienced in agriculture ; for they ought not only to give orders, but to work, that they may imitate him, and that they may consider that he presides over them with reason, because he is superior in knowledge and experience : nor is he to be suffered to be so imperious to use coercion with stripes rather than words, if this can be done. Nor are many to be procured of the same country, for domestic animosities very often arise from this source. You must encourage them who preside, by rewarding them, and you must endeavour to let them have some privilege, and maid servants wedded to them, by whom they may have a family ; for by these means they become more steady and more attached to the farm. On account of these connections, the Epirotic families are so distinguished and attached. To give the persons who preside some degree of pleasure, you must hold them in some estimation ; and you must consult with some of the superior workmen concerning the work that is to be done : when you behave thus, they think that they are less despicable, and that they are held in some degree of esteem by their master. They become more eager for work by liberal treatment, by giving them victuals, or a large garment, or by granting them some recreation or favour, as the privilege of feeding something on the farm, or some such thing. In relation to them, who are commanded to do work of greater drudgery, or who are punished, let somebody restore their good will and affection to their master by affording them the benefit of consolation."

164. *Knowledge in matters relative to agriculture* is inculcated by all the rustic authors. " Whoever," says Columella, " would be perfect in this science, must be well acquainted with the qualities of soils and plants ; must not be ignorant of the various climates, that so he may know what is agreeable, and what is repugnant, to each ; he must know exactly the succession of the seasons, and the nature of each, lest, beginning his work when showers and wind are just at hand, his labour shall be lost. He must be capable to observe exactly the present temper of the sky and seasons ; for these are not always regular, nor in every year does the summer and winter bring the same kind of weather, nor is the spring always rainy, and the autumn wet. To know these things before they happen, without a very good capacity, and the greatest care to acquire knowledge, is, in my opinion, in the power of no man." (*Col.*, lib. i. præf.) To these things mentioned by Columella, Virgil adds several others. " Before we plough a field to which we are strangers," says he, " we must be careful to attain a knowledge of the winds, from what points they blow at the particular seasons, and when and from whence they are most violent ; the nature of the climate, which in different places is very different ; the customs of our forefathers ; the customs of the country ; the qualities of the different soils ; and what are the crops that each country and climate produces and rejects." (*Virg. Georg.*, i. 1.)

165. *The making of experiments* is a thing very strongly recommended to the farmer by some of our authors. " Nature," says Varro, " has pointed out to us two paths, which lead to the knowledge of agriculture, viz. experience and imitation. The ancient husbandmen, by making experiments, have established many maxims. Their posterity, for the most part, imitate them ; we ought to do both, imitate others and make experiments ourselves, not directed by chance, but reason." (*Var.*, lib. i. cap. 18.)

Sect. V. *Of the Produce and Profit of Roman Agriculture.*

166. *The topics of produce and profits in agriculture, are very difficult to be discussed satisfactorily.* In manufactures the raw material is purchased for a sum certain, and the

manipulation given by the manufacturer can be accurately calculated; but in farming, though we know the rent of the land and price of seed-corn, which may be considered the raw materials; yet the quantity of labour required to bring forth the produce, depends so much on seasons, accidents, and other circumstances, to which agriculture is more liable than any other art, that its value or cost price cannot easily be determined. It is a common mode to estimate the profits of farming by the numerical returns of the seed sown. But this is a most fallacious ground of judgment, since the quantity of seed given to lands of different qualities, and of different conditions, is very different; and the acre, which, being highly cultivated and sown with only a bushel of seed, returns forty for one, may yield no more profit than that which, being in a middling condition, requires four bushels of seed, and yields only ten for one.

167. *The returns of seed sown*, mentioned by the ancients, are very remarkable. We have noticed Isaac's sowing and reaping at Gerar (7.), where he received a hundred for one. In Mark's gospel, " good seed sown upon good ground, is said to bring forth in some places thirty, in others forty, in others sixty, and in others even an hundred fold." (*Mark*, iv. 8.) A hundred fold, Varro informs us, was reaped about Garada in Syria, and Byzacium in Africa. Pliny adds, that from the last place, there were sent to Augustus by his factor nearly 400 stalks, all from one grain; and to Nero, 340 stalks. He says he has seen the soil of this field, " which when dry the stoutest oxen cannot plough; but after rain I have seen it opened up by a share, drawn by a wretched ass on the one side, and an old woman on the other." (*Nat. Hist.*, lib. xviii. cap. 5.) The returns in Italy were much less extraordinary. Varro says, there are sown on a jugerum, four modii (pecks) of beans, five of wheat, six of barley, and ten of far (maize); more or less as the soil is rich or poor. The produce is in some places ten after one, but in others, as in Tuscany, fifteen after one." (Lib. i. cap. 44.) This, in round numbers, is at the rate of twenty-one and thirty-two bushels an English acre. On the excellent lands of Leontinum in Sicily, the produce, according to Cicero, was no more than from eight to ten for one. In Columella's time, when agriculture had declined, it was still less.

168. *The farmer's profit* cannot be correctly ascertained; but, according to a calculation made by the Rev. A. Dickson, the surplus produce of good land in the time of Varro, was about fifteen pecks of wheat per acre; and in the time of Columella, lands being worse cultivated, it did not exceed three and one third pecks per acre. What proportion of this went to the landlord cannot be ascertained. Corn, in Varro's time, was from 4*d.* to 5½*d.* per peck; seventy years afterwards, in the time of Columella, it had risen to 1*s.* 9*d.* per peck. Vineyards were so neglected in the time of this author, that they did not yield more to the landlord as rent, than 14*s.* or 15*s.* per acre.

169. *The price of land*, in the time of Columella and Pliny, was twenty-five years' purchase. It was common, both these writers inform us, to receive 4 per cent for capital so invested. The interest of money was then 6 per cent; but this 6 per cent was not what we would call legal interest; money among the Romans being left to find its value, like other commodities, of course the interest was always fluctuating. — Such is the essence of what is known as to the produce, rent, and price of lands among the Romans.

Sect. VI. *Of the Roman Agriculturists, in respect to general Science, and the Advancement of the Art.*

170. *The sciences cultivated by the Greeks and Romans were chiefly of the mental and mathematical kind.* They knew nothing of chemistry or physiology, and very little of other branches of natural philosophy; and hence their progress in the practical arts was entirely the result of observation, experience, or accident. In none of their agricultural writers is there any attempt made to give the *rationale* of the practices described: absolute directions are either given, as is frequently the case in Virgil and Columella; or the historical relation is adopted, and the reader is informed what is done by certain persons, or in certain places, as is generally the case with Varro and Pliny.

171. *Wherever the phenomena of nature are not accounted for scientifically, recourse is had to supernatural causes;* and the idea of this kind of agency once admitted, there is no limit that can be set to its influence over the mind. In the early and ignorant ages, good and evil spirits were supposed to take a concern in every thing; and hence the endless and absurd superstitions of the Egyptians, some of which have been already noticed, and the equally numerous though perhaps less absurd rites and ceremonies of the Greeks, to procure their favour, or avert their evil influence. Hesiod considered it of not more importance to describe what works were to be done, than to describe the lucky and unlucky days for their performance. Homer, Aristotle, Theophrastus, and all the Greek authors, are more or less tinctured with this religion, or superstition as we are pleased to call it, of their age.

172. *As the Romans made few advances in science*, consequently they made equally few in divesting themselves of the superstitions of their ancestors. These, as most readers know, entered into every action and art of that people, and into none more than agri-

culture. In some cases it is of importance for the general reader to be aware of this, before perusing their rustic authors; as in the case of heterogeneous grafting, and the spontaneous generation and transmutation of plants, which, though stated by Virgil and Pliny, and others, as facts, are known to every physiologist to be impossible: but other relations are too gross to be entertained as truths by any one. Of these we may mention the lunar days, the impregnation of animals by particular winds, &c. It is impossible not heartily to concur with Lord Kaimes in congratulating the present age on its delivery from such "heavy fetters." It is curious to observe the religious economy of Cato. After recommending the master of the family to be regular in performing his devotions, he expressly forbids the rest of the family to perform any, either by themselves or others, telling them that they were to consider that the master performed sufficient devotions for the family. (*Cat.*, cap. 43.) This was probably intended not only to save time, but also to prevent such slaves as had naturally more susceptible imaginations than the others, from becoming religious enthusiasts.

173. *What degree of improvement agriculture received from the Romans*, is a question we have no means of answering. Agriculture appears obviously to have declined from the time of Cato and Varro to Pliny; and therefore any improvement it received must have taken place antecedently to their era. As these authors, however, generally refer to the Greeks as their masters in this art, it appears very doubtful whether they did any thing more than imitate their practice. As a more luxurious people, they introduced new fruits, and probably improved the treatment of birds, and other minor products; but these belong more to gardening and domestic economy, than to field cultivation. In the culture of corn, herbage, plants, and fruit trees, and in the breeding and rearing of cattle, Noah and his sons, the Jews, the Babylonians, Egyptians, and Greeks, may have been as far advanced as the Romans, for any thing that appears to the contrary. The great agricultural advantage which mankind have derived from the Romans, is the diffusion of the art by their almost universal conquests.

Sect. VII. *Of the Extent to which Agriculture was carried in the Roman Provinces, and of its Decline.*

174. *The art of agriculture was not only familiar to, but held in estimation by, every Roman soldier.* It was practised by him in every foreign country where he was stationary; and he taught it to the inhabitants of such as were uncultivated. In some countries, as in Carthaginia, great part of Spain, and a part of the south-east of France, agriculture was as far advanced as in Italy; because at Carthage and Marseilles the Greeks had planted colonies, which flourished anterior to the Romans, or at least long before they extended their conquests to these countries: but in Helvetia, Germany, and Britain, it was in a very rude state or unknown.

175. *In Germany*, except on the borders of the Rhine, agriculture was never generally practised. The greater part of the country was covered with forests; and hunting and pasturage were the chief occupations of the people when not engaged in war. The decline of the Roman power in that country, therefore, could make very little difference as to its agriculture.

176. *In Britain*, according to Cæsar, *agriculture was introduced by colonies from Belgium*, which took shelter there from the encroachments of the Belgæ from Germany, about B.C. 150. These colonies began to cultivate the sea coasts; but the natives of the inland parts lived on roots, berries, flesh, and milk, and it appears from Dionysius that they never tasted fish. Pliny mentions the use of marl as being known to the Britons; and Diodorus Siculus describes their method of preserving corn, by laying it up in the ear in caves or granaries.

177. *But the general spread of agriculture in Britain* was no doubt effected by the Romans. The tribute of a certain quantity of corn, which they imposed on every part of the country, as it fell under their dominion, obliged the inhabitants to practise tillage; and from the example of the conquerors, and the richness of the soil, they soon not only produced a sufficient quantity of corn for their own use and that of the Roman troops, but afforded every year a very great surplus for exportation. The Emperor Julian, in the fourth century, built granaries to receive this corn, and on one occasion sent a fleet of eight hundred ships, "larger than common barks," to convey it to the mouth of the Rhine, where it was sent up the country for the support of the plundered inhabitants.

178. *Agriculture among the Romans themselves had begun to decline in Varro's time*, and was at a low ebb in the days of Pliny. Many of the great men in Rome, trusting to their revenues from the provinces, neglected the culture of their estates in Italy; others, in want of money to answer the demands of luxury, raised all they could upon credit or mortgage, and raised the rents of their tenants to an oppressive height to enable them to pay the interest. The farmer was in this manner deprived of his capital; his spirits were broken, and he ceased to exert himself, or became idle and rapacious like his landlord. The civil wars in the end of the second century, the tyrannic conduct of

the emperors in the third; and the removal of the seat of empire to Constantinople in the middle of that which followed, prepared the way for the entrance of the Goths in the beginning of the fifth century, which completed the downfal of agriculture and every peaceful art. It declined at the same time in all the western provinces: in Africa and Spain, from the incursions of the Moors; in France, from the inroads of the Germans; in Germany and Helvetia, from the inhabitants leaving their country and preferring a predatory life in other states; and in Britain, from the invasion of the Saxons, and the inroads of the Scots and Picts.

Chap. III.

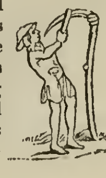
History of Agriculture during the Middle Ages, or from the Fifth to the Seventeenth Century.

179. *In the ages of anarchy and barbarism which succeeded the fall of the Roman power* in Europe, agriculture appears to have been abandoned, or at least extremely neglected. Pasturage, in troublesome times, is always preferred to tillage, because sheep or cattle may be concealed from an enemy, or driven away on his approach; but who would sow without a certainty of being able to reap? Happily, the weaknesses of mankind sometimes serve to mitigate the effects of their vices. Thus, the credulity of the barbarians of those times led them to respect the religious establishments, and in these were preserved such remains of letters and of arts as had escaped from utter destruction. These institutions were at first very limited, both in their buildings and possessions, and the inhabitants frugal and virtuous in their habits; but in a very few years, by the grants of the rich warriors, they acquired extensive possessions; erected the most magnificent buildings, and lived in abundance and luxury. Their lands were cultivated by servants, under the direction of the priests, who would have recourse for information to the Roman agricultural writers, which, in common with such other books as then existed, were almost exclusively to be found in their libraries. We know little of the progress of agriculture under these circumstances for nearly ten centuries, when it began to revive throughout Europe among the lay proprietors. We shall notice some particulars relative to this revival, first in Italy, and next in Germany, France, and England. So little is known of the husbandry of Spain and the Netherlands during this period, that we shall defer what we have to say of those countries till we treat of their modern state.

Sect. I. *History of Agriculture in Italy, during the Middle Ages.*

180. *Little is known of the agriculture of Italy from the time of Pliny till that of* Crescenzio, a senator of Bologna, whose work *In Commodum Ruralium,* written in 1300, was first printed at Florence in 1478. He was soon followed by several of his countrymen, among whom Tatti, Stefano, Augustino Gallo, Sansovino, Lauro, and Torello deserve to be mentioned with honour. From some records, however, it appears that irrigation had been practised in Italy previously to 1037. The monks of Chiaravalle had formed extensive works of this kind, and had become so celebrated as to be consulted and employed as hydraulic engineers, by the Emperor Frederic I., in the thirteenth century. Silkworms were imported from Greece into Sicily by Roger, the first king of that island, in 1146; but they did not extend to the Continental states for many years afterwards.

181. *In the early part of the fourteenth century,* the inhabitants of the south of Italy were strangers to many of the conveniences of life; they were ignorant of the proper cultivation of the vine, and the common people were just beginning to wear shirts. The Florentines were the only people of Italy who, at that time, traded with England and France. The work of Crescenzio is, in great part, a compilation from the Roman authors; but an edition published at Basil in 1548, and illustrated with figures, may probably be considered as indicating the implements then in use. The plough is drawn by only one ox: but different kinds to be drawn by two and four oxen are described in the text. A driver is also mentioned, which shows that the ploughmen in those days were less expert than during the time of the Romans, who did not use drivers. A waggon is described with a wooden axle and low wooden wheels; each wheel formed either of one piece or of four pieces joined together. Knives, scythes (*fig.* 21.), and grafting-tools, as well as the mode of performing the operation, are figured. Sowing was then performed exactly as it was among the Romans, and is still in most parts of Europe, where a sowing machine is not employed. The various hand tools for stirring and turning the soil are described and exhibited; and the Roman bidens shown as in use for cultivating the vine. All the agricultural and horticultural plants described by Pliny are treated of, but no others.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182. *Towards the end of the sixteenth century,* Torello's *Ricordo d'Agricultura* was published. In 1584, Pope Sixtus, according to Harte (*Essay* i.), forced his subjects to work, that they might pay the heavy taxes imposed on them; and by this means rendered them happy and contented, and himself rich and powerful. He found them sunk in sloth, overrun with pride and poverty, and lost to all sense of civil duties; but he recovered them from that despicable state, first to industry, and next to plenty and regularity.

183. *Naples* being at this period a Spanish province, the wars in which Spain was engaged obliged her to put a tax upon fruit; and as fruits were not only the chief delicacies, but articles of subsistence, among the Neapolitans, this imposition is said to have rendered them industrious. But though some agricultural books were published at Naples during the sixteenth century, there is no evidence that they ever made much progress in culture. Their best lands are in Sicily; and on them a corn crop and a fallow was and is the rotation, and the produce seldom exceeded eight or ten for one, as in the time of the Romans. This is the case in Sicily at present; and it is likely that it was not different, or at least, that it was not better, from the fifth to the seventeenth centuries.

184. *The greatest agricultural improvements in Italy* which took place during the period in question, were in Tuscany and Lombardy, In the former country the culture of the vine and the olive were brought to greater perfection than any where else in Europe. The oil of Lucca and the wines of Florence became celebrated in other countries, and the commerce in these articles enriched the inhabitants, and enabled the proprietors to bestow increased attention on the cultivation of their estates. Lombardy excelled in the management of corn and cattle as well as of the vine. The butter, cheese, and beef of the country, were esteemed the best in Italy. The pastures were at that time, and still are, more productive than any in Europe, or perhaps in the world, having the three advantages of a climate so temperate in winter that the grass grows all the year, a soil naturally rich, and an abundant supply of river water for irrigation. The irrigation of Lombardy forms the chief feature of its culture. It was begun and carried to a considerable extent under the Romans, and in the period of which we speak extended and increased under the Lombard kings and wealthy religious establishments. Some idea may be formed of the comfort of the farmers in Lombardy in the thirteenth century, by the picture of a farm-house given by Crescenzio, who lived on its borders, which, as a French antiquarian (Paulinay) has observed, differs little from the best modern ones of Italy, but in being covered with thatch.

SECT. II. *History of Agriculture in France, from the Fifth to the Seventeenth Century.*

185. *The nations who conquered France in the fifth century* were the Goths, Vandals, and Franks. The two former nations claimed two thirds of the conquered lands (*Leges Burgundiorum,* tit. 54.), and must of course have very much altered both the state of property, and the management of the affairs of husbandry. The claim of the Franks is more uncertain; they were so much a warlike people, that they probably dealt more favourably with those whom they subjected to their dominion.

186. *All that is known of the agriculture of these nations and of France, till the ninth century,* is derived from a perusal of their laws. These appear to have been favourable to cultivation, especially the laws of the Franks. Horses are frequently mentioned, and a distinction made between the war horse and farm horse, which shows that this animal was at that period more common in France than in Italy. Horses, cattle, and sheep were pastured in the forests and commons, with bells about the necks of several of them, for their more ready discovery. The culture of vines and orchards was greatly encouraged by Charlemagne in the ninth century. He planted many vineyards on the crown lands which were situated in every part of the country, and left in his capitularies particular instructions for their culture. One of his injunctions prohibits an ox and an ass from being yoked together in the same plough.

187. *During great part of the ninth and tenth centuries,* France was harassed by civil wars, and agriculture declined; but to what extent, scarcely any facts are left us to ascertain. A law passed in that period, respecting a farmer's tilling the lands of his superior, enacts that, if the cattle are so weak that four could not go a whole day in the plough, he was to join these to the cattle of another and work two days instead of one. He who kept no cattle of his own was obliged to work for his superior three days as a labourer.

188. *In the eleventh and twelfth centuries,* the country enjoyed more tranquillity, and agriculture was improved. Judging from the Abbé Suger's account of the abbey lands of St. Denis, better farm-houses were built, waste lands cultivated, and rents more than doubled. The church published several canons for the security of agriculture during this period, which must have had a beneficial effect, as the greatest proportion of the best lands in every country was then in the hands of the clergy.

189. *In the thirteenth century* little alteration took place; but the number of holidays were diminished, and mills for grinding corn driven by wind introduced.

190. *In the fourteenth and fifteenth centuries,* agriculture suffered greatly by the English wars and conquests, and by political regulations relative to the export and market price of corn.

191. *About the middle of the sixteenth century,* the first agricultural work produced in France made its appearance. It was entitled, *Les Moyens de devenir riche,* and was composed by Bernard de Pallisy, a potter, who had written on various subjects. It is a very short tract, composed of economical remarks on husbandry, or rural and domestic economy. Towards the end of this century, under Henry IV., and his virtuous minister Sully, considerable enterprise was displayed. Canals were projected, and one begun, and, according to Sully, France in his time abounded with corn, grain, pulse, wine, cider, flax, hemp, salt, wool, oil, dying drugs, cattle great and small, and every thing else, whether necessary or convenient for life, both for home consumption and exportation. (*Mem.,* xvi. 225. ; *Ranken's Hist. of France,* i. 433.)

Sect. III. *Of the Agriculture of Germany and other Northern States, from the Fifth to the Seventeenth Century.*

192. *The nations north of the Rhine and the Danube,* during the first half of these centuries, were chiefly employed in making inroads or conquests on their southern neighbours ; and during the whole period they were more or less engaged in attacking one another. Under such circumstances, agriculture must either have remained in the state which we have already described (178.), or it must have declined. In some states or kingdoms it may have been less neglected than in others, or may even have improved ; but, during the whole of this period, nothing was effected which demands particular attention.

193. *The earliest German author on husbandry* is Conradus Heresbachius, who was born in 1508, and died in 1576. His work, *De Re Rustica,* was published after his death. It is an avowed compilation from all the authors who had preceded him, and contains no information as to the state of agriculture around him. It is a dialogue in four books, and also includes gardening. The persons are Cono, a gentleman retired into the country ; Rigo, a courtier ; Metelea, wife of Cono ; and Hermes, a servant. The conversation is carried on in Cono's house, and on his farm, and the different speakers are made to deliver all that has been said by all the Greek and Roman writers, from Hesiod to Pliny, by Crescenzio and other Italians, and by various writers on general subjects: they converse on the advantages of agriculture as a pursuit ; on its general maxims and practices ; on the culture of particular plants ; and on the economy of the house and garden.

194. *No other books on agriculture, of any note, appeared in Germany during the period under review.* About the middle of the sixteenth century, the Elector of Saxony, Augustus II., is said to have encouraged agriculture, and to have planted the first vineyard in Saxony ; but, from the implements with which he worked in person, which are still preserved in the arsenal of Dresden, he appears to have been more a gardener than a farmer. It is to be regretted that the histories of the arts in the northern countries during the middle ages are very few, and so little known or accessible, that we cannot derive much advantage from them.

Sect. IV. *History of Agriculture in Britain, from the Fifth to the Seventeenth Century.*

195. *Britain, on being quitted by the Romans, was invaded by the Saxons,* a ferocious and ignorant people, by whom agriculture and all other civilised arts were neglected. In the eleventh century, when the Saxons had amalgamated with the natives, and constituted the main body of the English nation, the country was again invaded by the Normans, a much more civilised race, who introduced considerable improvement. These two events form distinct periods in the history of British agriculture, and two others will bring it down to the seventeenth century.

Subsect. 1. *History of Agriculture in Britain during the Anglo-Saxon Dynasty, or from the Fifth to the Eleventh Century.*

196. *At the arrival of the Anglo-Saxons* this island, according to Fleury (*History,* vol. iv. p. 97.), abounded in numerous flocks and herds, which these conquerors seized, and pastured for their own use ; and, after their settlement, they still continued to follow pasturage as one of the chief means of their subsistence. This is evident from the great number of laws that were made in the Anglo-Saxon times, for regulating the prices of all kinds of tame cattle, for directing the manner in which they were to be pastured, and for preserving them from thieves, robbers, and beasts of prey. (*Wilkins, Leges Saxon.,* passim.)

197. *The Welsh in this period,* from the nature of their country and other circumstances, depended still more on their flocks and herds for their support ; hence their laws respecting pasturage were more numerous and minute than those of the Saxons. (*Leges*

Wallicæ, passim.) From these laws we learn, among many other particulars which need not be mentioned, that all the cattle of a village, though belonging to different owners, were pastured together in one herd, under the direction of one person (with proper assistants); whose oath, in all disputes about the cattle under his care, was decisive.

198. *By one of these laws, they were prohibited from ploughing with horses, mares, or cows,* and restricted to oxen. (*Leges Wallicæ*, p. 288.) Their ploughs seem to have been very slight and inartificial: for it was enacted that no man should undertake to guide a plough, who could not make one; and that the driver should make the ropes with which it was drawn of twisted willows. (*Ibid.*, p. 283.) Hence the names still in use of ridge-withy, wanty or womb-tye, whipping-trees, tail-withes, &c. But slight as these ploughs were, it was usual for six or eight persons to form themselves into a society for fitting out one of them, and providing it with oxen, and every thing necessary for ploughing; and many minute and curious laws were made for the regulation of such societies. This is a sufficient proof both of the poverty of the husbandmen, and of the imperfect state of agriculture among the ancient Britons in this period.

199. *Certain privileges were allowed to any person who laid dung on a field,* cut down a wood, or folded his cattle on another's land for a year. Such was the state of agriculture during this period in Wales; it was probably in a still more imperfect state among the Scots and Picts, but this we have no means of ascertaining.

200. *Our Anglo-Saxon ancestors derived their origin and manners from the ancient Germans,* who were not much addicted to agriculture, but depended chiefly on their flocks and herds for their subsistence. (*Strabo*, l. vii.; *Cæsar de Bell. Gall.*, l. vi.) These restless and haughty warriors esteemed the cultivation of their lands too ignoble and laborious an employment for themselves, and therefore committed it wholly to their women and slaves. (*Tacit. de Morib. German.*, c. 15.) They were even at pains to contrive laws to prevent their contracting a taste for agriculture, lest it should render them less fond of arms and warlike expeditions. (*Id.*, c. 26.)

201. *The division of landed estates into what are called inlands and outlands,* originated with the Saxon princes and great men, who, in the division of the conquered lands, obtained the largest shares, and are said to have subdivided their territory into two parts, which were so named. The inlands were those which lay most contiguous to the mansion-house of their owner, which he kept in his own immediate possession, and cultivated by his slaves, under the direction of a bailiff, for the purpose of raising provisions for his family. The outlands were those which lay at a greater distance from the mansion-house, and were let to the ceorls or farmers of those times at a certain rent, which was very moderate, and generally paid in kind. (*Reliquiæ Spelmannianæ*, p. 12.)

202. *The rent of lands in these times was established by law,* and not by the owners of the land. By the laws of Ina, king of the West Saxons, who flourished in the end of the seventh and beginning of the eighth century, a farm consisting of ten hides, or plough lands, was to pay the following rent, viz. ten casks of honey, three hundred loaves of bread, twelve casks of strong ale, thirty casks of small ale, two oxen, ten wethers, ten geese, twenty hens, ten cheeses, one cask of butter, five salmon, twenty pounds of forage, and one hundred eels. (*Wilkins, Leges Saxon.*, p. 25.) The greatest part of the crown lands in every county was farmed in this manner by ceorls or farmers, who in general appear to have been freemen and soldiers.

203. *Very little is known of the implements or operations of husbandry during this period.* In one of Strutt's plates of ancient dresses, entitled, *Saxon Rarities of the Eighth Century*, may be seen a picture of a plough and ploughman. (*fig.* 22.) This is sufficiently rude, though it has evidently undergone some improvement from the art of the delineator. The labourers were no doubt slaves, and the animals of draught, oxen. The lands belonging to the monasteries were by much the best cultivated; because the secular canons who possessed them spent some part of their time in cultivating their own lands. The venerable Bede, in his life of Easterwin, Abbot of Weremouth, tells us that "This abbot, being a strong man, and of an humble disposition, used to assist his monks in their rural labours, sometimes guiding the plough by its stilt or handle, sometimes winnowing corn, and sometimes forging instruments of husbandry with a hammer upon an anvil." (*Bedæ Hist. Abbat. Weremath.*, p. 296.) For in those times the husbandmen were under a necessity of making many implements of husbandry with their own hands.

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Subsect. 2. *Of the State of Agriculture in Britain after the Norman Conquest, or from the Eleventh to the Thirteenth Centuries.*

204. *That the conquest of England by the Normans contributed to the improvement of agriculture in Britain is undeniable.* " For by that event many thousands of husbandmen, from the fertile and well cultivated plains of Flanders, France, and Normandy, settled in this island, obtained estates or farms, and employed the same methods in the cultivation of them that they had used in their native countries. Some of the Norman barons were great improvers of their lands, and are celebrated in history for their skill in agriculture." " Richard de Rulos, lord of Brunne and Deeping," says Ingulphus, " was much addicted to agriculture, and delighted in breeding horses and cattle. Besides enclosing and draining a great extent of country, he imbanked the river Wielland, (which used every year to overflow the neighbouring fields) in a most substantial manner, building many houses and cottages upon the bank ; which increased so much, that in a little time they formed a large town called *Deeping*, from its low situation. Here he planted orchards, cultivated commons, converted deep lakes and impassible quagmires into fertile fields, rich meadows, and pastures ; and, in a word, rendered the whole country about it a garden of delights." (*Hist. Ingulphi.*, Oxon. edit. 1684, tom. i. p. 77, 78.) From the above description, it appears that this nobleman (who was chamberlain to William the Conqueror) was not only fond of agriculture, but also that he conducted his improvements with skill and success.

205. *The Norman clergy, and particularly the monks*, were still greater improvers than the nobility ; and the lands of the church, especially of the convents, were conspicuous for their superior cultivation : for the monks of every monastery retained such of their lands as lay most convenient in their own possession, which they cultivated with great care, under their own inspection, and frequently with their own hands. It was so much the custom of the monks of this period to assist in the cultivation of their lands, especially in seed-time, hay-time, and harvest, that the famous Thomas Becket, after he was Archbishop of Canterbury, used to go out to the field, with the monks of the monasteries where he happened to reside, and join with them in reaping their corn and making their hay. (*Chron. Gervas.*, col. 1400.) This is indeed mentioned by the historian as an act of uncommon condescension in a person of his high station in the church ; but it is sufficient proof that the monks of those times used to work with their own hands, at some seasons, in the labours of the field : and, as many of them were men of genius and invention, they no doubt made various improvements in the art of agriculture. The twenty-sixth canon of the general council of Lateran, held A.D. 1179, affords a further proof that the protection and encouragement of all who were concerned in agriculture, were objects of attention to the church. For by that canon it is decreed, " That all presbyters, clerks, monks, converts, pilgrims, and peasants, when they are engaged in the labours of husbandry, together with the cattle in their ploughs, and the seed which they carry into the field, shall enjoy perfect security ; and that all who molest or interrupt them, if they do not desist when they have been admonished, shall be excommunicated." (*Ibid.*, col. 1456.)

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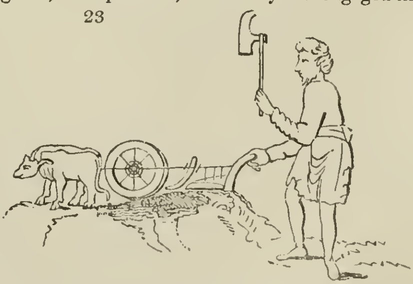

206. *The implements of husbandry, in this period*, were of the same kind with those that are employed at present, though all of them, no doubt, much less perfect in their construction. One sort of plough, for example, had but one stilt or handle, which the ploughman guided with one hand, having in his other hand an instrument which served both for cleaning and mending his plough, and breaking the clods. (*fig.* 23.) This implement was probably intended for breaking up strong lands ; for such a purpose the wheels would contribute much to its steadiness, which would render two handles unnecessary, and thus leave the holder with one hand at liberty to use his axe-like instrument in clearing away roots and clods, or otherwise aiding the operation of the plough. Another plough (*fig.* 24.) seems to have been without wheels, and was propably intended for light soil. (See *Strutt's Complete View of the Manners, &c. of England*, vol. ii. p. 12.) The Norman

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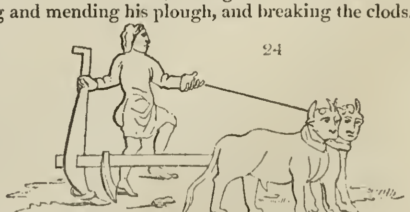

plough had two wheels; and, in the light soil of Normandy, was commonly drawn by one ox, or two oxen; but in England a greater number, according to the nature of the soil, were often necessary. (*M. Montfaucon, Monumens de Monarchie François*, tom. i. plate 47.; *Girald. Cambrens. Descript. Cambriæ*, c. 17.) In Wales, the person who conducted the oxen in the plough walked backwards. (*Girald. Cambrens.*, c. 17.) Their carts, harrows, scythes, sickles, and flails, from the figures of them still remaining, appear to have been nearly of the same construction with those that are now used. (*Strutt's View*, vol. i. pl. 26. 32, 33. and our *fig.* 25.) In Wales they did not use a sickle in reaping their corn, but an instrument like the blade of a knife, with a wooden handle at each end. (*Girald. Cam.*, c. 17.) Water-mills for grinding corn were very common, but they had also a kind of mills turned by horses, which were chiefly used in their armies, and at sieges, or in places where running water was scarce. (*Gaufrid. Vinisauf. Iter Hierosolymit.*, l. i. c. 33.; *M. Paris, Vit. Abbot.*, p. 94. col. 2.)

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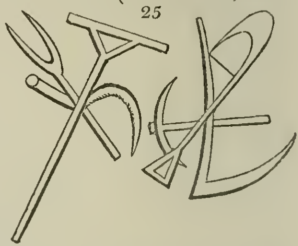

207. *The various operations of husbandry*, as manuring, ploughing, sowing, harrowing, reaping, threshing, winnowing, &c., are incidentally mentioned by the writers of this period; but it is impossible to collect from them a distinct account of the manner in which these operations were performed. Marl seems to have been the chief manure next to dung, employed by the Anglo-Normans, as it had been by the Anglo-Saxon and British husbandmen. (*M. Paris, Hist.*, p. 181.; *In Vit. Abbot.*, p. 101. col. 1.) Summer fallowing of lands designed for wheat, and ploughing them several times, appear to have been common practices of the English farmers of this period: for Giraldus Cambrensis, in his description of Wales, takes notice of it as a great singularity in the husbandmen of that country, "that they ploughed their lands only once a year, in March or April, in order to sow them with oats; but did not, like other farmers, plough them twice in summer, and once in winter, in order to prepare them for wheat." (*Girald. Cambrens. Descript. Cambriæ*, c. viii. p. 887.) On the border of one of the compartments in the famous tapestry of Bayeux, we see the figure of one man sowing with a sheet about his neck, containing the seed under his left arm, and scattering it with his right hand; and of another man harrowing with one harrow, drawn by one horse. (*Montfaucon, Monumens de Monarchie François*, tom. i. plate 47.) In two plates of Strutt's very curious and valuable work (*figs.* 26, 27.), we perceive the figures

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of several persons engaged in mowing, reaping, threshing, and winnowing; in all which operations there appears to be little singular or different from modern practice. (*Strutt's Complete View of the Manners, Customs, &c., of England*, vol. i. plates 11, 12.)

208. *Agriculture in Scotland* seems to have been in a very imperfect state towards the end of this period. For in a parliament held at Scone, by King Alexander II., A. D.

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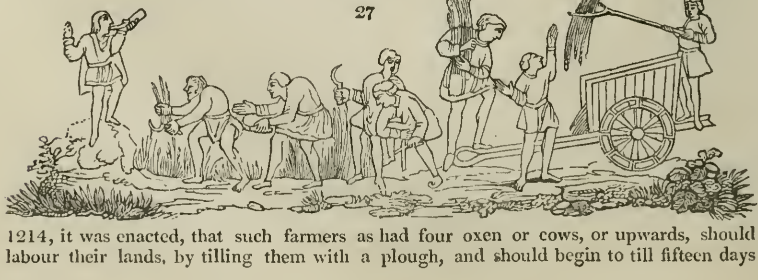

1214, it was enacted, that such farmers as had four oxen or cows, or upwards, should labour their lands, by tilling them with a plough, and should begin to till fifteen days before Candlemas; and that such farmers as had not so many as four oxen, though they could not labour their lands by tilling, should delve as much with hand and foot as would produce a sufficient quantity of corn to support themselves and their families. (*Regiam Majestatem*, p. 307.) But this law was probably designed for the highlands, and most uncultivated parts of the kingdom; for in the same parliament a very severe law was made against those farmers who did not extirpate a pernicious weed called *guilde* (Chrysánthemum ségetum *L.*) out of their lands, which seems to indicate a more advanced state of cultivation. (*Ibid.*, p. 335.) Their agricultural operations, as far as can be gathered from old tapestries and illuminated missals, were similar to those of England. Threshing appears to have been performed by women (*fig.* 28.), and reaping by the men (*fig.* 29.), which is the reverse of the modern practice in that and in most countries. Such is the account of Henry. (*History of Britain*, vol. vi. p. 173.)

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209. *The field culture of the vine*, which had been commenced by the monks for their own use, was more extensively spread by the Normans. William of Malmsbury, who flourished in the early part of the twelfth century, says there were a greater number of vineyards in the vale of Gloucester than any where else, and that from the grapes was produced a wine very little inferior to that of France. Orchards and cider were also abundant, and the apple trees, it is said, lined the roads in some parts of the country, as they still do in Normandy, whence in all probability the plants or at least the grafts were imported.

Subsect. 3. *History of Agriculture in Britain, from the Thirteenth Century to the Time of Henry VIII.*

210. *Agriculture in the thirteenth and fourteenth centuries*, it appears, was still carried on with vigour. Sir John Fortescue, in a work in praise of the English laws, mentions the progress that had been made in planting hedges and hedge-row trees before the end of the fourteenth century. Judge Fortescue wrote his *Legum Angliæ* in the fifteenth century, but it was not published till the reign of Henry VIII. In the law book called *Fleta* (supposed to have been written by some lawyers, prisoners in the Fleet, in 1340), very particular directions are given as to the most proper times and best manner of ploughing and dressing fallows. (*Fleta*, lib. ii. chap. 73. p. 163.) The farmer is there directed to plough no deeper in summer, than is necessary for destroying the weeds; nor to lay on his manure till a little before the last ploughing, which is to be with a deep and narrow furrow. Rules are also given for the changing and choosing of seed; for proportioning the quantity of different kinds of seed to be sown on an acre, according to the nature of the soil, and the degree of richness; for collecting and compounding manures, and accommodating them to the grounds on which they are to be laid; for the best seasons for sowing seeds of different kinds on all the variety of soils; and, in a word, for performing every operation in husbandry, at the best time, and in the best manner. (*Fleta*, lib. ii. chap. 72, 73. 76.) In the same work, the duties and business of the steward, bailiff, and overseer, of a manor and of all the other persons concerned in the cultivation of it, are explained at full length, and with so much good sense, that if they were well performed the manor could not be ill cultivated. (*Ibid.*, chap. 72. 88.; *Henry*, viii. 267.) This work, as well as others of the kind, is written in Latin, and even the farming accounts were in those days kept in that language, as they still are in the greater part of Hungary.

211. *During the greater part of the fifteenth century* England was engaged in civil wars, and agriculture, as well as other arts, declined. The labourers, called from the plough by royal proclamation or the mandates of their lords, perished in battle, or by accident and fatigue, in immense numbers. Labour rose in price notwithstanding various laws for its limitation, and this at last produced a memorable revolution in the state of agriculture, which made a mighty noise for many years. The prelates, barons, and other great proprietors of land, kept extensive tracts around their castles, which were called their demesne lands, in their own immediate possession, and cultivated them by their villains, and by hired servants, under the direction of their bailiffs. But these great landholders having often led their followers into the fields of war, their numbers were gradually diminished, and hired servants could not be procured on reasonable terms. This obliged the prelates, lords, and gentlemen to enclose the lands around their castles, and to convert them into pasture grounds. This practice of enclosing became very general in England about the middle of this period, and occasioned prodigious clamours from those who mistook the effect of depopulation for its cause.

212. *The habit of enclosing lands and converting them to pasture* continued after the cause had ceased, and an act was passed to stop its progress in the beginning of the reign

of Henry VII. The dearths of this period furnish another proof of the low state of agriculture. Wheat in 1437 and 1438 rose from 4*s.* or 4*s.* 6*d.*, the ordinary price per quarter, to 1*l.* 6*s.* 8*d.*, equivalent to 13*l.* 6*s.* 8*d.* of our money. Stow observes that, in these extremities, the common people endeavoured to preserve their wretched lives, by drying the roots of herbs and converting them into a kind of bread. Land in those days was sold for ten years' purchase, so great was the insecurity of possession.

213. *Agriculture in Scotland* was at a low ebb during the thirteenth, fourteenth, and fifteenth centuries, on account of the long and ruinous wars in which the country was engaged. A law passed in 1424 enacts that every labourer of "simple estate" dig a piece of ground daily, of seven feet square; another in 1457, that farmers who had eight oxen should sow every year one firlot (bushel) of wheat, half a firlot of pease, and forty beans, under the pain of ten shillings to be paid to the baron; and if the baron did not do the same thing to the lands in his possession, he should pay the same penalty to the king.

214. *From the accession of Henry VII. in* 1485, *to nearly the middle of the seventeenth century*, England enjoyed peace. To remove the effects of former wars, however, required a considerable time. The high price of labour, and the conversion of so much land to tillage, gave rise to different impolitic statutes, prohibiting the exportation of corn; while a great demand was created for wool by the manufactures of the Netherlands, which tended to enhance the value of pasture lands, and depopulate the country. The flocks of individuals, in these times, sometimes exceeded twenty thousand, and an act was passed by Henry VIII., restricting them to a tenth of that number, apparently eluded from the partial exception of hereditary opulence. Had the restraints imposed on the exportation of corn been transferred to wool, the internal consumption would have soon regulated the respective prices of those articles; the proportion between arable and pasture lands would soon have been adjusted; and the declining cultivation of the country restored. An improved cultivation was reserved, however, for a future period, when persecution extirpated manufactures from the Netherlands; then, when the exportation of English wool had subsided, and its price diminished, the farmer or landholder, disappointed of his former exuberant profits, discovered the necessity of resuming the plough, and restoring his pastures to culture. (*Henry*, xii. 261.)

215. *Of the state of agriculture in Scotland* during the fifteenth and sixteenth centuries little can be stated. According to Major (*Historia Britannica*, Paris, 1526), a native of Berwick, "the peasants neither enclosed nor planted, nor endeavoured to ameliorate the sterility of the soil." According to Fynnis Moryson, the produce of the country consisted chiefly of oats and barley; but it would appear from Chalmers that wheat was cultivated in Scotland, at least upon the church lands, so early as the thirteenth century. Different laws were enacted for planting groves and hedges, pruning orchards and gardens, and forming parks for deer: but it is not the barren injunctions of statutes that will excite a spirit of improvement in a country.

Subsect. 4. *History of Agriculture, from the Time of Henry VIII. to the Revolution in* 1688.

216. *Agriculture, soon after the beginning of the sixteenth century*, partook of the general improvement which followed the invention of the art of printing, the revival of literature, and the more settled authority of government; and, instead of the occasional notices of historians, we can now refer to regular treatises, written by men who engaged eagerly in this neglected, and hitherto degraded, occupation.

217. *The culture of hops* was either introduced or revived early in the reign of Henry VIII.; and that of flax was attempted, but without success, though enforced by law. (*Holinshead*, p. 110, 111.; 24 *Hen.* 8. c. 4.) The legislature at that time endeavoured to execute, by means of penalties, those rational improvements which have since been fostered and cherished by bounties; or, what is better, pursued from the common motive of self-interest.

218. *The breeding of horses* was now much encouraged. To the passion of the age, and the predilection of the monarch for splendid tournaments, may be attributed the attention bestowed on a breed of horses of a strength and stature adapted to the weight of the complicated panoply with which the knight and his courser were both invested. Statutes of a singular nature were enacted, allotting for deer parks a certain proportion of breeding mares, and enjoining, not the prelates and nobles only, but those whose wives wore velvet bonnets, to have stallions of a certain size for their saddle. The legal standard was fifteen hands in horses, thirteen in mares, and "unlikely tits" were, without distinction, consigned to execution. (27 *Hen.* 8. cap. 6.; 36 *Hen.* 8. cap. 13. See *Barrington's Observations on the Statutes*, p. 443.) James the Fourth, of Scotland, with more propriety, imported horses from foreign countries in order to improve the degenerate breed of his own. (*Pitscottie*, p. 153.) The cultivation of grasses for their winter provender was still unknown; nor were asses propagated in

England till a subsequent period. (*Holinshead*, p. 220.; *Polydore Virgil*, p. 13.; *Henry*, xii. 268)

219. *The first English treatise on husbandry* now appeared, written by Sir A. Fitzherbert, judge of the common pleas. It is entitled *The Book of Husbandry*, and contains directions for draining, clearing, and enclosing a farm; and for enriching and reducing the soil to tillage. Lime, marl, and fallowing are strongly recommended. The landlords are advised to grant leases to farmers who will surround their farms, and divide them by hedges into proper enclosures; by which operation, he says, "if an acre of land be worth sixpence before it is enclosed, it will be worth eightpence when it is enclosed, by reason of the compost and dunging of the cattle." Another reason is, that it will preserve the corn without the expense of a herdsman. From the time of the appearance of this work, in 1534, Harte dates the revival of husbandry in England.

220. *The Book of Surveying and Improvements*, by the author of *The Book of Husbandry*, appeared in 1539. In the former treatise we have a clear and minute description of the rural practices of that period; and from the latter may be learned a good deal of the economy of the feudal system in its decline. The author of *The Book of Husbandry* writes from his own experience of more than forty years; and, if we except his biblical allusions, and some vestiges of the superstition of the Roman writers about the influence of the moon, there is very little of his work that should be omitted, and not a great deal of subsequent science that need be added, with regard to the culture of corn, in a manual of husbandry adapted to the present time. It may surprise some of the agriculturists of the present day, an eminent agricultural writer remarks, to be told that, after the lapse of almost three centuries, Fitzherbert's practice, in some material branches, has not been improved upon; and that in several districts abuses still exist, which were as clearly pointed out by him at that early period, as by any writer of the present age. His remarks on sheep are so accurate, that one might imagine they came from a storemaster of the present day: those on horses, cattle, &c., are not less interesting; and there is a very good account of the diseases of each species, and some just observations on the advantage of mixing different kinds in the same pasture. Swine and bees conclude this branch of the work. He then points out the great advantages of enclosures; recommends "quycksettynge, dychynge, and hedgyng;" and gives particular directions about the *settes*, and the method of training a hedge, as well as concerning the planting and management of trees. We have then a short information "for a yonge gentylman that intendeth to thryve," and a "prolouge for the wive's occupation," in some instances, rather too homely for the present time. Among other things, she is to "make her husband and herself some clothes;" and "she may have the lockes of the shepe, either to make blankettes and coverlettes, or both." This is not so much amiss; but what follows will bring our learned judge into disrepute, even with our most industrious housewives. "It is a wive's occupation to wynowe all manner of cornes, to make malte, to washe and wrynge, to make heye, shere corne, and, in time of nede, to helpe her husbande to fyll the muckewayne or dounge carte, drive the ploughe, to loade heye, corne, and suche other. And to go or ride to the market, to sel butter, chese, mylke, egges, chekyns, capons, hennes, pygges, gese, and all manner of cornes." The rest of the book contains some useful advices about diligence and economy; and concludes, after the manner of the age, with many pious exhortations. (*Encyc. Brit.*, art. *Agr.*)

221. *The state of agriculture in England in the early part of the sixteenth century*, and probably for a long time before, is thus ascertained; for Fitzherbert no where speaks of the practices which he describes or recommends as of recent introduction. *The Book of Surveyinge* adds considerably to our knowledge of the rural economy of that age. "Four maner of commens" are described; several kinds of mills for corn, and other purposes, and also "quernes that goo with hand;" different orders of tenants, down to the "boundmen," who "in some places contynue as yet;......and many tymes, by color thereof, there be many freemen taken as boundmen, and their lands and goods is taken from them." Lime and marl are mentioned as common manures; and the former was sometimes spread on the surface to destroy heath. Both draining and irrigation are noticed; though the latter but slightly. The work concludes with an enquiry "How to make a township that is worth XX merke a yere worth XX li. a year:" this is to be done by enclosing, by which, he says, live stock may be better kept and without herds; and the closes or fields alternately cropped with corn, and "let lye" for a time.

222. *Agriculture had attained a considerable degree of respectability during the reign of Elizabeth.* According to Tusser, who wrote in that age, and whose work will be presently noticed, agriculture was best understood in Essex and Suffolk; at least enclosures were more common in these counties than in any other, which is always a proof of advancement. A farmer, according to Harrison the geographer, "will thinke his gaines very small towardes the end of his terme if he have not six or seven years rent lieing by him, therewith to purchase a new lease; beside a fair garnish of pewter on his cupboard,

with as much more in odd vessels going about the house; three or four feather-beds; so many coverlets, and carpets of tapestrie; a silver salt; a bowle for wine, if not a whole neast; and a dozen of spoones to furnish owte the sute." (*Harrison's Description of England*, p. 188.)

223. *The condition of a yeoman, before or about Elizabeth's time*, is exemplified in the case of Bishop Latimer's father. "My father," says Hugh Latimer, "was a yeoman, and had no land of his own; only he had a farm of three or four pounds by the year at the utmost; and hereupon he tilled so much as kept half a dozen men. He had a walk for a hundred sheep; and my mother milked thirty kine, &c. He kept his son at school till he went to the university, and maintained him there; he married his daughters with five pounds, or twenty nobles apiece; he kept hospitality with his neighbours, and some alms he gave to the poor; and all this he did out of the said farm." (*Gilpin's Life of Latimer.*)

224. *Cattle were not plentiful in England at the beginning of Elizabeth's reign.* In 1563 it was enacted that no one should eat flesh on Wednesdays or Fridays, on forfeiture of three pounds, unless in case of sickness, or of a special license, neither of which was to extend to beef or veal. (*Stat. 5 Eliz.* cap. 4.) Great pains were taken in the act to prove that it was a political, not a religious measure.

225. *The vast number of parks in the kingdom* are complained of by Harrison. "There are not less," he says, "than an hundred in Essex alone, where almost nothing is kept but a sorte of wilde and savage beasts, cherished for pleasure and delight." And pursuing the same subject, he says, "that if the world last a while after this rate, wheate and rie will be no graine for poore men to feed on." (*Description of Britaine*, p. 168.)

226. *In Scotland* the civil dissensions, and even anarchy, which prevailed until a late period in the sixteenth century, operated as a harsh check on every improvement in agriculture, and the total expulsion of ecclesiastical landholders increased this evil; as the monks were easy landlords, and frequently not uninstructed in georgical knowledge. The tillers of the earth in Scotland had at least their full share of their country's misfortunes, when private vengeance for private wrongs superseded the regular but timid proceedings of public justice. A statute was then formed for their particular benefit, whereby (*Stat.* 110. *Parl.* 7. *Jac.* 6.) "the slayers and houchers (houghers) of horses and uther cattel," with their employers and maintainers, are declared "to have incurred the paine of death, and confiscation of alle their gudes movvabil." A second act passed in 1587 for the further protection of husbandmen, declaring all such as destroyed or maimed horses, oxen, &c., cut or destroyed ploughs or plough-geers (in time of tilling), or trees and corn, should suffer death. (*Stat.* 83. *Parl.* 2. *Jac.* 6.) Several acts of parliament were made to protect the farmers from petulant tithe-gatherers; the proper times of notice were herein pointed out, and liberty given to the tiller of the land to proceed in his work if this notice were neglected. The last (*Stat.* 84. *Parl.* 2. *Jac.* 6.) confirmed and explained the others. (*Andrew's Continuation of Henry's Hist.*, ii. 124.)

227. *Great attention was still paid to the breed of horses in England;* but, during the reign of Elizabeth, it was found necessary to lower the standard appointed by Henry VIII. for stallions, from fourteen hands to thirteen. This modification, however, was only to take place in the counties of Cambridge, Huntingdon, Northampton, Lincoln, Norfolk, and Suffolk. (18 *Eliz.* cap. 8.) No stallion of less height could be turned out on commons, forests, &c., for fear of deteriorating the breed. Harrison extols the height and strength of the English draught-horses; five or six of them, he says, will with ease draw three thousand weight of the greatest tale for a long journey.

228. *An English traveller, who visited Scotland in* 1598, *observed a great abundance of all kind of cattle, and many horses;* not large, but high-spirited and patient of labour. (*Moryson's Itin.*, part iii. p. 154.) Great care, indeed, was taken by the English, while the kingdoms were separate, to prevent the Scots from improving their breed by southern stallions; it was even made felony to export horses thither from England. (1 *Eliz.* cap. 7.) This unneighbourly prohibition was answered by a reciprocal restriction in 1567, as to the exportation of Scottish horses (*Stat.* 22. *Parl.* 1. *Jac.* 6.); but France, rather than England, seems to be aimed at by that statute. One circumstance, pointed out by a curious antiquary (*Paper apud Transactions of Sc. Ant. Soc.*, vol. i. p. 171.), is a convincing proof of the modern improvement in the breed: for many years past eight nails have been used to each horse's shoe in the north; six used to be the number.

229. *The proper seasons for turning horses to grass* was thought a consideration worth the attention of the Scottish government, avowedly to prevent the waste of corn. All horses were, therefore, ordered to be put to grass from May 15th to Oct. 15th, on pain of forfeiting each horse, or its value, to the king. Gentlemen of 1000 marks, yearly rent, and all upwards, are excepted. (*Stat.* 122. *Parl.* 7. *Jac.* 6.) The 1st of June was substituted in a subsequent act (*Stat.* 56. *Parl.* 2. *Jac.* 6.) for the 15th of May.

230. *The vine in England continued to be cultivated for wine;* but not generally, for the vineyards of the Lords Cobham and Williams of Thames, are pointed out by Barnaby Gooch as eminently productive. It is probable this branch of culture declined with the suppression of the monasteries, and the more general culture of barley; as farmers and others would soon find that good beer was a cheaper and better drink, than any wine that could be made in this country. Though in 1565, in this reign, the potato was introduced from Santa Fé by Capt. Hawkins, yet it did not come into general use, even in gardens, for nearly two centuries afterwards.

231. *The principal agricultural authors of Elizabeth's reign* are, Tusser, Googe, and Sir Hugh Platt. Thomas Tusser was born at Rivenhall in Essex, in 1527. Having a fine voice, he was impressed for the royal chapel, and sang in St. Paul's, under a celebrated musician. " Afterwards he was a scholar at Eton, and next a student at Cambridge. He next became, by turns, musician, farmer, grazier, and poet; but always unsuccessfully, although guilty of neither vice nor extravagance." His *Five Hundred Points of Husbandry* was published in 1562, and has been recommended by Lord Molesworth to be taught in schools. (*Some Considerations for the Promoting of Agriculture and employing the Poor*, Dublin, 1723.) It is written in hobbling verse, and contains some useful notices concerning the state of agriculture in different parts of England. Hops, which had been introduced in the early part of the sixteenth century, and on the culture of which a treatise was published in 1574, by Reynolds Scott, are mentioned as a well known crop. Buck-wheat was sown after barley. It seems to have been the practice then, in some places, to " geld fillies " as well as colts. Hemp and flax are mentioned as common crops. Enclosures must have been numerous in several counties; and there is a very good " comparison between champion (open fields) country, and severall." There is nothing to be found in Tusser about *serfs* or bondmen, as in Fitzherbert's works. (*Encyc. Brit.*, art. *Agricul.*)

232. *The next writer is Barnaby Googe, a Lincolnshire gentleman*, whose *Whole Art of Husbandry* was printed in 1578. It is, for the most part, made up of gleanings from all the ancient writers of Greece and Rome, whose absurdities are faithfully retained; with here and there some description of the practices of the age, in which there is little novelty or importance. Googe mentions a number of English writers who lived about the time of Fitzherbert, whose works have not been preserved.

233. *Sir Hugh Platt's Jewel Houses of Art and Nature* was printed in 1594. It is chiefly a compilation from other writers. The author appears to have been a lawyer of Lincoln's Inn, but he had a seat in Essex, and another in Middlesex, where he spent great part of his time. — The *Rev. William Harrison*, a contemporary of Platt, and chaplain to Baron Cobham, wrote a description of Britain, and translated Boethius's *History of Scotland*. In the former work are many valuable hints on the progress of husbandry in the early part of the reign of Elizabeth. Among other curious things he asserts that the Spanish, or Merino sheep, was originally derived from England.

234. *The seventeenth century is distinguished by some important improvements in agriculture*, among which are the introduction of clovers and turnips in England; of hedges in Scotland and Ireland; and the execution of extensive embankments and drainages. Some useful writers also appeared, especially Norden, Gabriel Plattes, Sir Richard Weston, Hartlib, and Blythe, to whom may be added Evelyn.

235. *For the adoption of the clover, as an agricultural plant*, we are indebted to Sir Richard Weston, who, in 1645, gives an account of its culture in Flanders, where he says " he saw it cutting near Antwerp, on the 1st of June 1644, being then two feet long, and very thick; that he saw it cut again on the 29th of the same month, being twenty inches long; and a third time in August, being eighteen inches long." Blythe, in 1653, is copious in his directions for its cultivation; and Lisle (*Obs. on Husbandry*), in the beginning of the eighteenth century, speaks of it as commonly cultivated in Hampshire, Wiltshire, Gloucestershire, and other counties.

236. *Turnips* were probably introduced as a field crop by the same patriotic author, though they may probably have been grown in the gardens of the church establishments long before. They are cultivated, he observes, "for feeding kine in many parts of England; but there is as much difference between what groweth in Flanders and here, as is between the same thing which groweth in a garden and that which groweth wild in the fields." It is probable the English turnips he alludes to were rape, which is mentioned by Googe in 1586; but, though Gerarde, in 1597, and Parkinson, in 1629, mention the turnip as a garden vegetable, yet neither of these authors gives the least hint of their field culture: be that as it may, Ray, in 1686, informs us, that they are sown every where in fields and gardens, both in England and abroad, for the sake of their roots. Lisle also, in 1707, mentions their being common in Norfolk, Hampshire, Berkshire, and various counties. The common story, therefore, that their culture was first introduced by Charles Lord Viscount Townsend, cannot be true; but their culture was probably greatly improved by him, when he retired from public business to Rainham in Norfolk, in 1730.

237. *The first notices of sheep being fed on the ground with turnips*, is given in *Houghton's Collections on Husbandry and Trade*, a periodical work begun in 1681. In 1684, Worlidge, one of Houghton's correspondents, observes, " sheep fatten very well on turnips, which prove an excellent nourishment for them in hard winters, when fodder is scarce;

for they will not only eat the greens, but feed on the roots in the ground, and scoop them hollow even to the very skin. ...... Ten acres," he adds, " sown with clover, turnips, &c, will feed as many sheep as one hundred acres thereof would before have done." (*Houghton's Collections*, vol. iv. p. 142—144.)

238. *Potatoes*, first introduced in 1565 (230.), were at this time beginning to attract notice. " The potato, " says Houghton, " is a *bacciferous* herb, with *esculent* roots, bearing winged leaves, and a *bell* flower. ...... This, I have been informed, was brought first out of Virginia by Sir *Walter Raleigh*; and he stopping at Ireland, some was planted there, where it thrived very well, and to good purpose; for in their succeeding wars, when all the corn above ground was destroyed, this supported them; for the soldiers, unless they had dug up all the ground where they grew, and almost sifted it, could not extirpate them. From thence they were brought to *Lancashire*, where they are very numerous, and now they began to spread all the kingdom over. They are a pleasant food, boiled or roasted, and eaten with butter and sugar. There is a sort brought from Spain that are of a longer form (Convólvulus *Batàtas*) (*fig.* 30.), and are more luscious than ours; they are much set by, and sold for sixpence or eightpence the pound." (*Ib.*, vol. ii. p. 468.)


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239. *Embankments* were made on the eastward of England, in various places, by the Romans, when in possession of the country, and afterwards by some wealthy religious houses, and by the government. Considerable exertions were made at Boston during the reign of Henry VII., under the direction of Mayhave Hake, a Flemish engineer, and fourteen masons; but the principal effort, as far as respects gaining land for agricultural purposes, was made during the protectorate, by Col. Vermuyden, a Fleming, who served in Cromwell's army. Speaking of this engineer's exertions, Harte observes, " if my account stands right (and it comes from the best authority extant), our kingdom in the space of a few years, till the year 1651 only, had recovered, or was on the point of recovering, in Lincolnshire, Cambridgeshire, Huntingdonshire, and Kent, 425,000 acres of fens and morasses, which were advanced in general, from half a crown an acre to twenty and thirty shillings. So that, perhaps, few statesmen and generals have better deserved a statue or monument from this country than Vermuyden, the principal undertaker."

240. *The exportation of corn* was regulated by various laws, during the sixteenth century; and importation was not restrained even in plenty and cheapness. In 1663 was passed the first statute for levying tolls at turnpikes. Enclosures by consent and by act of parliament began also to be made during this century.

241. *The agriculture of Scotland during the fifteenth and sixteenth centuries* continued to languish, especially upon the estates of the barons, where the profession of a soldier was regarded as of greater importance than that of a cultivator of the ground; but the ecclesiastical lands were considerably improved, and the tenants of them were generally much more comfortably circumstanced than those upon the estates of laymen. The reformation of religion, beneficial as it was in other respects, rather checked than promoted agricultural improvement; because the change of property, which then occurred, occasioned a similar change of tenantry, and almost took husbandry out of the hands of the monks, the only class of people by whom it was practised upon correct principles. The dissolution of the monasteries and other religious houses was also attended with injurious consequences in the first instance; though latterly the greatest benefit has been derived from tithes and church lands having come into the hands of laymen. It is probable, had not these circumstances occurred, that the tithe system would have still remained in force, and Scottish husbandry have continued under a burthen, which sinks and oppresses the cultivator of England and Ireland. But tithes having got into the hands of lay titulars, or impropriators, were in general collected or farmed with such severity as to occasion the most grievous complaints, not only from the tenantry, but also from the numerous class of proprietors, who had not been so fortunate as to procure a share of the general spoil. This, added to the desire shown by the crown to resume the grants made when its power was comparatively feeble, occasioned the celebrated submission to Charles I., which ended in a settlement, that in modern times has proved highly beneficial, not only to the interest of proprietors, but likewise to general improvement. Tithes, in fact, are a burthen, which operate as a tax upon industry, though it was a long time before the beneficial consequences of withdrawing them were fully understood. (*Edin. Encyc.*, art. *Agr.*)

242. *Of the state of agriculture in Scotland during the greater part of the seventeenth century very little is known*; no professed treatise on the subject appeared till after the revolution. The south-eastern counties were the earliest improved, and yet, in 1660, their condition seems to have been very wretched. Ray, who made a tour along the eastern coast in that year, says, "We observed little or no fallow grounds in Scotland; some ley ground we saw, which they manured with sea wreck. The men seemed to be very lazy, and may be frequently observed to plough in their cloaks. It is the fashion of them to wear cloaks when they go abroad, but especially on Sundays. They have neither good bread, cheese, nor drink. They cannot make them, nor will they learn. Their butter is very indifferent, and one would wonder how they could contrive to make it so bad. They use much pottage made of colewort, which they call *kail*, sometimes broth of decorticated barley. The ordinary country houses are pitiful cots, built of stone, and covered with turfs, having in them but one room, many of them no chimneys, the windows very small holes, and not glazed. The ground in the valleys and plains bears very good corn, but especially bears barley or bigge and oats, but rarely wheat and rye." (*Select Remains of John Ray*. Lond. 1760.)

243. *It is probable that no great change had taken place in Scotland from the end of the fifteenth century*, except that tenants gradually became possessed of a little stock of their own, instead of having their farms stocked by the landlord. "The minority of James V., the reign of Mary Stewart, the infancy of her son, and the civil wars of her grandson Charles I., were all periods of lasting waste. The very laws which were made during successive reigns, for protecting the tillers of the soil from spoil, are the best proofs of the deplorable state of the husbandman." (*Chalmers's Caledonia*, vol. ii. p. 732.; *Encyc. Brit.*, art. *Agr.*)

244. *The accession of James VI. to the crown of England* is understood to have been unfavourable to the agricultural interest of Scotland; inasmuch as the nobles and gentry, being by that event led into great expenses, raised the rents of the tenantry considerably, whilst the very circumstance which occasioned the rise, contributed to lessen the means of the tenant for fulfilling his engagements. Scotland, however, was much benefited by the soldiers of Cromwell, who were chiefly English yeomen, not only well acquainted with husbandry, but, like the Romans at a former period, studious also to improve and enlighten the nation which they had subdued. The soldiers of Cromwell's army were regularly paid at the rate of eightpence per day, a sum equal at least to the money value of two shillings of our currency; and as this army lay in Scotland for many years, there was a great circulation of money through the country. Perhaps the low country districts were at that time in a higher state of improvement than at any former period. In the counties of Lanark, Renfrew, Ayr, and Kirkcudbright, the rentals of various estates were greater in 1660, than they were seventy years afterwards; and the causes which brought about a declension in value are ascertained without difficulty. The large fines exacted from country gentlemen and tenants in these counties, during the reign of Charles II. and his brother James, were almost sufficient to impoverish both proprietors and cultivators, had they even been as wealthy as they are at the present day. In addition to those fines, the dreadful imprisonments, and other oppressive measures pursued by those in power, equally contrary to sound policy and to justice and humanity, desolated large tracts, drove the oppressed gentry and many of their wealthy tenants into foreign countries, and extinguished the spirit of industry and improvement in the breasts of those who were left behind.

245. *Yet in the seventeenth century were those laws made which paved the way for the present improved system of agriculture in Scotland.* By statute 1633, landholders were enabled to have their tithes valued, and to buy them either at nine or at six years' purchase, according to the nature of the property. The statute 1685, conferring on landlords a power to entail their estates, was indeed of a very different tendency, in regard to its effects on agriculture; but the two acts in 1695, for the division of commons, and separation of intermixed properties, have facilitated in an eminent degree the progress of improvement. (*Encyc. Brit.*, art. *Agr.*)

246. *The literary history of agriculture, during the seventeenth century*, is of no great interest till about the middle of that period. For more than fifty years after the appearance of Googe's work, there are no systematic works on husbandry, though several treatises on particular departments of it. From these it is evident, that all the different operations of the farmer were performed with more care and correctness than formerly; that the fallows were better worked; the fields kept free of weeds; and much more attention paid to manures of every kind. A few of the writers of this period deserve to be shortly noticed.

247. *Sir John Norden's Surveyor's Dialogue*, printed in 1607, is a work of considerable merit. The first three books of it relate to the rights of the lord of the manor, and the various tenures by which landed property was then held, and the obligations which they imposed: among others, we find the singular custom, so humorously described in the *Spectator*, about the incontinent widow riding upon a ram. In the fifth book, there are a good many judicious observations on the "different natures of grounds, how

they may be employed, how they may be bettered, reformed, and amended." The famous meadows near Salisbury are mentioned; and when cattle have fed their fill, hogs, it is pretended, "are made fat with the remnant, namely, with the knots and sappe of the grasse." So many extravagant assertions have been made about these meadows by several of our early writers, that we ought to receive their statements with some degree of scepticism, wherever they seem to approach the marvellous. "Clover grass, or the grass honeysuckle" (white clover), is directed to be sown with other hay-seeds. "Carrot-roots" were then raised in several parts of England, and sometimes by farmers." London street-dung and stable-dung were carried to a distance by water; though it appears from later writers to have been got almost for the trouble of removing. And leases of twenty-one years are recommended for persons of small capital, as better than employing it in purchasing land; an opinion that prevails very generally among our present farmers.

248. *Bees* seem to have been great favourites with these early writers; and among others, there is a treatise by Butler, a gentleman of Oxford, called the *Feminine Monarchie, or the History of Bees,* printed in 1609, full of all manner of quaintness and pedantry.

249. *Markham, Mascall, Gabriel Plattes, Weston,* and other authors, belonged to this period. In Sir Richard Weston's *Discourse on the Husbandry of Brabant and Flanders,* published by Hartlib, in 1645, we may mark the dawn of the vast improvements which have since been effected in Britain. This gentleman was ambassador from England to the Elector Palatine and King of Bohemia, in 1619, and had the merit of being the first who introduced the *great clover,* as it was then called, into English agriculture, about 1645, and probably turnips also. In less than ten years after its introduction, that is, before 1655, the culture of clover, exactly according to the present method, seems to have been well known in England, and had made its way even to Ireland.

250. *A great many works on agriculture appeared during the time of the commonwealth,* of which Blythe's *Improver improved* and Hartlib's *Legacy* are the most valuable. The first edition of the former was published in 1649, and of the latter in 1650; and both of them were enlarged in subsequent editions. In the first edition of the *Improver improved,* no mention is made of clover, nor in the second of turnips; but, in the third, published in 1662, clover is treated of at some length; and turnips are recommended as an excellent cattle crop, the culture of which should be extended from the kitchen-garden to the field. Sir Richard Weston must have cultivated turnips before this; for Blythe says, that "Sir Richard affirmed to himself, he did feed his swine with them; they were first given boiled, but afterwards the swine came to eat them raw," and "would run after the carts and pull them forth as they gathered them;" an expression which conveys an idea of their being cultivated in the fields.

251. *Blythe's book is the first systematic work in which there are some traces of the convertible husbandry,* so beneficially established since, by interposing clover and turnip between culmiferous crops. He is a great enemy to commons and common fields; and to retaining land in old pasture, unless it be of the best quality. His description of different kinds of ploughs is interesting; and he justly recommends such as were drawn by two horses (some even by one horse), in preference to the weighty clumsy machines which required four horses or oxen, or more. Almost all the manures now used seem to have been then well known; and he brought lime himself from a distance of twenty miles. He speaks of an instrument which ploughed, sowed, and harrowed at the same time; and the *setting of corn* was then a subject of much discussion. "It was not many years," says Blythe, "since the famous city of London petitioned the parliament of England against two anusancies or offensive commodities, which were likely to come into great use and esteem; and that was Newcastle coal, in regard of their stench, &c.; and hops, in regard they would spoyle the taste of drinck, and endanger the people!"

252. *Hartlib's Legacy* is a very heterogeneous performance, containing among some very judicious directions, a great deal of rash speculation. Several of the deficiencies which the writer (R. Child) complains of in English agriculture, must be placed to the account of our climate, and never have been nor can be supplied.

253. *Houghton's valuable Collections of Husbandry* have been already mentioned. (237.)

254. *Worlidge's Systèma Agriculturæ* was published in 1668; it treats of improvements in general, of enclosing meadows and pastures, and of watering and draining them, of clovers, vetches, spurry, Wiltshire long-grass (probably that of the meadows of Salisbury), hemp, flax, rape, turnips, &c. A Persian wheel was made by his direction in Wiltshire, in 1665, that carried water in good quantity above twenty feet high, for watering meadows, and another near Godalming in Surrey. Sowing clover and other seeds preserved the cattle in the fatal winter of 1673, in the southern parts of England; whereas in the western and northern, through defect of hay and pasture, the greater part of their cattle perished. Hops enough were not planted, but we imported them from the Netherlands of a quality not so good as our own. The authors he chiefly quotes are Weston, Hartlib, and Blythe.

255. *Among other writers of this century* may be mentioned Bacon, who, in his natural history, has some curious observations on agriculture; Ray, the botanist, whose works are rich in facts; and Evelyn, a great encourager of all manner of improvements, as well as a useful writer on planting.

256. *Some of the works of the sixteenth and seventeenth centuries* are now very scarce,

and most of them little known to agriculturists of the present day. In almost all of them there is much that is now useless, and not a little that is trifling and foolish; yet the labour of perusal is not altogether fruitless. He who wishes to view the condition of the great body of the people during this period, as well as the cultivator who still obstinately resists every new practice, may, each of them, be gratified and instructed, in tracing the gradual progress of improvement, both in enjoyment and useful industry. (*Encyc. Brit.*, art. *Agr.*)

Sect. V. *History of Agriculture in Ultra-European Countries during the Middle Ages.*

257. *The general history of the old Ultra-European countries,* during this period, is not known with sufficient precision and detail, to enable us to give a progressive account of their agriculture. There is no evidence of any improvement having been made in the agriculture of the Indian and Chinese nations, from the earliest period of their known history to the present time. The agriculture of Persia, of the African shores of the Mediterranean sea, and of all the countries under the Turks, seems, if any change has taken place, rather to have declined than advanced during the latter centuries of the middle ages.

258. *The history of the new Ultra-European countries of America and Australasia,* only dates its commencement (with the exception of part of America) from the latter end of the period under notice, and therefore cannot furnish sufficient materials for any useful account of their agriculture. Under these circumstances we think it better to defer an account of the origin and progress of Ultra-European agriculture till the succeeding Chapter, where it will precede some account of its present state. We have adopted the same plan with respect to the agriculture of some of the northern European nations, as Russia and Sweden, and also with regard to that of Spain and Ireland.

Chap. IV.

Present State of Agriculture in Europe.

259. *Agriculture began to be studied, as a science,* in the principal countries of Europe, about the middle of the 16th century. The works of Crescenzio in Italy, Olivier de Serres in France, Heresbach in Germany, Herrera in Spain, and Fitzherbert in England, all published about that period, supplied the materials of study, and led to improved practices among the reading agriculturists. The art received a second impulse in the middle of the century following, after the general peace of Aix-la-Chapelle. Then, as Harte has observed (*Essays*, i. p. 62.), "almost all the European nations, by a sort of tacit consent, applied themselves to the study of agriculture, and continued to do so, more or less, even amidst the universal confusion that soon succeeded." During the 18th century, the march of agriculture has been progressive throughout Europe, with little exception; and it has attained to a very considerable degree of perfection, in some districts of Italy, in the Netherlands, and in Great Britain. In Spain it has been least improved, and it is still in a very backward state in most parts of Hungary, Poland, and Russia. We shall, in the following sections, give such notices of the agriculture of these and the other countries of Europe, as we have been enabled to glean from the very scanty materials which exist on the subject. Had these been more abundant, this part of our work would have been much more instructive. The past state of agriculture can do little more than gratify the curiosity, but its present state is calculated both to excite our curiosity and affect our interests. Independently of the political relations which may be established by a free trade in corn, there is probably no European country that does not possess some animal or vegetable production, or pursue some mode of culture or management, that might not be beneficially introduced into Britain; but, with the exception of Flanders and some parts of France and Italy, there are as yet no sufficient data for obtaining the necessary details.

Sect. I. *Of the present State of Agriculture in Italy.*

260. *Italy is the most interesting country of Europe in respect to its rural economy.* Its climate, soils, rivers, and surface are so various, as to have given rise to a greater variety of culture than is to be found throughout the rest of Europe; while the number of governments and petty states into which it is divided, has occasioned an almost equally great variety in the tenure of land, and the political circumstances which affect the cultivator. The great advantage which Italy possesses over the rest of Europe, in an agricultural point of view, is its climate; for though, as the learned Sismondi has shown (*Annals of Agric.*, vol. i.), it is, in point of health and agreeableness, one of the worst in the

world, yet the cool temperature of some of the northern districts admits of the finest pastures, while, from the warmth of others, the rocky sides of hills are as productive of grapes and olives as the plains are in corn. It is the only country in Europe, with the exception of some parts of Spain, where corn, grass, butcher's meat, cheese, butter, rice, silk, cotton, wine, oil, and fruits are produced, all in the highest degree of perfection. Only a fifth of its surface is considered sterile; while only a fifth of the surface of France is considered fertile. The population of Italy is greater in proportion to the surface, than that of either France or Britain.

261. *The writers on the rural economy of Italy* are, Arthur Young, in 1788; Sismondi, in 1801; and, Chateauvieux, in 1812. From the works of these authors, from those of Forsyth, Wilson, and other recent tourists, and from our own observations in 1819, we shall select some of the most characteristic traits as to the agriculture of Italy, adopting the division of Chateauvieux, of the region of irrigation, and the rotation of crops, in Lombardy; the region of vines and olives, exemplified in Tuscany; the region of insalubrious air, or the states of the church; and the region of volcanic ashes, or the Neapolitan culture.

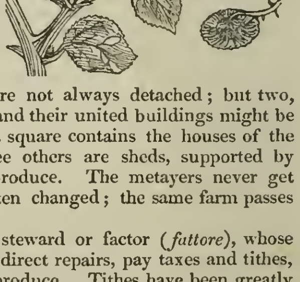
Subsect. 1. *Of the Agriculture of Lombardy.*

262. *The climate of Lombardy* is less irregular than that of some other districts. It is temperate on the declivities of the mountains in Piedmont, where the richest sheep pastures are situated; subject to great vicissitudes and to severe storms at the base of the Alps; and warm and humid in the plain of the Po. In some parts the olive and the orange endure the open air throughout the year, as in the islands of the lakes; in other places, at Milan for example, they require nearly as much protection in winter as in England.

263. *The soil* of the plain of the Po has evidently been formed by the recession or deposition of water, and is a rich black mould, deep, and every where perfectly level.

264. *These lands are every where enclosed*, either with hedges and ditches, or with open water-courses for irrigation. The hedges, however, are not very well kept: they are a mixture of different plants; often of willows chiefly, occasionally of the mulberry for feeding the silkworms, and sometimes of reeds. The hedge-plants of the country are the Christ's thorn (*Paliùrus austràlis*, *fig.* 31.), common hawthorn, and pomegranate.

31



265. *The lands are generally farmed by metayers* (from *meta*, one half, *Ital.*). The landlord pays the taxes, and repairs the buildings; the tenant provides cattle, implements, and seed; and the produce is divided. In some cases the landlord's half is delivered to him in kind; in others it is valued annually at harvest, and paid in money, or partly in money and partly in produce. There are some farmers who have leases, generally for short periods, not exceeding nine years, and pay fixed rents. The size of farms is from ten to sixty acres; but there are a few of two or three hundred acres. The latter, however, are chiefly cultivated by the proprietors. Farm-houses are of brick, sometimes stuccoed, and covered with tiles. They are not always detached; but two, three, or more, farmeries are often grouped together, and their united buildings might be mistaken for those of one large farm. One side of a square contains the houses of the farmers, the stables, and cattle-sheds; and the three others are sheds, supported by columns, and open on all sides, for implements and produce. The metayers never get rich, and are seldom totally ruined; they are not often changed; the same farm passes from father to son, like a patrimonial estate.

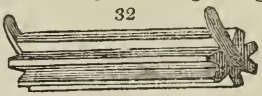
266. *Landed property is generally managed* by a steward or factor (*fattore*), whose business it is to inspect the cultivation of the lands, to direct repairs, pay taxes and tithes, and see that the landlord has his proper share of the produce. Tithes have been greatly lessened by the sale of a great part of the church lands at the revolution; but are still taken in kind, or commuted for, in order to support the parish clergy.

267. *The irrigation of Lombardy* is its most remarkable feature. The antiquity of the practice has been already noticed (180). In most states of Italy, the right and property of all rivers, and in some, as Venice, even of springs and rain, are considered as vested in the king or government. All canals taken from rivers are, therefore, purchased from the state, and may be carried through any person's lands, provided they do not pass through a garden, or within a certain distance of a mansion, on paying the value of the ground occupied. Such canals, indeed, are generally considered as enhancing the value of the property they pass through, by enabling them to purchase water, which is sold by the hour, half hour, or quarter, or by so many days' run, at certain fixed times, in the year. The right to water from such canals may even be purchased; and Arthur Young

mentions that the fee-simple for an hour's run per week, through a sluice of a certain dimension, near Turin, was, in 1788, 1500 livres. The water is not only used for grass-lands, which, when fully watered, are mown four, and sometimes five, times a year, and in some cases (e. g. Prato Marcita) as early as March; but is conducted between the narrow ridges of corn-lands, in the hollows between drilled crops, among vines, or to flood, a foot or more in depth, lands which are sown with rice. It is also used for *combles*, or depositing a surface of mud, in some places where the water is charged with that material; and this is done somewhat in the manner of what we call warping. The details of watering, for these and other purposes, are given in various works; and collected in those of Professor Re. In general, watered lands let at one third higher than lands unwatered.

268. *The implements and operations of agriculture in Lombardy* are very imperfect. The plough is of very rude contrivance, with a handle thirteen or fourteen feet long. It is drawn by two oxen without a driver or reins, the ploughman using a long light rod or goad. The names given to the different parts of the plough are corruptions or variations of the Roman terms already mentioned. (111.) Corn is generally beaten out by a wheel or large fluted cylinder (*fig.* 32.), which is turned in a circular track, somewhat in the manner of a bark-mill in England.

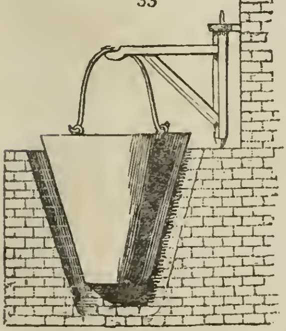
32



269. *The cattle of Piedmont* are, in some cases, fed with extraordinary care. They are tied up in stalls; then bled once or twice; cleaned and rubbed with oil; afterwards combed and brushed twice a day: their food in summer is clover, or other green herbage; in winter a mixture of elm leaves, clover-hay, and pulverised walnut-cake, over which boiling water is poured, and bran and salt added. Where grains (ponture) can be procured, they are also given. In a short time, the cattle cast their hair, grow smooth, round, fat, and so improved as to double their value to the butcher. (*Mem. della Soc. Agr.*, vol. i. p. 73.)

270. *The dairies on the plain of the Po*, near Lodi, produce the Parmesan cheese. The peculiar qualities of this cheese depend more on the manner of making than on any thing else. The cows are a mixed breed, between the red Hungarian or Swiss cow, and those of Lombardy. The chief peculiarity in their feeding is, that they are allowed to eat four or five hours in the twenty-four; all the rest of the time they are stalled, and get hay. Both their pasture and hay are chiefly from irrigated lands. The cheeses are made entirely of skimmed milk; half of that which has stood sixteen or seventeen hours, and half of that which has stood only six. The milk is heated and coagulated in a caldron (*fig.* 33.), placed in a very ingenious fire-place, being an inverted semi-cone in brickwork, well adapted for preserving heat and for the use of wood as fuel. Without being taken out of the caldron, the curd is broken very small by an implement, consisting of a stick with cross wires; it is again heated, or rather scalded, till the curd, now a deposition from the whey, has attained a considerable degree of firmness; it is then taken out, drained, salted, and pressed, and in forty days is fit to put in the cheese-loft. The peculiar properties of this cheese seem to depend on the mode of scalding the curd; though the dairyists pretend that it also depends on the mode of feeding the cows. Where one farmer has not enough of cows to carry on the process himself, it is common for two or more to join and keep a partnership account, as in Switzerland. More minute details will be found in Book IV. Part VII.

33



271. *Sheep are not common in Lombardy:* there are flocks on the mountains, but in the plains only a few are kept, in the manner pigs are in England, to eat refuse vegetables. The Merino breed was introduced, and found not to succeed.

272. *The rotations of crops* are not so remarkable for preserving the fertility of the soil, as for an immediate return of profit. The produce however being seldom bulky, the object is defeated. As examples, we may mention, 1. maize drilled; 2, 3, and 4. wheat; 5. maize drilled; 6, 7, and 8. wheat. Another is, 1. fallow; 2, 3, and 4. rice; 5. fallow; 6. wheat and clover, &c. Hemp, flax, lupines, rape, millet, panic, rye, and sometimes oats, with other crops, enter into the rotations. Rice is reckoned the most profitable crop; the next, wheat and millet. The rice-grounds receive but one ploughing, which is given in the middle of March, and the seed is sown at the end of the same month; sometimes in water up to the seedsman's knees, but more frequently the water is not let on till the rice is come up. The water is then admitted, and left on the ground till the beginning of June, when the crop is weeded by hand, by women half naked, with their petticoats tucked to their waists, wading in the water; and they make so droll a

figure, that parties are often made at that season to go and view the rice-grounds. When the weeding is finished, the water is drawn off for eight days; it is again drawn off when the ear begins to form, but after its formation is let in again till the rice is nearly ripe, which is about the end of August or beginning of September. The produce is from ten to twenty fold.

273. *Among the herbage crops cultivated*, may be mentioned chiccory, very common in the watered meadows, rib-grass, also very common, oat-grass, and some other grasses; but not near the variety of grasses found in the English meadows and pastures; fenugreek (Trigonélla *L.*), clovers, lucerne, saintfoin, and in some places burnet and spurry.

274. *Among the trees grown by the farmer*, the mulberry predominates, and is pollarded once or oftener every year for the silkworm. The tree is common in the hedge-rows, and in rows along with vines parallel to broad ridges. The vine is generally cultivated; trained or rather hung on mulberry, maple, or flowering ash pollards, or climbing up tall elms, or in the hedges, or against willow poles or rude espalier rails. The olive is not very common, but is planted in schistous declivities in warm situations; the apple, pear, and green gage plum are common.

275. *Though the agriculture of Lombardy appears to be practised more for subsistence, than for the employment of capital and the acquisition of riches*, yet, from the effect of irrigation in producing large crops of grass, the profits of rearing silk, and the rigid economy of the farmers, it is thought by Chateauvieux that it sends more produce to market than any district of Italy. (*Italy*, let. iv.)

Subsect. 2. *Of the Agriculture of Tuscany.*

276. *The picture of the agriculture of Tuscany given by Sismondi*, a distinguished literary character of Geneva, who resided five years as a cultivator in that country, is well known. Sismondi arranges the rural economy of this district into that of the plains, the slopes, and the mountains; and we shall here state the most interesting or characteristic circumstances which occur in his work, or that of Chateauvieux, under these heads. According to Forsyth, one half of Tuscany consists of mountains which produce nothing but timber; one sixth of olive and vine hills; and the remaining third is plain. The whole is distributed into eighty thousand fattorie, or stewardships. Each fattoria includes, on an average, seven farms. This property is divided among forty thousand families or corporations. The Riccardi, the Strozzi, the Feroni, and the Benedictines rank first in the number. The clergy keep the farmers well disciplined in faith, and through the terror of bad crops, they begin to extort the abolished tithes. This was in 1802: tithes are again fully established under the Austrian power.

277. *The climate of Tuscany* is esteemed the best in Italy, with the exception of that of its maremme, or pestilential region on the sea-coast. The great heats commence at the end of June, and diminish in the middle of September; the rest of the year is a perpetual spring, and vegetation in the plains is only interrupted for two or three weeks in the middle of winter. On the mountains there is snow all the year; and the hilly districts enjoy a temperate but irregular weather in summer, and a winter of from one to three months.

278. *The soil of the plains* is either sand or mud of "inexpressible fertility;" some parts were marshy, but the surface is now comparatively elevated and enriched (as was that of the Delta) by combles (colmata), or warping, a process ably described by Sismondi. (*Agr. Tuscan.*, § ii.)

279. *Irrigation in the plains* is practised in all the different modes as in Lombardy, but on a smaller scale, correspondent with their extent.

280. *The plain is every where enclosed.* The fields are parallelograms, generally one hundred feet broad, and four or five hundred feet long, surrounded by a ditch planted with Lombardy poplars and vines, with rows, lengthwise, of mulberries, maple, or the flowering or manna ash, also interspersed with vines; and often, by the way-sides, these hang in festoons, from tall elms. (*fig.* 34.) The poplars supply leaves for feeding heifers, rods which are sold for making espaliers for vines, and spray for fuel. Every now and then a few are cut down for timber, as at twenty years they are found to be too large for the situation. The top of the ash and maple is used for fuel; the timber for implements of husbandry. The mulberry is pollarded every other year for the leaves, which are stripped off for the silkworms, and the spray used as fuel. The produce of raw silk is one of the most important in Tuscany, and is almost the only article the farmer of the plains has to exchange for money. He has wine also, it is true, but that, though produced in abundance, is of so wretched a quality, compared with that of the hills, that it brings but little. Hedges are only planted on the road sides to keep off beggars and thieves, who are very numerous, and who steal the grapes and the ears of maize. Some-

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times the grapes next the road are sprinkled with mud or lime-water to deter them; at other times a temporary dead fence of thorns is used during the ripening season and taken down afterwards. The hedge plants are the hawthorn, sloe, bramble, briar, evergreen rose, ilex, service, myrtle, pomegranate, bay, laurel, &c.

281. *In the arable lands of the plains,* the row and mostly the raised drill culture are generally followed, or the land is ploughed into beds of three or four feet broad, between which water is introduced in the furrows. Every year a third of the farm is turned over with a spade to double the depth of the plough, so as to bring a new soil to the surface. The sort of trenching which effects this is performed differently from that of any other country; the spade being thrust in horizontally or obliquely, and the trench formed by taking off successive layers from the top of the firm side, and turning them regularly over in the trench. In this way the surface is completely reversed.

282. *The rotation of crops in the plain* includes a period of three or five years, and five or seven crops. There are, for a three-years' course; 1. wheat or other grain, and lupines in the autumn; 2. corn of some sort, and turnips or clover in the autumn; 3. maize, panic, or common millet, and Indian or black millet (*Hólcus Sórghum*). Corn is cut about the end of June close to the earth, left to dry a day or two, and then tied in bundles (bottes), and put in cocks for a week or two. At the end of this period the ears are cut off, and beaten out on a smooth prepared piece of ground in the farm-yard. The straw is stacked, and the corn cleaned by throwing it with shovels, &c. The corn is laid up till wanted in oval excavations in dry ground, which are covered with tiled roofs. The excavations are lined with straw; one holds from twenty to a hundred sacks, and being covered with straw, is heaped over with earth. In this way it is kept in perfect preservation a year or longer, and untouched by insects. The lupines sown after wheat are often ploughed in for manure; sometimes French beans are substituted, and the ripe seeds used as food; or turnips are sown for cattle. They have few sorts of turnips that are good; and Sismondi complains that half of them never bulb. Maize is sown in drills, and forms a superb crop in appearance, and no less important, constituting the principal food of the lower classes in every part of Italy where the chestnut does not abound. When the male flowers of the maize begin to fade, they are cut off by degrees, so as not to injure the swelling grain; the leaves are also cut off about that time, cattle being remarkably fond of them. In the plain of Bologna, hemp, flax, and beans enter into the rotation.

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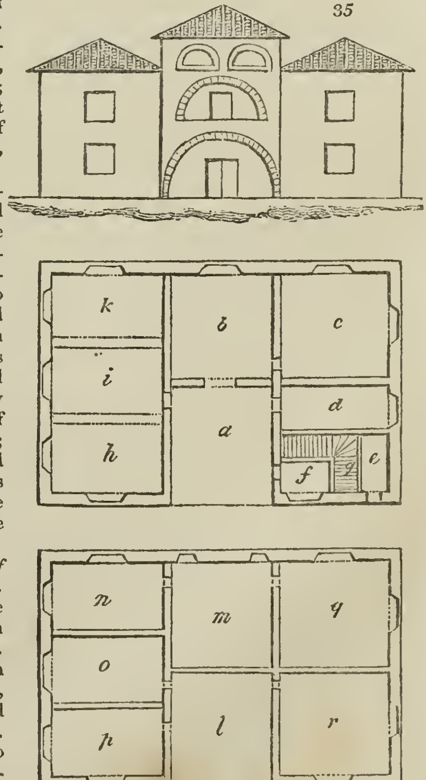

283. *Cattle in the plains* are kept constantly in close warm houses, and fed with weeds, leaves, or whatever can be got. The oxen in Tuscany are all dove-coloured; even those which are imported from other states, are said to change their coat here. They are guided in the team by reins fixed to rings which are inserted in their nostrils; sometimes two hooks, jointed like pincers, are used for the same purpose. In general, only one crop in four is raised for the food of cattle, so that these are not numerous; it may thus appear that manure would be scarce, but the Tuscan farmers are as assiduous in preserving every particle both of human and animal manure as the Flemings.

284. *The farm-houses of the plain of Tuscany,* according to Lasteyrie (*Coll. de Mach.*), are constructed with more taste, solidity, and convenience, than in any other country on the Continent. They are built of stones generally, in rubble work, with good lime and sand, which become as hard as stucco, and they are covered with red pantiles. The elevation (*fig.* 35.) presents two deep recesses, the one a porch or common hall to the ground floor, or hus-

bandry part of the edifice (*a*); and the other above it to the dwelling family apartments. The ground floor consists of this porch, which is arched over (*a*), a workshop (*b*), a harness and tool-room (*c*), pigsty (*d*), poultry-house (*e*), a stove (*f*), staircase (*g*), stable (*h*), cow or ox house (*i*), and sheep-house (*k*). The dwelling floor consists of the upper gallery or open hall (*l*), which serves as a sort of kitchen, work-room, or scullery, a kitchen (*m*), a master and mistress's room (*n*), a girls' room (*o*), a boys' room (*p*), a store room (*q*), and silkworm room (*r*).

285. *The peasants, or farmers, of the plains* are for the most part metayers; their farms are from five to ten acres, each having a house and offices, like that just described, towards its centre. Some pay a fixed rent on short leases; and some hold farms on improving leases which extend to four generations. They are more than economical; never tasting butcher's meat but on Sunday. The three repasts of the other days are either of porridge of maize and a salad; porridge of bread and French beans, seasoned with olive oil; or of some sort of soup. In general the whole family remain at home, and aid their parents in performing the labours of the farm. Seldom any but the oldest son marries; and when the father dies he succeeds in his turn, and his brothers and sisters serve him as they did their father till they die off, and are replaced by their nephews and nieces. Such is the state of things which, as Chateauvieux has observed, is the result of early civilisation and excessive population.

286. *The culture of the hills and declivities,* Chateauvieux supposes to have been introduced from Canaan at the time of the crusades: but, though that culture, and also the irrigation system, have, no doubt, been originally copied from that country and Egypt, yet some think it more likely to have been imported by the Romans or the priests, than by the chivalric adventurers of the eleventh and twelfth centuries.

287. *The soil of the hills* is in general either schistous or calcareous, on a pliable rocky or gravelly bottom. It is cut into horizontal terraces, of different widths according to the steepness of the declivity, and each terrace is supported by a wall or sloping bank of turf or stones. Intercepting gutters are formed every sixty or seventy feet, in the direction of the slope, to carry off the waters which do not sink in the rainy season. Sismondi considers the turfed terraces of the hills of Nievole the most elegant. On the terraces of the most rapid and least favourably exposed slopes, olives are planted; on the best exposure, vines. Where the terrace is broad, two rows of mulberries, and sometimes of fig trees, are planted, and between these, where the soil is not too dry, early crops of grain or legumes are taken. The walls of turf are mown.

288. *The olive* being an evergreen, and in a state of growth all the year, requires a more equable climate than the vine; but it will grow on any dry soil, and in an inferior exposure, because the fruit never ripens till the hoar frosts have commenced. The young plants are raised from cuttings or suckers in a nursery, and in the same manner in which it was during the time of the Romans. "An old tree is hewn down, and the ceppo, or stock (that is, the collar or neck between the root and the trunk, where in all plants the principle of life more eminently resides), is cut into pieces of nearly the size and shape of a mushroom, and which from that circumstance are called novali; care at the same time is taken that a small portion of bark shall belong to each novalo; these, after having been dipped in manure, are put into the earth, soon throw up shoots, are transplanted at the end of one year, and in three years are fit to form an olive yard." (*Blunt's Vestiges*, 216.) They are planted generally fifteen feet apart in rows, with the same distance between the rows.

289. *The olive is of very slow growth but of great duration.* Some plantations exist, which are supposed to be those mentioned by Pliny, and therefore must have existed nearly two thousand years, if not more. In one of these, which we have seen in the vale of Marmora, near Terni, the trunks of many trees have rotted at the core, and the circumference has split open and formed several distinct stems. Though in ruins, these trees still bear abundant crops. The olive requires little pruning, and is seldom otherwise manured than by sowing lupines under it, and digging them in. The fruit becomes black in November; is gathered in the course of that and the three following months; and ground in a stone trough by a stone turned by a water-wheel. The paste formed by the fruit, and its kernels, is then put in a hair cloth and pressed, and the oil drops in a tub of water somewhat warm, from which it is skimmed and put in glass bottles for sale, or glazed jars for home consumption. The paste is moistened and pressed a second and third time for oils of inferior quality. The crop of olives is very uncertain; sometimes one that yields a profit does not occur for six or eight years together, as in the culture of wine and cider: and these departments of culture on the Continent are considered as injurious to the peasant, because in the year of plenty he consumes his superfluous profits, without laying any thing aside to meet the years of loss. Hence the remark common in France and Italy, that wine and oil farming is less beneficial than that of corn.

290. *The vine on the hills* is generally raised where it is to remain, by planting cuttings; but it is also planted with roots procured by layering: in either case, it seldom bears fruit

till the fifth year after planting. It is trained on trees, poles, and trellised roofs, over paths, and different kinds of espalier rails. The poles are of barked chestnut, and the lesser rods used are generally of reeds; the latter forms a profitable article of culture on the brink of water-courses for this purpose. These reeds last from one to four years, according to their size. The ties used in binding the vine both on the hills and plains are of willow, often the yellow or golden sort. The general maxim in pruning the vine is to leave as much wood to one stool as possible, in order to prevent two shoots from proceeding from one eye, in which case both are generally barren. They give no summer pruning; but, when the fruit is nearly ripe, they cut off the extremities of the shoots for the sake of the leaves as forage, and to admit the sun and air more directly to the fruit. The pruning-hook they use (*fig.* 36.) is not unlike a hand hedge-bill. The fruit is gathered by women, and put into baskets and hampers; then carried to a tub or cistern of masonry, where it lies and ferments, being frequently stirred, but not pressed as in France and other parts of Italy. The management of the wine is not considered good; and there are but few sorts of Tuscan wine that will keep above a year.


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291. *The potato*, little known in Lombardy, was introduced in the hills of Tuscany by Sismondi, but was little cultivated or esteemed. It is only known, he says, to the gardeners of Florence and Leghorn. If not taken up about the middle of July, the tubers are either burned and rotted by the heat, or they germinate at every bud. An early sort, he thinks, might be introduced both in the plain and hill culture with great advantage.

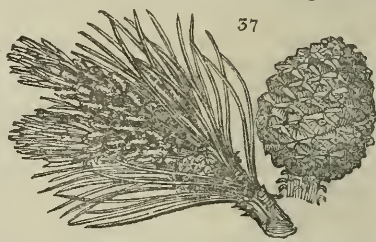
292. *The hill farmers*, like those of the plains, are generally metayers, and rent their farms, which seldom exceed seven or eight acres; and the most general conditions of their lease (bail), according to M. Sismondi, are the following: — 1. The farmer engages to cultivate the lands, and find the requisite props for the vines. 2. To advance the half of the seed, and the half of the dung that is obliged to be purchased. 3. To deliver to the proprietor half the crop, or sell it for his account. 4. To divide with the proprietor the profit made on cattle, and to deliver a certain number of eggs, chickens, and capons in lieu of that on poultry. 5. To wash the whole or a part of the proprietor's linen, he finding soap. The proprietor on his part engages to advance the other half of the seed, and of the manure which must be purchased; to be at the expense of making up new grounds and other radical improvements, to effect repairs, &c., and to find the first props for newly planted vines. This contract goes on from year to year, and can only be dissolved by a year's notice; changes, however, very seldom take place. The conditions in some places are more severe for the farmer; and on oil and certain other articles he only receives a third of the profits.

293. *The culture of the mountains of Tuscany* consists of the harvesting of chestnuts, and the management of live stock and of forests. The chestnut trees, Sismondi is of opinion, have been originally planted, but they now receive no other care than that of replacing a worn out tree by a young one, and cutting out dead wood, which is done more for the sake of fuel than any thing else. The fruit is gathered in November, after it drops on the turf: it is eaten either in its natural state, or it is ground into meal and prepared as flour. Such as are to be ground, are first kilndried; next, they are put into small bags, which hold half a bushel each, and these are beat against the ground till the outer husk is removed; they are then taken out, the outer husks separated, and the chestnuts replaced, and beat as before till the inner husk comes off; they are then cleaned in the wind, and sent to a corn-mill to be ground. The flour they produce has no bran, and is mild and sweet, and keeps well. Lands covered with chestnuts are valued, not by their extent, but by the number of sacks of fruit annually produced. Chestnut flour is chiefly used in the form of porridge or pudding. In the coffee-houses of Lucca, Pescia, and Pistoja, patés, muffins, tarts, and other articles are made of it, and are considered delicate.

294. *The management of sheep in the mountains* is rude and unprofitable, and so little is mutton esteemed in Tuscany that it always sells at two or three sous a pound under every other meat. The sheep are pastured all the summer under the chestnut trees; but in October, when the fruit begins to fall, they are sent to the maremmes, where they remain till the May or June following, at the cost of not more than a penny a head. A wretched cheese is made from the milk; but, bad as it is, it is better than what is made from the milk of goats or cows. The Tuscans, indeed, are so unwilling to believe that good cheese can be produced from the latter animals, that they consider the Dutch and other excellent foreign cheeses which they purchase at Leghorn, as all made from the milk of sheep.

295. *Forests of timber trees cover the highest parts of the mountains.* These form sources of profit to the peasantry, independently of the sale of timber, which is very limited, owing to the difficulty of carriage. Hogs are pastured there, left to themselves the whole year, and only sought for when wanted for the butcher. Their flesh is excellent,

and, being very abundant in the markets of most parts of Italy, is not dear. Acorns are collected in some places, and sold to the farmers of the plains, for feeding swine. The cones of the Pìnus Pìnea (*fig.* 37.) are collected, and the seeds taken out: these are much esteemed, and bear a high price. The same thing is, in some places, done with the cones of the wild pine, commonly but erroneously called the Scotch fir (Pìnus sylvéstris *L.*), whose seeds are equally good, though smaller. Strawberries, bramble-berries, gooseberries, currants, raspberries, and other wild fruits, are collected, and either sold publicly in the markets of the plains, or privately to the confectioners for flavouring ices; an article in great demand throughout all Italy. Sismondi seems to have been the first who noticed that the black mulberry was grown in the mountains for its leaves, being considered as hardier than the white. The fruit was only eaten by children. In the plains and gardens of Italy the mulberry is scarcely known as a fruit tree, though the white species is every where grown for the silkworm.



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296. *The mountain farmers* are generally proprietors of their farms. They live together in villages, which are very numerous; many of them hire themselves to the farmers of the maremmes, where there is a scarcity of population, to assist in their harvests; and with the money saved in this way, and by sending fruits, collected by their wives and children, to the towns in the plains, they are generally better off than the farmers of the hills, or of the low country.

297. *The agricultural establishment of Rossore* may be mentioned as belonging to Tuscany. It is situated at the gate of Pisa, and was founded by the family of Medici, in the time of the crusades, and now belongs to government. A league square of ground, which was so poor and sandy as to be unfit for culture, was surrounded by a fence, and, having been left to itself, has now the appearance of a neglected park. A building was erected in its centre as a lodge, and the grounds were interspersed with stables and sheep houses. The park was stocked with an Arabian stallion and a few mares, and some Asiatic camels; and these were left to breed and live in a state of nature. About the beginning of the present century a flock of Merino sheep was added. The horses have formed themselves into distinct tribes or troops, each of fifteen or twenty mares governed by a stallion. These tribes never mix together, each has its quarter of pasture which they divide among themselves without the interference of shepherds. The shape of these horses is wretched, and the spare or superfluous ones are sold only to fuel-drivers (coalmen, *carbonari*) and the post. There are more than two hundred camels which associate together, and multiply at pleasure. They are worked in the plough and cart, and the spare stock supplies all the mountebanks of Europe, who buy them at the low price of six or seven louis each. The next feature of this establishment is a herd of 1800 wild bulls and cows, fierce and dangerous: the superfluous stock of these is either hunted and killed for their hides and flesh, or sold alive to the farmers to be fed or worked. The flock of Merinos are but lately introduced. Such are the chief features of this establishment, which Chateauvieux terms a specimen of Tatar culture. It is evident it has no other art or merit than that of allowing the powers and instincts of nature to operate in their own way; and it forms a very singular contrast to the highly artificial state of rural economy in Tuscany.

Subsect. 3. *Of the Agriculture of the Maremmes, or the District of Pestilential Air.*

298. *The extent of this district* is from Leghorn to Terracina in length; and its widest part is in the states of the church; it includes Rome, and extends to the base of the Apennines.

299. *The climate of the maremmes* is so mild that vegetation goes on during the whole of the winter; but so pestilential that there are scarcely any fixed inhabitants in this immense tract of country, with the exception of those of the towns or cities on its borders.

300. *The surface* is flat or gently varied; and the soil in most places deep and rich. In the maremmes of Tuscany it is in some places a blue clay abounding in sulphur and alum, and produces almost nothing but coltsfoot (Tussilàgo).

301. *The estates* are generally extensive, and let in large farms, at fixed rents, to men of capital. The maremmes of Rome, forty leagues in extent, are divided into a few hundred estates only, and let to not more than eighty farmers. These farmers grow corn, and pasture oxen of their own; and in winter they graze the wandering flocks of the mountains of Tuscany and other states at so much a head. The corn grown is chiefly wheat, which is reaped by peasants from the mountains, some of whom also stay

and assist in sowing the succeeding crop; after which the whole disappear, and the maremmes remain a desert with a few men, whom Chateauvieux designates as "half savages, who run over these solitudes like Tatars, armed with long lances, and covered with coarse woollens and untanned skins." The lance they use in hunting down the oxen when they are to be caught for the butcher, or to be broken in for labour; and the clothing alluded to has been recommended by the medical men of Rome, as the most likely to resist the attacks of the malaria (bad air), or pestilence.

302. *The agricultural implements and operations* differ little from those of other parts of Italy. The plough, or araire, of Rome (*fig.* 38.) is a rude implement, with a broad flat share, on the hinder end of which the ploughman stands; and thus drawn along, his weight makes a deeper furrow. Two strips of wood (the *binæ aures* of Virgil), about eighteen inches long, are often attached to the share, diverging a little from each other, and these serve to lay open the furrow like our mould-board. In the operation of propagating the vine, cuttings are planted in trenches four feet deep, into which stones have been previously thrown, for the alleged purpose of encouraging moisture about the roots. The same mode was practised in Virgil's time. (*Georg.*, ii. 346.) The common Roman cart (*fig.* 39.) is supposed to have been originally designed by the celebrated Michael Angelo, in his quality of engineer and wheeler. (See *Lasteyrie, Col. des Mach.*)

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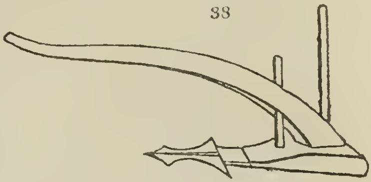

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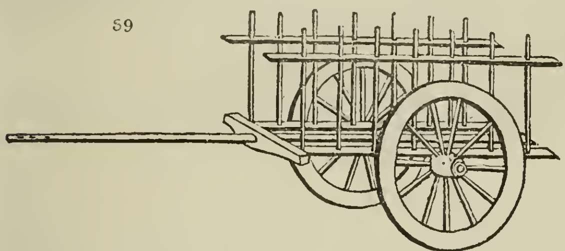

303. *The farm of Campo Morto* (field of death) includes the whole property of St. Peter's church in Rome, which is supported from its sole revenue. This vast estate is situated in the Pontine marshes, and the following outline of its management is taken from a letter of Chateauvieux, written in July 1813: —

304. *The farmery*, the only building on an estate of many thousand acres, consists of a central building and two wings, the ground-floor of the central part consists of an immense kitchen and five large rooms, the latter without windows, and unfurnished. The first story consists of six rooms, used as corn-chambers, with the exception of one, which was furnished, and served to lodge the principal officers. The two wings contained large vaulted stables, with hay-lofts over. One female lived in the house, in order to cook for the officers or upper servants, whose wives and families live in the towns as do those of the shepherds. There was no garden, nor any appearance of neatness or cleanliness, and not a fence or a hedge, and scarcely a tree on the whole farm.

305. *The fattore, or steward*, was an educated man, and a citizen of Rome, where his family lived; he and all the other officers, and even shepherds, always went out mounted and armed.

306. *The reapers* were at work in a distant part of the estate, when Chateauvieux went over it: they were an immense band, ranged as in the order of battle, and guarded by twelve chiefs or overseers on horseback, with lances in their hands. These reapers had lately arrived from the mountains; half were men and the rest women. "They were bathed in sweat; the sun was intolerable; the men were good figures, but the women were frightful. They had been some days from the mountains, and the foul air had begun to attack them. Two only had yet taken the fever; but they told me, from that time a great number would be seized every day, and that by the end of harvest the troop would be reduced at least one half. What then, I said, becomes of these unhappy creatures? They give them a morsel of bread, and send them back. But whither do they go? They take the way to the mountains; some remain on the road, some die, but others arrive, suffering under misery and inanition, to come again the following year."

307. *The corn is threshed* fifteen days after being cut: the grain is trodden out under the feet of horses, cleaned, and carried to Rome. The straw was formerly suffered to be dispersed by the wind; but it is now collected in heaps at regular distances over the country, and always on eminences: there it lies ready to be burned on the approach of "those clouds of grashoppers which often devastate the whole of this country."

308. *The live stock of the farm* consisted of a hundred working oxen; several hundreds of wild cows and bulls, kept for maintaining the stock, and for the sale of their calves and heifers; two thousand swine, which are fatted upon nuts and acorns in the forests belonging to the estate; and a hundred horses for the use of the herdsmen. There were four thousand sheep on the low grounds, and six hundred and eighty thousand on the mountains belonging to the estate. Of the latter, eighty thousand were of the Negretti breed, whose wool it was intended to have manufactured into the dresses of all the mendicant monks in Italy, and into the great coats of the shepherds: the rest were of the Pouille breed, which produces a white wool, but only on the upper part of the body. As mutton is not good in Italy, and but little eaten, they kill most of the tup-lambs as soon as they are born, and milk the ewes to make cheese. The temporary flocks had not arrived when Chateauvieux was at Campo Morto, the fields not being then cleared of their crops.

309. *The farmer of this extensive domain* is M. Trucci, who pays a rent for it of 22,000 piastres (4950*l.*). This, said M. Trucci to Chateauvieux, "supposes an extent of three thousand rubbi, or six thousand acres, of culturable land. I have nearly as

much that is not fit for the plough, and it is there my pigs and my cows principally feed. My three thousand rubbi are divided into nearly nine equal parts of three hundred and thirty rubbi each: one of these is in fallow, another in corn, and the seven others in pasture. On the two thousand three hundred rubbi, which remain in grass, I support four thousand sheep, four hundred horses, and two hundred oxen, and I reserve a portion for hay. In the macchie (bushy places, woody wastes) I have seven hundred cows, and sometimes nearly two thousand pigs.

310. *My expenses* "are limited to paying the rent of the farm, to purchasing bread for the workmen, and to the entire maintenance of my army of shepherds, superintendents, and the fattore; to paying for the work of the day-labourers, of the harvest-men, &c.; and, in short, to the expense of moving the flocks, and to what, in large farms, are called the extra-charges, the amount of which is always very high. There must also be deducted from the gross profits of the flock about one tenth, which belongs, in different proportions, to my chiefs and to my shepherds, because I support this tenth at my expense. We have also, in this mode of culture, to sustain great losses on our cattle, notwithstanding which I must acknowledge that our farming is profitable.

311. *Of annual profit* "I average above five thousand piastres, besides five per cent on the capital of my flocks. You see, then, that the lands in the Campagna of Rome, so despised, and in such a state of wildness, let at the rate of eighteen francs (fifteen shillings) the Paris acre: there is an immense quantity in France which does not let for so much. They would, doubtlessly, let for more if they were divided and peopled, but not in the proportion supposed: for the secret in large farms consists in their economy; and nothing on the subject of agricultural profit is so deceptive as the appearance they present to our view, for the profit depends solely on the amount of the economical combinations, and not on the richness of the productions displayed to the eye." (*Letters on Italy.*)

Subsect. 4. *Of Farming in the Neapolitan Territory, or the Land of Ashes.*

312. *The farming on the volcanic soil,* in the neighbourhood of Vesuvius, belongs to the valley farming of Tuscany; but, as it varies a little, and as the farmers are much more wretched, we shall give the following relation, as received by Chateauvieux from a Neapolitan metayer: —

313. *We, poor metayers,* he said, "occupy only so much land as we can cultivate by our own families, that is to say, four or five acres. Our condition is not a good one, since we get for our trouble only a third of the produce, two thirds belonging to the owner, which we pay in kind into the hands of the steward. We have no ploughs, and the whole is cultivated by the spade. It is true that the soil, being mixed with ashes, is easily stirred; and even our children assist us in this work. At times the mountain, hence named Vesuvius, pours forth showers of ashes, which spread over our fields and fertilise them.

314. *The trees* which you see on the land, "are not without their use; they support the vine, and give us fruit; we also carefully gather their leaves: it is the last autumnal crop, and serves to feed our cattle in the winter. We cultivate, in succession, melons, between the rows of elms, which we carry to the city to sell; after which we sow wheat. When the wheat crop is taken off, we dig in the stubble, which is done by our families, to sow beans or purple clover. During six months, our children go every morning to cut a quantity of it with the sickle, to feed the cows. We prefer the females of the buffaloes, as they give most milk. We have also goats, and sometimes an ass, or a small horse, to go to the city and carry our burthens; but this advantage belongs only to the richer metayers.

315. *We plant the maize* "the following spring, after clover or beans. We manure the land at this time, because this plant is to support our families; this crop, therefore, interests us more than all the others, and the day in which it is harvested is a day of festivity in our country. All the villagers assemble together, the young women dance, and the rest of us walk slowly, being laden with our tools: arrived at our dwellings, each family goes into its own; but they are so near each other, that we can still converse together.

316. *We often gather seven ears from one stalk of maize,* "and many of them are three palms long. When the sun is high, the father of the family goes into the adjoining field to get some melons, while the children gather fruit from the surrounding fig trees. The fruit is brought under an elm tree, round which the whole family sits; after this repast the work begins again, and does not cease until the close of day. Each family then visits its neighbours, and tells of the rich crop the season has bestowed upon them.

317. *We have no sooner gotten in the maize than the earth is again dug, to be sown once more with wheat;* after this second crop, we grow in the fields only vegetables of different kinds. Our lands thus produce wine and fruit, corn and vegetables, and leaves and grass for the cattle. We have no reason to complain of their fertility: but our conditions are

hard, little being left for our pains; and if the season is not propitious, the metayer has much to complain of." (*Letters on Italy.*)

318. *The cotton plant* (Gossýpium herbàceum) (*fig.* 40.) is beginning to be cultivated in the neighbourhood of Vesuvius, and in Sicily. It is sown in March, in lines three feet distant, and the plants two feet apart in the lines. The earth is stirred by a one-horse plough, or by hoes, and carefully weeded. As soon as the flowering season is over, about the middle of September, the ends of the shoots are nipped off, to determine the sap to the fruit. The capsules are collected as they ripen; a tedious process, lasting two months: the cotton and the seeds are then separated; an operation still more tedious. The most extensive cotton farmers are in the vale of Sorento. There the rotation is, 1. maize; 2. wheat, followed by beans, which ripen next March; 3. cotton; 4. wheat, followed by clover; 5. melons, followed by French or common beans. Thus, in five years, are produced eight crops. In this district, wherever water can be commanded, it is distributed, as in Tuscany and Lombardy, among every kind of crop.

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319. *The tomato, or love apple* (Solànum Lycopérsicum *L.*), so extensively used in Italian cookery, forms also an article of field culture near Pompeii, and especially in Sicily, whence they are sent to Naples, Rome, and several towns on the Mediterranean sea. It is treated much in the same way as the cotton plant.

320. *The orange, lemon, peach, fig,* and various other fruits, are grown in the Neapolitan territory, both for home use and exportation: but their culture we consider to belong to gardening.

321. *The Neapolitan maremmes,* near Salerno, to the evils of those of Rome, add that of a wretched soil. They are pastured by a few herds of buffaloes and oxen; the herdsmen of which have no other shelter during the night than reed huts; these desert tracts being without either houses or ruins. The plough of this ancient Greek colony is thought to be the nearest to that of Greece, and has been already adverted to (31.).

322. *The manna,* a concrete juice, forms an article of cultivation in Calabria. This substance is nothing more than the exsiccated juice of the flowering ash tree (O'rnus rotundifòlia), which grows there wild in abundance. In April or May, the peasants make one or two incisions in the trunk of the tree with a hatchet, a few inches deep; and insert a reed in each, round which the sap trickles down: after a month or two they return, and find this reed sheathed with manna. The use of manna, in medicine, is on the decline.

323. *The filberts and chestnuts* of the Calabrian Apennines are collected by the farmers, and sold in Naples for exportation or consumption.

324. *The culture of indigo and sugar* was attempted in the Neapolitan territory, under the reign of Murat. The indigo succeeded; but sufficient time had not elapsed to judge of the sugar culture when it was abandoned. The plants, however, grew vigorously, and their remains may still (1819) be seen in the fields near Terracina.

325 *Oysters have been bred and reared in the kingdom of Naples* from the time of the Romans. The subject is mentioned by Nonnius (*De Reb. Cib.*, l. iii. c. 37.); and by

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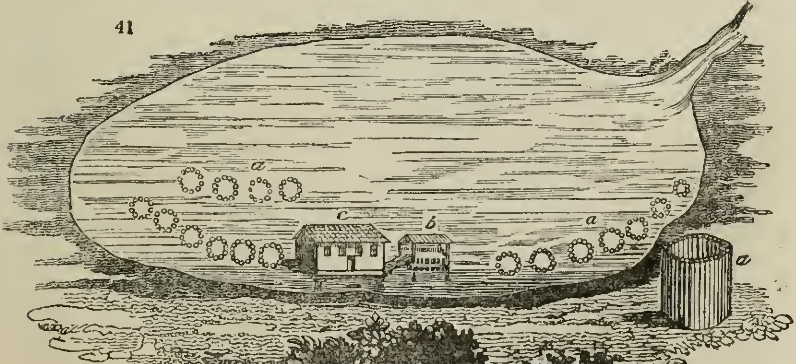

Pliny (*Nat. Hist.*, b. xviii. c. 54.). Count Lasteyrie (*Col. des Mach.*) describes the place mentioned by the latter author, as it now exists in the Lake Facino, at Baia. This lake (*fig.* 41.) communicates with the sea by a narrow passage. On the water near its margin, a house (*c*) is constructed for those who take care of the oysters, and who sell them to the dealers in Naples, or to those who come and eat them on the spot; and adjoining the house is a covered enclosure (*b*), where the oysters are kept till wanted. Along the margin of the lake, and in most parts of it, are placed circles of reeds (*a*), with their summits above the water. The spawn of the oysters attaches itself to these reeds, and grows there till of an edible size: the oysters are then removed to the reserve (*b*), and kept there till wanted. In removing them the reeds are pulled up one by one, examined, and the full-grown oysters removed and put in baskets, while the small-sized and spawn are suffered to remain, and the reed is replaced as it was. The baskets are then placed in the reserve, and not emptied till sold. In two years from the spawn, Lasteyrie observes, the oyster is fully grown.

Sect. II. *Of the present State of Agriculture in Switzerland.*

326. *The agriculture of Switzerland* is necessarily of a peculiar nature, and on a very confined scale. The country is strictly pastoral; little corn is produced, and the crops are scanty and precarious. Cattle, sheep, and goats constitute the chief riches and dependence of the inhabitants. Each proprietor farms his own small portion of land; or the mountainous tracts belonging to the communities are pastured in common. But, whether private or common property, it is evident that mountainous pastures are little susceptible of improvement. (*For. Quart. and Continent. Miscell.*, Jan. 1828.)

327. *Though of a very primitive kind*, this agriculture is not without interest, from the nice attention required in some parts of its operations. The surface, soil, and climate of the country, are so extraordinarily irregular and diversified, that in some places grapes ripen, and in many others corn will not arrive at maturity; on one side of a hill the inhabitants are often reaping, while they are sowing on the other; or they are obliged to feed the cattle on its summits with leaves of evergreens while they are making hay at its base. A season often happens in which rains during harvest prevent the corn from being dried, and it germinates, rots, and becomes useless; in others it is destroyed by frost. In some cases there is no corn to reap, from the effect of summer storms. In no country is so much skill required in harvesting corn and hay as Switzerland; and no better school could be found for the study of that part of Scotch and Irish farming. After noticing some leading features of the culture of the cantons which form the republic, we shall cast our eye on the mountains of Savoy.

Subsect. 1. *Of the Agriculture of the Swiss Cantons.*

328. *Agriculture began to attract public attention in Switzerland* about the middle of the eighteenth century. In 1759, a society for the promotion of rural economy established itself at Berne: they offered premiums, and have published some useful papers in several volumes. Long before that period, however, the Swiss farmers were considered the most exact in Europe. (*Stanyan's Account of Switzerland in* 1714.) Chateauvieux attributes the progress which agriculture has made, near Vevay, on the Lake of Geneva, to the settlement of the protestants, who emigrated thither from France, at the end of the seventeenth century. They cut the hills into terraces, and planted vines, which has so much increased the value of the land, that what was before worth little, now sells at 10,000 francs per acre. (*Let.* xxi.) Improvement in Switzerland is not likely to be rapid; because agriculture there is limited almost entirely to procuring the means of subsistence, and not to the employment of capital for profit.

329. *Landed property in Switzerland* is minutely divided, and almost always farmed by the proprietors and their families: or it is in immense tracts of mountain belonging to the bailiwicks, and pastured in common: every proprietor and burgess having a right according to the extent of his property. These men are, perhaps, the most frugal cultivators in Europe: they rear numerous families, a part of which is obliged to emigrate, because there are few manufactures; and land is excessively dear, and seldom in the market.

330. *The valleys of the Alpine regions of Switzerland* are subject to very peculiar injuries from the rivers, mountain rocks, and glaciers. As the rivers are subject to vast and sudden inundations, from the thawing of the snow on the mountains, they bring down at such times an immense quantity of stones, and spread them over the bottoms of the valleys. Many a stream, which appears in ordinary times inconsiderable, has a stony bed of half a mile in breadth, in various parts of its course; thus a portion of the finest land is rendered useless. The cultivated slopes, at the bases of the mountains, are subject to be buried under *éboulemens*, when the rocks above fall down, and sometimes cover many square miles with their ruins.

331. *E'boulement* (Fr.) denotes a falling down of a mountain or mass of rock, and consequent covering of the lower grounds with its fragments; when an immense quantity of stones are suddenly brought down from the mountains by the breaking or thawing of a glacier, it is also called an *éboulement*. (*Bakewell*, vol. i. p. 11.) Vast *éboulemens* are every year falling from the enormous precipices that overhang the valley of the Rhone: many of these are recorded which have destroyed entire villages.

332. *One of the most extraordinary* éboulemens *ever known* was that of Mont Grenier, five miles south of Chambery. A part of this mountain fell down in the year 1248, and entirely buried five parishes, and the town and church of St. André. The ruins spread over an extent of about nine square miles, and are called *Les Abymes des Myans*. After a lapse of so many centuries, they still present a singular scene of desolation. The catastrophe must have been most awful when seen from the vicinity; for Mont Grenier is almost isolated, advancing into a narrow plain, which extends to the valley of the Isere.

333. *Mont Grenier* rises very abruptly upwards of 4000 feet above the plain. Like the mountains of Les Echelles, with which it is connected, it is capped with an immense mass of limestone strata, not less than 600 feet in thickness, which presents on every side the appearance of a wall. The strata dip gently to the side which fell into the plain. This mass of limestone rests on a foundation of softer strata, probably molasse. Under this molasse are distinctly seen thin strata, probably of limestone, alternating with soft strata. There can be little doubt that the catastrophe was caused by the gradual erosion of the soft strata which undermined the mass of limestone above, and projected it into the plain; it is also probable that the part which fell had for some time been nearly detached from the mountain by a shrinking of the southern side, as there is at present a rent at this end, upwards of two thousand feet deep, which seems to have cut off a large section from the eastern end, and that now "Hangs in doubtful ruins o'er its base," as if prepared to renew the catastrophe of 1248.

334. *Avalanches*, or falls of immense masses of snow from the mountains, often occasion dreadful effects. Villages are overwhelmed by them; and rivers, stopped in their course by them, inundate narrow valleys to a ruinous extent. In February 1820, the village of Obergestelen, with eighty-eight of its inhabitants, was overwhelmed by an avalanche.

335. *The glaciers*, or ice-hills, or ice-heaps, slide down into the mountain valleys, and form dams across them, which produce large lakes; by the breaking up of the glacier, these lakes are sometimes suddenly poured into the lower valleys, and do immense mischief. Man, in such a country, as Bakewell has observed, is in a constant state of warfare with the elements, and compelled to be incessantly on his guard against the powers that threaten his destruction. This constant exposure to superhuman dangers is supposed to have given the aged inhabitants, especially of the Vallais, an air of uncommon seriousness and melancholy.

336. *The Swiss cottages* are generally formed of wood, with projecting roofs, covered with slates, tiles, or shingles. A few small enclosures surround or are contiguous to them, some of which are watered meadows, others dry pasture; and one or more always devoted to the raising of oats, some barley, and rye or wheat, for the family consumption. In the garden, which is large in proportion to the farm, are grown hemp, flax, tobacco, potatoes, white beet to be used as spinach and asparagus, French beans, cabbages, and turnips. The whole has every appearance of neatness and comfort. There are, however, some farmers who hire lands from the corporate bodies and others at a fixed rent, or on the metayer system; and in some cases both land and stock are hired; and peasants are found who hire so many cows and their keep, during a certain number of months, either for a third or more of the produce, or for a fixed sum.

337. *The villages of Switzerland* are often built in lofty situations, and some so high as 5000 feet above the level of the sea. "In a country where land is much divided, and small proprietors cultivate their own property on the mountains, it is absolutely necessary that they should reside near it, otherwise a great part of their time and strength would be exhausted in ascending and descending, as it would take a mountaineer four hours in each day, to ascend to many of these villages and return to the valley. In building their houses on the mountains, they place them together in villages, when it can be done, and at a moderate distance from their property, to have the comforts of society, and be more secure from the attack of wolves and other wild animals. Potatoes and barley can be cultivated at the height of 4500 feet in Savoy, and these, with cheese and milk, and a little maize for porridge, form the principal part of the food of the peasantry. The harvest is over in the plains by the end of June, and in the mountains by the end of September. Several of the mountain villages, with the white spires of their churches, form pleasing objects in the landscape, but on entering them the charm vanishes, and nothing can exceed the dirtiness and want of comfort which they present, except the cabins of the Irish." (*Bakewell's Travels*, vol. i. 270.) Yet habit, and a feeling of independence, which the mountain peasant enjoys under almost every form of government, make him disregard the inconveniences of his situation and abode. Damsels and their flocks form pleasing groups at a distance; but the former, viewed near, bear no more resemblance to *les bergères des Alpes* of the poets, than a female Hottentot to the Venus de Medicis.

338. *The vine* is cultivated in several of the Swiss cantons on a small scale; and either against trellises, or kept low and tied to short stakes as in France. The grapes, which seldom ripen well, produce a very inferior wine. The best in Switzerland are grown in the Pays de Vaud round Vevay. They are white, and, Bakewell says, "as large and fine-flavoured as our best hot-house grapes." The physicians at Geneva send some of their patients here during the vintage, to take what is called a regular course of grapes; that is, to subsist for three weeks entirely on this fruit, without taking any other food or drink. In a few days a grape diet becomes agreeable, and weak persons, and also the insane, have found great relief from subsisting on it for three or four weeks. (*Bakewell's Travels*, ii. 206.)

339. *Of fruit trees*, the apple, pear, cherry, plum, and walnut, surround the small field or fields of every peasant. The walnut tree also lines the public roads in many places, and its dropping fruit is often the only food of the mendicant traveller.

340. *The management of woods and forests* forms a part of Swiss culture. The herbage is pastured with sheep and swine as in Italy; the copse wood and lop are used

for fuel, as in all countries; and when a mode of conveyance and a market can be found the timber is sold, but in many places neither is the case. A singular construction was erected for the purpose of bringing down to the Lake of Lucerne the fine pine trees which grow upon Mount Pilatus, by the engineer Rupp. The wood was purchased by a company for 3000*l*., and 9000*l*. were expended in constructing the slide. The length of the slide is about 44,000 English feet, or about eight miles and two furlongs; and the difference of level of its two extremities is about 2600 feet. It is a wooden trough, about five feet broad and four deep, the bottom of which consists of three trees, the middle one being a little hollowed; and small rills of water are conducted into it, for the purpose of diminishing the friction. The declivity, at its commencement, is about $22\frac{1}{2}°$. The large pines, with their branches and boughs cut off, are placed in the slide, and descending by their own gravity, they acquire such an impetus by their descent through the first part of the slide, that they perform their journey of eight miles and a quarter in the short space of six minutes; and, under favourable circumstances, that is, in wet weather, in three minutes. Only one tree descends at a time, but, by means of signals placed along the slide, another tree is launched as soon as its predecessor has plunged into the lake. Sometimes the moving trees spring or bolt out of the trough, and when this happens, they have been known to cut through trees in the neighbourhood, as if it had been done by an axe. When the trees reach the lake, they are formed into rafts, and floated down the Reuss into the Rhine.

341. *Timber is also floated down mountain torrents* from a great height. The trees are cut down during summer and laid in the then dry bed of the stream: with the first heavy rains in autumn they are set in motion, and go thundering down among the rocks to the valleys, where what arrives sound is laid aside for construction, and the rest is used as fuel.

342. *The chamois goats* abound in some of the forests, and are hunted for their fat and flesh, and for their skins, which are valuable as glove and breeches leather. They herd in flocks, led by a female; live on lichens, and on the young shoots and bark of pines; are remarkably fond of salt; and require great caution in hunting. (*Simond's Switzerland*, vol. i. p. 245.) The common goat is frequently domesticated for the sake of its milk, and may be seen near cottages, curiously harnessed (*fig.* 42.) to prevent its breaking through, or jumping over, fences.

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343. *The care of pastures and mowing grounds* forms an important part of the agricultural economy of Switzerland. In places inaccessible to cattle, the peasant sometimes makes hay with cramps on his feet. Grass, not three inches high, is cut in some places three times a year; and, in the valleys, the fields are seen shaven as close as a bowling-green, and all inequalities cropped as with a pair of scissors. In Switzerland, as in Norway, and for the same reasons, the arts of mowing and hay-making seem to be carried to the highest degree of perfection. Harvesting corn is not less perfect; and the art of procuring fodder for cattle, from the trees, shrubs, and wild plants, and applying this fodder with economy, is pushed as far as it will go. In some parts, very minute attention is paid to forming and collecting manure, especially that liquid manure, which, in the German cantons, is known under the name of *jauche* or *mist-wasser*, and in the Canton de Vaud, of *sissier*. (*For. Quart. Rev. and Cont. Mis.*, Jan. 1828.)

344. *Cows, goats, and sheep* constitute the wealth of the Swiss farmers, and their principal means of support; or, to discriminate more accurately, the goats, in a great measure, support the poorer class; and the cows supply the cheese from which the richer derive their little wealth. The extent of a pasture is estimated by the number of cows it maintains: six or eight goats are deemed equal to a cow, as are four calves, four sheep, or four hogs; but a horse is reckoned equal to five or six cows, because he roots up the grass. Throughout the high Alps, they are of opinion that sheep are destructive to the pastures, in proportion to their elevation, because the herbage, which they eat down to the roots, cannot, in such a cold climate, regain its strength and luxuriance. The mountain pastures are rented at so much per cow's feed, from the 15th of May to the 18th of October; and the cows are hired from the peasants for the same period: at the end of it, both are restored to their owners. In other parts, the proprietors of the pastures hire the cows, or the proprietors of the cows rent the land. The proceeds of a cow are estimated at 3*l*. or 3*l*. 10*s*., viz. 25*s*. in summer; and, during the time they are kept in the valleys or in the house, at 2*l*. The Grindelwald Alps feed three thousand cows, and as many sheep and goats. The cattle are attended on the mountains by herdsmen; when the weather is tempestuous they are up all night calling to them, otherwise they would take fright and run into danger. Chalets are built for the use of the herdsmen: these are log-houses of the rudest construction, without a chimney, having a pit or trench dug for the fire, the earth thrown up forming a mound around it, by way of a seat. To those chalets, the persons whose employment it is to milk the cows, and to make cheese and butter, ascend in the summer time. When they go out to milk the cows, a portable seat, with a single leg, is strapped to their backs; at the hour of milking, the cows are attracted home from the most distant pastures by a handful of salt, which the shepherd takes from a leathern pouch hanging over his shoulder. During the milking, the *Ranz des Vaches* is frequently sung. (*For. Quart. Rev. and Cont. Misc.*)

345. *The Swiss cows* yield more milk than those of Lombardy, where they are in great demand; but after the third generation their milk falls off. In some parts of Switzerland they yield, on an average,

twelve English quarts a day; and with forty cows, a cheese of forty-five pounds can be made daily. In the vicinity of Altdorf they make, in the course of a hundred days, from the 20th of June, two cheeses daily, of twenty-five pounds each, from the milk of eighteen cows. On the high pastures of Scarla, a cow during the best season, supplies near sixty pounds of skim-milk cheese, and forty pounds of butter. Reckoning twenty pounds of milk, observes our author, equivalent to one of butter, the produce in milk will be eight hundred pounds for ninety days, or less than nine pounds a day. This small supply he ascribes to the great elevation of the pastures, and the bad keep of the cows in the winter. (*For. Quart. Rev. and Cont. Misc.*)

346. *Great variety of cheese is made in Switzerland.* The most celebrated are the Schabzieger and Gruyère; the former made by the mountaineers of the canton of Glarus, and the latter in the valley of Gruyère. The cheese of Switzerland must have been for a long period a great article of commerce; for, Myconius, of Lucerne, in the beginning of the sixteenth century, in a commentary on a poem of his friend Glarianus, expatiates on the large quantities of butter and cheese which his fellow-citizens sent into Burgundy, Suabia, and Italy: he adds, that twenty cows would bring in, annually, a net sum of 100 crowns. In 1563, a law was passed in the Upper Engadine to guard against fraud in the manufacture of cheese meant for sale. Formerly, the depots of rich cheese were principally near Lake Como; it was supposed that the exhalations, at once warm and moist, ripened the cheese, without drying it too much; at present, however, these depots are not near so numerous. In the Upper Engadine, cheese loses, by drying, a twentieth part of its weight in the first ten weeks; and skim-milk cheese the half of its weight in two years. Of the quantity of cheeses exported from Switzerland we have no information that can be relied upon; but it is computed that thirty-thousand hundred-weight of Gruyère cheese alone, fit for exportation, is annually made; and that, from the middle of July to October, three hundred horses, weekly, are employed in transporting Swiss cheese over Mount Grias. (*For. Rev. and Cont. Misc.*)

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347. *The Schabzieger cheese* is made by the mountaineers of the Canton of Glarus alone; and, in its greatest perfection, in the valley of Kloen. It is readily distinguished by its marbled appearance and aromatic flavour, both produced by the bruised leaves of the melilot. The dairy is built near a stream of water; the vessels containing the milk are placed on gravel or stone in the dairy, and the water conducted into it in such a manner as to reach their brim. The milk is exposed to this temperature, about six degrees of Reaumur (forty-six degrees of Fahrenheit), for five or six days, and in that time the cream is completely formed. After this it is drained off, the caseous particles are separated, by the addition of some sour milk, and not by rennet. The curd thus obtained is pressed strongly in bags, on which stones are laid; when sufficiently pressed and dried, it is ground to powder in autumn, salted, and mixed with either the pressed flowers or the bruised seeds of the melilot trefoil (*Melilòtus officinàlis*). (*fig.* 43.) The practice of mixing the flowers or the seeds of plants with cheese was common among the Romans, who used those of the thyme for that purpose. The entire separation of the cream or unctuous portion of the milk is indispensable in the manufacture of Schabzieger. The unprepared curd never sells for more than three halfpence a pound; whereas, prepared as Schabzieger, it sells for sixpence or seven-pence. (*For. Rev. and Cont. Misc.*)

348. *The Gruyère cheese of Switzerland* is so named after a valley, where the best of that kind is made. Its merit depends chiefly on the herbage of the mountain pastures, and partly on the custom of mixing the flowers or bruised seeds of *Melilòtus officinàlis* with the curd, before it is pressed. The mountain pastures are rented at so much per cow's feed from the 15th of May to the 18th of October; and the cows are hired from the peasants, at so much, for the same period. On the precise day both land and cows return to their owners. It is estimated that 15,000 cows are so grazed, and 30,000 cwt. of cheese made fit for exportation, besides what is reserved for home use.

349. *Ewe-milk cheese of Switzerland.* One measure of ewe's milk is added to three measures of cow's milk; little rennet is used, and no acid. The best Swiss cheese of this kind is made by the Bergamese sheep-masters, on Mount Splugen. (*For. Rev. and Cont. Misc.*)

350. *The establishment at Hofwyl, near Berne,* may be considered as in great part belonging to agriculture, and deserves to be noticed in this outline. It was projected by, and is conducted at the sole expense of, M. Fellenberg, a proprietor and agriculturist. His object was to apply a sounder system of education for the great body of the people, in order to stop the progress of misery and crime. Upwards of twelve years ago he undertook to systematise domestic education, and to show, on a large scale, how the children of the poor might be best taught, and their labour at the same time most profitably applied; in short, how the first twenty years of a poor man's life might be so employed as to provide both for his support and his education. The peasants in his neighbourhood were at first rather shy of trusting their children for a new experiment; and being thus obliged to take his pupils where he could find them, many of the earliest were the sons of vagrants, and literally picked up on the highways: this is the case with one or two of the most distinguished pupils.

351. *Their treatment* is nearly that of children under the paternal roof. They go out every morning to their work soon after sunrise, having first breakfasted, and received a lesson of about an hour: they return at noon. Dinner takes them half an hour, a lesson of one hour follows; then to work again till six in the evening. On Sunday the different lessons take six hours instead of two; and they have butcher's meat on that day only. They are divided into three classes, according to age and strength; an entry is made in a book every night of the number of hours each class has worked, specifying the sort of labour done, in order that it may be charged to the proper account, each particular crop having an account opened for it, as well as every new building, the live stock, the machines, the schools themselves, &c. &c. In winter, and whenever there is not out-

of-doors work, the boys plait straw for chairs, make baskets, saw logs with the cross-saw and split them, thrash and winnow corn, grind colours, knit stockings, or assist the wheelwright and other artificers, of whom there are many employed in the establishment. For all which different sorts of labour an adequate salary is credited to each boy's class.

352. *The boys never see a newspaper, and scarcely a book;* they are taught, *vivâ voce*, a few matters of fact, and rules of practical application: the rest of their education consists chiefly in inculcating habits of industry, frugality, veracity, docility, and mutual kindness, by means of good example, rather than precepts; and, above all, by the absence of bad example. It has been said of the Bell and Lancaster schools, that the good they do is mostly negative: they take children out of the streets, employ them in a harmless sort of mental sport two or three hours in the day, exercise their understanding gently and pleasantly, and accustom them to order and rule, without compulsion. Now, what these schools undertake to do for a few hours of each week, during one or two years of a boy's life, the *School of Industry* at Hofwyl does incessantly, during the whole course of his youth; providing, at the same time, for his whole physical maintenance, at a rate which must be deemed excessively cheap for any but the very lowest of the people.

353. *The practicability of this scheme* for inculcating individual prudence and practical morality, not only in the agricultural, but in all the operative, classes of society, M. Simond considers as demonstrated; and it only remains to ascertain the extent of its application. Two only of the pupils have left Hofwyl, for a place, before the end of their time; and one, with M. de Fellenberg's leave, is become chief manager of the immense estates of Comte Abaffy, in Hungary, and has, it is said, doubled its proceeds by the improved method of husbandry he has introduced. This young man, whose name is Madorly, was originally a beggar boy, and not particularly distinguished at school. Another directs a school established near Zurich, and acquits himself to the entire satisfaction of his employers. M. Fellenberg has besides a number of pupils of the higher classes, some of whom belong to the first families of Germany, Russia, and Switzerland. They live *en famille* with their master, and are instructed by the different tutors in the theory and practice of agriculture, and in the arts and sciences on which it is founded. (See *Simond's Account of Switzerland*, vol. i.; *Ed. Rev.* 1819, No. 64.; *Des Institutes de Hofwyl de par Cte. L. de V.* Paris, 1821.)

Subsect. 2. *Of the Agriculture of the Duchy of Savoy.*

354. *Of the agriculture of Savoy*, which naturally belongs to Switzerland, a general view, with some interesting details, is given by Bakewell. (*Travels in the Tarantaise*, &c., 1820–22.) Landed property there is divided into three qualities, and rated for a land-tax accordingly. There is an office for registering estates, to which a per centage is paid on each transfer or additional registering. There is also an office for registering all mortgages, with the particulars; both are found of great benefit to the landed interest and the public, by the certainty which they give to titles, and the safety both to borrowers and lenders on land.

355. *Land in Savoy* is divided into very small farms, and is occupied by the proprietors or *paysans*, who live in an exceedingly frugal manner, and cultivate the ground with the assistance of their wives and children; for in Savoy, as in many other parts of Europe, the women do nearly as much field labour as the men.

356. *The lands belonging to the monasteries* were sold during the French revolution, when Savoy was annexed to France. The gradual abolition of the monasteries had been begun by the old government of Sardinia before the revolution, for the monks were prohibited from receiving any new brethren into their establishments, in order that the estates might devolve to the crown, on the extinction of the different fraternities. This measure, though wise in the abstract, was not unattended with inconvenience, and perhaps we may add, injustice. The poor, who had been accustomed to fly to the monasteries for relief in cases of distress, were left without any support, except the casual charity of their neighbours, who had little to spare from their own absolute necessities. The situation of the poor is therefore much worse in Savoy, than before the abolition of the monasteries. The poor in England suffered in the same manner, on the abolition of the monasteries in the reigns of Henry VIII. and Elizabeth, before the poor's rates were enacted. The charity of the monks of Savoy lost much of its usefulness by the indiscriminate manner in which it was generally bestowed: certain days and hours were appointed at each monastery, for the distribution of provisions, and the indolent were thereby enabled to support themselves during the whole week, by walking to the different monasteries on the days of donation. This was offering a premium to idleness, and was the means of increasing the number of mendicants, which will, in every country, be proportionate to the facility of obtaining food without labour.

357. *The peasantry in Savoy are very poor, but they cannot be called miserable.* In the neighbourhood of towns, their situation is worse than at a distance; and not far from Chambery may be seen a few families that might almost vie in squalid misery, rags, and filth, with the poor of Ireland; but the general appearance of the peasantry is respectable. Having learnt the price of labour in various parts of Savoy, Bakewell proposed the following question: Is it possible for a labourer, with a family, to procure a sufficient quantity of wholesome food for their consumption? One of the answers was, "*Cela est très-facile* (It is very easy)", the other was, "The labourer lives very frugally (*très-sobrement*)." "In general he eats very coarse, but wholesome, bread, and, except in the mountains, he eats very little meat, and rarely drinks wine, but he has a great resource in potatoes."

358. *One day's labour* of a farming man will purchase about twelve pounds avoirdupois of wheat, or from four to five pounds of beef, veal, or mutton; but these are dainties which he rarely tastes; potatoes, rye-bread, chestnuts, and milk, form the principal part of the food of the poor. The day-labourer in Savoy has to deduct, from the amount of his labour, about seventy days in the year, including saint-days and Sundays, on which he receives no wages. (*Bakewell's Travels*, vol. i. 314.)

359. *There are four modes of occupying land for cultivation in Savoy*: by the proprietors; by farmers; by grangers; and by tacheurs.

360. *Land very near to towns* is generally cultivated by the proprietors, who either keep cattle, or take them in to graze at so much per head.

361. *By farming land*, is understood, letting it at a fixed rent, to be paid according to the value of the produce, taken at an average of ten years.

362. *By grangers*, or renting land *à moitié fruit*, is understood, that the proprietor takes half of all the grain and fruit, half the produce or increase of the cows, half the eggs, and, in short, half of every thing which is productive.

363. *By tacheurs*, is another mode of cultivating land, in the immediate vicinity of towns. The proprietors, to avoid keeping too many servants in their own houses, place a father of a family in the house upon the farm. This man is called *le tacheur*. He takes care of the cows, for half their produce: he ploughs the ground, receiving for every pair of oxen employed, or for three horses, from seventy to eighty francs per annum: he has half the wine: the share he receives of the wheat and grain is in the proportion of two parts for every nine taken by the proprietor. The latter pays all the taxes, and keeps the accounts. The tacheur may be changed every year. When he is employed in repairing fences, &c., he is paid by the day; this is always undertaken when he enters the farm.

364. *The leases granted to the farmers and grangers* are on terms of three, six, or nine years; but when the leases are for six or nine years, a reservation is always made, that at the expiration of every three years the proprietor may revoke the lease, by giving three months' notice, if he be not satisfied with the tenant. The proprietor always supplies the farmer or granger with a sum of money without interest, called *chaptal* (capital), to aid him in buying oxen: for a farm of two oxen it is generally about twenty louis; for a farm of four oxen, forty louis; and so on. The proprietor, for this sum, has an exclusive right to seize the cattle of the farmer, should he sell them clandestinely.

365. *The mode of pasturage* in Chamouny will apply, with little variation, to all the Alpine communes in Savoy. The rich peasants in the Alps possess meadows, and even habitations, at different heights. In winter they live in the bottom of the valley, but they quit it in spring, and ascend gradually, as the heat pushes out vegetation. In autumn they descend by the same gradation. Those who are less rich have a resource in the common pastures, to which they send a number of cows, proportionate to their resources, and their means of keeping them during the winter. The poor, who have no meadows to supply fodder for the winter, cannot avail themselves of this advantage. Eight days after the cows have been driven up into the common pasture, all the owners assemble, and the quantity of milk from each cow is weighed. The same operation is repeated one day in the middle of the summer, and at the end of the season, the quantity of cheese and butter is divided, according to the quantity of milk each cow yielded on the days of trial. (*Bakewell.*)

366. *There are chalets, or public dairies*, near the mountain pastures in Savoy, as well as in Switzerland; persons reside in these chalets during the summer months, to make cheese and butter. In many situations it is the labour of a day to ascend to these chalets, and return to the valleys immediately below them. There are also public dairies in some of the villages, where the poorer peasants may bring all the milk they can spare, from the daily consumption of their families. The milk is measured, and an account kept of it; and at the end of the season the due portion of cheese is allotted to each, after a small deduction for the expense of making. (*Id.*)

367. *No large flocks of sheep* are kept in Savoy, as it is necessary to house them during the winter, at which time they are principally fed with dried leaves of trees, collected during the autumn. Many poor families keep a few sheep to supply them with wool for their domestic use. These little flocks are driven home every evening, and are almost always accompanied by a goat, a cow, a pig, or an ass, and followed by a young girl spinning with a distaff. As they wind down the lower slopes of the mountains, they form the most picturesque groups for the pencil of the painter; and, seen at a distance, carry back the imagination to the ages of pastoral simplicity, sung by Theocritus and Virgil. (*Id.*)

368. *The vineyards in Savoy* are cultivated for half the produce of the wine. The cultivator pays the whole expense, except the taxes, which are paid by the proprietor.

369. *Walnut trees*, of immense size and great beauty, enrich the scenery of Savoy, and supply sufficient oil for the consumption of the inhabitants, and for the adjoining canton of Geneva. The walnut has been called the olive of the country. The trees belong principally to the larger proprietors. They are planted by nature, being scattered over the fields, and in the woods and hedge-rows, intermixed with chestnuts and forest trees of various kinds. (*Bakewell.*)

370. *The walnut harvest* at Chateau Duing commences in September. "They are beaten off the trees with long poles; the green husks are taken off as soon as they begin to decay; the walnuts are then laid in a chamber to dry, where they remain till November, when the process of making the oil commences. The first operation is to crack the nuts, and take out the kernel. For this purpose several of the neighbouring peasants, with their wives and elder children, assembled at the chateau of an evening, after their work was done. The party generally consisted of about thirty persons, who were placed around a long table in the kitchen. One man sat at each end of the table, with a small mallet to crack the nuts by hitting them on the point: as fast as they are cracked, they are distributed to the other persons around the table, who take the kernels out of the shell, and remove the inner part; but they are not peeled. The peasants of Savoy are naturally lively and loquacious; and they enliven their labour with facetious stories, jokes, and noisy mirth. About ten o'clock the table is cleared to make room for the *gouté*, or supper, consisting of dried fruit, vegetables, and wine; and the remainder of the evening is spent in singing and dancing, which is sometimes continued till midnight. In a favourable season, the number of walnuts from the Duing estate is so great, that the party assemble in this manner every evening for a fortnight, before all the walnuts are cracked; and the poor people look forward to these meetings, from year to year, as a kind of

festival. They do not receive any pay; the *gouté* and the amusement of the evening are their only reward." (*Bakewell.*)

371. *The walnut kernels* are laid on cloths to dry, and in about a fortnight are carried to the crushing-mill, where they are ground into a paste; this is put into cloths, and undergoes the operation of pressing to extract the oil. The best oil, which is used for salads and cooking, is pressed cold; but an inferior oil for lamps is extracted by heating the paste. Thirty people in one evening will crack as many walnuts as will produce sixty pounds of paste; this yields about fifteen wine-quarts of oil. The walnut-shells are not lost among so frugal a people as the Savoyards, but are burned for the ashes, which are used for washing. Two pounds of these ashes are equal in strength to three of wood-ashes; but the alkali is so caustic, that it frequently injures the linen. The paste, after it is pressed, is dried in cakes, called *pain amer;* this is eaten by children and poor people, and it is sold in the shops in Savoy and Geneva.

372. *The best walnut oil,* pressed cold, has but very little of the kernelly taste; but it may be easily distinguished from the best olive oil, which it resembles in colour. If the peel were taken off the walnuts, the oil would probably be quite free from any peculiar flavour; but this operation would be too tedious. (*Ib.*)

373. *Tobacco,* which is much used in Savoy, was cultivated with success in the neighbourhood of Ramilly; but on the restoration of the old despotism, its culture was prohibited, and the implements of manufacture seized.

374. *The culture of artificial grasses* is spreading in Savoy, but is not yet very general. In the neighbourhood of Aix, Ramilly, and Annecy, wheat is succeeded by rye. The rye-harvest being over in June, they immediately sow the land with buck-wheat (sarrasin), which is cut in September; the following year the land is sown with spring corn.

375. *The grass-lands* are always mown twice, and the latter mowing is sufficiently early to allow a good pasturage in the autumn. Water-meadows are occasionally found near towns. The water is generally let down from mountain streams; but sometimes it is raised from rivers by a sort of bucket-wheel (*fig.* 44.), which is called the *Noria of the*

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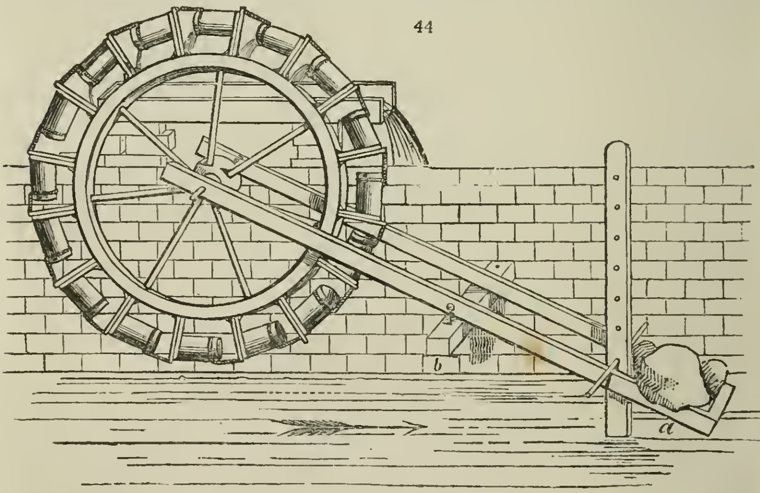

Alps. This wheel is raised or lowered by means of a loaded lever (*a*), which turns on a fulcrum (*b*), formed by a piece of wood with its end inserted in the river's bank.

376. *Agricultural improvement in Savoy* must be in a very low state, if the answers Bakewell received respecting the average quantity of the produce are correct. One of the answers stated the average increase of wheat to be from three to five on the quantity sown, and near the towns from five to seven. Another agriculturist stated the average increase on the best lands to be nine, and, in the neighbourhood of Annecy, thirteen, fold. One part of Savoy is, perhaps, the finest corn-land in Europe; and the very heavy crops Bakewell saw in the neighbourhood of Aix and Annecy, made him doubt the accuracy of the above statements: but, on referring to Arthur Young's account of the agriculture of France before the revolution, it appears that four and a half was regarded as the average increase in that country, which is very similar in climate to Savoy. (*Travels*, i. 328.)

377. *The salt-works of Moutiers,* in the valley of the Isere, in the Tarantaise, are particularly deserving attention, being perhaps the best conducted of any in Europe, with respect to economy. Nearly three million pounds of salt are extracted annually from a source of water which would scarcely be noticed, except for medical purposes, in any other country.

378. *The springs that supply the salt-works at Moutiers,* rise at the bottom of a nearly perpendicular rock of limestone, situated on the south side of a deep valley or gorge. The temperature of the strongest spring is ninety-nine Fahrenheit, it contains 1·83 per cent of saline matter. It may seem extraordinary that the waters at Moutiers, which have only half the strength of sea-water, should repay the expense of evaporation; but the process by which it is effected is both simple and ingenious, and might be

introduced with great advantage on many parts of our own coast, more particularly in Ireland. It is obvious that water, so weakly impregnated with salt as to contain only one pound and a half in every thirteen gallons, could not repay the expense of evaporating by fuel in any country. The water of the North Sea contains two and a quarter per cent of salt, and yet it has never been attempted to make salt from it by evaporation with coal-fires, even on the coast of Northumberland or Durham, where refuse coal, suited to the purpose, might be purchased for one shilling and sixpence per ton. In order to make salt from the saline water at Moutiers, it was necessary to concentrate it by natural evaporation; and to effect this speedily, it was required to spread the surface of the fluid over as large a space as possible, the ratio of evaporation being, *cæteris paribus*, in proportion to the extent of the surface exposed to the action of the atmosphere. The first attempt at Moutiers was made in 1550, by arranging pyramids of rye straw in open galleries, and letting the water trickle through the straw gradually and repeatedly. This was abandoned, and faggots of thorns were substituted: these faggots are suspended on frames, the water is raised to their height, and spread by channels so as to trickle through them: it passes through three separate sets or frames of thorns, and has then become so concentrated as to contain nearly 22 per cent of salt: it is then boiled in pans in the usual manner.

379. *Evaporating on vertical cords*, erected in a house open on all sides, is a third method, which succeeds even better than the mode by thorns. The water, by repeatedly passing over the cords, is found in forty-five days to deposit all its salt on them, and the saline cylinder is then broken off. The cords are renewed once in twenty or thirty years, and the faggots once in seven years. Minute details of these simple but very ingenious processes will be found in the very scientific *Travels* of Bakewell (vol. i. 230.).

Sect. III. *Of the present State of Agriculture in France.*

380. *The first agricultural survey of France* was made in 1787, 8, and 9. by the celebrated Arthur Young. Since that period no similar account has been published either in France or England: but several French writers have given the statistics and culture of different districts, as the Baron de la Peyrouse, Sinetti, Cordier, &c.; and others have given general views of the whole kingdom, as *La Statistique Générale de la France*, by Penchet; *De l'Industrie Françoise*, by Chaptal; and *Les Forces Productes et Commerciales de la France*, &c., by Dupin. From these works, some recent tours of Englishmen, and our own observations in 1815, 1819, and 1828, we have drawn the following outline of the progress of French agriculture since the middle of the sixteenth century, and more especially since the time of Louis XIV.; including the general circumstances of France as to agriculture, its common culture, its culture of vines and maize, and its culture of olives and oranges.

Subsect. 1. *Of the Progress of French Agriculture, from the Sixteenth Century to the present Time.*

381. *That France is the most favourable country in Europe for agriculture*, is the opinion both of its own and foreign writers on the subject. For, though the country "suffered deeply from the wars in which she was engaged, first by a hateful conspiracy of kings, and next, by the mad ambition of Bonaparte, the purifying effects of the revolution have indemnified her ten fold for all the losses she has sustained. She has come out of the contest with a debt comparatively light, with laws greatly amended, many old abuses destroyed, and with a population more industrious, moral, enlightened, and happy, than she ever had before. The fortunate change which peace has made in her situation, has filled her with a healthy activity, which is carrying her forward with rapid strides; she has the most popular, and therefore the most rational, liberal, and beneficial, system of government of any state in Europe, Britain not excepted; and, altogether, she is perhaps in a condition of more sound prosperity than any other state in the old world." (*Scotsman*, vol. xii. No. 861.)

382. *The agriculture of France at present*, as Mr. Jacob has observed (*Report, &c.*, 1828), occupies one of the lowest ranks in that of the Northern States of Europe; but the fertility of the soil, the suitableness of the subsoil and of the surface for aration, and, above all, the excellence of the climate, are such as are not united to an equal extent in any other European State. When we consider these circumstances in connection with the extraordinary exertions now making for the education of the laborious classes, and the no less extraordinary progress that has been made within these few years in manufactures (*For. Rev.*, Jan. 1829, art. 1.), it is easy to see that in a few years the territorial riches of France will be augmented to an extraordinary extent.

383. *Of the agriculture of France, previous to the middle of the sixteenth century*, scarcely any thing is known. Chopin, who it appears resided in the neighbourhood of Paris, wrote a treatise on the *Privileges of Labourers*, in 1574, which, M. Grégoire remarks (*Hist. of Agr. prefixed to edit. of Olivier de Serres, pub. in* 1804), is calculated rather for the advantage of the proprietor than of the farmer. A *Code Rural*, published some time after, is characterised by the same writer as a Manual of Tyranny.

384. *French agriculture began to flourish* in the beginning of the seventeenth century, under Henry IV., and its precepts at that time were published by Olivier de Serres, and Charles Estienne. In 1621, great quantities of corn were exported to England, in consequence of a wise ordinance of Sully, passed some years before, permitting a free commerce in corn. In 1641, the draining of fens and bogs was encouraged; and, in 1756, the land-tax taken off newly broken up lands for the space of twenty years. Mazarin, during the minority of Louis XIV., prohibited the exportation of corn, and checked the progress of its culture. This circumstance, and the wars of that king, greatly

discouraged agriculture, and produced several dearths. Fleury, under Louis XV., was not favourable to agriculture; but, in 1754, an act was passed for a free corn trade, which effected its revival. The economists of this time, however mistaken in their views, inspired a taste for the art; and agricultural societies were first established in France under the patronage and at the expense of government. In 1761, there were thirteen such societies in France, and nineteen cooperating societies. Those of Paris, Lyons, Amiens, and Bourdeaux, have distinguished themselves by their published *Memoirs*. At Tours a georgical society was established and directed by the Marquis of Tourbili, a patriot and agricultural writer. Du Hamel and Buffon gave eclat to the study of rural economy, and many other writers might be mentioned as having contributed to its improvement. M. de Trudaine introduced the Merino breed of sheep in 1776, and Comte Lasteyrie has studied that breed in Spain, and written a valuable work on the subject; as has the Baron de Mortemart on the English breeds, some of which he has introduced.

385. *The agriculture of France in* 1819, *as compared with what it was in* 1789, presents, Chaptal observes, astonishing improvements. Crops of every kind cover the soil; numerous and robust animals are employed in labouring it, and they also enrich it by their manure. The country population are lodged in commodious habitations, decently clothed, and abundantly nourished with wholesome food. The misery which existed in France in former times, when properties of immense extent supported little more than a single family, is banished, and its place supplied by ease and liberty. We are not to suppose, however, the same author observes, that the agriculture of France has arrived at perfection; much still remains to be done: new plans of improvement should be more generally introduced; and a greater quantity of live stock is wanted for every province of France, except two or three which abound in natural meadows. Few domains have more than half the requisite number of labouring cattle; the necessary result of which is a deficiency of labour, of manure, and of crop. The only mode of remedying these evils is to multiply the artificial pastures, and increase the cultivation of plants of forage. Abundance of forage is indeed the foundation of every good system of agriculture, as a proper succession of crops is the foundation of abundance of forage. The rich inhabitants of France have already adopted these principles; but they have not yet found their way among the lowest class of cultivators. According to M. Dupin, four fifths of the peasantry of France are proprietors of land, which they cultivate themselves; and though they are at present very ignorant, yet knowledge of every kind is rapidly advancing. The wages of labourers in France, compared with the price of corn, are calculated to be higher than the wages paid to labourers in England.

Subsect. 2. *Of the general Circumstances of France, in respect to Agriculture.*

386. *The surface of France* has been divided by geographers into what are called basins, or great plains, through which flow the principal rivers, and which basins are separated by original or secondary ridges of mountains. The chief basins are those of the Loire (*fig.* 45. *a*), of the Seine (*b*), of the Garonne (*c*), and of the Rhone and Saone (*d*). (*Journal de Physique*, tom. xxx.)

387. *The soil of France* has been divided by Arthur Young into the mountainous district of Languedoc and Provence (*e*); the loamy district of Limosin (*f*); the chalky districts of Champagne and Poitiers (*g*); the gravelly district of Bourbonnois (*h*); the stony district of Lorraine and Franche Comté (*i*); the rich loam of Picardy and Guienne (*k*); and the heathy surface on gravel, or gravelly sand, of Bretagne and Gascoigne (*l*). (*Agr. France*, chap. ii.)

388. *The climate of France* has been ingeniously divided by the same author into that of corn and common British agriculture, including Picardy, Normandy, French Flanders, Artois, Hainault, &c. (*fig.* 45. *l*, *b*, *k*); that of vines, mulberries, and common culture (*y*, *a*, *h*, *g*, *i*); that of vines, mulberries, maize, and common culture (*c*, *f*, *d*, *i*); that of olives, vines, mulberries, maize, oranges, and common culture (*o*, *e*). It is singular that these zones (*m m*, *n n*, and *o o*) do not run parallel to the degrees of latitude, but obliquely to them to such an extent that the climate for the vines leaves off at 46° on the west coast (*y m*), but extends to 49½° on the east (*g m*). The cause is to be found chiefly in the soil and surface producing a more favourable climate in one place than in another; but partly also in the wants of cultivators. The vine is cultivated in Germany in situations where it would not be cultivated in France, because wine is of more value in the former country than in the latter. The northern boundary of the vine culture has even extended in France since the revolution, from the natural wish of small proprietors to supply themselves with wine of their own growth. In Germany the vine is cultivated as far north as latitude 52°, on the warm sides of dry rocky hills.

389. *The central climate*, which admits vines without being hot enough for maize (*y*, *a*, *h*, *g*, *i*), Young considers as the finest in the world, and the most eligible part of France or of Europe as to soil. "Here," he says, "you are exempt from the extreme humidity which gives verdure to Normandy and England; and yet equally free from the

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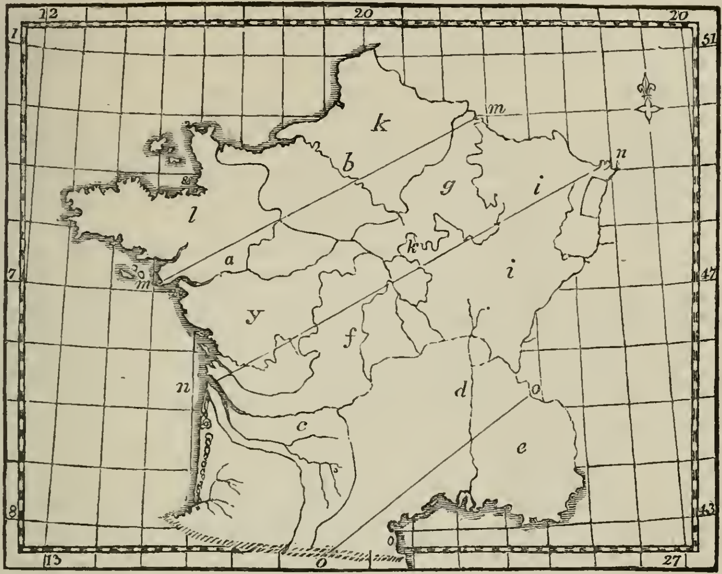

burning heats which turn verdure itself into a russet brown : no ardent rays that oppress with their fervour in summer, nor pinching tedious frosts that chill with their severity in winter, but a light, pure, elastic air, admirable for every constitution except consumptive ones." This climate, however, has its drawbacks ; and is so subject to violent storms of rain and hail, that " no year ever passes without whole parishes suffering to a degree of which we in Britain have no conception." It has been calculated, that in some provinces the damage from hail amounts, on an average of years, to one tenth of the whole produce. Spring frosts are sometimes so severe as to kill the broom : few years pass that they do not blacken the first leaves of the walnut trees ; the fig trees are protected with straw.

390. *Of the vine and maize climate* (c, *f*, *d*, *i*) some account is given by M. Picot, Baron de la Peyrouse, an extensive and spirited cultivator. He kept an accurate account of the crops and seasons in his district for twenty years from 1800 ; and the result is, twelve years of fair average crops, four years most abundant, and four years attended with total loss.

391. *In the olive climate* (*o*, *e*) insects are incredibly numerous and troublesome, and the locust is injurious to corn crops ; but both the olive and maize districts have this advantage, that two crops a year, or at least three in two years, may be obtained. The orange is cultivated in so small a proportion of the olive climate as scarcely to deserve notice. The caper (Cápparis spinòsa) (*fig.* 46.) and the fig are also articles of field culture in this climate.

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392. *The climate of Picardy and Normandy is the nearest to that of England,* and is rather superior. The great agricultural advantage which France possesses over Britain, in regard to climate, is, that, by means of the vine and olive, as valuable produce may be raised on rocky wastes as on rich soils ; and that in all soils whatever, root weeds may be easily and effectually destroyed without a naked fallow. (*Young's France*, ch. iii.)

393. *The lands of France are not generally enclosed and subdivided* by hedges or other fences. Some fences are to be seen near towns, and in the northern parts of the kingdom more especially : but, in general, the whole country is open ; the boundaries of estates being marked by slight ditches or ridges, with occasional stones or heaps of earth, rows of trees, or occasional trees. Depredations from passengers on the highways are prevented by *gardes champêtres*, which are established throughout all France. Farms are sometimes compact and distinct, but generally scattered, and often alternating in the common field manner of England, or run-rig of Scotland. The farm-houses of large farms are generally placed on the lands ; those of smaller ones in villages, often at some distance.

394. *The value of landed property* is in general lower than in England, being at present (1829) sold at from twenty-two to twenty-six years' purchase.

395. *The farming of lands in France*, according to Professor Thouin, naturally divides itself into three kinds: 1. The grand culture, in which from two to twelve ploughs are employed, and corn chiefly cultivated; 2. The middle culture, including the metayers, who also grow corn, but more frequently rear live stock, maintain a dairy, or produce silk, wine, cider, or oil, according to the climate in which they may be situated; and 3. The minor culture, or that which is done by manual labour, and into which live stock or corns do not enter. The middle culture is by far the most common. There are very few farms of six or eight ploughs in France, and equally few farmers who do not labour in person at all times of the year. It is acknowledged by Professor Thouin, that each of these divisions is susceptible of very great improvement.

Subsect. 3. *Of the common Farming of France.*

396. *The corn farming in France* is carried on in the best manner in French Flanders, Picardy, and Brie. The first may be considered as equally well cultivated with Suffolk; and the last produces three crops in two years, or five in three years. The crops of these districts are wheat, beans, turnips, maize, and buckwheat. The most frequent rotations are, two corn crops and a fallow, or an alternation of corn and green or pulse crops, without a naked fallow. In the heath district, broom enters into the rotation for fuel, and is cut the fourth year; buckwheat is also extensively sown, and rye and oats. After lands have borne crops, it is usual to let them rest a year or two, during which they produce nothing but grass and weeds, and they are afterwards broken up with a naked fallow. Potatoes enter more or less into the field culture of the greater part of France, and especially of the northern districts; but in Provence, and some parts of Languedoc, they are still little known. Irrigation, both of arable and grass lands, is adopted whereever it is practicable. It is common in the Vosges, and remarkably well conducted in the lands round Avignon, formerly for many miles the property of the church.

397. *The meadows of France* contain nearly the same herbage, plants, and grasses as those of England; but though clovers and lucerne are cultivated in many places, yet ryegrass and other grasses, either for hay crops or temporary or permanent pasture, are not generally resorted to. (*Chaptal de l'Industrie Française*, vol. i. p. 157.)

398. *To sheep the French have paid considerable attention* from the time of Colbert; and there are now considerable flocks of short-woolled and Spanish breeds in some places, besides several national flocks. That of Rambouillet (established in 1786 by Louis XVI.) is managed by M. Tessier, a well known writer on agriculture, and when visited by Birkbeck, in 1814, was in excellent order. Sheep are housed, and kept in folds and little yards or enclosures, much more than in England. Great part of the sheep of France are black. (*Birkbeck.*) Some curious attempts have lately been made to inoculate them for the claveau and the scab, but a definite result has not yet been ascertained, at least as to the latter disease. Birkbeck considers the practice of housing as the cause why the foot-rot is so common a disease among sheep in France. Where flocks remain out all night, the shepherd sleeps in a small thatched hut or portable watchhouse, placed on wheels. He guides the flock by walking before them, and his dog guards them from the wolves, which still abound even in Picardy. During summer, in the hottest districts, they are fed in the night, and housed in the heat of the day. Hay is the general winter food; and, in some parts of the Picardy climate, turnips. In 1811, Bonaparte monopolised the breeding of Merinos, and from that time to the passing of an act for the exportation of wool and rams in 1814 they declined; but they are now greatly on the increase. Among the most extensive flocks, are those of the celebrated M. Ternaux.

399. *The beasts of labour* are chiefly the ox on small farms, and the horse on the larger. Both are kept under cover the greater part of the year. The breeds of oxen are very various; they are generally cream-coloured. The best oxen are in Auvergne, Poitiers, and Languedoc. Normandy furnishes the best breed of working horses; as Limosin does of those for the saddle. In the south of France the ass and mule are of frequent use in husbandry. There, as in many parts of Italy, the poor people collect the stolones of *Agróstis*, and creeping roots of couch, and sell them in little bundles to the carriers and others who keep road horses. A royal stud of Arabians has been kept up at Aurillac in Limosin, for a century; and another has been lately formed near Nismes. Studs of English horses and mixed breeds of high blood, have been established by government in several departments.

400. *The best dairies* are in Normandy; but in this department France does not excel. In the southern districts, olive, almond, and poppy oil supply the place of butter; and goats' milk is that used in cookery.

401. *The goats of Thibet*, have been imported by M. Ternaux, who has been successful in multiplying them and in manufacturing their hair.

402. *Poultry* is an important article of French husbandry, and well understood as far as breeding and feeding. Birkbeck thinks the consumption of poultry in towns may be equal to that of mutton. The smallest cottage owns a few hens, which often roost under cover, in a neat little structure (*fig.* 47.), elevated so as to be secure from dogs, wolves, and foxes.

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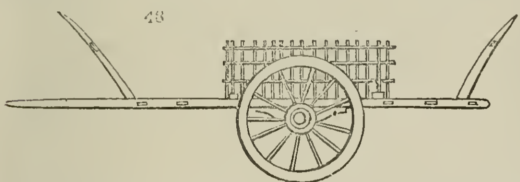
403. *The breed of swine* is in general bad; but excellent hams are sent from Bretagne, from hogs reared on acorns, and fatted off with maize. Pigeon-houses are not uncommon.

404. *The management of fish-ponds* is well understood in France, owing to fish in all catholic countries being an article of necessity. In the internal district there are many large artificial ponds, as well as natural lakes, where the eel, carp, pike, and a few other species, are reared, separated, and fed, as in the Berkshire ponds in England.

405. *The implements and operations* of the common farms of France are in general rude. The ploughs of Normandy resemble the large wheel-ploughs of Kent. Those farther south are generally without wheels; often without coulters; and an iron mould-board is rare. In many parts of the south the ploughs have no mould-board, and turn the earth in the manner of the simplest form of Roman plough. (110.) Harrows are in general wholly of wood; and, instead of a roller, a plank is for the most part used. Large farmers, as in Normandy, plough with four or six oxen: small farmers with two, or even one; or, when stiff soils are to be worked out of season, they join together, and form a team of four or six cattle. Their carts are narrow and long, with low wheels, seldom shod in the remote parts of the country. The *guimbarde* of the Seine and Oise (*fig.* 48.) is a light and useful machine. Corn is reaped with sickles, hooks, and the Brabant and cradle scythes. (*fig.* 49.) Threshing, in Normandy, is performed with the flail in houses, as in England; in the other climates, in the open air with flails, or by the tread of horses. There are few permanent threshing-floors; a piece of ground being smoothed in the most convenient part of the field is found sufficiently hard. Farmers, as we have already observed, perform most of their operations without extra labourers; and their wives and daughters reap, thresh, and perform almost every part of the farm and garden work indifferently. Such farmers " prefer living in villages; society and the evening dance being nearly as indispensable to them as their daily food. If the farm be distant, the farmer and his servants of all descriptions set off early in the morning in a light waggon, carrying with them their provisions for the day." (*Neill.*) Hence it is, that a traveller in France may pass through ten or twenty miles of corn-fields, without seeing a single farm-house.

48



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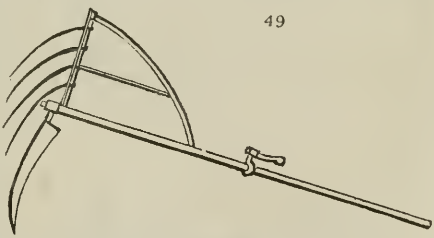


406. *Large farms*, which are extremely rare, have generally farmeries on the lands; and there the labour is in great part performed by labourers, who, as well as the tradesmen employed, are frequently paid in kind. (*Birkbeck.*)

407. *All the plants cultivated* by the British farmer are also grown in France; the turnip not generally, and in the warm districts scarcely at all, as it does not bulb; but it is questionable, whether, if it did bulb, it would be so valuable in these districts as the lucerne, or clover, which grow all the winter; or the potato, from which flour is now made extensively; or the field beet, which may be used either as food for cattle, or for yielding sugar. Of plants not usually cultivated on British farms may be mentioned, the chiccory for green food, fuller's thistle for its heads, furze and broom for green food, madder, tobacco, poppies for oil, rice in Dauphine (but now dropped as prejudicial to health), saffron about Angouleme, *L*áthyrus satìvus, the pois Breton or lentil of Spain, *L*áthyrus setifòlius, *V*ícia *l*athyröìdes and satìva, *C*ícer *a*rietìnum, *E*'rvum *L*éns, *M*elilòtus sibírica, Coronílla vària, *H*edýsarum coronàrium, &c. They have a hardy red wheat, called *l'épeautre* (spelt), which grows in the worst soil and climates, and is common in Alsace and Suabia. They grow the millet, the dura or douro of Egypt

(*Hólcus Sórghum* L.), in the maize district. The flower-stalks and spikes of this plant are sold at Marseilles and Leghorn, for making chamber-besoms and clothes-brushes. The hop and the common fruit trees are cultivated; and the chestnut is used as food in some places. An oil used as food, and also much esteemed by painters, is made from the walnut. The other fruits of field-culture, as the almond, fig, vine, caper, olive, and orange, belong to the farming of the southern districts.

408. *The forest culture* of France is scientifically conducted, both in the extensive national forests, and on private estates. The chief objects are fuel, charcoal, and bark; and next, timber for construction: but in some districts other products are collected, as acorns, mast, nuts, resin, &c. The French and Germans have written more on this department of rural economy than the English, and understand it better.

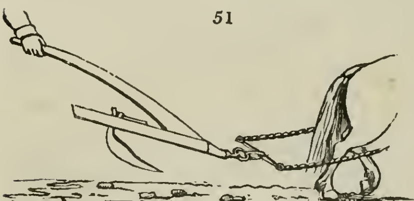
409. *A remarkable feature* in the agriculture of France, and of most warm countries, is the use of leaves of trees as food for cattle. Not only are mulberry, olive, poplar, vine, and other leaves gathered in autumn, when they begin to change colour, and acquire a sweetness of taste; but spray is cut green in July, dried in the sun or in the shade of trees in woods, faggoted, and stacked for winter use. During that season they are given to sheep and cattle like hay; and sometimes, boiled with grains or bran, to cows. The astringency of some sorts of leaves, as the oak, is esteemed medicinal, especially for sheep. Such are the outlines of that description of agriculture which is practised more or less throughout France, but chiefly in the northern and middle districts.

Subsect. 4. *Of Farming in the warmer Climates of France.*

410. *The culture peculiar to the vine, maize, olive, and orange climates*, we shall extract from the very interesting work of Baron de la Peyrouse. The estate of this gentleman is situated in the maize district at Pepils, near Toulouse. Its extent is 800 acres; and he has, since the year 1788, been engaged, and not without success, in introducing a better system of agriculture.

411. *The farm-houses and offices in the warm districts* are generally built of brick; framework filled up with a mixture of straw and clay; or, *en pisé;* and they are covered with gutter-tiles. The vineyards are enclosed by hawthorn hedges or mud walls; the boundaries of arable farms are formed by wide ditches; and those of grass lands by fixed stones or wild quince trees. Implements are wretched, operations not well performed, and labourers, and even overseers, paid in kind, and allowed to sow flax, beans, haricots, &c., for themselves. The old plough (*fig.* 50.) resembles that used by the Arabs, which the French antiquarian, Gouguet, (*Origine des Lois*) thinks, in all probability, the same as that used by the ancient Egyptians. They have also a light one-handled plough for stirring fallows, called the *araire.* (*fig.* 51.) A plough with coulters was first employed at Pepils; and a Scotch plough, with a cast-iron mould-board, was lately sent there, and excited the wonder of the whole district. In nothing is France more deficient than in suitable agricultural implements.


50

51


412. *Fallow, wheat, and maize constitute the common rotation of crops.*

413. *The live stock* consists chiefly of oxen and mules; the latter are sold to the Spaniards. Some flocks of sheep are kept; but it is calculated that the rot destroys them once in three years. Beans are the grain of the poor, and are mixed with wheat for bread. The chick pea (*Cicer arietinum*) (*fig.* 52.) is a favourite dish with the Provençals, and much cultivated. Spelt is sown on newly broken up lands. Potatoes were unknown till introduced at Pepils from the Pyrenees, where they had been cultivated for fifty years. In the neighbourhood they are beginning to be cultivated. Turnips and rutabaga were tried often at Pepils, but did not succeed once in ten years. Maize is reckoned a clearing crop, and its grain is the principal food of the people.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414. *The vine* is cultivated in France in fields, and on terraced hills, as in Italy, but managed in a different manner from what it is in that country. Here it is kept low, and treated more as a plantation of raspberries or currants

is in England. It is either planted in large plots, in rows three or four feet apart, and the plants two or three feet distant in the row; or it is planted in double or single rows alternating with ridges of arable land. In some cases, also, two close rows and a space of six or seven feet alternate, to admit a sort of horse-hoeing culture in the wide interval. Most generally, plantations are made by dibbling in cuttings of two feet in length, pressing the earth firmly to their lower end; an essential part of the operation, noticed even by Xenophon. In pruning, a stem or stool of a foot or more is left above ground, and the young shoots are every year cut down within two buds of this stool. These stools get very bulky after sixty or a hundred years, and then it is customary, in some places, to lay down branches from them, and form new stools, leaving the old for a time, which, however, soon cease to produce any but weak shoots. The winter pruning of the vine generally takes place in February: a bill is used resembling that of Italy (*fig.* 36.); the women faggot the branches, and their value, as fuel, is expected to pay the expense of dressing. In summer, the ground is twice or thrice hoed, and the young shoots are tied to short stakes with wheat or rye straw, or whatever else comes cheapest. The shoots are stopped, in some places, after the blossom has expanded; the tops are given to cows. In some places, also, great part of the young wood is cut off before vintage for feed for cows, and to let the sun directly to the fruit. The sorts cultivated are almost as numerous as the vineyards. Fourteen hundred sorts were collected from all parts of France, by order of the Comte Chaptal, and are now in the nursery of the Luxembourg: but little or no good will result from the collection, or from attempting to describe them; for it has been ascertained that, after a considerable time, the fruit of the vine takes a particular character from the soil in which it is planted; so that fourteen hundred sorts, planted in one soil and garden, would in time, probably in less than half a century, be reduced to two or three sorts; and, on the contrary, two or three sorts planted in fourteen hundred different vineyards, would soon become as many distinct varieties. The *pineau* of Burgogne, and the *auvernat* of Orleans, are esteemed varieties; and these, with several others grown for wine-making, have small berries and branches like our Burgundy grape. Small berries and a harsh flavour are universally preferred for wine-making, both in France and Italy. The oldest vines invariably give the best grapes, and produce the best wines. The Baron de la Peyrouse planted a vineyard twenty years ago, which, though in full bearing, he says, is still too vigorous to enable him to judge of the fineness and quality of the wine, which it may one day afford. "In the *Clos de Vougeot vineyard*, in which the most celebrated Burgundy wine is produced, new vine plants have not been set for 300 years: the vines are renewed by laying (*provigner*); but the root is never separated from the stock. This celebrated vineyard is never manured. The extent is 160 French arpents. It makes, in a good year, from 160 to 200 hogsheads, of 260 bottles each hogshead. The expense of labour and cooperage, in such a year, has arisen to 33,000 francs; and the wine sells on the spot at five francs a bottle. The vineyard is of the pineau grape. The soil, about three feet deep, is a limestone gravel on a limestone rock." (*Peyrouse*, 96.)

415. *The white mulberry* is very extensively cultivated in France for feeding the silkworm. It is placed in corners, rows along roads, or round fields or farms. The trees are raised from seeds in nurseries, sometimes grafted with a large-leafed sort, and sold generally at five years, when they have strong stems. They are planted, staked, and treated as pollards. Some strip the leaves from the young shoots, others cut these off twice one year, and only once the next; others pollard the tree every second year.

416. *The eggs of the silk-moth* (*Bómbyx mòri*) are hatched in rooms heated by means of stoves to 18° of Reaumur (72½° Fah.). One ounce of eggs requires one hundred-weight of leaves, and will produce from seven to nine pounds of raw silk. The hatching commences about the end of April, and, with the feeding, is over in about a month. Second broods are procured in some places. The silk is wound off the coccoons, or little balls, by women and children. This operation is reserved for leisure days throughout the rest of the season, or given out to women in towns. The eggs are small round objects; the caterpillar attains a considerable size; the chrysalis is ovate; and the male and female are readily distinguishable.

417. *The olive*, of which the most luxuriant plantations are between Aix and Nice, is treated in France in the same way as in Italy. (288.) The fruit is picked green, or, when ripe, crushed for oil, as in the latter country.

418. *The fig* is cultivated in the olive district as a standard tree; and dried for winter use, and exportation. At Argenteuil it is cultivated in the gardening manner for eating green.

419. *The almond* is cultivated about Lyons, and in different parts in the department of the Rhone, as a standard, in the vineyards. As it blossoms early, and the fruit is liable to injury from fogs and rains, it is a very precarious article of culture, and does not yield a good crop above once in five, or, according to some, ten, years.

420. *The caper* is an article of field culture about Toulon. It has the habit of a bramble bush, and is planted in squares, ten or twelve feet plant from plant every way. Standard figs, peaches, and other fruit trees are intermixed with it.

421. The culture of the *orange* is very limited; it is conducted in large walled enclosures at Hieres and its neighbourhood. The fruit, like that of Geneva and Naples, is very inferior to the St. Michael's and Maltese oranges, as imported to Britain; but the lemons are good.

422. *The winter melon* is cultivated in different parts of Provence and Languedoc, and especially in the orange orchards of Hieres. It forms an article of exportation.

423. *Various other fruits* are cultivated by the small proprietors in all the districts of France, and sold in the adjoining markets; but this department of rural economy belongs rather to gardening than to agriculture.

Sect. IV. *Of the present State of Agriculture in Holland and the Netherlands.*

424. *The agriculture of the Low Countries*, and especially of Flanders, has been celebrated by the rest of Europe for upwards of 600 years; that of Holland for its pasturage, and that of the Netherlands for tillage. We shall notice a part of the agricultural circumstances of the two countries.

Subsect. 1. *Of the present State of Agriculture in Holland.*

425. *The climate of Holland* is cold and moist. The surface of the country towards the sea is low and marshy, and that of the interior sandy and naturally barren. A considerable part of Holland, indeed the chief part of the seven provinces comprising the country, is lower than the sea, and is secured from inundation by immense embankments; while the internal water is delivered over these banks into the canals and drains leading to the sea, by mills, commonly impelled by wind. In the province of Guelderland and other internal parts, the waste grounds are extensive; being overrun with broom and heath, and the soil a black sand. The marshes, morasses, and heaths, which are characteristic of the different provinces, are, however, intermixed with cities, towns, villages, groves, gardens, and meadows, to a degree only equalled in England. There are no hills, but only gentle elevations, and no extensive woods; but almost every where an intimate combination of land, water, and buildings. The soil in the low districts is a rich, deep, sandy mud; sometimes alluvial, but more frequently siliceous, and mixed with rotten shells. In a few places there are beds of decayed trees; but no where rough gravel or rocks. The soil of the inland provinces is in general a brown or black sand, naturally poor, and, wherever it is productive, indebted entirely to art.

426. *The landed property of Holland* is in moderate or rather small divisions; and, in the richer parts, generally in farms of from twenty to one hundred and fifty or two hundred acres, often farmed by the proprietor. In the interior provinces, both estates and farms are much larger; and instances occur of farms of five hundred or seven hundred acres, partly in tillage, and partly in wood and pasture.

427. *The agriculture of Holland* is almost entirely confined to a system of pasturage and dairy management, for the production of butter and cheese; the latter well known in every part of the world. Almost the only objects of tillage are some madder, tobacco, and herbage plants and roots for stall-feeding the cattle. The pastures, and especially the lower meadows, produce a coarse grass, but in great abundance. The cows are allowed to graze at least a part of the day throughout the greater part of the year, but are generally fed in sheds, once a day or oftener, with rape cake, grains, and a great variety of other preparations. Their manure is preserved with the greatest care, and the animals themselves are kept perfectly clean. The breed is large, small-legged, generally red and white, with long slender horns; they are very well known in England as the Dutch breed. The fuel used in Amsterdam and most of the towns is peat, and the ashes are collected and sold at high prices, chiefly to the Flemings, but also to other nations. A considerable quantity has been imported to England; they are found excellent as a top dressing for clovers and other green crops, and are strongly recommended by Sir John Sinclair and other writers. Other particulars of Dutch culture and economy correspond with the practice of the Netherlands.

428. *The field implements, buildings, and operations of Holland*, are more ingeniously contrived and better executed than those of any other country on the Continent. The best plough in the world (the Scotch) is an improvement on the Rotheram or Dutch implement. The farmeries, and especially the cow-houses and stables, are remarkable for arrangements which facilitate and economise manual labour, and insure comfort to the animals and general cleanliness. Even the fences and gates are generally found in a better state than in most other countries. They have a simple field gate (*fig.* 53.) constructed with few rails, and balanced so as it may be opened and shut without straining the posts or hinges, which deserves imitation. Their bridges, foot-planks, and other mechanical agents of culture, are in general indicative of more art and invention than is usual in Continental agriculture.

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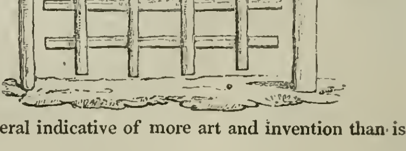

Subsect. 2. *Of the present State of Agriculture in the Netherlands.*

429. *The Netherlands and Holland*, from the tenth to the fifteenth century, were the great marts of manufactures and commerce in the west of Europe; and, at the same time, made distinguished progress in other arts. The particular causes which first contributed to the advancement of agriculture are not exactly known at this distance of time; but it is certain that even in the thirteenth century the art was in an advanced state, and, ever since, the culture of the Low Countries, both agricultural and horticultural, has been looked up to by the rest of Europe.

430. *About the beginning of the seventeenth century*, according to Harte, the Flemings dealt more in the practice of husbandry, than in publishing books upon the subject: so that, questionless, their intention was to carry on a private lucrative trade without instructing their neighbours; and hence it happened, that whoever wanted to copy their agriculture, was obliged to travel into their country, and make his own remarks; as Plattes, Hartlib, and Sir R. Weston actually did.

431. *To make a farm resemble a garden as nearly as possible* was their principal idea of husbandry. Such an excellent principle, at first setting out, led them of course to undertake the culture of small estates only, which they kept free from weeds, continually turning the ground, and manuring it plentifully and judiciously. Having thus brought the soil to a just degree of cleanliness, health, and sweetness, they ventured chiefly upon the culture of the more delicate grasses, as the surest means of acquiring wealth in husbandry, upon a small scale, without the expense of keeping many draught horses or servants. After a few years' experience, they soon found that ten acres of the best vegetables for feeding cattle, properly cultivated, would maintain a larger stock of grazing animals, than forty acres of common farm grass: and the vegetables they chiefly cultivated for this purpose were lucerne, saintfoin, trefoils of most denominations, sweet fenugreek (Trigonélla), buck and cow wheat (*M*elampýrum praténse) (*fig.* 54.), field turnips, and spurry (Spérgula), by them called Marian grass.

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432. *The political secret of Flemish husbandry* was, the letting farms on improvement. Add to this, they discovered eight or ten new sorts of manures. They were the first among the moderns, who ploughed in living crops for the sake of fertilising the earth, and confined their sheep at night in large sheds built on purpose, whose floor was covered with sand, or earth, &c., which the shepherd carted away every morning to the compost-dunghill. Such was the chief mystery of the Flemish husbandry. (*Harte.*)

433. *The present state of agriculture in the Netherlands* corresponds entirely with the outline given by Harte, and it has probably been in this state for nearly a thousand years. The country has lately been visited with a view to its rural economy by Sir John Sinclair, and minutely examined and ably depicted by the Rev. Thomas Radcliff. To such British farmers as wish to receive a most valuable lecture on the importance of a proper frugality and economy in farming, as well as judicious modes of culture, we would recommend the latter work; all that we can do here, is to select from it the leading features of Flemish farming.

434. *The climate of Flanders* may be considered the same as that of Holland, and not materially different from that of the low parts of the opposite coast of England.

435. *The surface* of the country is every where flat, or very gently elevated, and some extensive tracts have been recovered from the sea. The soil is for the most part poor, generally sandy; but in various parts of a loamy or clayey nature. "Flanders," Radcliff observes, "was in general believed to be a soil of extreme natural richness; whereas, with the exception of some few districts, it is precisely the reverse." He found the strongest and best soil near Ostend; and between Bruges and Ghent some of the worst, being little better than a pure sand.

436. *From confounding the Dutch Netherlands with the Flemish Netherlands*, a good deal of confusion in ideas has resulted. Radcliff, on arriving in Flanders, was informed that, "with respect to culture, not only the English, but the French, confounded under the general name of Brabant or Flanders, all the provinces of the Low Countries, however different might be their modes of cultivation; but that in Flanders itself might best be seen, with what skill the farmer cultivates a bad soil (*un sol ingrat*), which he forces to return to him, with usury, a produce that the richest and strongest lands of the neighbouring provinces of Holland refuse to yield." The districts described as East and West Flanders, are bounded on the east by Brabant and Hainault; on the west by the German Ocean; on the north by the Sea of Zealand and the West Scheldt; and on the south by

French Flanders. It is about ninety miles long, and sixty broad, and abounds with towns and villages.

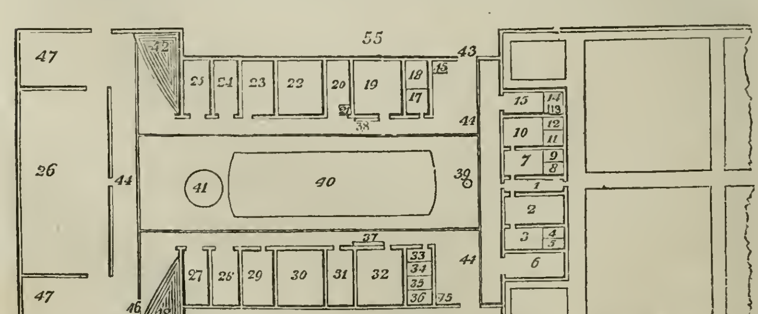
437. *The landed property of Flanders* is not in large estates: very few amount to 2000 acres. It is generally freehold, or the property of religious or civil corporations. When the proprietor does not cultivate his own lands, which, however, is most frequently the case, he lets it on leases; generally of seven, fourteen, or twenty-one years' endurance, at a fixed money rent, and sometimes a corn and money rent combined. The occupier is bound to live on the premises, pay taxes, effect repairs, preserve timber, not sublet without a written agreement, and to give the usual accommodations to an incoming tenant at the end of the lease. Leases of fourteen or twenty-one years are most common: there are scarcely any lands held from year to year, or on the metayer system. Estates are every where enclosed with hedges, and the fields are generally small.

438. *Farmeries* are convenient, and generally more ample in proportion to the extent of the farm than in England. On the larger farms a distillery, oil mill, and sometimes a flour mill, are added to the usual accommodations. The buildings on a farm of 150 acres of strong soil, enumerated by Radcliff, are: — 1. The farm-house, with an arched cellar used as a dairy, an apartment for churning, with an adjoining one for a horse wheel to turn the churning machinery. 2. A small building for the use of extra-labourers, with a fire-place for cooking. 3. The grange or great barn, 130 feet long, by 35 feet wide. The ground floor of this structure, besides accommodating by its divisions all the horses and cows of the farm in comfortable stables, and furnishing two threshing floors for the flail, is sufficient also for a considerable depot of corn in the sheaf, in two extensive compartments to the height of twelve feet, at which elevation an open floor of joists, supported by wooden pillars, is extended over the entire area of the barn, and is repeated at every five feet in height, to the top. Each floor is braced from the pillars, and not only forms a connection of strength throughout the whole, but separates at the same time, without much loss of space, the different layers of corn, securing them from damage, by taking off the pressure of the great mass. 4. A house for farming implements, with granary over, and piggery behind. In the centre is the dunghill; the bottom of which is rendered impervious to moisture.

439. *A plan of a Flemish farmery*, is given by Sir John Sinclair, as suited to a farm of 300 acres: it is executed with great solidity and a due attention to salubrity, being vaulted and well aired. Sir John mentions that he saw, in some places, "a mode of making floors by small brick arches, from one beam to the other, instead of using deals, and then making the floor of bricks," a mode generally adopted in British manufactories, where the beams which serve as abutments are of cast-iron, tied together with transverse wrought-iron rods.

440. *The accommodations of this farmery* (*fig.* 55.) *are*,

1, The vestibule, or entrance of the farm-house.
2, The hall.
3, 4, 5, Closets.
6, Sheds destined for different purposes, but more especially for elevating or letting down grain from the granaries, by machinery.
7, Kitchen.
8, Washing-house.
9, Chamber for female servants.
10, Hall.
11, 12, Closets.
13, Necessaries.
14, Room for the gardener.
15, Shed for fuel.
16, 16, Kitchen-garden.
17, Hoggery.
18, Poultry-yard.
19, 20, Stables for cows and calves.
21, Necessaries for the servants, connected with the cisterns.
22, 23, Sheep-folds.
24, 25, Sheds for carts.
26, Barn.
27, Area.
28, Flax barn.
29, 30, Sheep-houses
31, 32, Stables for the horses and foals.
33, 34, 35, 36, Places for the hogs.
37 and 38, Cisterns destined to receive the urine of the cattle.
39, Well.
40, Dung-pit, concave in the middle.
41, Pool serving to receive the superabundant waters of the dung-pit, the weedings of the gardens, &c.
42, 42, Reservoirs to receive the waters of the farm-yard.
43, Entrance gateway with dovecot over.
44, Small trenches, or gutters.
45, 45, Sheds destined for clover, cut green in summer, or dry in winter.
46, Cistern for the wash-houses.
47, 47, Situations of the corn stacks, in years of abundance.



Four elevations (*fig.* 56.) represent the four internal sides of the quadrangle; the north side (*a*); the barn, or west side (*b*); the south side (*c*); and the house, or east side (*d*).

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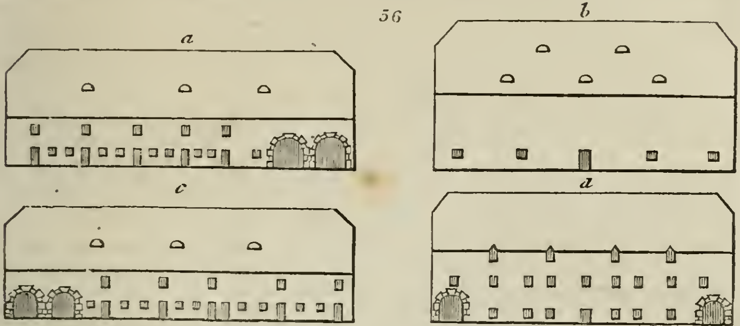

441. *Urine cisterns* are formed in the fields, to receive purchased liquid manure; but, for that made in the farm-yard, generally in the yard, or under the stables. In the latter case, the urine is conducted from each stall to a common grating, through which it descends into the vault, whence it is taken up by a pump: in the best-regulated farmeries there is a partition in the cistern, with a valve to admit the contents of the first space into the second, to be preserved there free from the more recent additions, age rendering it considerably more efficacious. This species of manure is relied on beyond any other, upon all the light soils throughout Flanders; and, even upon the strong lands (originally so rich as to preclude the necessity of manure), it is now coming into great esteem, being considered applicable to most crops, and to all the varieties of soil.

442. *The arable lands of Flanders* include by far the greater part of the surface of the country. The crops raised are the same as those in Britain; but, from local circumstances, flax, hemp, chiccory, rape, spurry, madder, woad, tobacco, and some others, enter more generally into rotations.

443. *Fallows*, according to Sir John Sinclair, are in a great measure abolished, even on strong land; by means of which, produce is increased, and the expense of cultivation, on the crops raised in the course of a rotation, necessarily diminished; and by the great profit they derive from their flax and rape, or colsat, they can afford to sell all their crops of grain at a lower rate. The Flemish farmers, however, understand their interest too well, to abolish naked fallows on strong clayey soils in a humid climate.

444. *In regard to soil and culture*, Radcliff arranges Flanders into eleven agricultural divisions, and of the principal of these we shall notice the soil and rotations, and some other features of culture.

445. *The first division* extends along the North Sea, and includes Ostend. This district consists of the strongest and heaviest soil which Flanders possesses, and a similarity of quality prevails generally throughout, with some occasional exceptions. It may be represented as a clay loam of a greyish colour, and yields the various produce to be expected from a strong soil; rich pasture, wheat, beans, barley, and rape, considered as primary crops; and, as secondary (or such as are not so generally cultivated), oats, carrots, potatoes, flax, and tares. In this division, however, though the nature of the soil may be stated under the general description of a clay loam, yet there are of this three degrees of quality, not to be marked by regular limits, but to be found throughout the whole, in distinct situations. It becomes the more necessary to remark this, as the succession of crops depends on the quality of the soil; and as there are here three different degrees of quality, so are there three different systems of rotation.

446. *Upon the first quality of soil*, the succession is as follows: first year, barley; second, beans; third, wheat; fourth, oats; fifth, fallow. For the second quality of soil, the succession is as follows: first year, wheat; second, beans or tares; third, wheat or oats; fourth, fallow. For the third quality of soil, the succession is as follows: first year, wheat; second, fallow; third, wheat; fourth, fallow. Besides these three qualities of strong soil, another of still superior fertility prevails in this district in considerable extent, known by the denomination of Polders.

447. *The polders, or embanked lands of Flanders*, are certain areas of land reclaimed from the sea by embankment, whose surface, once secured from the influx of the tide, becomes the most productive soil, without requiring the assistance of any description of manure. They owe their origin partly to the collection of sand, in the small branches of rivers, gradually increasing, so as naturally to embank a portion of land, and convert it into an arable and fertile soil. They also have proceeded from the contraction of the river itself, which, by the effect of the tides, is diminished in one place, whilst an alluvial soil is formed in another by its overflow. Hence it is, that, within a century, entire polders in certain situations have been inundated, whilst, in others, new and fertile land has appeared, as if from the bosom of the water. These operations of nature pointed out facilities many centuries back, which excited the industry of the Low Countries, an industry

which has been rewarded by the acquisition of their richest soil. These newly-formed lands, before their embankment, are called *schorres.* They are flooded at every tide by the water of the sea, and are augmented by mire, bits of wood, rushes, sea-weeds, and other marine plants decayed and putrid, also by shells and fishy particles which the ebb always leaves behind in considerable quantity. This growing soil soon produces various plants and grasses, and improves daily. When such lands have acquired a crust or surface of black earth, three or four inches deep, they may be embanked and fallowed. Those are always the most productive which have been deepened in their soil by the augmentations of the sea; and experience proves that in the corners and hollows, where, from an obstructing boundary, the greatest quantity of mire has been deposited, the soil is doubly rich and good, and cannot be impoverished by the crops of many years. In some instances, the embankments are made on the part of government; in others, by companies or individuals, under a grant of a specific tenure (generally twenty-one years), rent free, or, according to circumstances, at some moderate annual payment.

448. *The polder of Snaerskirke,* near Ostend, contains about 1300 acres. It is of late formation, and was overflowed by a creek with its minor branches every spring tide. By constructing two banks and a flood-gate at the creek, the sea is excluded, and the space subdivided by roads, and laid out in fields of thirteen acres each, surrounded by ditches. The bank is fifteen feet in height, thirty feet in the base, and ten feet across the top: the land which has been reclaimed by it, was let for a sheep pasturage at 600 francs (25*l.*) per annum, and was thrown up by the farmer as untenable. Upon being dried by this summary improvement, the lots, of which there are one hundred of thirteen acres each, were sold by auction at an average of 7000 francs (291*l.* 13*s.* 4*d.*) a lot, and would now bring nearly double that rate. They are let to the occupying farmers at 36 guilders the *mésure*, or about 2*l.* 15*s.* the English acre, and are now producing superior crops of rape, of sucrion (winter barley), and beans, which constitute the usual rotation; this, however, is varied according to circumstances, as follows: — 1. oats, or rape; 2. winter barley, or rape; 3. winter barley; 4. beans, pease, or tares.

449. *Other examples of reclaimed lands are given.* One called the *Great Moor*, recovered through the spirited exertions of M. Hyrwein, contains 2400 acres. Attempts had been made to recover it by the Spaniards, in 1610, but without success. This marsh was seven feet below the level of the surrounding land; therefore, to drain it, the following operations became necessary: —

450. *To surround the whole with a bank* of eight feet in height, above the level of the enclosed ground, formed by the excavation of a *fossé*, fifteen feet wide and ten feet deep, which serves to conduct the water to the navigable canal. — *To construct mills* to throw the water over the bank into the *fossé*. — *To intersect the interior* by numerous drains from eight to twelve feet wide, with a fall to the respective mills, to which they conduct all the rain water, and all the soakage water which oozes through the banks.

451. *The mills in use* for raising the water, are of a simple but effectual construction, and are driven by wind. The horizontal shaft above works an upright shaft, at the bottom of which a screw bucket, twenty-four feet in length, is put in motion by a bevil wheel, at such an angle as to give a perpendicular height of eight feet from the level of the interior drain to the point of disgorgement, whence the water is emptied with great force into the exterior canal. With full wind, each mill can discharge 150 *tonneaux* of water every minute. The height of the building from the foundation is about fifty feet, one half of it above the level of the bank. The whole is executed in brickwork, and the entire cost 36,000 francs, about 1500*l.* British. It is judiciously contrived that the drains, which conduct the water to the mills, constitute the divisions and subdivisions of the land, forming it into regular oblong fields of considerable extent, marked out by the lines of osiers which ornament their banks. Roads of thirty feet wide lead through the whole in parallel directions.

452. *The soil of this tract*, which has been formed by the alluvial deposit of ages, is a clay loam, strong and rich, but not of the extraordinary fertility of some polders, which are cropped independent of manure for many years. The first course of crops, commencing with rape, is obtained without manure, and the return for six years is abundant; the second commences and proceeds as follows: —

1. Fallow, with manure from farm-yard.
2. Sucrion (winter barley).
3. Beans.
4. Wheat.
5. Clover.
6. Beans and Peas mixed.
7. Oats.

453. *The second division* adjoins French Flanders, but does not extend to the sea. The soil may be described as a good loam of a yellowish colour, mixed with some sand; but is not in its nature as strong as that of the former division. Its chief produce is wheat, barley, oats, hops, tobacco, meadow, rape-seed and flax, as primary crops; and, as secondary, buckwheat, beans, turnips, potatoes, carrots, and clover. This division, unlike the former in this respect, is richly wooded.

454. *The general course of crops in this division is as follows:* —

1. Wheat upon manured fallow.
2. Clover, top dressed with ashes.
3. Oats, } same year, without manure
4. Turnips, }
5. Flax, highly manured with urine and rape cake, }
6. Wheat, } or { Fallow, manured. / Rye. / Wheat.
7. Beans, }
8. Beans, manured, }

9. Wheat.
10. Oats.
11. Turnips.
12. Rye.
13. Tobacco, three times ploughed, and richly manured.
14. Wheat.
15. Hops, with abundant manure.

This last crop remains generally five years, and the ground is afterwards fit for any kind of produce.

455. *In another part of this division*, where hops are not grown, the following rotation is observed: —

1. Potatoes, with manure.
2. Wheat.
3. Beans, with manure.
4. Rye.
5. Wheat, with manure.
6. Clover, top-dressed with ashes.
7. Turnips, with manure.
8. Flax, highly manured with urine and rape cake.
9. Wheat.
10. Oats, } same year.
11. Turnips, } same year.
12. Fallow, without manure.
13. Rye.
14. Tobacco, richly manured.
15. Wheat.

456. *In addition to these crops* in some parts of the district, particularly in the line between Woomen and Ypres, magnificent crops of rape are cultivated, and are relied on as a sure and profitable return. Flax is also a crop upon which their best industry is bestowed, and their careful preparation of the soil is scarcely to be surpassed by that of the neatest garden.

457. *In the third division* the soil is a good sandy loam, of a light colour, and is in a superior state of cultivation; it yields a produce similar to that of the foregoing division, with the same quality of hay; but plantations are here more numerous. The succession is as follows: —

1. Wheat, with dung.
2. Clover, with ashes, seed sometimes saved.
3. Flax, with urine and rape cake.
4. Wheat, with compost of short dung and various sweepings.
5. Potatoes, with farm-yard dung or night soil.
6. Rye, with urine.
7. Rape seed, with rape cake and urine.
8. Potatoes, with dung.
9. Wheat, with manure of divers kinds.
10. Clover, with ashes, seeds sometimes saved.
11. Oats, without manure.
12. Flax, with urine and rape cake.
13. Wheat, with dung.
14. { Beans, with dung. / Beet root, with rape cake, or / Tobacco, with rape cake in great quantities.

Turnips are also grown, but are taken as a second crop after rape, flax, wheat, or rye.

458. *Passing over the other divisions to the eighth and ninth*, we find the reporter describes them as of considerable extent, and, in the poverty of their soil and abundance of their produce, bearing ample testimony to the skill and perseverance of the Flemish farmers. The soil consists of a poor light sand, in the fifteenth century exhibiting barren gravel and heaths. The chief produce here consists of rye, flax, potatoes, oats, buckwheat, rape-seed, and wheat, in a few favourable spots; clover, carrots, and turnips generally.

459. *On the western side of these districts*, and where the soil is capable of yielding wheat, there are two modes of rotation: one comprising a nine years' course, in which wheat is but once introduced; and the other a ten years' course, in which they contrive to produce that crop a second time; but in neither instance without manure, which, indeed, is never omitted in these divisions, except for buckwheat, and occasionally for rye. The first course alluded to above is as follows: —

1. Potatoes or Carrots, with four ploughings, and twelve tons of farm-yard dung per English acre.
2. Flax, with two ploughings, and 105 Winchester bushels of ashes, and 48 hogsheads, beer measure, of urine per English acre.
3. Wheat, with two ploughings, and ten tons and a half of farm-yard dung per English acre.
4. Rye and Turnips, with two ploughings, and ten tons and a half of farm-yard dung per English acre.
5. Oats with Clover, with two ploughings, and ten tons and a half of farm-yard dung per English acre.
6. Clover, top-dressed, with 105 Winchester bushels of peat or Dutch ashes per English acre.
7. Rye, with one ploughing, and 52 hogsheads, beer measure, of night soil and urine.
8. Oats, with two ploughings, and 52 hogsheads, beer measure, of night soil and urine.
9. Buckwheat, with four ploughings, and without any manure.

460. *Of the Flemish mode of cultivating some particular crops* we shall give a few examples. The drill husbandry has never been generally introduced in the Low Countries. It has been tried in the neighbourhood of Ostend, forty acres of beans against forty acres of drilled crop, and the result was considered to be in favour of the system. But the row culture, as distinguished from the raised drill manner, has been long known in the case of tobacco, cabbages, and some other crops.

461. *Wheat* is not often diseased in Flanders. Most farmers change their seed, and others in several places steep it in salt water or urine, and copperas or verdigrise. The proportion of verdigrise is half a pound to every six bushels of seed; and the time in which the latter remains in the mixture is three hours, or one hour if cows' urine be used, because of its ammonia, which is considered injurious. The ripest and plumpest seed is always preferred.

462. *Rye* is grown both as a bread corn, and for the distillery. In Flanders frequently, and in Brabant very generally, the farmer upon the scale of from one hundred to two hundred acres of light soil is also a distiller, purely for the improvement of the land by the manure of the beasts, which he can feed upon the straw of the rye, and the grains of the distillery.

463. *Buckwheat* enters into the rotations on the poorest soils, and is sown on lands not got ready in time for other grain. The chief application of buckwheat is to the feeding of swine and poultry, for which it is preeminent; it is also used in flour as a constituent in the liquid nourishment prepared for cattle and horses; and bears no inconsiderable share in the diet of the peasant. Formed into a cake, without yeast, it is a very wholesome, and not a disagreeable, species of bread; but it is necessary to use it while

fresh, as, if kept, it would turn sour sooner than bread made of barley, rye, or wheaten flour. Its blossom is considered to afford the best food for bees. If cut green, it yields good forage, and if ploughed in when in flower, it is thought one of the best vegetable manures in use. It is also said to be used in distillation; but this is not generally admitted to be the case.

464. *Rape* (*colza*, *colsat*, or *cole seed*; not the *Brássica Nàpus* of Linnæus, but the *B.* campéstris of Decandolle) is considered an important article of Flemish agriculture. It is sometimes sown broad-cast, but the general and improved method is by transplanting, which they allege, and apparently with great justice, to have many advantages: one is, that the seed-bed occupies but a small space, whilst the land which is to carry the general crop is bearing corn. By having the plants growing, they have time to harvest their corn, to plough and manure the stubble intended for the rape, which they put in with the dibble or the plough, from the latter end of September to the second week of November, without apprehending any miscarriage.

465. *The seed-bed* is sown in August, and even to the middle of September. In October, or sooner, the stubble is ploughed over, manured, and ploughed again. The plants are dibbled in the seams of the ploughing (each furrow slice being twelve inches broad), and are set out at twelve inches' distance in the rows. Instead of dibbling upon the second ploughing, in many cases they lay the plants at the proper distances across the furrow, and as the plough goes forward, the roots are covered, and a woman follows to set them a little up, and to give them a firmness in the ground where necessary. Immediately after the frost, and again in the month of April, the intervals are weeded and hand-hoed, and the earth drawn up to the plants, which is the last operation till the harvest. It is pulled rather green, but ripens in the stack; and is threshed without any particular management: but the application of the haulm, or straw, is a matter of new and profitable discovery; it is burned for ashes, as manure, which are found to be so highly valuable beyond all other sorts which have been tried, that they bear a price as three to one above the other kinds, and it is considered that, upon clover, a dressing of one third less of these is amply sufficient.

466. *The seed is sold for crushing*; or, as is frequently the case, it is crushed by the farmer himself; an oil mill being a very common appendage to a farmery.

467. *The oilette, or poppy* (*Papàver somníferum*), is cultivated in some parts, and yields a very fine oil; in many instances, of so good a quality as to be used for salad oil. The seed requires a rich and well manured soil. The crop is generally taken after rape, for which the ground has been plentifully manured; and for the oilettes it receives a dressing not less abundant. The seed is sown at the rate of one gallon to the English acre, and is lightly covered by shovelling the furrows. The average produce is about thirty Winchester bushels to the English acre. The seed is not so productive as rape, in point of quantity, but exceeds it in price, both as grain and as oil, by at least one sixth. The measure of oil produced from rape, is as one to four of the seed; that produced from the seed of the oilettes, is as one to five.

468. *Poppy seed* is sown both in spring and autumn, but the latter is considered the best season; great attention is given to the pulverisation of the soil, by frequently harrowing, and (if the weather and state of the soil permit) sufficient rolling to reduce all the clods.

469. *The harvesting of the poppy* is performed in a particular manner, and requires a great number of hands. The labourers work in a row, and sheets are laid along the line of the standing crop, upon which, bending the plants gently forward, they shake out the seed. When it ceases to fall from the capsules, that row of the plants is pulled up, and placed upright in small sheaves, in the same, or an adjoining field, in order to ripen such as refused to yield their seed at the first operation. The sheets are then again drawn forward to the standing crop, and the same process is repeated, till all the plants are shaken, pulled up, and removed. In two or three days, if the weather has been very fine, the sheets are placed before the rows of the sheaves, which are shaken upon them, as the plants were before; if any seed remains, it is extracted in the barn by the flail: and, if the weather is unpromising, the plants are not left in the field after the first operation, but are placed at once under some cover to ripen; and yield the remainder of their seed, either by being threshed or shaken.

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470. *The red clover* is an important and frequent article in the Flemish rotations. The quantity of seed sown does not exceed six pounds and a quarter to the English acre. The soil is ploughed deep and well prepared, and the crop kept very clear of weeds. Their great attention to prevent weeds, is marked by the perseverance practised to get rid of one, which occasionally infests the clover crop, and is indeed most difficult to be exterminated. The *O*robánche, or broom rape (*O*robánche màjor) (*fig.* 57.), is a parasitical plant which attaches itself to the pea tribe. In land where clover has been too frequently sown, it stations itself at its root, and, if suffered to arrive at its wonted vigour, will spread and destroy an entire crop. The farmer considers the mischief half done, if this dangerous plant is permitted to appear above the surface; and he takes the precaution to inspect his clover in the early spring. The moment the *O*robánche establishes itself at the root, the stem and leaf of the clover, deprived of their circulating juices, fade to a sickly hue, which the farmer recognises, and, with true Flemish industry, roots up and destroys the latent enemy. If this is done in time, and with great care, the crop is saved; if not, the infected soil refuses to yield clover again for many years.

471. *The turnip* is not in general cultivated as a main crop, but usually after rye or rape, or some crop early removed. The turnip is sown broad-cast, thinned, and hoed with great care; but it affords a very scanty crop of green food, generally eat off with sheep in September or later. The Swedish turnip is unknown; and indeed the turnip husbandry, as practised in Britain, cannot be considered as known in Flanders.

472. *The potato* was introduced early in the seventeenth century, but attracted little notice till the beginning of the eighteenth. It is cultivated with great care. The ground is trenched to the depth of nearly two feet; and small square holes having been formed at about eighteen inches from each other, a set is deposited in each, the hole nearly filled with dung, and the earth thrown back over all. As the stalks rise they are earthed up from the intervals, and manured with liquid manure; and, as they continue to rise, they receive a second earthing round each distinct plant, which, with a suitable weeding, terminates the labour. Notwithstanding the distance between the plants, the whole surface is closely covered by the luxuriance of the stems, and the return is abundant. If the seed is large, it is cut; if small, it is planted whole. In some parts of the Pays de Waes they drop the potato sets in the furrow as the plough works, and cross-hoe them as they rise; but the method first mentioned is the most usual, and the produce in many cases amounts to ten tons and one sixth, by the English acre.

473. *Potatoes are the chief food of the lower classes.* They are prized in Flanders, as being both wholesome and economical, and are considered there so essential to the subsistence of a dense population, that at one time it was in serious contemplation to erect a statue, or some other monument of the country's gratitude, to the person who first introduced amongst them so valuable a production. They are also very much used in feeding cattle and swine; but, for this purpose, a particular sort, much resembling our ox-noble, or cattle potato, is made use of, and the produce is in Flanders, as with us, considerably greater than that of the other kinds intended for the table.

474. *The carrot* is a much valued crop in sandy loam. The culture is as follows: — After harvest they give the land a moderate ploughing, which buries the stubble, and clearing up the furrows to drain off the waters, they let the field lie so for the winter; early in spring they give it a second ploughing very deep (from eleven to twelve inches), and shortly after they harrow the surface well, and spread on it ninety-six carts of manure to the bonnier, about twenty-one tons to the English acre. This manure is in general half from the dunghill, and half of what is termed *merde*, or a collection from the privies, which being ploughed in, and the surface made smooth, they sow the seed in the month of April, broad-cast, and cover it with a harrow. The quantity sown is estimated at eleven pounds to the bonnier, or about three pounds to the English acre. The average produce, about one hundred and sixty bushels to the English acre.

475. *The carrot, as nutritive food both for cattle and horses*, is a crop extremely valuable. In Flanders it is generally substituted in the room of hay, and a moderate quantity of oats is also given. To each horse, in twenty-four hours, a measure is allotted, which weighs about twenty-five pounds. This appears a great quantity, but it makes hay-feeding altogether unnecessary. To each of the milch cows, a similar measure is given, including the tops, and this is relied on for good butter, both as to quantity and quality.

476. *The white beet, or mangold-würzel,* is not in use in Flanders as food for cattle, but was once cultivated very extensively for the production of sugar. At the time the French government encouraged the manufacture of sugar from this root, experiments were made on a considerable scale, and with great success, in the town of Bruges. The machinery was unexpensive, and the remaining cost was merely that of the manual labour, and a moderate consumption of fuel. The material itself came at a very low rate, about ten shillings British by the ton; and to this circumstance may be chiefly attributed the cessation of the manufacture. Instead of encouraging the cultivator, the government leaned altogether to the manufacturer, and made it imperative on every farmer to give up a certain proportion of his land to this root, without securing to him a fair remuneration. The consequence was, that the manufacturers, thus supported, and taking advantage of the constrained supply, have in many instances been known to refuse payment even of the *carriage* of a parcel, in other respects sent in gratuitously; and a consequence still more natural was, that the farmers, wherever they had the opportunity of shaking off so profitless a crop, converted the space it occupied to better purposes.

477. *To the manufacturer of beet root sugar* the profit was ample. An equal quantity of sugar with that of the West Indies, which at that time sold for five shillings a pound, could be produced on the spot from mangold-würzel, at less than one shilling by the pound: and to such perfection had the sugar thus made arrived, that the prefect, mayor, and some of the chief persons of Bruges, who were invited by a manufacturer to witness the result of his experiments, allowed the specimens which he produced to exceed those of the foreign sugar.

478. *The process of manufacturing beet root sugar*, as then in use, was simple. A cylindrical grater of sheet-iron was made to work in a trough, prepared at one side in the hopper form, to receive the clean-washed roots of the beet, which, by the rotation of this rough cylinder, were reduced to a pulp. This pulp, when placed in bags of linen or hair-cloth, and submitted to a pressure resembling that of a cider press, yielded its liquor in considerable quantity; which being boiled and subjected to a proportion of lime, the saccharine matter was precipitated. The liquor being then got rid of, a solution of sulphuric acid was

added to the precipitate, which being boiled again, the lime was disengaged; the saccharine matter, being then freed from the liquor, granulated, and was ready for the refiner. The pulp has been found to yield, upon distillation, a wholesome spirit, very inferior, but not very unlike, to geneva, and has been proved excellent as a manure, but not valuable as food for cattle, beyond the first or second day from the press. The foregoing process required but a fortnight to complete it.

479. *Flax* is cultivated with the utmost care. The field intended for this crop, after two or three ploughings and harrowings, is again ploughed, commencing in the centre, and ploughing round and round to the circumference, so as to leave it without any furrow. The heavy roller is drawn across the ploughing by three horses; the liquid manure is then spread equally over the entire surface, and when well harrowed in by eight or nine strokes of the harrow, the seed is sown, which is also harrowed in by a light harrow, with wooden pins of less than three inches; and the surface, to conclude the operation, is again carefully rolled. Nothing can exceed the smoothness and cultivated appearance of fields thus accurately prepared.

480. *The manure universally used for the flax crop*, demands particular notice: it is termed liquid manure, and consists of the urine of cattle, in which rape-cake has been dissolved, and in which the *vidanges* conveyed from the privies of the adjoining towns and villages have also been blended. This manure is gradually collected in subterraneous vaults of brickwork, at the verge of the farm next to the main road. Those receptacles are generally forty feet long, by fourteen wide, and seven or eight feet deep, and in some cases are contrived with the crown of the arch so much below the surface of the ground, as to admit the plough to work over it. An aperture is left in the side, through which the manure is received from the cart by means of a shoot or trough, and at one end an opening is left to bring it up again, by means of a temporary pump, which delivers it either into carts or tonneaus.

481. *The liquid is carried to the field* in sheets or barrels, according to the distance. Where the cart plies, the manure is carried in a great sheet called a *voile*, closed at the corners by running strings, and secured to the four uprights of the carts; and two men, standing one on each side of the cart, scatter it with hollow shovels upon the rolled ground. Where the tonneaus are made use of, each is carried by two men with poles, and set down at equal intervals across the field in the line of the rolling. There are two sets of vessels, which enable the men, who deposit the loaded ones, to bring back the others empty. One man to each vessel, with a scoop, or rather a kind of bowl with a long handle, spreads the manure, so as to cover a certain space; and thus, by preserving the intervals correctly, they can precisely gauge the quantity for a given extent of surface. For the flax crop they are profuse; and of this liquid mixture, in this part of the country, they usually allow at the rate of 2480 gallons, beer measure, to the English acre.


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482. *Spurry* (Spérgula arvénsis) (*fig.* 58.) is cultivated on the poorest soils. It is so quick of growth and short of duration, that it is often made to take an intermediate place between the harvest and the spring sowing, without any strict adherence to the regularity of succession. It is sown sometimes in the spring, but in general in the autumn, immediately after harvesting the corn crops. One light ploughing is sufficient; and as the grain is very small, it is but very lightly covered. About twenty-four pounds of seed to the acre is the usual quantity. Its growth is so rapid that in five or six weeks it acquires its full height, which seldom exceeds twelve or fourteen inches. The crop is of course a light one, but is considered of great value, both as supplying a certain quantum of provender at very little cost, and as being the best food for milch cows, to improve the quality of the butter. It lasts till the frost sets in, and is usually fed off by milch cows tethered on it, but is sometimes cut and carried to the stalls.

483. *Where spurry is sown in spring* the crop is occasionally made into hay; but from the watery nature of the plant, it shrinks very much in bulk, and upon the whole is much more advantageously consumed in the other manner. It is indigenous in Flanders; and, except when cultivated, is looked on as a weed, as in this country.

484. *The hop* is cultivated on good soils, and generally after wheat. The land being four times ploughed, the plants are put in, in the month of May, in rows with intervals of six feet, and six feet distant in the row. In the month of October they raise the earth round each plant, in little mounds about two feet and a half high, for the purpose of encouraging a number of shoots, and of preserving them from the frost. When all harsh weather has disappeared, about the beginning of April in the second year, they level those little heaps, and take away all superfluous shoots at the root, leaving but four or five of the strongest. They then spread over the entire surface, at the rate of twelve carts of 1500 lbs. each, by the English acre, of dung, either of cows, or of cows

and swine mixed; but they avoid the heat and fermentation of horse-dung. This dressing is given when the shoots begin to appear; at which time also, they fix in the earth, close to each hill, a pole of dry wood, about eighteen feet in length, for the vines to cling by. In the month of July, they give the surface another dressing with urine, at the rate of 1000 gallons the English acre. In the month of August, the crop has nearly arrived at its full growth, and flourishes in all its beauty.

485. *The crop is ready to gather in the month of September*, when they cut the runners at about three feet from the ground, and in November they cut them to the earth; they then heap up the soil about each plant as before, to the height of two feet and a half, and follow precisely the same course as above-mentioned each year, during five, which is the usual time they suffer the plantation to continue, and at the expiration of which the land is in the highest condition, and suited to the reception of any other crop.

486. *Madder* is sometimes cultivated, but only on land of the best quality, and with plenty of manure. At the end of April or May, accordingly as the young plants are large enough to be transplanted, the land must be ploughed in beds of two feet and two feet and a half wide; the beds are then to be harrowed and raked, and the young suckers of the roots or plants are to be put down in rows, at intervals of a foot or a foot and a half, and six or eight inches distant in the row.

487. *During the entire summer* the land should be frequently stirred, and kept free from weeds. In the month of November, when the leaves are faded, the plants are covered with two inches of earth by a plough, having the point of the coulter a little raised or rounded, so as not to injure the young plants.

488. *In the following spring*, when the young shoots are four or five inches long, they are gathered or torn off, and planted in new beds, in the same manner as has been pointed out above; and then in the month of September or October, after the faded leaves have been removed, the old roots are taken up.

489. *The madder thus taken up* should be deposited under cover, to protect it from the rain; and, after ten or twelve days, placed in an oven moderately heated. When dried sufficiently, it is gently beaten with a flail, to get rid of any clay that may adhere to the plants; and, by means of a small windmill, is ground and sifted, to separate it from any remaining earth or dirt. It is then replaced in the oven for a short time, and when taken out is spread upon a hair-cloth to cool; after which it is ground and cleaned once more. It is then carried to a bruising-mill, and reduced to a fine powder, after which it is packed in casks or barrels for market.

490. *The culture of woad*, though not general, has been practised in Flanders. It was an object with the French government to spread the cultivation of it, and a considerable quantity of seed was sent gratis into the country for that purpose.

491. *Woad thrives only on gravelly and sandy soils*, which must be well pulverised, manured, and formed into beds, as in the case of madder culture. It is sown in March or April in rows, or broad-cast, and harrowed or covered with a rake. All weeds are cleared away, and the plants thinned, if a careful culture is followed. The leaves are the part of the plant which is used by the indigo manufacturer. They should be gathered singly, like those of spinach, as soon as they begin to show signs of maturity, and the mature leaves taken off from time to time as they grow. This operation goes on from June to September in the first year, and from June to August in the second; when the plant being a biennial, shoots into flower stems. The leaves are fermented, and the dye precipitated from the liquor and dried, &c., in a manner analogous to what is practised in India with indigo; but with great improvements, made at the instance of the French government, which, in 1810, called forth the process described in a French work, and translated in the appendix to Radcliff's report. At present it is to be considered more as matter of curious historical information, or of local adoption, than of general utility; because no mode of cultivating or preparing woad could bring it into competition, either in the European or American market, with indigo.

492. *With culinary vegetables the Flemish markets are abundantly supplied.* Most of these are grown by the small farmers, and are of excellent quality. To every cottage in Flanders a garden of some description is attached; and according to the means, the leisure, and the skill of the possessor, is rendered more or less productive. The general principles of management with all are, frequent digging, careful weeding, ample manuring, and immediate succession. The rotation depends on circumstances. The chief vegetables in common use are, parsnep, carrot, turnip, scorzonera, savoy, jettechou cabbage (Brussels sprouts), onions, leeks, peas, beans, and all kinds of salading, with another vegetable called *fève haricot*, a large species of French bean, which has a place in the field or garden of almost every farmer, and being sliced down, pod and seed, is made a chief ingredient in all farm-house cookery.

493. *The treatment of asparagus* here, and generally in Flanders, differs considerably from our method. In forming their beds, they are not by any means particular as to very deep trenching, or a profusion of manure; nor, as they grow up, do they cover the beds with litter for the winter, nor fork and dress them in the spring. In the furrows they form a rich and mellow compost of earth and dung, with which, before winter sets in, they dress up the beds to the height of nearly eighteen inches from the level of the crowns; and, without any further operation (except supplying the furrows again for the ensuing year), as soon as the buds appear, they cut them nine inches under the surface, by which means, having but just reached the light, the whole of the stock is blanched.

494. *The frequent manurings given by the Flemish farmer* astonish a stranger; the sources whence it is obtained in sufficient quantity form the difficulty, and this can only be resolved by referring to the practice of *soiling*; to the numerous towns and villages; and to the care with which every particle of vegetable or animal refuse is saved for this purpose. Manure in Flanders, as in China, is an article of trade. The selling price of each description is easily ascertained; the towns let the cleansing of the streets and public retiring places at great rents. Chaptal says there are in every town sworn brokers, expressly for the purpose of valuing night soil; and that these brokers know the exact degree of fermentation in that manure which suits every kind of vegetable, at the different periods of its growth. (*Chimie appliquée à l'Agriculture*, l. 137.)

495. *Every substance that constitutes, or is convertible to, manure, is sought after with avidity,* which accounts for the extreme cleanliness of the Flemish towns and pavements, hourly resorted to, with brooms and barrows, as a source of profit. Even the chips which accumulate in the formation of the wooden shoes worn by the peasantry, are made to constitute a part of the compost dung-heap; and trees are frequently cultivated in barren lands, merely to remain till their deciduous leaves shall, in course of time, have formed an artificial surface for the purpose of cultivation. The manures in general use are, —

496. *The farm-yard dung,* which is a mixture of every matter that the farm-yard produces, formed into a compost, which consists of dung and litter from the stables, chaff, sweepings, straw, sludge, and rubbish, all collected in a hollow part of the yard, so prepared as to prevent the juices from being wasted; and the value of this, by the cart-load of 1500 lbs. of Ghent, is estimated at five francs.

497. *The dung of sheep, pigeons, or poultry,* by the same cart-load, five francs and a half.

498. *Sweepings of streets and roads,* same quantity, three francs.

499. *Ashes of peat and wood mixed,* same quantity, eight francs.

500. *Privy manure and urine,* same quantity, seven francs.

501. *Lime,* same quantity, twenty-four francs.

502. *Rape-cake,* per hundred cakes, fifteen francs.

503. *Gypsum, sea mud, and the sediment of the canals,* have been all tried experimentally, and with fair results: but the two former have been merely tried; the latter is used successfully in the vicinity of Bruges.

504. *Bone manure* was altogether unknown in Flanders; but, at the suggestion of Rad liff, is now under experiment in that country.

505. *The agricultural implements* of Flanders are by no means such as the excellence of the Flemish culture would lead us to suspect. They are in general of rude workmanship, but constructed with attention to strength, durability, and cheapness.

506. *The plough* has a rude appearance, but works easily, and makes excellent work in loose friable soil; though it would not make a sharp angled furrow-slice in breaking up pastures. It is never drawn by more than two horses, and on light sands often by one, or by a single ass.

507. *The binot,* or Walloon plough, used in Brabant, described by Sir John Sinclair, is a plough with a double or scuffler share, two mould-boards, but no coulter. It is chiefly used for breaking up lands. If the soil is foul, they employ it two or three times, for the purpose of cleaning it thoroughly. The land is not turned over, as by the plough, and the weeds buried, but the soil is elevated into small ridges, by means of which the couch and other root-weeds are not only cut, but they are exposed to the frost in winter, and to the drought of spring; and when the land becomes dry, which it does quickly when thus elevated, these weeds are collected by the harrow, by a trident (or large pitchfork), by a rake, or by the hand. After the binot, the land is always ploughed for the seed furrow. This implement and its application are strongly recommended to the British farmer, by Sir J. Sinclair, as improvements; but, as the editor of the *Farmer's Magazine* observes, the implement is nothing more than a double mould-board plough, and the operation of ridging with it is the justly exploded practice of "ribbing." The late machinist Weir informed us, that he had orders for several binots from Sir J. Sinclair and others, and that he used exactly the same form, as when a double mould-board plough was ordered.

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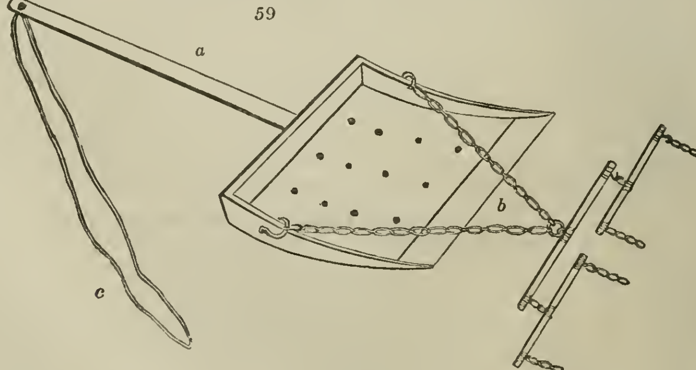

508. *The mouldebaert* (*fig.* 59.) is a curious and useful implement. It resembles a large square malt or cinder shovel, strongly prepared with iron on the cutting edge, and

is drawn by a pair of horses with swingle-trees. It is used to lessen inequalities of surface, by removing a part of the soil from the heights to the hollows, which it does in an easy and expeditious manner. The driver, who uses long reins, by pressing moderately on the handle (*a*) as the horses go forward, collects and transports about five hundred weight of earth to the place where it is to be deposited; which is effected in the most summary manner by his letting go the handle: this causes the front, or edge of the machine, (*b*) to dip, and catch against the ground, whereby it is at once inverted and emptied of its load. The extremity of the handle, to which a rope (*c*) is affixed, by this inversion strikes against, and rests upon the swingle-tree bar, and in this manner the mouldebaert is drawn along towards the accumulated earth, when, by taking up the rope, the driver draws back the handle, collects his load as before, proceeds to the spot which is to receive it, and the horses are never for a moment delayed. The saving of time and labour, in filling and emptying, gives this implement a decided superiority over the cart; nor is the ground so much injured by this, as by wheels.

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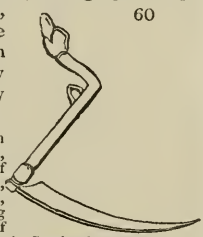
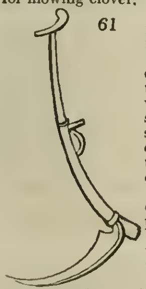


509. *The Hainault scythe* (*fig.* 60.) is the general reaping instrument both in the Netherlands and in French Flanders. The handle is fourteen inches, with a shield for the hand of four and a half inches, in all eighteen and a half inches: the blade is two feet three inches in length, the point a little raised, and the entire edge bevelled upwards so as to avoid the surface of the ground, and the frequent use of the sharpening stone. The handle of the crook being of hard wood, is used as a scythe board. A farther account of the mode of using this instrument, and of a series of trials which have been made with it in Scotland, will be found in a succeeding part of this work.

510. *The great Brabant scythe* (*fig.* 61.) differs little from the British implement, and is in general use for mowing clover.



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511. *The kylanderie*, to which Radcliff seems to attach unmerited importance, is nothing more than a screen for freeing grain from vermin, dust, or small seeds. It resembles a gravel screen, and is used in the same manner.

512. *The trenching spade* consists of a blade of iron fifteen inches long, and a handle of two feet. The labourer standing in the last formed trench, with his left hand at the bottom of the handle, and his right near the top, by the weight of his body, and without the assistance of his foot, sinks the spade about eighteen inches, and standing sideways, throws off the soil with a peculiar sleight and turn of the wrist, so as to lodge it in an oblique position in the trench, and against the preceding line of work, retiring as he casts it from the spade, and thereby effecting some little mixture of the two strata, though the upper surface is at the same time placed below the other.

513. *The pronged hoe* has a pronged blade on one side, and a common plate on the other; it is exceedingly useful; one side may be used for cutting weeds where they prevail, and the other for stirring a surface already clean.

514. *The chariot, or great cart* (*fig.* 62.), is the only machine of the Flemish farmer which appears to transgress the bounds of a rigid economy. This, as it is not only to be used for the transport of grain, but of the farmer and his family occasionally, to the market-town, is more ornamentally finished than any other, and is painted in showy colours, chiefly green and red; an awning also is very ingeniously contrived, as an occasional defence against the rain and sun. From the natural spring of so long a perch, the centre part of this machine

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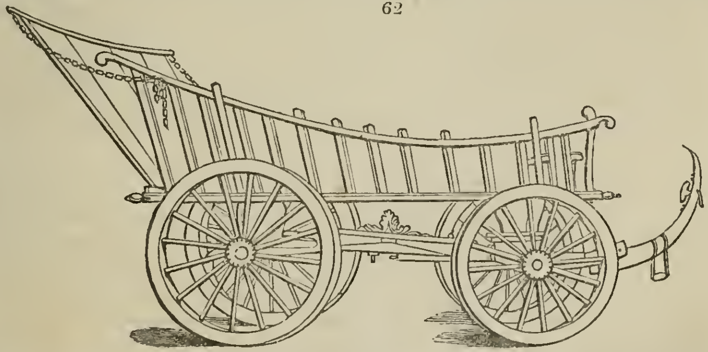

is by no means an uneasy conveyance; and there the farmer sits in all solemnity, whilst a well appointed boor acts as a postilion, and his fine and spirited pair of well-trained horses bring him home from market at a rapid trot.

515. *Agricultural operations* of every kind are performed with particular care in Flanders. The most remarkable feature in the operations of culture consists in the frequent ploughings given on all soils; in strong soils for the sake of pulverisation as well as cleanliness; in the lighter, chiefly for the destruction of weeds, and blending the manure with the soil. But, considering that but one pair of horses is in general allowed to about thirty acres, it is surprising how (with the execution of all the other farming work) time can be found for the number of ploughings which is universally given. Very generally, the number, for the various crops, respectively, is as follows: —

For *Wheat,*	two	ploughings,	with two harrowings.	For *Oilclles,*	two or three	ploughings,	with two harrowings.
Rye,	two or three	ditto,	ditto.	*Tobacco,*	four	ditto,	ditto.
Oats,	three	ditto,	ditto.	*Hemp,*	four	ditto,	ditto.
Potatoes,	four	ditto,	ditto.	*Turnip,*	three as a first crop,	ditto,	ditto.
Carrots,	four	ditto,	ditto.		one as a second crop,	ditto,	ditto.
Flax,	two	ditto,	ditto.	*Spurry,*	three as a first crop,	ditto,	ditto.
Buckwheat,	four	ditto,	ditto.		one as a second crop,	ditto,	ditto.
Rape,	three	ditto,	ditto.	*Beans,*	two	ditto,	ditto.
Barley,	three	ditto,	ditto.	*Fallows,*	four or five	ditto,	ditto.

516. *Trenching* is a feature almost peculiar to Flemish farming, and that of Tuscany. This remarkable practice is confined to the lighter soils, and is not used where the strong clay prevails. In the districts in which it is adopted, the depth of the operation varies with that of the soil; but till this has arrived at nearly two feet of mellow surface, a little is added to it at each trenching, by bringing to the top a certain proportion of the under stratum; which, being exposed to the action of the atmosphere, and minutely mixed with a soil already fertilised, gradually augments the staple till the sought-for depth be required.

517. *The management of live stock in Flanders,* though good, is not so eminently exemplary as their tillage culture. The cattle are the short-horned Dutch breed; the colour generally black, or black and white. Little attention is given to the improvement of the form by selection. The sheep are long-woolled and long-legged, and afford a coarse fleece and very indifferent mutton. They are housed at night, and, in the daytime, follow the shepherd and his dog through pathways and along the verges of the fields and roads, picking up a mere subsistence, and never enjoying the range of a sweet and wholesome pasture. In winter they are let out but once a day, and are fed in the sheep houses on rye and hay, &c. A cross with the Merino breed has been tried; but, as might have been predicted from the incongruous parentage, with no benefit. The swine are long-legged, narrow-backed, and flat-ribbed; not easily fatted, but, when well fed and long kept, making excellent pork and bacon.

518. *The horse* is the animal for which Flanders has long been noted, with regard to the excellence of its working breed; and that of England has been considerably improved by the frequent importation thence of stallions and mares, previous to the French revolution. The Suffolk punch horse comes nearest to the most prevalent variety in Flanders; the resemblance is strong, not only in colour, but in some of the essential points of form: however, though the prevailing colour is chestnut in all its shades, yet other colours are likewise to be met with; and, with very few exceptions, the Flemish horses are of superior strength, and of the true working character. The chief, indeed almost the only, defects to be observed in any are, a want of depth in the girth, and a dip behind the withers; for symmetry, perhaps the shoulder also, at the top, should be a little finer; but in all other respects they possess the best shapes.

519. *Every farmer breeds his own work-horses,* and disposes of the redundance. Even the total absence of pasture is not suffered to prevent it; and the foals are found to thrive remarkably well in a close house. For this purpose, as well as for the general keep of the stock, a regular dietary is observed. The manger is formed of well cemented brickwork. In summer clover, and in winter carrots, are usually given; hay in very small quantities, but in all cases chopped straw mixed with corn or beans, or both, and water aired by keeping in the stable, and whitened with a pretty strong proportion of barley-meal. With every symptom of sufficient spirit, they are extremely docile; and, besides being obedient to the word, are guided in intricate cases, in a manner surprising to a stranger, by a single cord; this rein is never thick, and, in some instances, is as small as a stout whipcord, and yet in the deeper soils three powerful horses abreast (the bridles of the middle and off-side horses being connected with that upon the near-side horse, to which this rein is affixed) are guided by it at all the turnings, the ploughman holding the rein in one hand, and his single-handed plough in the other, and performing his work with the most accurate straightness and precision. Of corn to market, a pair of horses generally draw two tons; of manure to the field, one ton and half; and on the pavement in the towns, three tons, without appearing to be overloaded.

520. *The shoeing of horses in Flanders* is attended to with particular care, and in that country has long been practised the mode of preserving the bars of the hoof, and of letting the frog come in contact with the ground, recommended in England by Freeman and Professor Colman. The use of cockers, or turned heels, is, except in part, entirely abandoned. In two respects, however, the shoeing in Flanders differs from any of the methods in use with us. In *one,* that to prevent ripping, the hoofs of the fore-feet are pared away towards the toe, and the shoes so fitted, that the fore part shall not touch (within three fourths of an inch) the same level surface, upon which the heel and middle of the shoe shall rest.

521. *This preparation of the foot* is in general use; the horses are not thereby in any degree injured, and are particularly sure-footed. The other point of difference is, that the shoe is nailed on flat and close to the foot, which, in depriving the iron of all spring, and all unequal pressure against the nails, may be in part the cause of the durability of the shoeing.

522. *For shoeing vicious horses* every precaution is taken by the use of the forge machine, a common appendage to the smithies in Flanders. If the horse is not altogether unmanageable, his hind foot is tied to a cross bar, or his fore leg to a stilt and bracket; but if he is extremely vicious indeed, he can be raised from the ground in a minute, by means of a cradle-sling of strong girth web, hooked to the upper side-rails, which, with a slight handspike, are turned in the blocks that support them (the extremities of the sling thereby coiling round them), till the horse is elevated to the proper height, and rendered wholly powerless.

523. *The Flemish and Dutch dairies* are more remarkable for the abundance than the excellence of their products; owing to the inferiority of their pastures, and the cows

being kept the greater part of the winter in the house. In summer the principal article of food in Flanders is clover, cut and carried to the stall. On a small scale, when pasturage is to be had, they are left at liberty; when this is not the case, each cow is led by a rope, and permitted to feed round the corn fields, the grassy borders of which are left about ten feet wide for this purpose.

524. *The food for one cow in winter*, for twenty-four hours, is straw, eighteen pounds; turnips, sixty pounds. Some farmers boil the turnips for them; others give them raw, chopping them with the spade: one or other operation is necessary to obviate the risk of the animal being choked, where the turnips, which is usually the case in Flanders, are of too small a size. In lieu of turnips, potatoes, carrots, and grains are occasionally used. Bean-straw is likewise given, and uniformly a white drink, prepared both for cows and horses, consisting of water in which some oilcake has been dissolved, whitened with ryemeal, oatmeal, or the flour of buckwheat.

525. *In the dairies* the summer feed is pasturage day and night; in winter, hay, turnips, carrots, grains from the breweries, cakes of linseed, rapeseed, bean and other meals, and the white drink before mentioned. For the sake of cleanliness, the tails of the cows are tied to the roof of the cow-house with a cord during the time of milking. The cow-houses, both in Flanders and Holland, are kept remarkably clean and warm; so much so, that a gentleman "spoke (to Radcliff) of having drunk coffee with a cow-keeper, in the general stable, in winter, without the annoyance of cold, of dirt, or of any offensive smell." The Dutch are particularly averse from unfolding the secrets of their dairy management; and, notwithstanding the pointed queries of Sir John Sinclair on the subject, no satisfactory idea was given him of their mode of manufacturing butter or cheese.

526. *The woodlands of Flanders* are of considerable extent; but more remarkable for the care bestowed on them, than for the bulk of timber grown. To this purpose, indeed, the soil is inadequate; most of these woods having been planted or sown on land considered too poor for tillage.

527. *In forming artificial plantations*, the general mode is to plough the ground three or four times, and take a crop of buckwheat; afterwards the plants or seeds are inserted and hoed for a year or two, till they cover the surface. For the Scotch pine, which is sometimes sown alone on the poorest soils, the most common and the simplest mode is that of burning the surface, for which process its heathy quality gives great facility. The ashes being spread, the ground is formed into beds from six to fifteen feet wide, according to circumstances; the seed sown at the rate of six pounds to the English acre, and covered by a light shoveling from the furrows, which are sunk about two feet, not only to supply covering to the beds, but as drains to carry off the surface water.

528. *Extensive artificial woods* have been created in this manner, converting a barren soil into a state of productiveness, the least expensive, very profitable, and highly ornamental. Of six years' growth, there exist flourishing plantations (treated in this manner), from five to nine feet in height. At about ten years from its formation, they begin to thin the wood, and continue to do so annually, with such profit by the sale, as at the end of thirty years to have it clear of every charge; a specific property being thus acquired, by industry and attention merely, without the loss of any capital.

529. *Pine woods are often sown*, and with great success, without the labour of burning the surface; as at Vladsloo, in the neighbourhood of Dixmude, where a luxuriant crop, seven feet high, though of but five years' growth, had been cultivated by Madame de Cleir, by merely ploughing the heathy surface into beds of fifteen feet, harrowing, sowing at the rate of six pounds to the English acre, raking in the seed, and covering the beds lightly from the furrows, which are sunk about eighteen inches deep.

530. *Another mode of sowing*, practised by the Baron de Serret, in the vicinity of Bruges, was productive of a growth not less luxuriant, merely by sowing the seed upon sand (taken from the excavation for a building) which was spread over the heathy surface, the seed raked in, and the furrows shoveled up.

531. *The sowing of pine seed* in many cases is adopted for the purpose of bringing waste land into an arable state, which, when the timber has been disposed of, is found to yield admirable crops, from a surface soil formed by the accumulation of the leaves which have fallen for so many years. For this purpose also, the broom is frequently sown upon waste lands of a similar description, and at the end of four or five years is pulled away, leaving the soil capable of yielding crops of corn.

532. *The preservation of trees* is attended to in the strictest manner, not only by proprietors, but by the government. As an example of this, Radcliff mentions that at a certain season of the year, when the caterpillars commence their attack upon the trees, every farmer is obliged to destroy those upon his own premises, to the satisfaction of the mayor of his particular commune, or to pay the cost of having it done for him. As a proof of the strictness with which this is enforced, the governor sends round a circular letter annually, reminding the sub-intendants and mayors of the obligations and penalties for nonperformance.

533. *There are a number of royal forests* in Flanders; and, besides these, all the trees on the sides of the public roads belong to the government. In West Flanders there are five, amounting together to nearly 10,000 acres. They are superintended by eighteen persons: an inspector, resident at Bruges; a deputy inspector, resident at Ypres; two *gardes généraux*, and fourteen *particuliers*, or privates. The inspector is answerable for all: from him the *garde général* takes his instructions, and sees that they are enforced by the privates, to whom is committed the regulation of the necessary labour.

534. *The cuttings take place periodically* with respect to small trees and fire-wood, so as to secure an annual produce; but reserves are always left to become, eventually, large and valuable timber.

535. *The cutting of the taillis or coppice*, chiefly used as fire-wood, takes place every eleventh year; that of the high and grosser coppice, every twenty-fifth year; the felling of the half-grown forest trees, every sixtieth year; and that of the full-grown forest trees, once in a hundred years.

536. *In the management of coppices*, it is considered essential to preserve the roots from stagnant water; the trenches originally formed for that purpose are from time to time cleared out; and the sediment and manure from the falling leaves, which have accumulated in them, are carefully spread upon the ridge, or rounded set, which the wood occupies. A second branch of regular attention is to remove all brambles and briars; a third, to replace the old and fading stocks by new plantations; a fourth, to thin the stems with regularity and care.

537. *The sorts of trees* are birch, oak, service, ash, maple, elm, beech, poplar, aspen, wild pine, Weymouth pine, plane, lime, larch, Spanish chestnut, and alder. A variety of pine, called the *Pinus maritima*, but not the plant of that name which is known on the coast of Italy and Greece, has been tried on the sea-coast, and found to resist the sea-breeze. It is said extensive plantations have been made of this tree on the coast of France, at Bourdeaux, and that it produces excellent timber; but whether it is a distinct species, or a variety possessing any particular qualities, or merely the common wild or Scotch pine, in a favourable situation, does not appear. Most probably the last circumstance is the case. The pine is liable to the attacks of the Bóstrichus *pinipérdus* (*fig.* 63.), on the wood of the old branches, and of the larva of a species of moth on the leading young shoots. The moth deposits its eggs among the buds at their extremities: the turpentine or resin which oozes from the buds, protects the eggs till the insect is brought out by the warmth of the atmosphere, when vegetation commences; it then inserts itself into one of the young shoots, about five or six inches below the end (*fig.* 64. *a*), and works upwards till it finds its way out at the extremity (*b*), which at this time begins to shoot, and lodging itself in the centre of it, perforates the young shoot up and down, till it either breaks off, or withers.

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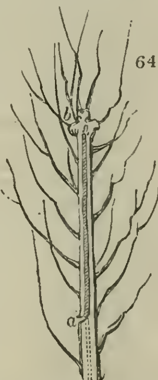

538. *The domestic circumstances* of the Flemish farmer and his servants are depicted by Radcliff in a favourable point of view. "Nothing," he says, "tends more to the uniform advancement of good farming, than a certain degree of ease and comfort in those who occupy the soil, and in the labouring classes whom they employ. Without it, an irregular, speculative, and anticipatory extraction of produce, always followed by eventual loss, is resorted to, in order to meet the emergencies and difficulties of the moment; whereas, under different circumstances, the successive returns of a well regulated course become the farmer's object, rather than the forced profit of a single year; and whilst he himself is thus intrinsically served, his landlord is secured, and his ground ameliorated.

539. *The laborious industry of the Flemish farmer* is recruited by intervals of decent and comfortable refreshment; and the farm-servants are treated with kindness and respect. They uniformly dine with the farmer and his family, at a clean tablecloth, well supplied with spoons, with four-pronged forks, and every thing necessary for their convenience. In Flanders, the gentlemen are all farmers; but the farmers do not aspire to be gentlemen, and their servants feel the benefit. They partake with them of a plentiful and orderly meal, which varies according to circumstances. One standing dish, however, is universal, a soup, composed of buttermilk, boiled and thickened with flour or rye-bread. Potatoes, salt pork, salt fish, various vegetables, and eggs are common; fresh meat and fresh fish occur occasionally, though not for daily consumption: add to these, a plentiful supply of butter, or rendered lard, which is sometimes substituted; and when it is recollected that these articles of provision are always made palatable by very tolerable cookery, it will be allowed that the farmer's table is comfortably supplied. The potatoes are always peeled, and are generally stewed in milk; a particular kind of kidneybean, as mentioned before, the *fève haricot*, sliced and stewed in milk also, is a frequent dish. No farmer is without a well cultivated garden, full of the best vegetables, which all appear at his own table; and apples are also introduced into their cookery. The great fruit and vegetable markets of the towns are supplied by gardeners who make it their means of subsistence; but the gardens of the farmers, unless in case of redundance, are cultivated wholly for their own consumption."

540. *The farm-servants* partake of their master's fare, except in his refreshments of tea, coffee, and beer.

541. *The day-labourers* are not so well provided: they have, however, rye-bread, potatoes, buttermilk, and occasionally some salt pork. The labourer is, in general, very well able to support himself by his work: in a country where so much manual labour is required in weeding, the labourer's family is occupied pretty constantly in summer; and in winter they spin. Each day-labourer has, in most cases, a small quantity of land, from a rood to half an acre, for his own cultivation.

542. *Beggars* in common times are scarcely to be seen, except in the towns, and but few there. In the country, habits of industry are kept up till health fails; and to meet the infirmities of age, the poor possess a reveuue from pious donations, regulated by the government, and vested by them in commissions, of which the mayors of the different communes are presidents, respectively, in right of their office.

543. *The clothing of the peasantry* is warm and comfortable, good shoes, stockings, and frequently gaiters of leather or strong linen, which are sold very cheap; their innate frugality leads them, however, to economise in those articles, substituting on many occasions coarse flannel socks and wooden *sabots*, both of which are supplied in all the public markets at about eightpence cost. Their comfortable supply

of linen is remarkable; there are few of the labouring classes without many changes. In riding with a landed proprietor through a part of the country in which his property was situated, a neat cottage presented itself: the clipped hedge which surrounded the garden, covered with linen very white, suggested an enquiry, "whether it did not belong to a washerwoman?" The answer was, "That it was occupied by a labourer and his family, and that the linen was all their own." It must, however, be observed, that universally in proportion to the supply is the postponement of the washing, which causes the greater display, and particularly at the beginning of May, which is a chosen season for this purpose. Any circumstance connected with the cleanliness, health, and comfort of the lower classes is interesting; and to this of which we have been speaking, a peculiar degree of decency is attached. If the labourer is comfortable in point of apparel, the farmer is still more so. In home-work, the farmer generally protects his clothes by a smock-frock of blue linen; and great attention to cleanliness prevails throughout his operations.

544. *With respect to the farm-house*, the exterior is for the most part ornamented with creepers, or fruit trees trained against the walls; and within, the neatness which prevails is quite fascinating. Every article of furniture is polished; the service of pewter displays a peculiar brightness; and the tiled floor is purified by frequent ablutions.

545. *The cottage of the labourer*, though not so well furnished, is, however, as clean; a frequent and periodical use of water and the broom pervades every house, great and small, in the country and in towns; originating, perhaps, in the necessity of cleanliness, and the public enforcement of it, when Flanders was visited by the plague.

546. *The Flemish farmer seldom amasses riches*, but is rarely afflicted by poverty: industry and frugality are his characteristics; he never looks beyond the enjoyment of moderate comforts; abstains from spirituous liquors, however easily to be procured; never exceeds his means; pays his rent punctually; and, in case of emergency, has always something to command, beyond his necessary disbursements.

Sect. V. *Of the present State of Agriculture in Germany.*

547. *The agriculture of Germany* is, in many respects, less different from that of Britain than is the agriculture of France or Italy. It is, however, but very imperfectly known in this country; partly from the numerous petty states into which the German empire is divided, which greatly increases the variety of political circumstances affecting agriculture; but principally from the German language being less generally cultivated by Britons, than that of France or of Italy. The outline which we submit is drawn chiefly from the published journals of recent travellers, especially Jacob, Hodgson, and Bright, and from our own observations made in 1813, 1814, and 1828. Those who desire more copious details may consult Thaer's *Annals der Landwirtschaft*, Hassel's *Erdebeschreibung*, and the agricultural writings of Hazzi, Schwartz, and Krunitz.

Subsect. 1. *General View of the Agricultural Circumstances of Germany.*

548. *A great variety of soil, surface, climate, and culture* must necessarily exist in a country so extensive as Germany. From the south of Hungary to the north of Denmark are included upwards of twelve degrees of latitude, which alone is calculated to produce a difference of temperature of twenty degrees: and the effect of this difference of geographical position is greatly increased by the variations of surface; the immense ridges of mountains, inlets of the sea, lakes and rivers, and extensive plains. The winters in Denmark and Prussia are very severe, and last from six to eight months; the winters in the south of Hungary are from one to three months. The south and south-east of Germany, comprising part of Bohemia, Silesia, and Hungary, are the most mountainous: and the north-east, including Prussia and part of Holstein and Hanover, presents the most level surface. The richest soil is included in the interior and south-western parts; in the immense plain of the Danube, from Presburg to Belgrade, an extent of three hundred miles; and great part of Swabia, Franconia, and Westphalia. The most barren parts are the mountains and sandy plains and heaths of the north, and especially of Prussia; and that country, and part of Denmark and Holstein, abound also in swamps, marshes, and stagnant lakes.

549. *Landed property*, throughout Germany, is almost universally held on feudal tenure, and strictly entailed on the eldest son. It is generally in estates from one hundred acres upwards, which cannot be divided or increased. Most of the sovereigns have large domains, and also the religious and civil corporations.

550. *The farmers of Germany* are still in many instances metayers; but the variety of this mode of holding is much greater there than in France and Italy. In some cases the farmer does not even find stock; and in others, more particularly in Hungary, he and his family are little better off than the cultivators of Russia. In Brandenburg, Saxony, and part of Hanover, the farmers hold on the metayer tenure, or that of paying a fixed rent of corn or money, unalterable either by landlord or tenant. In Mecklenburg, Friesland, Holstein, Bavaria, &c., most of the property is free, as in Britain, and there agriculture is carried to great perfection. Tithes are almost universal in Germany; but are not felt as any great grievance. Poor-rates are unknown.

551. *The consequence of these arrangements* of landed property in Germany is a comparatively fixed state of society. The regulations which have forbid an augmentation

of rent, or a union of farms, and which have secured to the owner the full enjoyment of the use of the land, have prevented any person, except the sovereign, from amassing an enormous quantity, and have preserved among the inhabitants a species of equality as to property. There are, comparatively, few absolutely destitute labourers. The mass of the people do not live in such affluence as Englishmen; but this is more than compensated to them by all being in some measure alike. In civilised society, it is not destitution, but the craving wants which the splendour of other persons excites, which are the true evils of poverty. The metayer regulations have hindered improvement; but they have also hindered absolute destitution and enormous accumulation. (*Hodgson.*)

552. *From the regulations concerning landed property in Germany,* it has resulted that fewer paupers are found there than in our country. Some other regulations are known, which have probably assisted in protecting Germany from the evil of pauperism to the same extent in which it exists with us. There is no legal provision for paupers. A law of the guilds, which extended to most trades, forbade, and still forbids, where guilds are not abolished, journeying mechanics from marrying; and, in most countries of Germany, people are obliged to have the permission of the civil magistrate, before it is legal for the clergyman to celebrate a marriage. The permission seems to be given or withheld, as the parties soliciting it are thought by the magistrates to be capable of maintaining a family. At least, it is to prevent the land from being overrun with paupers, that the law on this subject has been made.

553. *The agricultural produce of Germany* is for the greater part consumed there; but excellent wines are exported from Hungary and the Rhine; and also wool, flax, timber, bark, hams salted and smoked, geese, goosequills, the canary, goldfinch, and other singing birds, silk, &c.

554. *The culture of the mulberry and rearing of the silkworm, in Germany,* are carried on as far north as Berlin; that of the vine, as Dresden; and that of the peach, as a standard in the fields, as Vienna. The maize is little cultivated in Germany; but patches of it are to be found as far north as Augsburg, in Swabia. Rice is cultivated in a few places in Westphalia. The olive is not planted, because to it, even in the warmest part of Germany, the winters would prove fatal.

555. *The common cultivation* includes all the different corns, and many or most of the legumes, roots, herbage, and grasses, grown in Britain. They grow excellent hemp, flax, and oats; and rye is the bread-corn of all Germany. They also cultivate turnips, rapeseed, madder, woad, tobacco, hops, saffron, teasel, caraway; many garden vegetables, such as white beet, French beans, cabbage, carrots, parsneps, &c.; and some medicinal plants, as rhubarb, lavender, mint, &c.; independently of their garden culture of fruits, culinary vegetables, and herbs for apothecaries. The most common rotation in Germany is two corn crops and a fallow; or, in poor lands, one or two corn crops, and two or three years' rest; but in rich lands, in the south-western districts, green crops or legumes intervene with those of corn.

556. *The best pastures and meadows* are in Holstein, and along the margin of the German Ocean; and for the same reasons as in Holland and Britain, viz. the mildness and moisture of the winters. There are also good pastures and meadows on the Danube, in Hungary; but the great heats of summer stimulate the plants too much to send up flowers; and the culture there is not so perfected as to regulate this tendency by irrigation. Irrigation, however, is very scientifically conducted in some parts of Holstein, and on the Rhine and Oder.

557. *The operations and implements* of German agriculture vary exceedingly. They are wretched in Hungary, and some parts of Bohemia, where six or more oxen may be seen drawing a clumsy plough, entirely of wood, and without a mould-board. In Denmark, Hanover, and in Prussia, they use much better ploughs, some of which have iron mould-boards; and in many places they are drawn by a pair of oxen or horses. The plough, in the more improved districts, has a straight beam, two low wheels, a share, which cuts nearly horizontally, and a wooden mould-board sometimes partially shod with iron: it is drawn by two horses. In Friesland, and some parts of Holstein, the Dutch swing-plough is used. The common waggon is a heavy clumsy machine on low wheels. (*fig.* 65.) The theoretical agriculturists are well acquainted with all the improved implements of Britain, and some of them have been introduced, especially in Holstein, Hanover, and Westphalia; but these are nothing in a general view. Horses are the most common animals of labour in the north and west of Germany, and oxen in the south. Fallows are rarely well cultivated; and nothing can be worse than the mode of resting lands, and leaving them to be covered with weeds during two or three years in succession.

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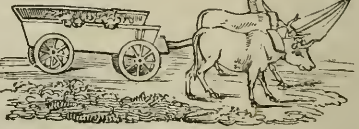

558. *Of the live stock of Germany*, the best breeds of working horses and of oxen are in Holstein, and some districts between Hamburg and Hanover. The best saddle horses are reared in Hungary. There are also excellent oxen and cows reared in that country, and exported to Italy and Turkey. The best sheep are in Saxony and Prussia, where the Spanish breed has been naturalised. Swine are common; but the breed is every where very indifferent. Goats are reared in the mountains; and also asses and mules. The forests are stocked with wild deer, boars, stags, hares, and other game. Fish are carefully bred and fattened in some places, especially in Prussia; and poultry is every where attended to, and carried to a high degree of luxury at Vienna. Bees are attended to in the neighbourhood of the forests; and silkworms in the southern districts, as far as Presburg. Canary and other singing birds are reared in Westphalia, and exported to most parts of Europe.

559. *The culture of forests* is particularly attended to in Germany, for the same reasons as in France, and the details in both countries are nearly the same. The number of German books on *Forst-wissenschaft* is astonishing, and most of the writers seem to consider woodlands in that country as a more eligible source of income than any other.

560. *The common agriculture of Germany* may be considered as every where in a state of gradual improvement. Both governments and individuals have formed institutions for its promotion, by the instruction of youth in its principles and most enlightened practices; or for the union of men of talent. The Imperial Society of Vienna, the Georgical Institution of Presburg, and that of the late Professor Thaer, in Prussia, may be mentioned as recent efforts. The farmers in Germany are particularly deficient in the breeding and rearing of horses, cattle, sheep, and swine. Of the latter two, they require new breeds from judicious crosses; and the former require selection, and much more care in rearing. The implements of husbandry also require to be improved, and the importance of working fallows in a very different manner from what is now done should be inculcated. If peace continue, there can be no doubt that these, and all other ameliorations will go rapidly forward; for the spirit of agricultural improvement is at present, perhaps, more alive in Germany than in any other country of Europe.

561. *In noticing some traits of agriculture in the different states* of Germany, we shall begin with Denmark at the most northerly extremity, and proceed, in the order of geographical position, to Hungary in the south.

Subsect. 2. *Agriculture of the Kingdom of Denmark, including Greenland and Iceland.*

562. *The improvement of the agriculture of Denmark* may be dated from 1660, when the king became despotic, and was enabled to carry measures of national benefit into execution without the jarring interference of councils. The slaves of the crown were immediately made free, and the example followed by several wealthy proprietors. Acts were passed for uniting and consolidating landed property by equitable exchanges, and for preventing the right of free way; both which led to enclosures, draining, and irrigation. There are now better meadows, and more hedges and walls, in Denmark, than in any country of Germany of the same extent. Various institutions for instruction and reward were formed, and among others, in 1686, the first veterinary school founded in Germany. Artificial grasses and herbage plants enter into most rotations, and rye-grass is perhaps more sown in Holstein than any where, except in England. In a word, considering the disadvantages of climate, the agriculture of Denmark is in a more advanced state than that of any other kingdom of Germany.

563. *The Danish farm-houses* are described by Dr. Neale, in 1805, as "generally built upon the same plan, having externally the appearance of large barns, with folding doors at each end, and of sufficient size to admit loaded waggons; on one hand are the apartments occupied by the farmer and his family; on the other, the stable, cow-house, dairy, and piggery; in the centre, a large space, set apart for the waggons, ploughs, harrows, and other implements of husbandry; and overhead, the granary and hay-loft." As the postmasters are generally farmers, it is customary to drive in at one end; change horses, and then drive out at the other, which is the case in the north of Germany and in Poland, and more or less so in every part of the north of Europe.

564. *Of the farmer's family*, the same accomplished traveller observes, "we were often agreeably surprised at finding the living-apartments furnished with a degree of comfort and neatness bordering upon luxury; every article was substantially good in itself, and was preserved in the greatest order and cleanliness. Thus, white muslin curtains, with fringes and draperies, covered the windows; looking-glasses and chests of drawers were placed around; excellent large feather beds, and a profusion of the best well-bleached linen displayed the industry of the good housewives, while their dinner tables were equally well supplied with damask cloths, and snow-white napkins; and near the doors of the dairies were ranged quantities of large, singularly shaped, brass and copper vessels, bright as mirrors."

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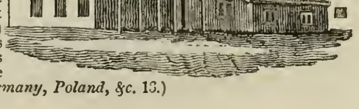

565. *The dimensions of some of their buildings*, he says, "is surprising; one measured 110 yards long, resembling in extent the area of Westminster Hall. On the tops of their roofs are generally displayed a set of antlers, and a weathercock; on others, two horses' heads are carved out in wood, and announce the rank of the inhabitants; the antlers, or rather bulls' horns, denoting the house of a tenant; and the horses' heads, that of a landed proprietor. This form of building (*fig.* 66.) seems to have been adopted from the earliest ages amongst the inhabitants of northern Germany," as similar ones are described by Joannes Lasicius in the middle of the sixteenth century. (*Travels through Germany, Poland, &c.* 13.)

566. *The rural economy of Greenland and Iceland* has been given, the former by Crantz, and the latter by Sir G. Mackenzie. Only a small part of Greenland produces pasture, and a still smaller part grain. The culture of the last, however, is now given up. Cabbages and turnips grow well in the gardens, and there are some oak trees, brambles, and junipers between the 60° and 65° N. lat. Sir G. Mackenzie thinks potatoes and barley might succeed in some places. There are considerable pasture farms, a good and hardy breed of horses, and herds and flocks of cattle and sheep. Farmers have no leases, but pay rent in kind, and cannot be removed from the land unless it can be proved that they have neglected its culture; that is, they hold on the metayer system. The stock of cattle and sheep is considered as belonging to the soil of the landlord. A tenant may quit his farm whenever he chooses, but must leave the proper amount of stock to be taken by his successor.

Subsect. 3. *Of the Agriculture of the Kingdom of Prussia.*

567. *The agriculture of Prussia* was considerably advanced by its second king, Frederic William, who is said to have imported 16,000 men from Saltzburg, and expended 25 millions of francs in building villages and distributing lands among them. His successor, Frederick the Great, after having procured a peace, made exertions in agriculture as extraordinary as in war and architecture. He drained and brought into cultivation the borders of the lakes of the Netz and the Wasta, and established 3500 families on what before was a marsh. He drained the marsh of Fridburg, and established on it 400 families. He made extensive drainages, enclosures, and other improvements in Brandenburg, and in Pomerania, and built the extensive embankments of Dallast, in Friesland, by which, by degrees, a large tract of land was recovered, which the sea submerged in 1724. He formed a Council of Woods and Waters for managing the national forests, and regulating rivers and lakes. He established the Royal Economical Society of Potsdam, and other societies, and cultivated a farm. He created a market for agricultural produce, by the establishment of manufactures; and, in short, he left nothing unattempted that might benefit his kingdom. The successors of the great Frederic have not distinguished themselves as encouragers of agriculture, with the exception of the present king, Frederic William I.

568. *The surface and soil of a country so extensive as Prussia* are necessarily various; but, nevertheless, there are few or no mountainous or hilly districts, or fertile plains. The prevailing soil is sand, and almost the whole of the country is in aration.

569. *The soil of the maritime provinces of Prussia* is in general so light, that it may be easily ploughed with two oxen, and those of diminished size, and no great strength. Jacobs not unfrequently saw, on the smaller portions of land, a single cow drawing the plough, and whilst the plough was guided by the owner, the cow was led by his wife. The more tenacious soils, on the banks of the streams, are commonly but of small extent. There is, indeed, a large portion of land in the delta, formed by the separation of the Nogat from the Vistula, between Derschau and Marienburg, which, under a good system of management, would be highly productive, and which requires greater strength to plough; there are some others, especially near Tilsit, of less extent; but the whole of them, if compared with the great extent of the surface of the country, are merely sufficient to form exceptions to the general classification which may be made of the soil. (*Jacob on the Trade in Corn, and on the Agriculture of Northern Europe.*)

570. *The landed estates in Prussia,* previously to the year 1807, were large, and could only be held by such as were of noble birth, or by merchants, manufacturers, or artisans, who had obtained a patent of nobility. When the French had overrun the country, in 1807, these restrictions were removed; and, by successive measures, personal services have been abolished, and the whole of the enslaved peasants have become converted into freemen and freeholders. These small and numerous freeholders are the occupiers and principal cultivators of the soil; rent-paying farmers being seldom to be met with, except in the vicinity of large towns, and on the domains of the crown. (*Ibid.*)

571. *The general course of cultivation in Prussia* is to fallow every third year, by ploughing three times when designed for rye, or five times if intended for wheat, and allowing the land to rest without any crop during the whole of the year, from one autumn to the next. Most of the land is deemed to be unfit for the growth of wheat, under any circumstances. Where it is deemed adapted to that grain, as much as can be manured, from their scanty supply of that article, is sown with wheat, and the remainder of the fallow-ground with rye. The portion which is destined for wheat, even in the best farms, is thus very small; and, as on many none is sown, the whole of the land devoted to wheat does not amount to one tenth of that on which rye is grown. (*Ibid.*)

572. *The live stock,* in proportion to the surface, is very deficient. According to a calculation by Mr. Jacob, the proportion of animals to an acre, over the whole of East Prussia, West Prussia, and Pomerania, is less than one third of what it is in England.

573. *The implements of husbandry* are quite of as low a description as the working cattle. The ploughs are ill-constructed, with very little iron on them. The harrows are made of wood, without any iron, even for the tines or teeth. The waggons are mere planks, laid on the frame loose, and resting against upright stakes fixed into its sides. The cattle are attached to these implements by ropes, without leather in any part of the harness. The use of the roller is scarcely known, and the clods, in preparing the fallow-ground, are commonly broken to pieces by hand with wooden mallets. In sowing, the seed is carried in the apron or the skirts of the frock of the man who scatters it on the ground. (*Ibid.*)

574. *The produce of the soil*, whether in corn or cattle, is of an inferior quality, and bears a low money price. The scale of living of all classes, is influenced by this state of things. The working classes, including both those who work for daily wages, and those who cultivate their own little portions of land, live in dwellings provided with few conveniences, on the lowest and coarsest food; potatoes, rye, and buckwheat form their chief, and frequently their only, food; linen, from flax of their own growth, and cloth from wool spun by their own hands, both coarse, and both worn as long as they will hold together, furnish their dress; whilst an earthen pot that will bear fire, forms one of the most valuable articles of their furniture. (*Ibid.*)

575. *The improvement of the agriculture of Prussia* is ardently desired by the present government, and in consequence, about twenty-four years ago, the Agricultural Institution of Moegelin on the Oder, conducted by the late Von Thaer, justly celebrated in Germany as an agricultural writer, was founded. This institution was visited by Jacob in 1819; and from his *Travels* we shall give a short account of it.

576. *The Agricultural Institution of Moegelin* is situated in the country or march of Brandenburg, about forty-five miles from Berlin. The chief professor, Von Thaer, was formerly a medical practitioner at Celle, near Luneburg, in the kingdom of Hanover; and had distinguished himself by the translation of various agricultural works from the French and English, and by editing a *Magazine of Rural Economy.* About 1804, the King of Prussia invited him to settle in his dominions, and gave him the estate of Moegelin to improve and manage as a pattern farm.

577. *This estate consists of* 1200 *acres.* Thaer began by erecting extensive buildings for himself, three professors, a variety of tradesmen, the requisite agricultural buildings, and a distillery. The three professors are, one for mathematics, chemistry, and geology; one for veterinary knowledge; and a third for botany and the use of the different vegetable productions in the Materia Medica, as well as for entomology. Besides these, an experienced agriculturist is engaged, whose office it is to point out to the pupils the mode of applying the sciences to the practical business of husbandry. The course commences in September. During the winter months, the time is occupied in mathematics, and the first six books of Euclid are studied; and in the summer, the geometrical knowledge is practically applied to the measurement of land, timber, buildings, and other objects. The first principles of chemistry are unfolded. By a good but economical apparatus, various experiments are made, both on a large and small scale. For the larger experiments, the brew-house and still-house with their respective fixtures are found highly useful.

578. *Much attention is paid to the analysation of various soils*, and the different kinds, with the relative quantity of their component parts, are arranged with great order and regularity. The classification is made with neatness, by having the specimens of soil arranged in order, and distinguished by different colours. Thus, for instance, if the basis of the soil is sandy, the glass has a cover of yellow paper; if the next predominating earth is calcareous, the glass has a white ticket on its side; if it is red clay, it has a red ticket; if blue clay, a blue one. Over these tickets, others, of a smaller size, indicate by their colour the third greatest quantity of the particular substance contained in the soil. This matter may appear to many more ingenious than useful, and savouring too much of the German habit of generalising. The classification of Von Thaer is, however, as much adopted, and as commonly used on the large estates in Germany, where exact statistical accounts are kept, as the classification of Linnæus in natural history is throughout the civilised world.

579. *There is a large botanic garden*, arranged on the system of the Swedish naturalist, kept in excellent order, with all the plants labelled, and the Latin as well as German names. A herbarium, with a good collection of dried plants which is constantly increasing, is open to the examination of the pupils, as well as skeletons of the different animals, and casts of their several parts, which must be of great use in veterinary pursuits. Models of agricultural implements, especially of ploughs, are preserved in a museum, which is stored as well with such as are common in Germany, as with those used in England, or other countries.

580. *The various implements* used on the farm are all made by smiths, wheelers, and carpenters, residing round the institution; the workshops are open to the pupils, and they are encouraged by attentive inspection, to become masters of the more minute branches of the economy of an estate.

581. *The sum paid by each pupil* is four hundred rix-dollars annually, besides which they provide their own beds and breakfasts. In this country, such an expense precludes the admission of all but youths of good fortune. Each has a separate apartment. They are very well behaved young men, and their conduct to each other, and to the professors, was polite, even to punctilio.

582. *Jacob's opinion of this institution* is, that an attempt is made to crowd too much instruction into too short a compass, for many of the pupils spend but one year in the institution; and thus only the foundation, and that a very slight one, can be laid in so short a space of time. It is, however, to be presumed, that the young men come here prepared with a considerable previous knowledge, as they are mostly between the ages of twenty and twenty-four, and some few appeared to be still older.

583. *The farm at Moegelin* was examined by Jacob in the autumn. The soil is light and sandy, and the climate cold. The wheat was put in the ground with a drill of Thaer's invention, which sows and covers nine rows at once, and is drawn by two horses. The saving of seed Thaer considers the only circumstance which makes drilling preferable to sowing broad-cast, as far as respects wheat, rye, barley, and oats. The average produce of wheat is sixteen bushels per acre: not much is sown in Prussia, as rye is the bread corn of that country; it produces, with Thaer, twenty-two bushels and a half to the acre. The usual rotation of crops is, potatoes or peas, rye, clover, and wheat. Winter tares are killed by the frost, and the summer species come to nothing, owing to the dry soil and drought. The spurry (Spérgula) is therefore grown for the winter food of sheep: it is sown on the stubbles immediately after harvest, and in six weeks furnishes an herbage of which the sheep are very fond, and which is said to be very nutritious. Potatoes are a favourite crop; and the small-tubered and rather glutinous ill-flavoured sort common in France and Germany is preferred, as containing more starch in proportion to bulk, than the large kinds. Thaer maintains that, beyond a certain size, the increase of the potato is only water and

not nutriment. The produce per acre is 300 bushels or five tons, which, Thaer contends, contain more nutriment than twenty tons of turnips, because the proportion of starch in potatoes to that in turnips is more than four to one. The soil is excellent for turnips, but the long series of dry weather, common on the Continent in the beginning of summer, renders them one of the most uncertain of crops.

584. *A brewery and distillery* are the necessary accompaniments of every large farming establishment in Germany. The result of many experiments in the latter proved that the same quantity of alcohol is produced from 100 bushels of potatoes as from twenty-four bushels of wheat, or thirty-three of barley. As the products of grain or of potatoes are relatively greater, the distillery is regulated by that proportion. During the enforcement of the Continental system, many experiments were tried in making sugar from native plants. Von Thaer found, after many trials, that the most profitable vegetable from which sugar could be made was the common garden turnip (of which variety Jacob did not ascertain), and that whilst sugar was sold at a rix-dollar the pound, it was very profitable to extract it from that root. The samples of sugar made during that period from different roots, the processes, and their results, are carefully preserved in the museum, but would now be tedious to describe. They are certainly equal in strength of sweetness, and those refined, in colour and hardness, to any produced from the sugar-cane of of the tropics.

585. *The improvement of the breed of sheep*, which has been an important object of this establishment, as far as the fineness of the wool is regarded, has admirably succeeded. By various crosses from select Merinos, by sedulously excluding from the flock every ewe that had coarse wool, and, still more, by keeping them in a warm house during the winter, Von Thaer has brought the wool of his sheep to great fineness, far greater than any that is clipped in Spain; but the improvement of the carcass has been neglected, so that his, like all other German mutton, is very indifferent.

586. *The various kinds of wool* have been arranged by Von Thaer, with the assistance of the professors of the institution, on cards; and the fineness of that produced from different races of sheep, is discriminated with geometrical exactness. The finest are some specimens from Saxony, his own are the next. The fine Spanish wool from Leon is inferior to his, in the proportion of eleven to sixteen. The wool from Botany Bay, of which he had specimens, is inferior to the Spanish. He had arranged, by a similar mode, the relative fineness of the wools produced on the different parts of the body of the sheep, so as to bring under the eye, at one view, the comparative value of the different parts of the fleeces; and he had, also, ascertained the proportionate weight of those different parts. The application of optics and geometry, by which the scales that accompany the specimens are constructed, is such as to leave no doubts on any mind of the accuracy of the results. The scales, indeed, show only the fineness, and not the length of the fibre; which is, I believe, of considerable importance in the process of spinning. The celebrity of the Moegelin sheep is so widely diffused, that the ewes and rams are sold at enormous prices to the agriculturists in East Prussia, Poland, and as far as Russia.

587. *The breeding of cows and the management of a dairy* are secondary objects, as far as the mere farming is regarded; but it is attended to with care, for the sake of the pupils, who thus have before their eyes that branch of agricultural practice, which may be beneficial on some soils though not adapted to this. The cows are in good order, of an excellent breed; and, considering that they are, like the sheep, fed only on potatoes and chopped straw, are in good condition. They yield, when in full milk, from five to six pounds of butter weekly. The custom of killing the calves, when only a fortnight or three weeks old, prevails here as well as elsewhere in Germany. There is no disputing about taste; but though veal is a favourite food in Germany at the tables of the rich, it always seems very unpleasant to an Englishman.

588. *The ploughs* at Moegelin are better constructed than in most parts of Germany. They resemble our common swing-plough, but with a broader fin at the point of the share. The mould-board is constructed on a very good principle and with great skill; the convexity of its fore-part so gradually changing into concavity at the hinder-part as to turn the soil completely upside down. The land is cleanly and straightly ploughed, to the depth of six and a half or seven inches, with a pair of oxen, whose usual work is about an acre and a quarter each day.

589. *A threshing-machine* is rarely used, and only to show the pupils the principle on which it is constructed, and the effect it produces; but having neither wind nor water machinery to work it, the flail is almost exclusively used, the threshers receive the sixteenth bushel for their labour. The rate of wages to the labourers is four groschen a day, winter and summer, besides which, they are provided with habitations and fuel. The women receive from two to three groschen, according to their strength and skill. They live on rye-bread or potatoes, thin soup, and scarcely any animal food but bacon, and a very small portion even of that; yet they look strong and healthy, and tolerably clean.

590. *The culture of the vine and the rearing of the silkworm* are carried on in the more southerly of the recent territorial accessions which have been made by Prussia. The culture of culinary vegetables is carried on round Erfurth, and other towns furnished with them whose neighbourhoods are less favourable for their growth. Garden seeds are also raised at Erfurth, and most of the seedsmen of Germany supplied with them. Anise, canary, coriander, mustard, and poppy seeds are grown for distillers and others, and woad, madder, teasel, saffron, rhubarb, &c., for dyers and druggists.

591. *The present king of Prussia* has done much for agriculture, and is said to design more, by lessening the feudal claims of the lords; by permitting estates even of knightly tenure to be purchased by burghers and non-nobles; by simplifying the modes of conveyance and investiture; by setting an example of renouncing most of the feudal dues on his vast patrimonial estates; and by making good communications by roads, rivers, and canals, through his extensive territories. (*Jacob's Travels*, 189.)

Subsect. 4. *Of the Agriculture of the Kingdom of Hanover.*

592. *The agriculture of the kingdom of Hanover* has been depicted by Hodgson as it appeared in 1817. The territory attached to the free town of Hanover, previously to its elector being made king of Britain, was very trifling; but so many dukedoms and other provinces have been since added, that it now contains upwards of 11,045 square geographical miles, and 1,314,104 inhabitants.

593. *An agricultural society* was founded in Hanover in 1751, by Geo. II., and about the same time one at Celle in Luneburg. The principal business of the latter was to superintend and conduct a general enclosure of all the common lands; it was conducted by Meyer, who wrote a large work on the subject. The present Hanoverian ministry are following up the plans of Meyer, and, according to Hodgson, are "extremely solicitous to promote agriculture."

594. *The landed property of Hanover* may be thus arranged: — One sixth belongs to the sovereign, possibly three sixths to the nobles, one sixth to the corporations of towns and religious bodies, and less than one sixth to persons not noble. The crown lands are let to noblemen, or rather favoured persons, at very moderate rents, who either farm them or sublet them to farmers. There are six hundred and forty-four noble properties, but few of them with mansions, the proprietors living in towns. For a nobleman to live in

the country without being a magistrate, or without holding some office, is looked on as degrading. Hodgson met with only three instances of nobles cultivating their own estates, and then they lived in towns. The farmers of these estates are bauers or peasants, who hold from ten to eighty acres each, at old fixed rents and services long since established, which the landlord has no power to alter. "It may be from this cause that so few nobles reside in the country. They have in truth no land, but what is occupied by other people. The use of these small portions of land on certain conditions, is the property of the occupier, which he can sell, as the stipulated rent and services are the property of the landlord. The bauer has a hereditary right to the use; the landlord a hereditary right to be paid for that use."

595. *The land of religious corporations* is let in the same manner as the crown lands. That of towns is generally divided into very small lots of twelve or ten acres, and let to the townsmen as gardens, or for growing potatoes and corn for their own consumption. Almost every family of the middling and poorer classes in towns, as well as in the country, has a small portion of land. Most of the towns and villages have large commons, and the inhabitants have certain rights of grazing cows, &c.

596. *The occupiers of land* may be divided into two classes, metayers and leibeigeners. The first occupy from eighty to twenty acres, and pay a fixed corn or money rent, which the landlord cannot alter; nor can he refuse to renew the lease, on the death of the occupier. The money rent paid by such farmers varies from seven to twelve shillings per acre. The term leibeigener signifies a slave, or a person who owns his own body and no more. He also holds his land on fixed terms independently of the will of his lord. His conditions are a certain number of days' labour at the different seasons of sowing, reaping, &c., bringing home his lord's fuel, supplying coach or cart horses when wanted, and various other feudal services. The stock of the leibeigener is generally the property of the landlord, who is obliged to make good all accidents or deaths in cattle, and to supply the family with food when the crops fail. This wretched tenure the governments of Hanover, Prussia, and Bavaria are endeavouring to mitigate, or do away altogether; and so much has already been done that the condition of the peasants is said to be greatly superior to what it was a century back.

597. *The free landed property* of the kingdom of Hanover lies principally in Friesland and the marsh lands. There it is cultivated in large, middling, and small farms, as in England, and the agriculture is evidently superior to that of the other provinces.

598. *The large farmers of Hanover* have in general extensive rights of pasturage; keep large flocks of sheep, grow artificial grasses, turnips, and even fiorin; and have permanent pastures or meadows. Sometimes a brewery, distillery, or public house, is united with the farm.

599. *The farm of Coldingen*, within eight miles of Hanover, was visited by Hodgson. It contained two thousand six hundred acres, with extensive rights of pasturage: it belonged to the crown, and was rented by an amptman or magistrate. The soil was a free brown loam, and partly in meadow, liable to be overflowed by a river. The rotation on one part of the arable lands was, 1. drilled green crop; 2. wheat or rye; 3. clover; 4. wheat or rye; 5. barley or peas; and 6. oats or rye. On another portion, fallow, rape, beans, the cabbage turnip or *kohl-rabi*, flax, and oats were introduced. Seven pair of horses and eight pair of oxen were kept as working cattle. No cattle were fattened; but a portion of the land was sublet for feeding cows

600. *Of sheep* there were two thousand two hundred, of a cross between the Rhenish or Saxon breed and the Merino. No attention was paid to the carcass, but only to the wool. The "shepherds were all dressed in long white linen coats, and white linen smallclothes, and wore large hats cocked up behind, and ornamented by a large steel buckle. They all looked respectable and clean. They were paid in proportion to the success of the flock, and had thus a considerable interest in watching over its improvement. They received a ninth of the profits, but also contributed on extraordinary occasions; such as buying oilcake for winter food, when it was necessary, and on buying new stock, a ninth of the expenses. The head shepherd had two ninths of the profits."

601. *Of the workmen* on this farm, some were paid in proportion to their labour. The threshers, for example, were paid with the sixteenth part of what they threshed. Other labourers were hired by the day, and they received about sevenpence. In harvest-time they may make eightpence. Some are paid by the piece, and then receive at the rate of two shillings for cutting and binding an acre of corn.

602. *The farming of the cultivators of free lands* resembles that of England, and is best exemplified on the Elbe, in the neighbourhood of Hamburg. A distinguishing characteristic is, that the farm-houses are not collected in villages; but each is built on the ground its owner cultivates. "This," Hodgson observes, "is a most reasonable plan, and marks a state of society which, in its early stages, was different from that of the rest of Germany, when all the vassals crowded round the castle of their lord. It is an emblem of security, and is of itself almost a proof of a different origin in the people, and of an origin the same as our own. So far as I am acquainted, this mode is followed only in Britain, and in Holland, on the sea-coast, from the Ems to the Elbe, to which Holstein may be added, and the vale of Arno in Italy. It is now followed in America; and we may judge that this reasonable practice is the result of men thinking for themselves, and following their individual interest." (*Travels*, vol. i. p. 247.) We may

add that it is also followed in great part of the mountainous regions of Norway, Sweden, and Switzerland. (See *Clarke's Scandinavia* and *Bakewell's Tarentaise.*)

603. *Many proprietors of free lands near Hamburg* also farm them. Speaking of these farmers, Hodgson observes, " compared with the other farmers of Germany, they live in affluence and splendour. They eat meat three or four times a day, and instead of being clad in coarse woollen, which has been made by their wives, they wear fine English clothes, and look like gentleman. Their sons go for soldier officers, and their daughters are said to study the *Journal des Modes.* The proprietors ride into town to take their coffee and play at billiards, and hear and tell the news, and at home they drink their wine out of cut glass, or tea out of china. Their houses are all surrounded by lofty trees and handsomely laid-out gardens; the floors are carpeted, and the windows of plate glass. The dwelling-apartments, the barns, and the places for the cattle, are all covered with one immense roof, and every house looks something like a palace surrounded with a little park. The proprietors direct the agriculture, without working a great deal themselves, and resemble much in their hearty manners English farmers."

604. *In Friesland* they use a swing-plough, known in England as the Dutch plough, the mediate origin of the Rotherham plough, and remotely of Small's Scotch plough. Even the cottagers who rent free lands are totally different from the bauers. Their cottages are white-washed; and they have gardens neatly enclosed, planted with fruit trees, and carefully cultivated. Such is the influence of liberty and security.

605. *The farming of the bauers,* like that of the metayers, is prescribed by the lease, and consists of two crops of corn and a fallow. " Sometimes," Hodgson observes, " they may sow a little clover, lucerne, or spergel (spurry); but they seldom have meadows, and keep no more cattle than is necessary for their work, and those the common lands can feed: sheep are only kept where there are extensive heaths; one or two long-legged swine are common; and poultry. The large farmers sometimes plough with two oxen; but the bauers, except in the sandy districts, invariably use horses. When they are very poor, and have no horses, they employ their cows. Two or more join their stock, and, with a team of four cows, they plough very well. Sometimes they work their land with the spade. The houses of the bauers in Hanover, as in most parts of Germany, are built of whatever materials are most readily come at, put together in the coarsest manner. They are seldom either painted or white-washed, and are unaccompanied by either yards, rails, gates, gardens, or other enclosures. They seem to be so much employed in providing the mere necessaries of life, that they have no time to attend to its luxuries. A savage curiously carves the head of his war spear, or the handle of his hatchet, or he cuts his own face and head into pretty devices; but no German bauer ever paints his carts or his ploughs, or ornaments his agricultural implements." (Vol. i. 246.)

606. *To improve the agriculture of Hanover,* Hodgson justly observes, " the simplest and most effectual way would be for government to sell all the domains by auction in good-sized farms, as the Prussian government has done in its newly acquired dominions." This would end in introducing the Northumberland husbandry, to which, according both to Jacobs and Hodgson, the soil and climate are well adapted, and double the present produce would be produced. To these improvements we may suggest another, that of limiting the rank of noble to the eldest son, so that the rest might without disgrace engage in agriculture or commerce. This last improvement is equally wanted for the whole of Germany.

Subsect. 5. *Of the present State of Agriculture in Saxony.*

607. *The husbandry and state of landed property in Saxony* have so much in common with that of Hanover and Prussia, that it will only be requisite to notice the few features in which they differ.

608. *The culture of the vine and the silkworm* are carried on in Saxony, and the latter to some extent. The vine is chiefly cultivated in the margravate, or county, of Theissen, and entirely in the French manner. (414.) The mulberry is more generally planted, and chiefly to separate properties or fields, or to fill up odd corners, or along roads, as in the southern provinces of Prussia and Hanover, and in France.

609. *The wool of Saxony* is reckoned the finest in Germany. There are three sorts, that from the native short-woolled Saxon sheep; that from the produce of a cross between this breed and the Merino; and that from the pure Merino. In 1819, Jacob inspected a flock of pure Merinos, which produced wool that he was told was surpassed by none in fineness, and the price it brought at market. It was the property of the lord of the soil, and managed by the amptman, or farmer of the manorial and other rights. Till the year 1813, it consisted of 1000 sheep; but so many were consumed in that year, first by the French, and next by the Swedes, that they have not been able to replace them further than to 650. The land over which they range is extensive and dry; not good enough to grow flax; but a course of 1. fallow, 2. potatoes, 3. rye or barley, was followed,

and the straw of the rye and barley, with the potatoes, constituted the winter food of the sheep. (*Travels*, p. 265.)

610. *The general rotation of crops in Saxony*, according to Jacob, is two corn crops, and a fallow, or two corn crops and pease. There are some exceptions; and cabbages, turnips, and *kohl-rabi* are occasionally to be seen. The plough has two wheels, and is drawn by two oxen; "and sometimes, notwithstanding the Mosaic prohibition, with a horse and a cow." There are some fine meadows on the borders of the brooks near the villages; but they are in general much neglected, and for want of draining yield but coarse and rushy grass. The houses of the farmers are in villages, the largest for the amptman, and the next for the metayers and leibeigeners. "The whole tract of land, from Meissen to within two English miles of Leipsic, is a sandy loam, admirably calculated for our Norfolk four-course system, by which it would be enabled to maintain a great quantity of live-stock, and produce double or treble the quantity of corn it now yields. In the whole distance from Wurzen, about fifteen miles, I saw but three flocks of sheep; two were small, the other, which I examined, consisting of about one thousand ewes, wedders, and tags, belonged to a count, whose name I did not ascertain. As he is lord of a considerable tract of country, the flock has the range of many thousand acres in the summer, and in the winter is fed with chopped straw and potatoes. Upon our system, which might be advantageously introduced, the same quantity of land would maintain ten times as many sheep, and still produce much more corn than it does at present." (*Ibid.* 301.)

611. *The cows near the villages*, between Meissen and Leipsic, were numerous compared with the sheep, but generally looked poor. "As I saw," continues Jacob, "no hay or corn stacks in the whole distance, I had been puzzled to conceive in what manner their cows could be supported through the winter. Upon enquiring, I learnt a mode of keeping them, which was quite new to me, but which I cannot condemn. The land is favourable to the growth of cabbages, and abundant quantities are raised, and form a material article of human sustenance; the surplus, which this year is considerable, is made into sour-krout, with a less portion of salt than is applied when it is prepared as food for man. This is found to be very good for cows, and favourable to the increase of their milk, when no green food, nor any thing but straw can be obtained." (*Travels*, 303.)

612. *The land within two miles of Leipsic* is almost wholly in garden-culture, and is vastly productive of every kind of culinary vegetable. The fruit trees and orchards, notwithstanding many of them showed vestiges of the war, surprised Jacob by their abundance. The inhabitants subsist much less on animal food than we do, but a larger quantity of fruit and vegetables is consumed; and hence they have greater inducements to improve their quality, and to increase their quantity, than exist in those rural districts of Great Britain which are removed from the great towns.

613. *Jacob's opinion of the agriculture of Saxony* is, that it is equal to that of Prussia. In one respect he thinks it superior, as no portion of the soil is wholly without some cultivation; but that cultivation is far below what the land requires, and the produce much less than the inhabitants must need for their subsistence.

Subsect. 6. *Of the present State of Agriculture in the Kingdom of Bavaria.*

614. *Bavaria, till lately, was one of the most backward countries* of Germany, in regard to every kind of improvement. A bigoted and ignorant priesthood, not content with possessing a valuable portion of the lands of the country, had insisted on the expulsion of the Protestants, and on the strict observance of the endless holidays and absurd usages which impede the progress of industry among their followers. "Hence a general habit of indolence and miserable backwardness in all arts, and especially in agriculture; and in point of learning, a complete contrast to the north of Germany." During the electorate of Bavaria, one of its electors, contemporary with Joseph II. of Austria, desirous of introducing improvements, abolished monastic orders in some parts of his dominions; but the people were not ripe for such a change, notwithstanding the existence of masonic societies, ignorantly supposed to have rendered them ripe for any sort of revolution.

615. *The agricultural improvement of Bavaria* commenced at the time of the French revolution, when the church lands were seized by the government, and sold to the people, and a system of schools was established in every canton or parish, for the education of the lower classes. Soon afterwards agriculture was taught in these schools by a catechism, in the same way as the Christian religion of Scotland is taught in the schools there. In consequence of this state of things the country is rapidly improving in every respect, and will soon be equal to any other in Germany. The names of Monteglas and Hazzi should not be passed over in this brief statement; nor that of Eichthal, who spent upwards of a year in Britain, and chiefly in Scotland, to study its agriculture, which he has introduced on his estate near Munich by a Scotch manager and a Scotch rent-paying farmer.

616. *The surface of Bavaria* is mountainous towards the south; the ground rising in the direction of the Alps, and containing a number of lakes and marshes. To the northward are extensive plains and also wooded mountains; round Nuremberg is a tract of warm sandy soil, and along the Danube are occasional plains of fertile alluvion, partly in meadow and partly under corn.

617. *The crops cultivated* are the usual corns, legumes, and roots; and the produce of corn and turnips, under proper culture, is equal to what it is in the north of England, or in Haddingtonshire. In the dry warm sand around Nuremberg garden seeds are raised

to such an extent as to supply the greater part of Germany and a part of France, and they are even sent to Holland and England.

618. *The forests of Bavaria* are extensive; and, in consequence of a law of the state, all the public roads are bordered with rows of fruit trees, chiefly the cherry and the apple. These trees are raised in nurseries by the government, and sold at cost.

Subsect. 7. *Of the present State of Agriculture in the Empire of Austria.*

619. *Agriculture is in a very backward state throughout the whole of the Austrian dominions.* The soil, surface, and climate are almost every where favourable for husbandry; but the political circumstances of the country, and the ignorance of its inhabitants, which is greater than in most other parts of Germany, have kept it in nearly a fixed state for several centuries. Various attempts have been made during the eighteenth century to improve the condition of the peasantry, and simplify the laws relating to landed property, especially by Joseph II.; but they have produced no effect, chiefly, as it appears, because too much was attempted at once. There are agricultural societies at Vienna, Pesth, Prague, and other places; and a very complete agricultural school has been established at Keszthely in Hungary, by the patriotic Graf Festetits. A copious account of it has been given by Dr. Bright (*Travels in Hungary, in* 1814, 341. et seq.), by which it appears much more extensive than those of Hofwyl or Moegelin.

620. *The landed property of Austria* is under similar circumstances of division and occupation with that of the rest of Germany. Perhaps the number of large estates is greater in proportion to the small properties. In Hungary they are of immense extent, and cultivated almost entirely by their proprietors. "In considering a Hungarian property," Dr. Bright observes, "we must figure to ourselves a landed proprietor possessing ten, twenty, or forty estates, distributed in different parts of the kingdom, reckoning his acres by hundreds of thousands, and the peasants upon his estates by numbers almost as great; and remember that all this extent of land is cultivated, not by farmers, but by his own stewards and officers, who have not only to take care of the agricultural management of the land, but to direct, to a certain extent, the administration of justice amongst the people: and we must further bear in mind, that perhaps one third of this extensive territory consists of the deepest forests, affording a retreat and shelter, not only to beasts of prey, but to many lawless and desperate characters, who often defy, for a great length of time, the vigilance of the police. We shall then have some faint conception of the situation and duties of a Hungarian magnate."

621. *To conduct the business of such extensive domains,* a system of officers is formed, which is governed by a court of directors; and on well regulated estates, this band of managers exhibit, in their operations, all the subordination of military, and the accuracy of mercantile, concerns. For this purpose an office is established at or near the estate on which the magnate resides, in which a court of directors is held at stated periods, usually once a week. This court consists of a president or plenipotentiary, a director or solicitor, a prefect, auditor, engineer or architect, a fiscal for law affairs, the keeper of the archives, besides a secretary, clerks, &c. Its business is to review all that has taken place on the different estates, whether of an economical or judicial nature, to examine accounts, and regulate future proceedings. The steward of each separate estate has also a weekly court. It consists of the fiscal or lawyer, the bailiff, the forest master, the engineer, the treasurer, foreman and sub-foreman, police officers to guard prisoners and keep them at work, forest-keeper, rangers, and a gaoler. The estates of Prince Esterhazy, which are the largest in Europe, of Graf Festetits, and Prince Ballhyani, are examples of this mode of government and culture; of which it may be observed, that, like many German plans, it is very accurate and systematic, but very unproductive of profit.

622. *The crown has immense tracts of lands,* especially in Gallicia; and, independently of these, the personal estates of the reigning family amount to upwards of 100,000*l.* sterling a year, all of which are farmed by stewards. In the Moravian, Bohemian, and Austrian districts, however, where the estates are not so large as in Hungary, and the people in rather better circumstances as to property and knowledge, they are frequently farmed on the meyer system.

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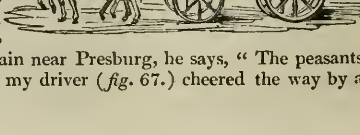

623. *The Austrian dominions,* like the rest of Germany, are unenclosed, with the usual exceptions; the farm-houses and cottages are usually built of wood, and thickly covered with thatch or with shingles. The cottages are remarkably uniform in Hungary, and village scenery there, according to Dr. Bright, must be the dullest in Europe. Not less so are their cultivated plains. Speaking of a plain near Presburg, he says, "The peasants were employed in ploughing the land, and my driver (*fig.* 67.) cheered the way by a

Sclavonian song. But let no one be induced, by these expressions, to figure to his imagination a scene of rural delight. The plain is unenlivened by trees, unintersected by hedges, and thinly inhabited by human beings; a waste of arable land, badly cultivated, and yielding imperfect crops to proprietors, who are scarcely conscious of the extent of territory they possess. It is for some branch of the families of Esterhazy or Palfy, known to them only by name, that the Sclavonian peasants who inhabit these regions are employed. Their appearance bespeaks no fostering care from the superior, no independent respect, yielded with free satisfaction from the inferior. It is easy to perceive that all stimulus to invention, all incitement to extraordinary exertion, are wanting. No one peasant has proceeded in the arts of life and civilisation a step farther than his neighbour. When you have seen one, you have seen all. From the same little hat, covered with oil, falls the same matted long black hair, negligently plaited, or tied in knots; and over the same dirty jacket and trowsers is wrapped on each a cloak of coarse woollen cloth, or sheep-skin still retaining its wool. Whether it be winter or summer, week-day or sabbath, the Sclavonian of this district never lays aside his cloak, nor is seen but in heavy boots.

624. *Their instruments of agriculture* (*fig.* 68.) are throughout the same; and in all their habitations is observed a perfect uniformity of design. A wide muddy road separates two rows of cottages, which constitute a village. From amongst them, there is no possibility of selecting the best or the worst; they are absolutely uniform. In some villages the cottages present their ends, in others their sides, to the road; but there is seldom this variety in the same village. The interior of the cottage is in general divided into three small rooms on the ground floor, and a little space in the roof destined for lumber. The roof is commonly covered with a very thick thatch; the walls are whitewashed, and pierced towards the road by two small windows. The cottages are usually placed a few yards distant from each other. The intervening space, defended by a rail and gate, or a hedge of wicker-work towards the road, forms the farm-yard, which runs back some way, and contains a shed or outhouse for the cattle. Such is the outward appearance of the peasant and his habitation. The door opens in the side of the house into the middle room, or kitchen, in which is an oven, constructed of clay, well calculated for baking bread, and various implements for household purposes, which generally occupy this apartment fully. On each side of the room is a door, communicating on one hand with the family dormitory, in which are the two windows that look into the road. This chamber is usually small, but well arranged; the beds in good order, piled upon each other, to be spread out on the floor at night; and the walls covered with a multiplicity of pictures and images of our Saviour, together with dishes, plates, and vessels of coarse earthenware. The other door from the kitchen leads to the store-room, the repository of the greater part of the peasant's riches, consisting of bags of grain of various kinds, both for consumption and for seed, bladders of tallow, sausages, and other articles of provision, in quantities which it would astonish us to find in an English cottage. We must, however, keep in mind, that the harvest of the Hungarian peasant anticipates the income of the whole year; and, from the circumstances in which he is placed, he should rather be compared with our farmer than our labourer. The yards or folds between the houses are usually much neglected, and are the dirty receptacles of a thousand uncleanly objects. Light carts and ploughs (*fig.* 68.), with which the owner performs his stated labour, his meagre cattle, a loose rudely formed heap of hay, and half a dozen ragged children, stand there in mixed confusion; over which three or four noble dogs, of a peculiar breed, resembling in some degree the Newfoundland dog, keep faithful watch." (*Trav. in Hung.*, 19.)

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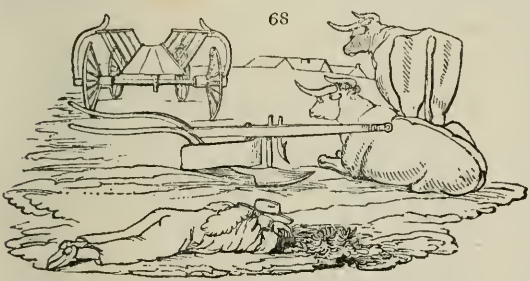

625. *The agricultural produce* of Austria is more varied than that of any other part of Germany. Excellent wheat is cultivated in Gallicia, where the soil is chiefly on limestone, and in the adjoining province of Buckowine; and, from both, immense quantities are sent down the Vistula to Dantzic. Wheat, rye, and all the other corns, are grown alike in every district, and the quantity might be greatly increased if there were a sufficient demand. Maize is cultivated in Hungary and Transylvania; millet in Hungary, Sclavonia, and Carinthia; and rice in the marshy districts of Temeswar. Tobacco is extensively cultivated in Hungary, and excellent hops are produced in Moravia and Bohemia. It is

estimated that about a sixth part of the Austrian dominions is under tillage. The most common rotation is two corn crops, and fallow or rest.

626. *The Austrian province of Moravia* is very fertile; and, with the exception of some districts of the Netherlands, scarcely any part of the Continent is so well cultivated. It bears too, a larger proportion of wheat than any other district in the east of Europe. Of the winter corn, wheat is estimated at one fourth, and rye at three fourths; whereas, in the adjoining province of Silesia, the land sown with rye is nearly ten times that sown with wheat. Moravia is defended by the Carpathian mountains from the east winds; and the harvest, the whole way from Teschen to Olmutz, and indeed to Brunn, is nearly six weeks earlier than in Silesia. This better state of things arose from the circumstance of Moravian agriculture finding domestic consumers. It is the chief manufacturing province of the Austrian empire. A greater proportion of the population can afford to live on meat, and to use wheaten flour; and hence the agriculturists find a market near home for their productions. The demand for animal food, too, being greater, a greater stock of cattle is kept, and more of the land is destined to clover and other green crops; and it may thence be inferred, that the growth of corn does not exhaust the land, so much as the cattle, by their manure, renew its prolific qualities. (*Jacob on the Trade in Corn, and on the Agriculture of northern Europe.*)

627. *The vine* is cultivated to the greatest extent in Hungary. The well known Tokay is raised on the last chain of the Carpathian hills, in the neighbourhood of the town of Tokay. The district extends over a space of about twenty English miles. " Throughout the whole of this country it is the custom to collect the grapes which have become dry and sweet, like raisins, whilst hanging on the trees. They are gathered one by one; and it is from them alone that the prime Tokay, or, as it is termed, Tokay Ausbruch, is prepared, which, in 1807, sold for 100 florins the cask of 180 halbes on the spot. They are first put together in a cask, in the bottom of which holes are bored to let that portion of the juice escape which will run from them without any pressure. This, which is called Tokay essence, is generally in very small quantity, and very highly prized. The grapes are then put into a vat, and trampled with the bare feet, no greater pressure being permitted. To the squeezed mass is next added an equal quantity of good wine, which is allowed to stand for twenty-four hours, and is then strained. This juice, without further preparation, becomes the far-famed wine of Tokay, which is difficult to be obtained, and sells in Vienna at the rate of 12*l.* sterling per dozen. The greater part of these vineyards is the property of the emperor; several, however, are in the hands of nobles." (*Bright's Travels.*)

628. *Another species of Hungarian wine*, called Méneser, is said to equal Tokay; next to that in value come the wines of Œdenburg, Rusth, St. Gyorgy, and Ofen, followed by a great variety, whose names are as various as the hills which produce them. The grape which is preferred for making the Tokay and other Hungarian wines of that character, is a small black or blue grape, figured and described by Sickler in his *Garten Magazin* of 1804, as the Hungarian Blue.

629. *Plums* are cultivated, or rather planted and left to themselves; and an excellent brandy is distilled from the fermented fruit.

630. *The culture of silk* is in the least flourishing state in Hungary; but succeeds well in Austria and Moravia; that of cotton was tried, but left off chiefly on account of the unfavourableness of the autumns for ripening the capsules. The mountain rice (*O*rỳza mùtica), from the north of China, was cultivated with success, but neglected during the late wars. " The greatest advantages which it promised arose from the situations in which it would flourish, and the fact of its not requiring marshy lands, which are so destructive to the health of those who are engaged in the cultivation of common rice." The *R*hús *C*ótinus is extensively collected from the wastes, and used as a tanning plant, especially in the preparation of morocco leather. Woad is cultivated as a substitute for indigo; the *C*ypèrus esculéntus (*fig.* 69. *a*), and the *A*strágalus bœ'ticus (*b*), as substitutes for coffee; the seeds of the latter, and the tubers of the former, being the parts used. The *A*cer campéstre, *p*latanòides, and Pseùdo-plátanus have been tapped for sugar, and the *A*. sacchàrinum extensively cultivated for the same purpose, but without any useful result: it was found cheaper to make sugar from the grape. The culture of coffee, olives, indigo, and other exotics, has been tried, but failed.

69

631 *The rearing and care of bees* were much attended to during the latter part of the eighteenth century; with a view to which a public school was opened at Vienna, and some in the provinces; and great encouragement was given to such as kept hives. Some proprietors in Hungary possessed 300 stock hives. It is customary there to transport them from place to place, preferring sites where buckwheat or the lime tree abounds. The honey, when procured, is greatly increased in value by exposure to the open air for some weeks during winter; it then becomes hard and as white as snow, and is sold to the manufacturers of liquors at a high price. The noted Italian liqueur, *rosoglio*, made also in Dantzic, is nothing more than this honey blanched by exposure to the frost, mixed with a spirituous liquor: though the honey used is said to be that of the lime tree, which is produced only in the forests of that tree near Kowno on the Niemen, and sells at more than three times the price of common honey.

632. *The live stock of Austria* consists of sheep, cattle, horses, pigs, and poultry. Considerable attention has lately been paid to the breeding of sheep, and the Merino breed has been introduced on the government estates and those of the great proprietors. The original Hungarian sheep (*O'vis strepsíceros*) (*fig.* 70.) bears upright spiral horns, and is covered with a very coarse wool. "Improvement on this stock by crosses," Dr. Bright informs us, "is become so general, that a flock of the native race is seldom to be met with, except on the estates of religious establishments." Baron Giesler has long cultivated the Merino breed in Moravia. In Hungary, Graf Hunyadi has paid great and successful attention to them for upwards of twenty years. His flock, when Dr. Bright saw it in 1814, amounted to 17,000, not one of which whose family he could not trace back for several generations by reference to his registers.

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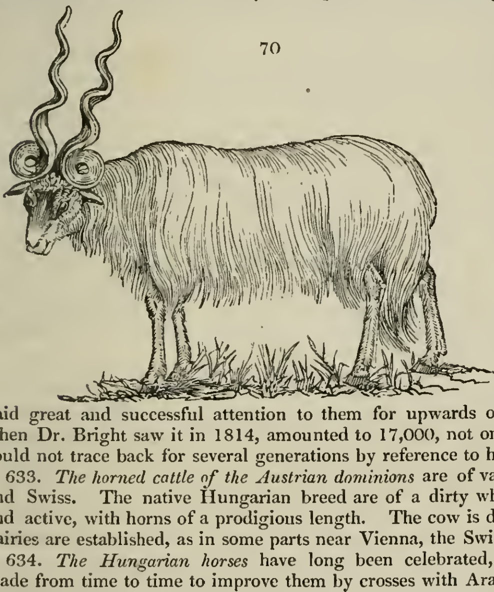

633. *The horned cattle of the Austrian dominions* are of various breeds, chiefly Danish and Swiss. The native Hungarian breed are of a dirty white colour, large, vigorous, and active, with horns of a prodigious length. The cow is deficient in milk; but where dairies are established, as in some parts near Vienna, the Swiss breed is adopted.

634. *The Hungarian horses* have long been celebrated, and considerable attempts made from time to time to improve them by crosses with Arabian, English, and Spanish breeds; and, lately, races have been established for this purpose. The imperial breeding shed, or huras, of Mezöhegyes, established in 1783, upon four commons, is the most extensive thing of the kind in Europe. It extends over nearly 50,000 acres; employs 500 persons; and contains nearly 1000 breeding mares of Bessarabian, Moldavian, Spanish, or English extraction.

635. *The breed of swine* in some parts of Hungary is excellent.

636. *Poultry* are extensively reared near Vienna, and also frogs and snails. Townson has described at length the method of treating these, and of feeding geese for their livers. (*Travels in Hungary in* 1796.)

637. *The land tortoise* likewise occurs in great numbers in various parts of Hungary, more particularly about Fuzes-Gyarmath, and the marshes of the river Theiss; and, being deemed a delicacy for the table, is caught and kept in preserves. The preserve of Keszthely encloses about an acre of land, intersected by trenches and ponds, in which the animals feed and enjoy themselves. In one corner was a space separated from the rest by boards two feet high, forming a pen for snails. The upper edge of the boards was spiked with nails an inch in height, and at intervals of half an inch, over which these animals never attempt to make their way. This snail (Hèlix pomàtia) (*fig.* 71. *a*) is in

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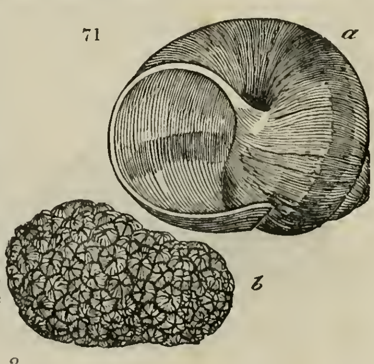

great demand in Vienna, where sacks of them are regularly exposed to sale in the market, alternating with sacks of beans, lentils, kidneybeans, and truffles. (*fig.* 71. *b.*)

638. *The implements and operations* of the agriculture of Austria differ little from those of Saxony. Dr. Bright has given figures of the Hungarian plough and cart (*fig.* 68.), and blames the mode of depositing the corn in holes in the ground, lined with straw, by which it acquires a strong mouldy smell. Vineyards are carefully dug and hoed, and the shoots of the vines, in places where the winter is severe, laid down and covered with earth to protect them from the frost. Many of the great proprietors are introducing the most improved British implements on their estates, and some have taken ploughmen from this country to instruct the natives in their use. Prince Esterhazy has English gardeners, bailiffs, grooms, and other servants.

639. *The forests of the Austrian dominions* are chiefly in Hungary, and on the borders of Gallicia, on the Carpathian mountains. They contain all the varieties of needle or pine-leaved, and broad-leaved trees, which are indigenous north of the Rhine. The oaks of Hungary are perhaps the finest in Europe. The forest of Belevar on the Drave was visited by Dr. Bright. It consists chiefly of different species of oak, the most luxuriant he ever beheld. Thousands measured, at several feet above the root, more than seven feet in diameter; continue almost of the same size, without throwing out a branch, to the height of thirty, forty, and fifty feet, and are still in the most flourishing and healthy condition. Timber there is of little value, except for the buildings wanted on an estate, or for hoops and wine barrels. In some cases the bark is not even taken from oak trees; but in others the leaf galls, and the knoppern, or smaller galls, which grow on the calyx of the acorn, are collected and exported for the use of tanners.

640. *The improvement of the agriculture* of Austria seems anxiously desired both by the government and the great proprietors. Various legislative measures are accordingly adopted from time to time, societies formed, and premiums offered. These will no doubt have a certain quantum of effect; but the radical wants, in our opinion, are information and taste for comfortable living among the lower classes; and these can only be remedied by the general diffusion of village schools; and by establishing easy rates, at which every peasant might purchase his personal liberty, or freedom from the whole or a certain part of the services he is now bound to render his lord.

Sect. VI. *Of the present State of Agriculture in the Kingdom of Poland.*

641. *Poland was formerly called the granary of Europe:* but this was when its boundaries extended from the Baltic to the Black Sea; and when the Ukraine and Lithuania were included. At present its limits are so circumscribed, and its arable surface so indifferently cultivated, or naturally so infertile, that the kingdom of Poland strictly speaking, or what is called Vice-regal Poland, furnishes little more corn than supplies its own population. The immense supplies of wheat sent to Dantzic are chiefly from the republic of Cracow, the province both of the kingdom and republic of Gallicia, united to Austria, and from Volhynia and Podolia, now belonging to Russia.

642. *The landed estates* are almost every where large, and either belong to the crown, to the nobles, or to religious corporations. One third of the surface of Vice-regal Poland belongs to the crown. Estates are farmed by the proprietors, by means of stewards; or let out in small portions on the metayer or leibeigener tenure. There are scarcely any rent-paying farmers. The nobles have generally houses on their estates, which they occupy, at least, part of the year; at other periods they are taken care of by the stewards, who are always admitted at the table of their lords, being themselves what is called of noble descent. The estates of religious houses are of great extent: they are sometimes let to nobles or others on a corn rent, who generally sublet them; and in a few cases they are farmed by the corporation. The postmasters on the different main roads invariably rent a considerable portion of land for the support of their horses. Many of these are metayers, but some pay a money rent; and there are one or two instances of nobles farming the post.

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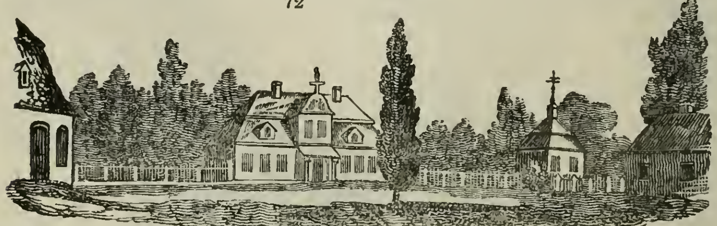

643. *The houses and offices of these noble postmasters* (*fig.* 72.) afford the only distant resemblance to a British farm-yard, that is to be met with in Poland. The farm-house and farmery of the peasant post-

master are both included in an immense shed or barn, with a small apartment at one end for the master's dwelling; the remaining space divided for live stock and implements of every description, and for the cattle, carriages, and lodging-place of travellers who may stop during night. Most of these places are sufficiently wretched as inns; but in the present state of things they answer very well for the other purposes to which they are applied, and are superior to the hovels of the farmers who are not postmasters, and who are clustered together in villages, or in the outskirts of towns. Some villages, however, in the south of Poland are almost entirely composed of Jews. There the houses are generally of a superior construction (*fig.* 73.), but still on the same general plan of a living-room at one end of a large barn, the

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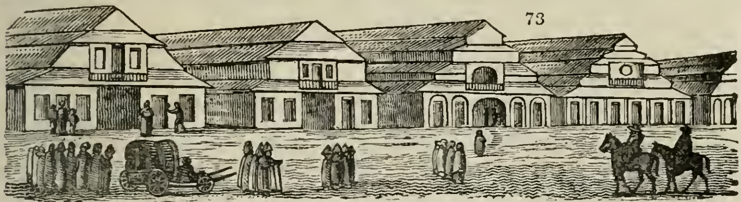

main area of which serves for all the purposes of a complete farmery. The buildings in Poland, except those of the principal towns, are constructed of timber and covered with shingles. The sheds and other agricultural buildings are boarded on the sides; but the cottages are formed of logs joined by moss or clay, of frames filled up with wickerwork and clay, or in modes and of materials still more rude. The commonest kind have no chimneys or glass windows.

644. *The climate of Poland,* though severe, is much less precarious than that of the south of Germany or of France. A winter of from five to seven months, during the greater part of which time the soil is covered with snow, is succeeded by a rapid spring and warm summer; and these are followed by a short cold wet autumn. Under such a climate good meadows and pastures cannot be expected; but arable culture is singularly easy on free soils, which the frost has rendered at once clear from most sorts of weeds and soft and mouldy on the surface.

645. *The surface of the vice-regal kingdom of Poland* is almost every where level, with scarcely an ascent or descent, except where the courses of the rivers have formed channels below the general level of the country. As these rivers, though in summer they appear small streams, are swollen by the rains of autumn, and the melting of the snow on the Carpathian mountains in the spring, they form large channels, extending over both sides to a great distance; and their deposit, in many parts, enriches the land, which presents, in the summer, the aspect of verdant and luxuriant meadows. In other parts the periodical swellings of the streams have formed morasses, which, in their present state, are not applicable to any agricultural purposes. The plains, which extend from the borders of one river to another, are open fields with scarcely any perceptible division of the land, and showing scarcely any trees even around the villages. The portion of woodland on these plains is very extensive; but they are in large masses, with great intervals of arable land between them. (*Jacob's Report on the Trade in Corn, and on the Agriculture of Northern Europe*, 1826, p. 25.)

646. *The soil of Vice-regal Poland* is mostly sandy, with an occasional mixture of a sandy loam; it is very thin, resting chiefly on a bed of granite, through which the heavy rains gradually percolate. Such a soil is easily ploughed; sometimes two horses or two oxen, and not unfrequently two cows, perform this and the other operations of husbandry. (*Ibid.*)

647. *The southern part of the ancient kingdom of Poland,* now forming the republic of Cracow, presents a comparatively varied surface, and a more tenacious and fruitful soil, which produces excellent wheat, oats, and clover. The best wheat of the Dantzic market comes from this district.

648. *The province of Gallicia,* a part of the ancient kingdom of Poland, but now added to the dominions of the Austrian empire, in surface, soil, and products, resembles the republic of Cracow.

649. *The landed estates* of Vice-regal Poland and the republic, belonging to the nobility of the highest rank, are of enormous extent: but, owing to the system of dividing the land among all the children, unless a special entail secures a majorat to the eldest son (which is, in some few instances, the case), much of it is possessed in allotments, which we should deem large; but which, on account of their low value, and when compared with those of a few others, are not so. Of these secondary classes of estates, 5 or 6,000 acres would be deemed small, and 30 or 40,000 acres large. There are, besides these, numerous small properties, some of a few acres, which, by frequent subdivisions, have descended to younger branches of noble families. The present owners are commonly poor, but too proud to follow any profession but that of a soldier, and prefer to labour in the fields with their own hands, rather than to engage in trade of any kind. As titles descended to every son, and are continued through all the successors, the nobility have naturally

become very numerous; but since the Emperor of Russia has gained the dominion over Poland, the use of titles has been restricted. The whole of the lands being made alienable may now be purchased by persons of any rank, and are actually held by some who are burghers or peasants; the Jews alone are prohibited from becoming proprietors of the soil, though they have very numerous mortgages upon it. When they foreclose, the lands must consequently be sold; and as these Jews, the monied capitalists, cannot become purchasers, the prices they yield are very trifling. (*Ibid.*)

650. *The cultivators are chiefly peasants.* They have a limited property in the lands which they occupy, and the cottages in which they live, under the condition of working a stipulated number of days in each week, on their lord's demesne, and paying specified quantities of produce, such as poultry, eggs, yarn, and other things, in conformity with ancient usage. The extent of these holdings varies, according to the quality of the land, and the quantity of duty-work, or of payments in kind, which are to be fulfilled. The peasantry of Poland were declared free in 1791, and this privilege was confirmed to them in 1815; and though their ignorance and poverty have hitherto prevented the practical effects of liberty from being very obvious among them, yet they are so far elevated in sentiment, at least, as to feel their superiority to the peasantry of Russia. (*Ibid.*)

651. *The arable culture of Poland* is abundantly simple: the course of crops is, in most places, 1st, wheat, barley, or rye; 2d, oats; 3d, fallow, or several years' rest to commence with fallow. In a very few places clover is sown, and also beans or peas, but only in small quantities. The Digitària sanguinàlis is sown as a plant of luxury in a few places, and the seeds used as rice; the buckwheat is also sown, and the seeds ground and used as meal. Almost every farmer sows linseed or hemp, to the extent required for home use, and some for sale. Rye is the bread corn of the country. Potatoes are now becoming general, and succeed well. The mangold, or white beet, was cultivated in many places in 1811 and 1812, by order of Bonaparte, in order that the natives might grow their own sugar; but that is now left off, and the peasants have not even learned its value as a garden plant, producing chard and spinach. Turnips or cabbages are rarely seen even in gardens; few of the cottagers, indeed, have any garden; those who have, cultivate chiefly potatoes, and kohl rübe. Many species of mushrooms grow wild in the woods and wastes, and most of these are carefully gathered, and cooked in a variety of ways as in Russia. The wastes or common pastures are left entirely to nature. There are some tracts of indifferent meadow on the Vistula, at Warsaw, Thorn, and Cracovie, and some on the tributary streams, which afford a tolerable hay in summer, and would be greatly improved by draining.

652. *The implements and operations* are incredibly rude. We have seen lands ploughed (after their manner) by one cow, tied by the horns to the trunk of a young fir tree, one of the roots sharpened and acting as a share, and the other serving the ploughman as a handle. In other instances we have seen a pair of oxen dragging a wretched implement (*fig.* 74.) formed by the peasant, who is in all cases his own plough and wheel wright, as well as house carpenter and builder. Their best or usual plough has no mould-board; and the crop is in many cases more indebted to the excellence of the soil, and the preceding winter's frost, than to the farmer.

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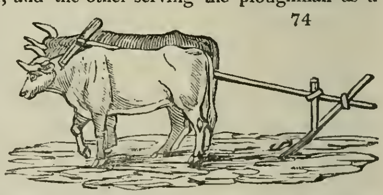

Horses are their general beasts of labour; their harness is very rude, often of straw ropes, and twisted willow shoots. The body of their best market carts, in which even the lesser nobles visit each other, are of wicker-work (*fig.* 75.), and the axle and wheels are made without any iron.

75

653. *The live stock of Poland* is very small in proportion to the land. Poultry are abundant, and swine; but the latter of the yellow long-legged breed. The horses are very hardy animals, and of better shapes than might be expected from their treatment. The best-shaped are in the province of Lublin, but they are far inferior to the breed of Saxony. The cows are a small race, and generally kept in bad condition both as to food and cleanliness. Warsaw and Cracow are supplied with beef and veal, chiefly from the Ukraine. Mutton is little used.

654. *The extensive forests of Poland* are little attended to, except on the banks of the principal rivers, and where oak abounds, from which bark and wheel spokes may be

procured. These are cut over regularly at intervals, and standards left in the usual way. The wild or Scotch pine forests are the most extensive; these perpetuate themselves by semination; and the trees are often so crowded as to be of little use but as fuel. The chief proprietors of these forests are the crown and the religious corporations, who, whenever they can find purchasers, are glad to let them thin out the best trees at a certain rate, and float them, down the nearest stream, to the Vistula, Pregel, or Niemen. A good deal has been said about the importance of felling timber at particular seasons. In Poland, the operation generally takes place in summer, but not, as far as we could learn, from any regard to the effect on the timber. The trees are often notched half through a year or two before, in order to obtain rosin. The other products of forests, as fuel, charcoal, ashes, hoops, poles, &c., are obtained in the usual manner. Game is abundant in them; and bears, polecats, &c., are to be seen in some places. The woods belonging to the crown consist of upwards of two millions of acres, and are felled in portions annually, so as to cut them every fifty years.

655. *The management of bees* is a material article in the forest culture of Poland. The honey is divided into three classes, namely lipiec, leszny, and stepowey prasznymird, thus described by How. (*Gen. Rep. Scot.* app.)

656. *Lipiec* is gathered by the bees from the lime tree alone, and is considered on the Continent most valuable, not only for the superiority of its flavour, but also for the estimation in which it is held as an arcanum in pulmonary complaints, containing very little wax, and being, consequently, less heating in its nature; it is as white as milk, and is only to be met with in the lime forests in the neighbourhood of the town of Kowno, in Lithuania. The great demand for this honey occasions it to bear a high price, insomuch, that a small barrel, containing hardly one pound's weight, has been known to sell for two ducats on the spot. This species of the lime-tree is peculiar to the province of Lithuania; and is quite different from all the rest of the genus Tilia, and is called *Kamienna lipsa*, or stone lime. The inhabitants have no regular bee-hives about Kowno; every peasant who is desirous of rearing bees, goes into the forest and district belonging to his master, without even his leave, makes a longitudinal hollow aperture or apertures in the trunk of a tree, or in the collateral branches, about three feet in length, one foot broad, and about a foot deep, where he deposits his bees, leaves them some food, but pays very little further attention to them, until late in the autumn; when, after cutting out some of their honey, and leaving some for their maintenance, he secures the aperture properly with clay and straw against the frost and inclemency of the approaching season: these tenements (if they may be so called), with their inhabitants and the produce of their labour, are then become his indisputable property; he may sell them, transfer them; in short, he may do whatever he pleases with them; and never is it heard that any depredation is committed on them (those of the bear excepted). In Poland, the laws are particularly severe against robbers or destroyers of this property, punishing the offender, when detected, by cutting out the navel and drawing out his intestines round and round the very tree which he has robbed.

657. *When spring arrives*, the proprietor goes again to the forest, examines the bees, and ascertains whether there is sufficient food left, till they are able to maintain themselves; should there not be a sufficient quantity, he deposits with them as much as he judges necessary till the spring blossom appears. If he observes that his stock has not decreased by mortality, he makes more of these apertures in the collateral branches, or in the trunk of the tree, that in case the bees should swarm in his absence, they may have a ready asylum. In the autumn he visits them again, carries the June and July work away with him, which is the lipiec, and leaves only that part for their food which was gathered by them before the commencement and after the decay of the flowering of the lime tree.

658. *The leszny, the next class of honey*, which is inferior in a great degree to the lipiec, being only for the common mead, is that of the pine forests; the inhabitants of which make apertures in the pine trees, similar to those near Kowno, and pay the same attention, in regard to the security of the bees, and their maintenance. The wax is also much inferior in quality; it requires more trouble in the bleaching, and is only made use of in the churches.

659. *The third class of honey is the stepowey prasznymird*, or the honey from meadows or places where there is an abundance of perennial plants, and hardly any wood. The province of Ukraine produces the very best, and also the very best wax. In that province the peasants pay particular attention to this branch of economy, as it is the only resource they have to enable them to defray the taxes levied by Russia; and they consider the produce of bees equal to ready money; wheat, and other species of corn, being so very fluctuating in price, some years it being of so little value that it is not worth the peasant's trouble to gather it in (this has happened in the Ukraine, four times in twelve years): but honey and wax having always a great demand all over Europe, and even Turkey, some of the peasants have from four to five hundred ule, or logs of wood in their bee-gardens, which are called *pasieka*, or bee-hives; these logs are about six feet high, commonly of birch wood (the bees prefer the birch to any other wood), hollowed out in the middle for about five feet; several lamina of thin boards are nailed before the aperture, and but a small hole left in the middle of one of them for the entrance of the bees. As the bees are often capricious at the beginning of their work, frequently commencing it at the front rather than the back, the peasants cover the aperture with a number of these thin boards, instead of one entire board, for fear of disturbing them, should they have begun their work at the front. It may appear extraordinary, but it is nevertheless true, that in some favourable seasons, this aperture of five feet in length, and a foot wide, is full before August; and the peasants are obliged to take the produce long before the usual time, with the view of giving room to the bees to continue their work, so favourable is the harvest some summers.

660. *The process of brewing mead in Poland* is very simple: the proportion is three parts of water to one of honey, and 50 lb. of mild hops to 163 gallons, which is called a *waar*, or a brewing. When the water is boiling, both the honey and hops are thrown into it, and it is kept stirring until it becomes milk-warm; it is then put into a large cask, and allowed to ferment for a few days; it is then drawn off into another cask, wherein there has been aqua-vitæ, or whisky, bunged quite close, and afterwards taken to the cellars, which in this country are excellent and cool. This mead becomes good in three years' time: and, by keeping, it improves, like many sorts of wine. The mead for immediate drink is made from malt, hops, and honey, in the same proportion, and undergoes a similar process. In Hungary, it is usual to put ginger in mead. There are other sorts of mead in Poland, as wisniak, dereniak, maliniak; they are made of honey, wild cherries, berries of the Cornus máscula, and raspberries; they all undergo the same process, and are most excellent and wholesome after a few years' keeping. The lipiec is made in the same way, but it contains the honey and pure water only. The honey gathered by the bees from the Azàlea póntica, at Oczakow, and in Potesia in Poland, is of an intoxicating nature; it produces nausea, and is used only for medical purposes, chiefly in rheumatism, scrophula, and eruption of the skin, in which complaints it has been attended with great success. In a disease among the hogs called *weugry* (a sort of plague among these animals) a decoction of the leaves and buds of Azàlea is given with the greatest

effect, and produces almost instantaneous relief. The disease attacks the hogs with a swelling of their throat, and terminates in large hard knots, not unlike the plague, on which the decoction acts as a digestive, abates the fever directly in the first stage, and suppurates the knots. It is used in Turkey, with the same view, in the cure of the plague.

661. *Such is the present state of agriculture in Poland,* as it appeared to us during a residence of four months in Warsaw and its neighbourhood in 1813, and the details in Mr. Jacob's *Report of* 1826 (p. 25. to 37.) afford us but little reason for altering our opinion. But it must always be recollected, that the above view does not include either Lithuania or Gallicia, the agriculture of which districts is of a much superior description. Since the middle of the 18th century some of the principal Polish nobles have occasionally made efforts for the improvement of the agriculture of their country; but they have not been designed and directed in the best manner, and what is much worse, not steadily pursued. Splendid wooden houses and villages have been built, and foreign farmers induced to settle and cultivate the lands. In the first heat of the business, all went on well; but the proprietors soon began to cool, to neglect their new tenants, and leave them to the mercy of their stewards, who, in Italy and Poland, are known to be the most corrupt set of men that can be met with. The oppression of these stewards, and the total disregard of their masters to their promises and agreements made to and with these strangers, have either forced the latter to return home, or reduced them to the necessity of becoming servants in the towns, or in Germany; and we know of instances where it has ruined men of some property. There are one or two exceptions; but we could produce names and dates in proof of the general truth of what we have asserted. The failure of a dairy establishment, and of a brewery, both established before the commencement of the French revolution, is attributable to this sort of conduct in the proprietors

662. *The efforts to introduce a better culture into Poland, since the peace of* 1814, have been more general, and conducted on more moderate and rational principles. British implements have been imported in considerable numbers, and an iron-foundery and manufactory of machinery of most kinds and agricultural implements is now established in Warsaw. Improved breeds of cattle and sheep have been procured from Prussia and Saxony; scientific managers are obtained from the German agricultural schools; and what will contribute essentially to improvement, encouragement is given to foreigners to settle, by letting or selling the crown lands at moderate rates, and not only free from all feudal services for ever, but for a certain period exempted from government taxes. Add to this, that the leibeigeners and metayers of every description may buy up the services which they now render their lords, at very easy rates established by law; and thus, according to their ambition and means, render themselves partially or wholly independent men. In short, the most judicious measures have been taken, by the new government of Poland, for the improvement of the country; and they have been followed up with considerable vigour by the proprietors. These proprietors are now a different and very superior class of men to what they were fifty or sixty years ago. They have mostly been officers in the French army, and with it traversed the greater part of Europe; better educated than many of the French, and more engaging in their manners than the Germans, they may be considered among the first gentlemen of the Continent. The Polish peasantry are naturally a much more lively and ingenious race than those of Russia, and since they have been rendered free, they have learned to feel their superiority, and they will gradually participate in the improvement of their masters.

Sect. VII. *Of the present State of Agriculture in Russia.*

663. *The rural economy of the Russian empire* was first described by Professor Pallas in his travels to explore that country, made by order of the Empress Catherine. It has also been incidentally noticed by various travellers, as Tooke, Coxe, Clarke, and several French and German authors. From these and other works, and a personal residence which occupied nearly a year in 1813 and 1814, we shall present a very concise statement of the agricultural circumstances of that semibarbarous country.

664. *The territory of Russia which may be subjected to aration* commences at the 43° and ends at the 65° of north latitude. Farther north, the summers are too short for ripening even barley, and the climate too severe for the growth of pasture or trees. It is a black waste, productive of little more than lichens, and supporting a few reindeer. The southern extremity of Asiatic Russia, on the other hand, admits the culture of Italy, and even the southern parts in Europe, that of the maize district of France.

665. *The climate of Russia* has been divided into four regions, the very cold, cold, temperate, and hot. The very cold extends from 60° to 78° of N. latitude, and includes Archangel. In many of its districts there is scarcely any summer; the spring has in general much frost, snow, and rain; and the winter is always severe. In this region there is no agriculture.

666. *The cold climate* extends from 55° to 60° N. latitude and includes Cazan Mos-

cow, Petersburg, and Riga; the summer is short, yet in many districts so warm and the days so long, that agricultural crops usually come to perfect maturity in a much shorter space of time than elsewhere. The winters are long and severe, even in the southern parts of the region. The ground round Moscow is generally covered with snow for six months in the year, and we have seen it covered to the depth of several inches in the first week of June.

667. *The moderate region* extends from 50° to 55° and includes Kioff, Saratoff, Wilna, and Smolensko. The Siberian part of this region being very mountainous, the winters are long and cold; but in the European part the winter is short and tolerably temperate, and the summer warm and agreeable. The snow, however, generally lies from one to three months, even at Kioff and Saratoff.

668. *The hot region* reaches from 43° to 50°, and includes the Taurida, Odessa, Astracan, and the greater part of Caucasus and the district of Kioff. Here the winter is short and the summer warm, hot, and very dry. The atmosphere in all the different climates is in general salubrious, both during the intense colds of the north, and the excessive heats of the southerly regions. The most remarkable circumstance is the shortness of the seasons of spring and autumn, even in the southern regions; while in the very cold and cold regions they can be hardly said to exist. About Moscow the termination of winter and the commencement of summer generally take place about the end of April. There the rivers, covered a yard in thickness with ice, break up at once and overflow their banks to a great extent; in a fortnight the snow has disappeared, the rotten-like blocks of ice dissolved, and the rivers are confined to their limits. A crackling from the bursting of buds is heard in the birch forests; in two days afterwards, they are in leaf; corn which was sown as soon as the lands were sufficiently dry to plough is now sprung up, and wheat and rye luxuriant. Reaping commences in the government of Moscow in September, and is finished by the middle of October. Heavy rains and sleet then come on, and by the beginning of November the ground is covered with snow, which accumulates generally to two or three feet in thickness before the middle of January, and remains with little addition till it dissolves in the following April and May. The climate of Russia, therefore, though severe, is not so uncertain as that of some other countries. From the middle of November till April it scarcely ever snows or rains; and if the cold is severe, it is dry, enlivening, and at least foreseen and provided for. Its greatest evils are violent summer rains, boisterous winds, and continued autumnal fogs. Late frosts are more injurious than long droughts; though there are instances of such hot and dry summers, that fields of standing corn and forests take fire and fill whole provinces with smoke. (*Tooke's View of the Russian Empire.*)

669. *The surface of Russia* is almost every where flat, like that of Poland, with the exception of certain ridges of mountains which separate Siberia from the other provinces, and which also occur in Siberian Russia. In travelling from Riga, Petersburg, Wilna, or Brody, to Odessa, the traveller scarcely meets with an inequality sufficiently great to be termed a hill; but he will meet with a greater proportion of forests, steppes or immense plains of pasture, sandy wastes, marshy surfaces, and gulleys or temporary water-courses, than in any other country of Europe.

670. *The soil of Russia* is almost every where a soft black mould of great depth, and generally on a sandy bottom. In some places it inclines to sand or gravel; in many it is peaty or boggy from not being drained: but only in Livonia and some parts of Lithuania was it inclined to clay, and no where to chalk. The most fertile provinces are those of Vladimir and Riazane, east of Moscow, and the whole country of the Ukraine on the Black Sea, and of the Cossacks on the Don. In Vladimir thirty-fold is often produced, and still more in Riazane. In many parts of the Ukraine no manure is used; the straw is burned; successive crops of wheat are taken from the same soil, and after a single ploughing each time, the stalks of which are so tall and thick that they resemble reeds, and the leaves are like those of Indian corn.

671. *Landed property in Russia* is almost every where in large tracts, and is either the property of the emperor, the religious or civil corporations, or the nobles. There are a few free natives who have purchased their liberty, and some foreigners, especially Germans, who have landed estates; but these are comparatively of no account. In the Ukraine, within the last thirty years, have been introduced on the government estates a number of foreigners from most countries of Europe, who may be considered as proprietors. These occupy the lands on leases of a hundred years or upwards, at little or no rent, on condition of peopling and cultivating them and residing there. In the country parts of Russia, there is no middle class between the nobles, including the priests, and the slaves. Estates are, therefore, either cultivated directly by the proprietors, acting as their own stewards; or indirectly, by letting them to agents or factors, as in Poland and Ireland, or by dividing them in small portions among the peasantry. In general, the proprietor is his own agent and farmer for a great part of his estate; and the rest he lets

to his slaves at certain rates of labour, corn, personal services, and sometimes a little money. These slaves, it is to be observed, are as much his property as the soil; and in seasons of scarcity, or in the event of any disaster, the lord is bound to provide for them, and indeed deeply interested in doing so, in order at least to maintain the population, and, if possible, to obtain a surplus for sale or for letting out to the towns. As in Poland, the lands are every where unenclosed.

672. *The farmeries* attached to the houses of noblemen, and the cottages of the peasants, resemble those of Poland. They are almost every where constructed of timber; the stove and its chimney being the only part built of brick or of mud and stones. The noblemen generally reside on their estates, and their houses are surrounded by the village which contains their peasants. These villages (*fig.* 76.) are in general dull and miserable

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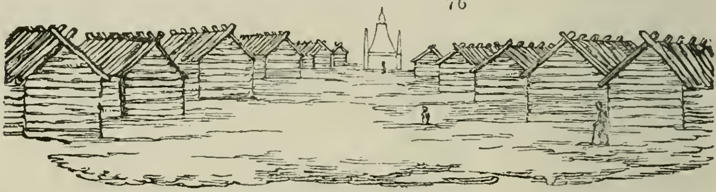

assemblages of log-houses all of one size and shape, with a small wooden church. The mansions of the poorer nobles are merely cottages on a larger scale, with two apartments; one used for the purposes of the kitchen and other domestic offices, and the other for all the purposes of the family living-rooms: the more wealthy have wooden or brick houses stuccoed, or mudded, and whitewashed. One nobleman in the neighbourhood of Moscow has a British steward, who has drained, enclosed, and greatly improved his estate, and has built some farmeries (*fig.* 77.) which might be mistaken for those of another country.

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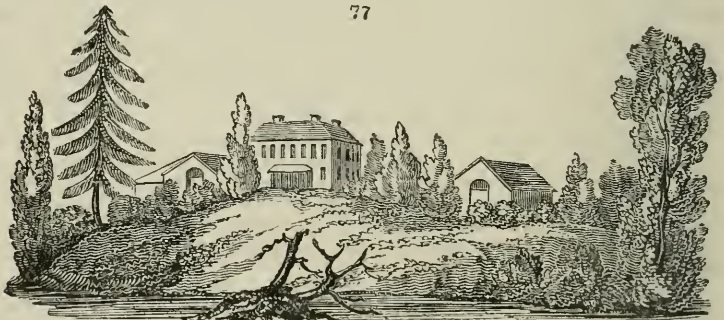

673. *The agricultural products* of Russia may be known from its climates. The vegetables of the most northerly region are limited to lichens, some coarse grass, and some birch, abele, and wild pine forests. The animals there are the reindeer, bear, fox, and other beasts of the chase, or in esteem for their furs or skins. Some cows and sheep are also pastured in the northern parts of that region during the summer months.

674. *The farming crops of the more southern regions* are the same as in similar climates and countries. Winter and summer rye and oats are cultivated in every part of the empire south of latitude 60°; winter wheat only in Russia as far as the Kama; summer wheat both in Russia and Siberia; barley and spelt plentifully in Russia. Peas, vetches, and beans are not cultivated in great quantities: but buckwheat is extensively grown, and there is a large variety, called the Tartarian millet; *P*ánicum germánicum and maize are grown in Taurida. Rice is cultivated in some parts of Taurida, and what is called manna (*Festùca* flùitans) grows wild in most places that are occasionally overflown with water, particularly in the governments of Novogorod, Twer, Polotsk, and Smolensk. But the grain the most universally cultivated in Russia is rye, which is the bread corn of the country; next oats, which furnish the spirit in common use: and then wheat and barley.

675. *The culture of herbage plants*, of grasses, clover, turnips, &c., is rare in Russia. Hay is made from the banks of rivers or lakes; and pasture obtained from the steppes, forests, grass lands in common, or arable lands at rest.

676. *For clothing and other economical purposes the plants* in cultivation are flax, which is cultivated to a great extent on the Volga ; and hemp, which is indigenous, and is cultivated both for its fibre and its seed. From the latter an oil is expressed much used as food during the time of the fasts. Woad is abundantly grown, madder and cotton have been tried in Astracan and Taurida. Hops grow wild in abundance in some parts of Siberia, and are cultivated in some European districts. Tobacco is planted in great abundance, and the produce in the Ukraine is of excellent quality. The potato is not yet in general cultivation, but has been introduced in different districts. Water melons, cabbages, turnips, and a variety of garden vegetables, are cultivated in the Ukraine and Taurida. Asparagus is extensively cultivated in the government of Moscow for the Petersburg market, and also turnips, onions, and carrots. Mushrooms are found in great plenty in the steppes and forests. About thirty species are eaten by the peasants, exclusive of our garden mushroom, which is neglected. Their names and habitats are given by Dr. Lyall. (*History of Moscow*, 1824.) The common and Siberian nettle are found wild on the Ural mountains, and their fibres are prepared and woven into linen by the Baschkirs and Tatars. The rearing of silkworms has been tried in the Ukraine, and found to answer, as has the culture of the caper and various other plants.

677. *Hemp and flax* are extensively cultivated, and form the principal article of exportation. There is nothing very peculiar in their culture ; the soil of the Ukraine is in general too rich for hemp, until reduced by a series of corn crops. Wheat, rye, barley, and oats are succeeded by one or two crops of hemp, and that by a crop of flax ; the whole without any manure. The time of sowing is from the 25th of May to the 10th of June, and that of reaping from the end of August to the end of September. In general the flax is three, and the hemp about four, months in a state of vegetation. The pulling, watering, drying, and other processes, are the same as in Britain.

678. *Of fruits grown on a large scale*, or plentiful in a wild state in Russia, may be mentioned the raspberry, currant, strawberry, and bilberry. The hazel is so plentiful in Kazan, that an oil used as food is made from the nuts. Sugar, musk, and water melons thrive in the open air, as far north as lat. 52°. Pears are wild almost every where, and cherries found in most forests. On the Oka and Volga are extensive orchards, principally of these fruits and apples. The apricot, almond, and peach succeed as standards in Taurida and Caucasus, and other southern districts. The quince is wild in forests on the Terek. Chestnuts are found singly in Taurida and districts adjacent. The walnut abounds in most southern districts. Figs and orange trees grow singly in Kitzliar and in Taurida, planted no doubt by the Tatars before they were driven out of that country. Lemons, oranges, and olives, according to Pallas, would bear the winter in Taurida, and have been tried by Stevens, the director of a government nursery at Nikitka, in that country. The vine is cultivated in the governments of Caucasus, Taurida, Ekatorinoslaf, and other places ; and it is calculated that nearly one fourth part of the empire is fit for the culture of this fruit for wine. An account of the products of the Crimea is given by Mary Holderness (*Notes*, 1821), from which it appears that all the fruits of France may be grown in the open air there, and that many of our culinary vegetables are found in a wild state. The Tatar inhabitants, who were driven out by the ambitious wars of Catherine, had formed gardens and orchards round their villages, which still exist, and present a singular combination of beauty, luxuriance, and ruin. The gardens of the village of Karagoss form a wilderness of upwards of three hundred and sixty English acres, full of scenes of the greatest beauty, and through which, she says, it requires a little experience to be able to find one's way. (*Notes*, 125—136.)

679. *The live stock of the Russian farmer* consists of the reindeer, horse, ox, ass, mule, and camel, as beasts of labour ; the ox, sheep, and swine, and in some places the goat and rabbit, as beasts of clothing and nourishment. Poultry are common, and housed with the family to promote early laying, in order to have eggs by Easter, a great object with a view to certain ceremonies in the Russian religion. Bees are much attended to in the Ural, in some parts of Lithuania, and in the southern provinces. The Russian working horses are remarkably strong and hardy, rather small, with large heads, long flabby ears, not handsome, but not without spirit : the best saddle horses are those of the Cossacks and Tatars in the Crimea. The horned cattle of the native breeds are small and brisk ; the cows give but little milk, which is poor and thin : a Dutch breed was introduced by Peter the Great, near Archangel, and do not degenerate. Oxen are much less used than horses, as beasts of labour. The original Russian sheep is distinguished by a short tail about seven inches in length : the Merinos, and other breeds from Germany, have been introduced in a few places, and promise success. The great graziers and breeders of horses, cattle, and sheep, in Russia, are the Cossacks of the Don, the Kalmucks, and other nomadic tribes. These supply the greater part of the towns both of Russia and Poland with butcher's meat ; and with the hides and tallow that form so material an article of export. In the northern districts of Russia and Siberia, the chase is pursued as an occupation for a livelihood or gain. The chief object is to

entrap by dogs and snares those animals whose skins are used as furs, and especially the sable. Next to the latter animal, the grey squirrel is the most valuable; but foxes, martins, fish, otters, bears, wolves, lynxes, gluttons, ferrets, polecats, and a variety of others, are taken for their skins by the hunters, who pay a rent or tribute to government in sable skins, or in other furs regulated by the value of those.

680. *The forests of Russia* are least abundant in the southern districts; but the cold region may, like Poland, be described as one entire forest with extensive glades. Forests of pine-leaved trees (or needle-leaved trees, as the German expression is) are chiefly indigenous in the very cold and cold regions. These include the spruce fir, the wild, and black pine, and the Siberian cedar or stone pine (*Pinus Cémbra*). The larch grows on most of the Siberian mountains. Among the leafy trees, the birch is the most common, next the trembling poplar, willow, lime, and ash. The oak is not indigenous in Siberia; the beech, elm, maple, and poplar, are found chiefly in the southern districts. Timber for construction, fuel, charcoal, bark, potashes, barilla, rosin, tar, pitch, &c., are obtained from these forests, which can hardly be said to have any sort of culture applied to them.

681 *Tar* is extracted from the roots of the wild pine These are cut into short pieces, then split, and put into an iron boiler which is closely covered. Fire being applied below, the tar oozes out of the roots, and collecting in the bottom of the boiler, runs off by a pipe into a cask, which when closed is fit for exportation. When pitch is wanted, the tar is returned to the boiler, and boiled a second time.

682. *Ashes* for the purposes of lixiviation are obtained by burning every sort of timber indiscriminately. After being lixiviated they are barrelled up and sold for exportation.

683. *The implements and operations of Russian husbandry* are the most simple and artless that can well be imagined. Pallas has given figures of ploughs and other articles; the former mere crooked sticks pointed, and drawn by horses attached by ropes of bark or straw. Speaking of the operations, he says, "the cultivator sows his oats, his rye, or his millet, in wastes which have never been dunged; he throws down the seed as if he meant it for the birds to pick up; he then takes a plough and scratches the earth, and a second horse following with a harrow terminates the work; the bounty of nature supplies the want of skill, and an abundant crop is produced." This applies to the greater part of ancient Russia and Siberia; but in Livonia and other Baltic provinces, and also in some parts of the Polish provinces of the Ukraine, the culture is performed in a superior manner, with implements equal to the best of those used in Germany. The most improved form of their carts (*fig* 78.), in use round Petersburg, is evidently copied from those of the Dutch, and was, probably, introduced by Peter the Great. In the Ukraine they thresh out their own corn by dragging boards studded with flints over it, and preserve it in pits in dry soil. In the northern provinces it is often dried on roofed frames of different sorts (*fig* 79.), as in Sweden; and about Riga and Mittau it is even kiln-dried in the sheaf before it can be stacked or threshed. The manner of performing the operation of kiln-drying in the sheaf, as it may sometimes be applicable in North Britain or Ireland in very late and wet seasons, we shall afterwards describe. (Part III. Book VI. Ch. II.)

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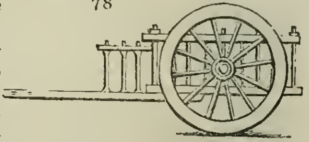

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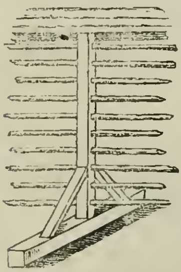


684. *In no part of Europe are the field operations performed with such facility as in Russia*, not only from the light nature of the soil, but from the severity and long continuance of the winters, which both pulverises the surface and destroys weeds. The same reasons prevent grass lands, or lands neglected or left to rest, from ever acquiring a close sward or tough rooty surface, so that even these are broken up with a very rude plough and very little labour. In short, there is no country in Europe where corn crops may be raised at so little expense of labour as in Russia; and as no more than one corn crop can be got in the year in almost any country, so Russia may be said to be, and actually is, even with her imperfect cultivation, better able to raise immense quantities of corn than any part of the world, except, perhaps, similar parts of North America.

685. *The improvement of Russian agriculture* was commenced by Peter the Great, and continued by Catherine, and the late and present emperor. The peasants, on many of the government estates, were made free; some of these estates were let or sold to freemen, and foreign agriculturists encouraged to settle on them. Rewards and premiums were given, and professorships of rural economy established in different parts of the empire. Some of the principal nobles have also made great efforts for the improvement of agriculture. Count Romansow, about the end of the last century, procured a British farmer (Rogers), and established him on his estate near Moscow, where he has intro-

duced the improved Scotch husbandry, drained extensively, established a dairy, and introduced the potato there and on other estates belonging to his master. Others have made similar efforts, and several British farm bailiffs are now settled in Russia. The foreigners, merchants in Petersburg, or Riga, or in the employ of government, have also contributed to the improvement of agriculture. Many of these, intending to establish their families in Russia, purchase estates, and some receive presents in land from the emperor. On these they in general introduce the culture of their native country, which, if only in the superiority of the live stock and implements, is certain of being better than that of the natives. In short, from these circumstances, and from the *comparatively* rational views of the present government, there can be no doubt of the rapid increase of agriculture and population in Russia.

Sect. VIII. *Of the present State of Agriculture in Sweden and Norway.*

686. *Sweden and Norway are not agricultural countries;* but still great attention has been paid to perfect such culture as they admit of, both by the government and individuals. From the time of Charles XI., in the end of the seventeenth century, various laws for the encouragement of agriculture have been passed, professorships founded, rewards distributed, and the state of the kingdom, in respect to its agricultural resources, examined by Linnæus and other eminent men. Norway, till lately under the dominion of Denmark, is chiefly a pastoral country; but its live stock and arable culture have been much improved during the end of the last, and beginning of the present, century, by the exertions of the Patriotic Society established in that country, which gives premiums for the best improvements and instructions in every part of farming. Our notices of the rural economy of these countries are drawn from Clarke, Thomson, James, and our own memoranda, made there in 1813.

687. *The climate of Sweden and Norway* is similar to that of the cold and very cold regions of Russia, but rather milder in its southern districts, on account of the numerous inlets of the sea. The lands on the sea-coast of Norway are not, on this account, so cold as their latitude would lead us to expect; still the winters are long, cold, and dreary; and the summers short and hot, owing to the length of the day and the reflection of the mountains. So great is the difference of temperature, that at Sideborg, in the latitude of Upsal, in June or July, it is frequently eighty or eighty-eight degrees, and in January at forty or fifty below the freezing point. The transition from sterility to luxuriant vegetation is in this, as it is in similar climates, sudden and rapid. In the climate of Upsal, the snow disappears in the open fields from the 6th to the 10th of May; barley is sown from the 13th to the 15th of that month, and reaped about the middle of August. In some parts of Norway corn is sown and cut within the short period of six or seven weeks. According to a statement published in the *Amœn. Acad.* vol. iv., a Lapland summer, including also what in other countries are called spring and autumn, consists of fifty-six days, as follows:—

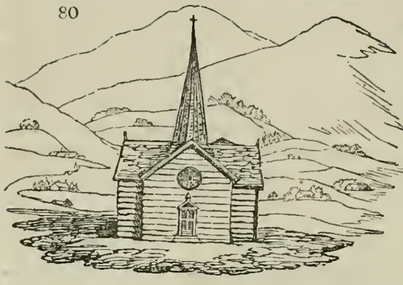
June 23. snow melts.
July 1. snow gone.
9. fields quite green.
17. plants at full growth.
25. plants in full blow.
Aug. 2. fruits ripe.
10. plants shed their seeds.
18. snow.
From this time to June 23. the ground is every where covered with snow, and the waters with ice.

In such a climate no department of agriculture can be expected to flourish. The culture of corn is only prevalent in two districts, east Gothland, and the eastern shores of the Gulf of Bothnia, now belonging to Russia.

688. *The surface* of Sweden every body knows to be exceedingly rocky and hilly, and to abound in fir and pine forests, and in narrow green valleys, often containing lakes or streams. "Sweden," Dr. Clarke observes, "is a hilly, but not a mountainous country, excepting in its boundary from the Norwegian provinces. It has been remarked, that in all countries, the abutment of the broken strata, which constitute the earth's surface every where, causes a gradual elevation to take place towards the north-west; hence, in all countries, the more level districts will be found upon the eastern, and the mountainous or metalliferous region upon the western side; either placed as a natural boundary against the territory occurring next in succession; or terminating in rocks of primary formation opposed as cliffs towards the sea." (*Clarke's Scandinavia.*) This is precisely the case with Sweden: the south-eastern provinces are level and cultivated; a ridge of mountains on the west separates it from Norway; and the intermediate space, from Gothenberg to Tornea, may be considered as one continued forest, varied by hills, rocks, lakes, streams, glades of pasture, and spots of corn culture. Norway may be considered as a continuation of the central country of Sweden, terminated by cliffs opposed to the ocean. "The tops and sloping sides of the mountains," Dr. Clarke observes, "are covered with verdure; farms are stationed on a series of tabular eminences, and grazing around them the herds of cattle all the way from the top to the bottom,

and sometimes in places so steep, that we wonder how they could find a footing. In some places the elevation of these farms is so extraordinary, that the houses and flocks appear above the clouds, and bordering on perpetual snow, and the actual site of them is hardly to be credited. Every hanging-meadow is pastured by cows and goats; the latter often browsing upon jutties, so fearfully placed, that their destruction seems to be inevitable; below is seen the village church with its spire, the whole built of plank (*fig.* 80.); the cheerful bleatings of the sheep, mingled at intervals with the deep tones of the cow-herds' *lures* (*fig.* 81.), resounding from the woods. The lure is a long trumpet made of splinters of wood, bound together by withy."

80

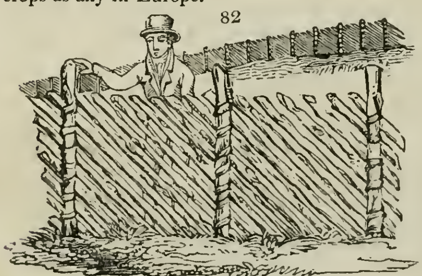


689. *Of Finland*, which we have included with Sweden and Norway, a considerable part is under corn culture; the forests cleared, the lands enclosed, and population increased. The whole country appears decked with farm-houses, and village churches, rising to the view or falling from it, over an undulating district, amidst woods and water, and rocks, and large loose masses of granite: it may be called Norway in miniature. Farther up the country, towards the north, there are scenes which were described to Dr. Clarke as unrivalled in the world. Every charm which the effect of cultivation can give to the aspect of a region where Nature's wildest features — headlong cataracts, lakes, majestic rivers, and forests — are combined, may there be seen. (*Scandinavia*, sect. ii. p. 459.)

81

690. *The soil* of the valleys is, in general, good friable loam, but so mixed with stones as to render it very troublesome to plough or harrow; and in many places so much so, that where the valleys are cultivated it is chiefly with the spade. The only exception to these remarks is a considerable tract of comparatively even surface in South and East Gothland, where the soil inclines to clay and is well cultivated, and is as prolific in corn crops as any in Europe.

82



691. *The landed property* of Sweden is generally in estates of a moderate size; in many cases their extent in acres is unknown, their value being estimated by the number of stock grazed in summer. The proprietors almost constantly farm their own estates, or let them out at fixed rents, in money or grain, to cottagers or farmers. The largest arable farms not occupied by the proprietors are in Gothland; but few of these exceed two hundred acres. The farm-buildings and cottages are there almost always built of timber and thatched, on account of the warmth of these materials, though stone is abundant in most places. There are a few small enclosures near the farm-yard; but to enclose generally could be of no use in a country where the snow, during six or eight months in the year, renders them nugatory either as shelters or fences. The fence in universal use is made of splinters of deal, set up in a sloping position, and fastened by withies to upright poles. (*fig.* 82.) This is the only fence used in Sweden, Norway, Lapland, and Finland; and it is very common in Poland, Russia, and the northern parts of Germany.

83

692. *The Swedish cottages* are built of logs, like those of Poland (*fig.* 83.), but they are roofed in a different manner. Above the usual covering of boards is laid birch bark in the manner of tiles, and on that a layer of turf, so thick that the grass grows as vigorously as on a natural meadow. The walls are often painted red. They are very small, and generally very close and dirty

within, at least in winter. There are various exceptions, however as to cleanliness, especially among the post-masters, who are all farmers. The post-house at Yfre, north of Stockholm, was found by Dr. Clarke and his party so " neat and comfortable, and every thing belonging to it in such order," that they resolved to dine there. " The women were spinning wool, weaving, heating the oven, and teaching children to read, all at the same time. The dairy was so clean and cool, that we preferred having our dinner there rather than in the parlour. For our fare they readily set before us a service consisting of bacon, eggs, cream, curd, and milk, sugar, bread, butter, &c.; and our bill of fare for the whole amounted only to twenty pence; receiving which they were very thankful. Cleanliness in this farmer's family was quite as conspicuous as in any part of Switzerland. The tables, chairs, and the tubs in which they kept their provisions, were as white as washing could make them; and the most extraordinary industry had been exerted in clearing the land, and in rendering it productive. They were at this time employed in removing rocks, and in burning them for levigation, to lay the earth again upon the soil." (*Scandinavia*, sect. i. p. 179.)

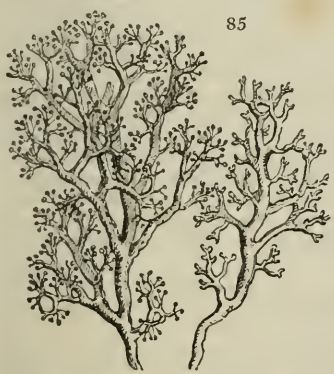
693. *The cottages in Norway* are formed as in Sweden, covered with birch, bark, and turf. On some of the roofs, after the hay was taken, Dr. Clarke found lambs pasturing; and on one house he found an excellent crop of turnips. The galleries about their houses remind the traveller of Switzerland.

84

694. *The cottages of the Laplanders* are round huts of the rudest description. (*fig.* 84.)

695. *The agricultural produce* of Sweden are the common corns. Wheat and rye are chiefly grown in South and East Gothland; oats are the bread corn of the country; and big, or Scotch barley, is the chief corn of Lapland and the north of Norway. The bean and pea are grown in Gothland, and potatoes, flax, and enough of tobacco for home consumption, by every farmer and cottager. Only a few districts grow sufficient corn for their own consumption, and annual importations are regular.

85

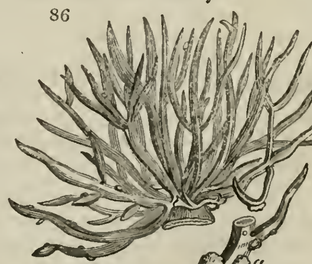


696. *The Cenomyce rangiferina*, or reindeer moss (*fig.* 85.), is not only used by the reindeer, but also as fodder for cows and other horned cattle. It adds a superior richness to the milk and butter. It is sometimes eaten by the inhabitants; and Dr. Clarke, having tasted it, found it crisp and agreeable.

697. Roccélla *tinctòria* (*fig.* 86.), which abounds near Gottenburg and in other parts of Sweden, was in considerable demand in the early part of last war as a scarlet dye.

698. *The Lycopòdium complanàtum* (*fig.* 86.) is employed in dyeing their woollen. Even the leaves, as they fall from the trees, are carefully raked together and preserved, to increase the stock of fodder. (*Scandinavia*, chap. xviii.)

86



699. *Tar*, in Sweden, is chiefly extracted from the roots of the spruce fir, and the more marshy the forest the more the roots are said to yield. Roots or billets of any kind are packed close in a kiln, made like our limekilns, in the face of a bank. They are covered with turf and earth, as in burning charcoal. At the bottom of the kiln is an iron pan, into which the tar runs during the smothered combustion of the wood. A spout from the iron pan conveys the tar at once into the barrels in which it arrives in this country.

700. *The native trees and plants* afford important products for the farmer. "The industry of the Norwegians," Dr. Clarke observes, "induces them to appropriate almost every thing to some useful purpose. Their *summum bonum* seems to consist in the produce of the fir (*i. e.* the wild pine, not the spruce fir). This tree affords materials for building their houses, churches, and bridges; for every article of their household furniture; for constructing sledges, carts, and boats; besides fuel for their hearths. With its leaves (here the spruce fir is alluded to) they strew their floors, and afterwards burn them and collect the ashes for manure. The birch affords, in its leaves and tender twigs, a grateful fodder for their cattle, and bark for covering their houses. The bark of the elm, in powder, is boiled up with other food, to fatten hogs; sometimes, but rarely, it is mixed in the composition of their bread. The flowers of the hæg-ber (*Córnus máscula*) flavour their distilled spirits. The moss, as a substitute for mortar, is used in calking the interstices between their under walls. The turf covers their roofs.

87

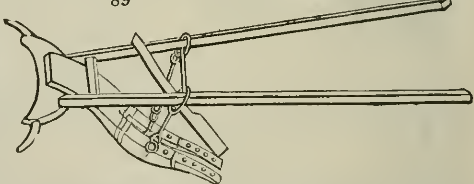
701. *The berries of the Cloud-berry* (*Rùbus Chamæmòrus*) (*fig.* 88.) are used in Lapland and the north of Sweden and Norway like the strawberry, and are esteemed as wholesome as they are agreeable. Dr. Clarke was cured of a bilious fever chiefly from eating freely of this fruit. They are used as a sauce to meat, and put into soup even, in Stockholm.

88

702. *The live stock* of the Swedish farmer consists chiefly of cows. These are treated in the same manner as in Switzerland. About the middle of May they are turned into meadows; towards the middle of June driven to the heights, or to the forests, where they continue till autumn. They are usually attended by a woman, who inhabits a small hut, milks them twice a day, and makes butter and cheese on the spot. On their return, the cattle are again pastured in the meadows, until the snow sets in about the middle of October, when they are removed to the cow-houses, and fed during winter with four fifths of straw and one of hay. In some places, portions of salted fish are given with the straw. The horses are the chief animals of labour; they are a small, hardy, spirited race, fed with hay and oat-straw the greater part of the year, and not littered, which is thought to preserve them from diseases. Sheep are not numerous, requiring to be kept under cover so great a portion of the year. Pigs and poultry are common.

703. *The implements and operations* of Swedish agriculture are simple, and in many places of an improved description. The swing plough, with an iron mould-board, is general throughout Gothland, and is drawn by two horses. The plough of Osterobothnia (*fig.* 89) is drawn by a single horse, and sometimes by a peasant, and called to Dr. Clarke's mind "the old Samnite plough, as it is still used in the neighbourhood of Beneventum, in Italy; where a peasant, by means of a cord passed over his shoulder, draws the plough, which his companion guides. It only differs from the most ancient plough of Egypt, as we see it represented upon images of Osiris (*fig.* 90.), in having a double instead of a single coulter." (*Scandinavia*, ch. xiii.) They have a very convenient cradle-scythe for mowing oats and barley, which we shall afterwards describe; a smaller scythe, not unlike that of Hainault, for cutting grass and clovers; and, among other planting instruments, a frame of dibblers (*fig.* 91.) for planting beans and peas at equal distances.

89



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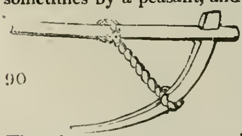

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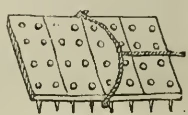
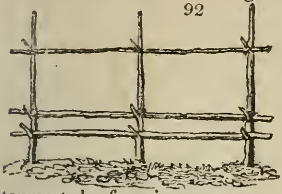


704. *Farming operations* are, in general, as neatly performed as any where in Britain. The humidity of the climate has given

rise to various tedious but ingenious processes for making hay and drying corn. The latter often remains in the fields in shocks or in small ricks, after the ground is covered with snow, till the clear frosts set in, when it becomes dry, and may be taken home. Besides the common mode of placing the sheaves astride with the ears downwards on horizontal fir poles (*fig.* 92.), there are various others. In some places young fir trees, with the stumps of the branches left on, are fixed in the ground, and the sheaves hung on them, like flowers on a maypole, the topmost sheaf serving as a cap or finish to all the rest. Sometimes covered rails or racks are resorted to (*fig.* 79.) : at other times skeleton roofs or racks are formed, and the sheaves distributed over them. (*fig* 93.) Often in Norway the corn is obliged to be cut green, from the sudden arrival of winter. Dr. Clarke found it in this state in October; and near Christiana it was suspended on poles and racks to dry, above fields covered with ice and snow. Corn is threshed in the north of Sweden by passing over it a threshing-carriage, which is sometimes made of cast-iron, and has twenty wheels, and sometimes more. The sheaves are spread on a floor of boards, and a week's labour of one carriage, horse, and man will not thresh more than a ton of corn, because the crop being always cut before it is fully ripened, its texture is exceedingly tough. The hay is sometimes dried in the same manner. After all, they are in some seasons obliged to dry both, especially the corn, in sheds or barns heated by stoves, as in Russia. (683.) In mowing hay in Lapland the scythe, the blade of which is not larger than a sickle, is swung by the mower to the right and left, turning it in his hands with great dexterity.

92



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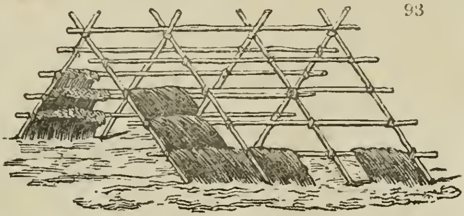

705. *The forests* of Sweden are chiefly of the wild pine and spruce fir; the latter supplies the spars, and the former the masts and building timber so extensively exported. The roads in Norway, as in some parts of Russia, are formed of young trees laid across and covered with earth, or left bare. Turpentine is extracted from the pine : the outer bark of the beech is used for covering houses, and the inner for tanning. The birch is tapped for wine; and the spray of this tree, and of the elm, alder, and willow is dried with the leaves on in summer, and fagoted and stacked for winter fodder. The young wood and inner bark of the pine, fir, and elm, are powdered and mixed with meal for feeding swine.

706. *The chase* is pursued as a profitable occupation in the northern parts of Sweden, and for the same animals as in Russia.

707. If any one, says Dr. Clarke, wishes to see *what English farmers once were*, and how they fared, he should visit Norway. Immense families, all sitting down together at one table, from the highest to the lowest. If but a bit of butter be called for in one of these houses, a mass is brought forth weighing six or eight pounds; and so highly ornamented, being turned out of moulds, with the shape of cathedrals, set off with Gothic spires and various other devices, that, according to the language of our English farmers' wives, we should deem it "almost a pity to cut." (*Scandinavia*. ch. xvi.) They do not live in villages, as in most other countries, but every one on his farm, however small. They have in consequence little intercourse with strangers, except during winter, when they attend fairs at immense distances, for the purpose of disposing of produce, and purchasing articles of dress. "What would be thought in England," Dr. Clarke asks, "of a labouring peasant, or the occupier of a small farm, making a journey of nearly 700 miles to a fair, for the articles of their home consumption?" Yet he found Finns at the fair at Abo, who had come from Torneo, a distance of 679 miles, for this purpose.

708. *With respect to improvement* the agriculture of Sweden is, perhaps, susceptible of less than that of any of the countries we have hitherto examined; but what it wants will be duly and steadily applied, by the intelligence and industry of all ranks in that country. It must not be forgotten, however, that it is a country of forests and mines, and not of agriculture.

Sect. IX. *Of the present State of Agriculture in Spain and Portugal.*

709. *Spain, when a Roman province,* was undoubtedly as far advanced in agriculture as any part of the empire. It was overrun by the Vandals and Visigoths in the beginning of the fifth century, under whom it continued till conquered by the Moors in the beginning of the eighth century. The Moors continued the chief possessors of Spain

until the middle of the thirteenth century. They are said to have materially improved agriculture during this period; to have introduced various new plants from Africa, and also bucket-wheels for irrigation. Professor Thouin mentions an ancient work by Ebn-al-Awam of Seville, of which a translation into Spanish was made by Banquieri of Madrid, in 1802, which contains some curious particulars of the culture of the Moors in Spain. The Moors and Arabs were always celebrated for their knowledge of plants; and, according to Harte, one fourth of the names of the useful plants of Spain are of Arabian extraction.

710. *Agriculture formed the principal and most honourable occupation among the Moors,* and more especially in Granada. So great was their attention to manure, that it was preserved in pits, walled round with rammed earth to retain moisture: irrigation was employed in every practicable situation. The Moorish or Mohammedan religion forbade them to sell their superflous corn to the surrounding nations; but in years of plenty it was deposited in the caverns of rocks and in other excavations, some of which, as Jacob informs us (*Travels,* let. xiii.), are still to be seen on the hills of Granada. These excavations were lined with straw, and are said (erroneously, we believe) to have preserved the corn for such a length of time, that, when a child was born, a cavern was filled with corn which was destined to be his portion when arrived at maturity. The Moors were particularly attentive to the culture of fruits, of which they introduced all the best kinds now found in Spain, besides the sugar and cotton. Though wine was forbidden, vines were cultivated to a great extent; for forbidden pleasures form a main source of enjoyment in every country. An Arabian author, who wrote on agriculture about the year 1140, and who quotes another author of his nation, who wrote in 1073, gives the following directions for the cultivation of the sugar-cane: —

711. *The canes* "should be planted in the month of March, in a plain, sheltered from the east wind, and near to water; they should be well manured with cow-dung, and watered every fourth day, till the shoots are one palm in height, when they should be dug round, manured with the dung of sheep, and watered every night and day till the month of October. In January, when the canes are ripe, they should be cut into short pieces and crushed in the mill. The juice should be boiled in iron caldrons, and left to cool till it becomes clarified; it should then be boiled again, till the fourth part only remains, when it should be put into vases of clay, of a conical form, and placed in the shade to thicken; afterwards the sugar must be drawn from the canes and left to cool. The canes, after the juice is expressed, are preserved for the horses, who eat them greedily, and become fat by feeding on them. (*Ebn-al-Awam, by Banquieri.* Madrid, 1801, fol.) From the above extract it is evident sugar has been cultivated in Spain upwards of 700 years, and probably two or three centuries before.

712. *About the end of the fifteenth century* the Moors were driven out of Spain, and the kingdom united under one monarchy. Under Charles V., in the first half of the sixteenth century, South America was discovered; and the prospect of making fortunes, by working the mines of that country, is said to have depressed the agriculture of Spain to a degree that it has never been able to surmount. (*Heylin's Cosmographia.* Lond. 1657.) Albyterio, a Spanish author of the seventeenth century, observes, "that the people who sailed to America, in order to return laden with wealth, would have done their country much better service to have staid at home and guided the plough; for more persons were employed in opening mines and bringing home money, than the money in effect proved worth:" this author thinking with Montesquieu, that those riches were of a bad kind which depend on accidental circumstances, and not on industry and application.

713. *The earliest Spanish work on agriculture generally* appeared in 1569, by Herrera: it is a treatise in many books, and, like other works of its age, is made up of extracts from the Roman authors. Herrera, however, had not only studied the ancients, but visited Germany, Italy, and part of France: his work has been translated into several languages; and the later editions contain some essays and memoirs by Augustin, author of *Secrets de l'Agriculture,* Gonzalo de las Cazas on the silkworm, and Mendez and others on bees.

714. *The agriculture of Spain in the middle of the eighteenth century* was in a very neglected state. According to Harte, "the inhabitants of Spain were then too lazy and proud to work. Such pride and indolence are death to agriculture in every country. Want of good roads and navigable rivers (or, to speak more properly, the want of making rivers navigable) has helped to ruin the Spanish husbandry. To which we may add another discouraging circumstance, namely, 'that the sale of an estate vacates the lease: *Venta deschaze renta.*' Nor can corn be transported from one province to another. The Spaniards plant no timber, and make few or no enclosures. With abundance of excellent cows, they are strangers to butter, and deal so little in cows' milk, that, at Madrid, those who drink milk with their chocolate, can only purchase goats' milk. What would Columella say (having written so largely on the Andalusian dairies), if it were possible for him to revisit this country? For certain it is that every branch of rural economics, in the time of him and his uncle, was carried to as high perfection in Spain as in any part of the Roman empire. Though they have no idea of destroying weeds, and scratch the ground instead of ploughing it, yet nature has been so bounti-

ful to them, that they raise the brightest and firmest wheat of any in Christendom." (*Essays*, i.)

715. *A general spirit for improvement* seems to have sprung up in Spain with the nineteenth century, though checked for a while by the wars against Bonaparte; subsequently retarded by internal discords; and again by the cruel interference of the French in 1823. In the midst of these troubles, economical societies have been established at Madrid, Valencia, and Saragossa. That of the latter place is connected with a charitable bank in favour of distressed farmers. Money is advanced to defray the expenses of harvest, and two years allowed for returning it. It commenced its operations in June 1801, and then distributed 458*l.* 2*s.* to one hundred and ten husbandmen. In the August following it had furnished sixty-two horses to as many indigent farmers. The Patriotic Society of Madrid distinguished itself by a memoir on the advancement of agriculture, and on agrarian laws, addressed to the supreme council of Castile, in 1812. It was drawn up by a distinguished member, Don G. M. Jovellanos, who recommends the enclosure of lands, the enactment of laws favourable to agriculturists, the prevention of the accumulation of landed property in mortmain tenure; exposes the noxious state of the estates of the clergy, of various taxes on agricultural productions, and of restrictions on trade and the export of corn. His whole work breathes the most liberal, enlightened, and benevolent spirit, and was in consequence so offensive to the clergy, that they procured his condemnation by the inquisition. (*Ed. Rev.*; *Jacob's Travels.*)

716. *The climate of Spain* is considered by many as superior to that of any country in Europe. It is every where dry, and though the heat in some provinces is very great in the day, it is tempered during the night by breezes from the sea, or from the ridges of high mountains which intersect the country in various directions. In some provinces the heat has been considered insalubrious, but this is owing to the undrained marshes, from which malignant effluvia are exhaled. The mean temperature of the elevated plains of Spain is 59°; that of the coasts, from 41° to 36° of latitude, is between 63½° and 68°, and is therefore suitable for the sugar-cane, coffee, banana, and all plants of the West India agriculture, not even excepting the pine-apple. The latter is cultivated in the open air in some gardens in Valencia and at Malaga.

717. *The surface of Spain* is more irregular and varied by mountains, than that either of France or Germany. These intersect the country at various distances from east to west, and are separated by valleys or plains. The strata of the mountains are chiefly granitic or calcareous; but many are argillaceous, some silicious, and Montserrat, near Cordova, is a mass of rock salt. A remarkable feature in the surface of Spain is the height of some of its plains above the level of the sea. According to Humboldt, the plain of Madrid is the highest plain in Europe that occupies any extent of country. It is 309⅗ fathoms above the level of the ocean, which is fifteen times higher than Paris. This circumstance both affects the climate of that part of the country, and its susceptibility of being improved by canal or river navigation. The rivers and streams of Spain are numerous, and the marshes not very common. Forests, or rather forest-wastes, downs, and Merino sheep-walks are numerous, and, with other uncultivated tracts and heaths, are said to amount to two-thirds of the surface of the country. Some tracts are well cultivated in the vine districts, as about Malaga; and others in the corn countries, as about Oviedo. The resemblance between the Asturias and many parts of England is very striking. The same is the aspect of the country, as to verdure, enclosures, live hedges, hedge-rows, and woods; the same mixture of woodlands, arable, and rich pasture; the same kind of trees and crops, and fruit, and cattle. Both suffer by humidity in winter, yet, from the same source, find an ample recompense in summer; and both enjoy a temperate climate, yet, with this difference, that as to humidity and heat, the scale preponderates on the side of the Asturias. In sheltered spots, and not far distant from the sea, they have olives, vines, and oranges. (*Townsend's Spain*, i. 318.)

718. *The soil of Spain* is in general light, and either sandy or calcareous, reposing on beds of gypsum or granite. The poorest soil is a ferrugineous sand on sandstone rock, only to be rendered of any value by irrigation. The marshes, and also the best meadow soils, are along the rivers.

719. *The landed property* of Spain till the late revolution was similarly circumstanced to that of France and Germany; that is, in the possession of the crown, great nobles, and religious and civil corporations. Tithes were more rigidly exacted by the clergy of Spain, than by those of any other country of Europe (*Jacob's Travels*, 99.), and a composition in lieu of tithes was unknown in most provinces. Great part of the lands of the religious corporations are now sold, and a new class of proprietors are originating, as in France. Some of these estates are of immense extent. The monks of Saint Hieronymo told Jacob that they could travel twenty-four miles from Seville on their own property, which is rich in corn, oil, and wine. Such was the corruption of this convent, that, notwithstanding all their riches, they were deeply in debt. Lands

were and are cultivated in great part by their proprietors; and even the monasteries held large tracts in hand before their dissolution. What is farmed, is let out in small portions of arable land, with large tracts of pasture or waste, and a fixed rent is generally paid, chiefly in kind. The lands are open every where, except immediately round towns and villages. Many persons in Granada are so remote from the farmeries, that during harvest the farmers and their labourers live in tents on the spot, both when they are sowing the corn, and when cutting and threshing it. The hedges about Cadiz are formed of the soccotrine aloe and prickly pear; the latter producing at the same time an agreeable fruit, and supporting the cochineal insect. Farm-houses and cottages are generally built of stone or brick, and often of rammed earth, and are covered with tiles or thatch.

720. *A bad feature in the policy of the old government*, considered highly injurious to agriculture and the improvement of landed property, deserves to be mentioned. This is, the right which the corporation of the mesta or merino proprietors possess, to drive their sheep over all the estates which lie in their route, from their summer pasture in the north, to their winter pasture in the south, of the kingdom. This practice, which we shall afterwards describe at length, must of course prevent or retard enclosing and aration. The *emfiteutic contract* is another bad feature. It prevails in Catalonia, and is found in various other parts of the kingdom. By the *emfiteutic contract* the great proprietor, inheriting more land than he can cultivate to profit, has power to grant any given quantity for a term of years; either absolute or conditional; either for lives or in perpetuity; always reserving a quit rent, like our copyhold, with a relief on every succession, a fine on the alienation of the land, and other seignorial rights dependent on the custom of the district; such as tithes, mills, public-houses, the obligation to plough his land, to furnish him with teams, and to pay hearth-money, with other contributions, by way of commutation for ancient stipulated services. One species of grant for uncultivated land, to be planted with vines, admitted formerly of much dispute. The tenant, holding his land as long as the first planted vines should continue to bear fruit, in order to prolong this term, was accustomed to train layers from the original stocks, and, by metaphysical distinctions between identity and diversity, to plead that the first planted vines were not exhausted, claiming thus the inheritance in perpetuity. After various litigations and inconsistent decisions of the judges, it was finally determined, that this species of grant should convey a right to the possession for fifty years, unless the plantation itself should previously fail.

721. *The agricultural products of Spain* include all those of the rest of Europe, and most of those of the West Indies; besides all the grains, for the production of which some provinces are more celebrated than others, and most of them are known to produce the best wheat in Europe. Boswell of Balmuto, a Scottish landholder, when at Xeres de la Fronteira, in the winter of 1809, was shown, on the estate of Mr. Gordon, a very beautiful crop of turnips, with drills drawn in the most masterly style. The drills were by a ploughman of East Lothian, and therefore their accuracy was not to be wondered at; but the turnips showed what the soil and climate were capable of producing under judicious management. Other products are flax, hemp, esparto, palmetto (*C*hamæ'rops hùmilis), madder, saffron, aloe, cork tree (*Qu*ércus *S*ùber); the kermes grana, a species of coccus, whose body in the grub state yields a beautiful scarlet colour, and which forms its nidus on the shrub *Qu*ércus coccífera; soda from the Salicórnia and other plants of the salt marshes; honey from the forests; dates (*P*hœ'nix dactylífera), coffee, almonds, filberts, figs, olives, grapes, peaches, prickly pears, carob beans (the locust trees of scripture, *C*eratònia síliqua), oranges, lemons, pomegranates, and other fruits.

722. *The esparto rush* (*Stìpa tenacíssima* L.) grows wild on the plains, and is made into a variety of articles for common use. It is employed for making ropes and cables, and is particularly calculated for the latter purpose, as it swims on the water, and the cables formed of it are, consequently, not so liable to rub against the rocks as those which are made of hemp. It is also woven into floorcloths and carpets, and made into baskets or panniers, for carrying produce to market, or manure to the fields. In Pliny's time this plant was used by the poor for beds, by the shepherds for garments, and by the fishermen for nets; but it is now superseded for these and various other ends by the hemp and flax.

723. *The pita,* or aloe (*A*'loe soccotorìna, *fig.* 94.), is an important plant in the hus-

bandry of Spain. It grows by the leaf, which it is only necessary to slip off, and lay on the ground with the broad end inserted a little way in the soil: it makes excellent fences; and the fibres, separated from the mucilage, have been twisted into ropes, and woven into cloth. Bowles, the best Spanish writer on natural history, says, the mucilage might easily be made into brandy. The same plant is used as the boundary fence for villages in the East Indies, and is found a powerful obstacle to cavalry.

724. *The hina,* or Indian fig (Cáctus Opúntia, *fig.* 94. *b*), is cultivated in the plains of Seville for its fruit, and also for raising the cochineal insect. It is either grown on rocky places or as hedges.

725. *The palmetto,* or fan palm (Chamæ'rops hùmilis), is grown near Seville. From the foot-stalks of the leaves, brushes and brooms of various kinds are formed both for home use and exportation.

726. *The potato* is grown, but not in large quantities; nor so good as in England. The Irish merchants of the sea-ports import them for themselves and friends. The batatas, or sweet potato (Convólvulus *Batàtas*), turnips, carrots, cabbages, broccoli, celery, onions, garlic, melons, pumpkins, cucumbers, &c., are grown in large quantities.

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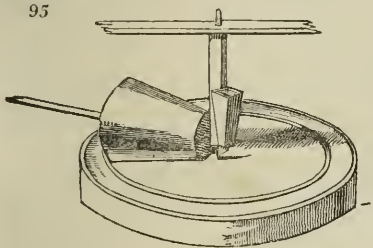

727. *Though the olive* is grown to greater perfection in Spain than in Italy, yet the oil is the worst in Europe; because the growers are thirled, that is obliged to grind their fruit at certain mills. To such mills (*fig.* 95.) all the olives of a district are obliged to be carried; and, as they cannot all be ground alone, they are put into heaps to wait their turn: these heaps heat and spoil, and when crushed, produce only an acrid rancid oil.

728. *The vine* is cultivated in every province of Spain, and chiefly in those of the east and south. The old sherry wine, *Xeres seco,* the sherry sack of Shakspeare, is produced in Valencia and Granada, and especially near Malaga. On the hills surrounding this city are upwards of seven thousand vineyards, cultivated by the proprietors, or by petty tenants who pay their rent monthly when in money, or during harvest when in kind. The first gathering of grapes commences in the month of June, and these are dried in the sun, and form what are known in Europe as Malaga raisins. A second crop is gathered in September, and a wine made from it resembling sherry; and a third in October and November, which furnishes the wine known on the Continent as Malaga, and in England as mountain. In Valencia the grapes for raisins are steeped in boiling water, sharpened with a ley made from vine stems, and then exposed in the air, and suspended in the sun till they are sufficiently dry.

729. *The sugar-cane* (*Sáccharum officinàrum*) is cultivated to a considerable extent in Malaga and other places, and the ground is irrigated with the greatest care. The sugar produced resembles that of Cuba, and comes somewhat cheaper than it can be procured from the West India Islands. Sugar has been cultivated in Spain upwards of seven hundred years; and Jacob is of opinion that capital only is wanted to push this branch of culture to a considerable extent.

730. *The white mulberry* is extensively grown for rearing the silkworm, especially in Murcia, Valencia, and Granada. The silk is manufactured into stuffs and ribands in Malaga.

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731. *Of other fruits cultivated* may be mentioned the fig, which is grown in most parts of Spain, and the fruit used as food, and dried for exportation. The gum cistus (Cístus ladaníferus, *fig.* 96.) grows wild, and the gum which exudes from it is eaten by the common people. The caper shrub grows wild, and is cultivated in some places. The orange and lemon are abundant, and also the pomegranate.

732. *Other productions,* such as coffee, cotton, cocoa, indigo, pimento, pepper, banana, plantain, &c., were cultivated in Granada for many ages before the West Indies or America was discovered, and might be carried to such an extent as to supply the whole or greater part of Europe.

733. *The rotations of common crops* vary according to the soil and climate. In some parts of the fertile plains of Malaga, wheat and barley are grown alternately without either fallow or manure. The common course of crops about Barcelona, according to Townsend, is, 1. wheat, which, being ripe in June, is immediately succeeded by 2. Indian corn, hemp, millet, cabbage, kidneybeans, or

lettuce. In the second year the same crops are repeated; and in the third, the place of wheat is supplied by barley, beans, or vetches. In this way six valuable crops are obtained in three years. Wheat produces tenfold; in rainy seasons fifteen, and in some places as much as fifty, for one. Near Carthagena the course is wheat, barley, and fallow. For wheat they plough thrice, and sow from the middle of November to the beginning of December; and in July they reap from ten to one hundred for one, as the season happens to be dry or humid. The Huerta, or rich vale of Alicant, yields a perpetual succession of crops. Barley is sown in September, and reaped in April; succeeded by maize, reaped in September; and that by a mixed crop of esculents. Wheat is sown in November, and reaped in June; flax sown in September is pulled in May. In the vale of Valencia, wheat yields from twenty to forty fold; barley from eighteen to twenty-four fold; oats from twenty to thirty fold; maize, one hundred fold; rice, forty fold.

734. *The live stock of the Spanish agriculturist* consists of oxen, asses, and mules, as beasts of labour; sometimes, also, horses are used on the farm, but these are chiefly reared for the saddle and the army. During the reign of Philip II. an act was passed forbidding their use even in coaches. The horses of Andalusia are celebrated: they are deep-chested, somewhat short-backed; rather heavy about the legs, but with a good shoulder. In general their appearance is magnificent when accoutred for the field. But for the last half century their numbers have been diminishing. The mules and asses are large, and carry heavy loads. The Spanish cows are an esteemed breed, resembling those of Devonshire. They are used chiefly for breeding, there being little use made of cow's milk in most parts of Spain; they are sometimes also put to the plough and cart. Goats are common about most towns, and furnish the milk used in cookery.

735. *The sheep of Spain* have long been celebrated. Pliny relates, that in his time Spanish clothes were of an excellent texture, and much used in Rome. For many centuries the wool has been transported to Flanders, for the supply of the Flemish manufactories, and afterwards to England, since the same manufacture was introduced there. By far the greater part of Spanish sheep are migratory, and belong to what is called the mesta or merino corporation; but there are also stationary flocks belonging to private individuals in Andalusia, whose wool is of equal fineness and value. The carcass of the sheep in Spain is held in no estimation, and only used by the shepherds and poor.

736. The term *mesta* (equivalent to *meslin*, Eng.) in general signifies a mixture of grain; but in a restricted sense a union of flocks. This collection is formed by an association of proprietors of lands, and originated in the time of the plague in 1350. The few persons who survived that destructive calamity, took possession of the lands which had been vacated by the death of their former occupiers; united them with their own; converted nearly the whole to pasturage; and confined their attention principally to the care and increase of their flocks. Hence, the immense pastures of Estremadura, Leon, and other provinces; and the prodigious quantity of uncultivated lands throughout the kingdom. Hence, also, the singular circumstance of many proprietors possessing extensive estates without any titles to them.

737. *The flocks which form the mesta* usually consist of about 10,000 sheep each. Every flock is under the care of a directing officer, fifty shepherds, and fifty dogs. The whole flocks, composing the mesta, consist of about five millions of sheep, and employ about 45 or 50,000 persons, and nearly as many dogs. The flocks are put in motion in the latter end of April, or beginning of May, leaving the plains of Estramadura, Andalusia, Leon, and Old and New Castile, where they usually winter, and they repair to the mountains of the two latter provinces, and those of Biscay, Navarre, and Arragon. The sheep, while feeding on the mountains, have occasionally administered to them small quantities of salt. It is laid upon flat stones, to which the flocks are driven, and permitted to eat what quantity they please. During the days the salt is administered the sheep are not allowed to depasture on a calcareous soil, but are moved to argillaceous lands, where they feed voraciously. (*Townsend.*)

738. *At the end of July* the ewes are put to the rams, after separation has been made of those already with lamb. Six or seven rams are considered sufficient for one hundred ewes.

739. *In September* the sheep are ochred, their backs and loins being rubbed with red ochre, or ruddle, dissolved in water. This practice is founded upon an ancient custom, the reason of which is not clearly ascertained. Some suppose that the ochre, uniting with the oleaginous matter of the fleece, forms a kind of varnish, which defends the animal from the inclemency of the weather; others think the ponderosity of this earth prevents the wool growing too thick and long in the staple: but the more eligible opinion is, that the earth absorbs the superabundant perspiration, which would otherwise render the wool both harsh and coarse.

740. *Towards the end of September* the flocks recommence their march. Descending from the mountains, they travel towards the warmer parts of the country, and again repair to the plains of Leon, Estremadura, and Andalusia. The sheep are generally conducted to the same pastures they had grazed the preceding year, and where most of them had been yeaned: there they are kept during the winter.

741. *Sheepshearing* commences in the beginning of May, and is performed while the sheep are on their summer journey, in large buildings called *esquileos*. Those, which are placed upon the road, are capable of containing forty, fifty, and some sixty thousand sheep.

They are erected in various places; but the principal are in the environs of Segovia, and the most celebrated is that of Iturviaca. The shearing is preceded by a pompous preparation, conducted in due form, and the interval is considered a time of feasting and recreation. One hundred and twenty-five men are usually employed for shearing a thousand ewes, and two hundred for a thousand wethers. Each sheep affords four kinds of wool, more or less fine according to the parts of the animal whence it is taken. The ewes produce the finest fleeces, and the wethers the heaviest: three wether fleeces ordinarily weigh on the average twenty-five pounds; but it will take five ewe fl eces to amount to the same weight.

742. *The journey which the flocks make* in their peregrination is regulated by particular laws, and immemorial customs. The sheep pass unmolested over the pastures belonging to the villages and the commons which lie in their road, and have a right to feed on them. They are not, however, allowed to pass over cultivated lands; but the proprietors of such lands are obliged to leave for them a path ninety varas, or about forty toises (eighty-four yards), in breadth. When they traverse the commonable pastures, they seldom travel more than two leagues, or five and a half miles, a day; but when they walk in close order over the cultivated fields, often more than six varas, or nearly seventeen miles. The whole of their journey is usually an extent of one hundred and twenty, thirty, or forty leagues, which they perform in thirty or thirty-five days. The price paid for depasturing the lands where they winter is equally regulated by usage, and is very low; but it is not in the power of the landed proprietors to make the smallest advance.

743. *The mesta has its particular laws*, and a tribunal before which are cited all persons who have any suit or difference with the proprietors. The public opinion in Spain has long been against the mesta, on account of the number of people it employs, the extent of land it keeps uncultivated, the injury done to the pasture and cultivated lands of individuals, and the tyranny of the directors and shepherds. These have been grievances from time immemorial. Government, yielding to the pressing solicitations of the people, instituted a committee to enquire into them about the middle of the eighteenth century; but it did no good, and it was not till the revolution of 1810, that the powers and privileges of the mesta were greatly reduced.

744. *The implements* of Spanish agriculture are very simple. The common plough of Castile and most of the provinces (*fig.* 97.) is supposed to be as old as the time of the Romans. It it thus described by Townsend: "The beam is about three feet long, curved, and tapered at one end, to receive an additional beam of about five feet, fastened to it by three iron collars; the other end of the three-foot beam touches the ground, and has a mortise to receive the share, the handle, and a wedge."

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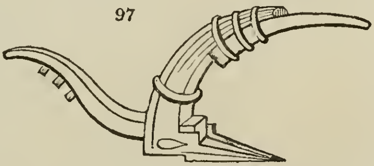

From this description it is evident that the beam itself supplies the place of the sheath; the share has no fin, and instead of a mould-board, there are two wooden pins fastened near the heel of the share. As in this plough the share, from the point to its insertion in the beam, is two feet six inches long, it is strengthened by a retch. That used near Malaga is described by Jacob as "a cross, with the end of the perpendicular part shod with iron. It penetrates about six inches into the soil, and is drawn by two oxen with ropes fastened to the horns. The plough of Valencia, on the eastern coast, we have already given (*fig.* 12.) as coming the nearest to that described by Virgil. There are many wheels and other contrivances used for raising water; the most general, as well as the most primitive, is the noria (*fig.* 98.), or bucket wheel, introduced by the Moors, from which our chain pump is evidently derived. A vertical wheel over a well has a series of earthen jars, fastened together by cords of esparto, which descend into the water and fill themselves; by the motion of the wheel they

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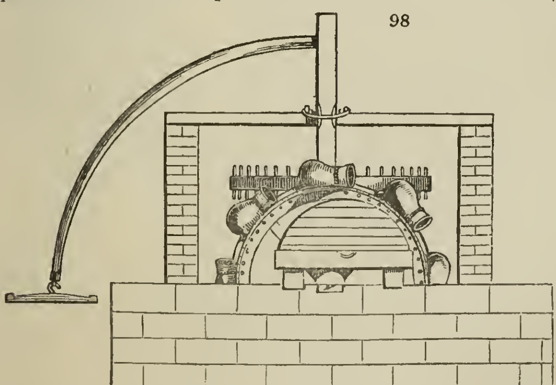

rise to the surface, and then by the same motion empty themselves into a trough, from which the water is conveyed by trenches into the different parts of the garden or field. The vertical wheel is put in motion by a horizontal one, which is turned by a cow." (*Jacob's Travels*, 152.) The construction of dung-pits has already been mentioned, (710.) as introduced by the Moors, and the practice of preserving the dung in that manner is still continued in Granada and Valencia. Threshing-floors are made in the fields, and paved with pebbles or other stones.

745. *Few of the operations of Spanish agriculture* afford any thing characteristic. No hay is made in Spain (*Townsend*); and so dry and brittle is the straw of the corn crops, that in the process of treading out, which is generally done by mares and colts, it is broken to pieces. The grain being separated, the straw is put in stacks, and preserved for litter, or mixed with barley as food for cattle. Irrigation is carefully performed, and is the only effectual mode of insuring a crop of grain, or any sort of herbaceous vegetable. On some farms on the Vega in Malaga, scarcely any attention is paid to stirring the soil, but by the very complete irrigation which can be there given, the land yields fifty bushels per acre. Where the soil is naturally light, situated in a warm climate, and not irrigated, it is remarkably free from weeds; because from the latter end of May, or the beginning of June, when the crop is harvested, till October or November, they have no rain; and the heat of the sun during that period destroys every plant, and leaves the soil like a fallow which only requires the seed furrow. In effect it gets no more; and thus, under such circumstances, one crop a year, after only one ploughing, may be raised for an endless period. —In the Asturias, after the women milk the sheep, they carry the milk home in leather bags, shaking it all the way, till by the time of their arrival butter is formed. (*Townsend's Travels*, i. 273.)

746. *The labouring man of Spain* adopts a custom which might be useful to the reapers and haymakers of Britain, in many situations. The labour and heat of hay time and harvest excite great perspiration and consequent thirst, which it is often necessary to quench with sun-warmed water. To cool such water, the Spanish reaper puts it in a porous earthen pitcher (alcarraza), the surface of which being constantly moist with the transudation of the fluid, its evaporation cools the water within. The frequent application of wet cloths to a bottle or earthen vessel, and exposure to the sun and wind, effects the same object, but with more trouble.

747. *The culture of forests* is very little attended to in Spain. The best charcoal is made from heath, chiefly the *E*rica mediterrànea, which grows to the size of a small tree, and of which there are immense tracts like forests. The cork tree (Quércus Sùber, *fig.* 99.) affords the most valuable products. The bark is taken off for the first time when the tree is about fifteen years old; it soon grows again, and may be rebarked three times, the bark improving every time, till the tree attains the age of thirty years. It is taken off in sheets or tables, much in the same way as oak or larch bark is taken from the standing trees in this country. After being detached, it is flattened by presenting the convex side to heat, or by pressure. In either case it is charred on both surfaces to close the transverse pores previously to its being sold. This charring may be seen in bungs and taps; but not in corks, which, being cut in the long way of the wood, the charring is taken off in the rounding.

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748. *The exertions that have been made for the improvement of the agriculture of Spain* we have already noticed, and need only add, that if the late government had maintained its power, and continued in the same spirit, perhaps every thing would have been effected that could be desired. Time, indeed, would have been requisite; but improvement once heartily commenced, the ratio of its increase is astonishing. But the French invasion of Spain, first under Bonaparte, and again under the Bourbons, has spoiled every thing, and for the present almost annihilated hope.

749. *The agricultural circumstances of Portugal* have so much in common with those of Spain, that they do not require separate consideration. The two countries differ in the latter having a more limited cultivation, the sugar-cane, and most of the West India plants grown in Spain, requiring a warmer climate than that of Portugal. The vine and orange are cultivated to great perfection; but common agriculture is neglected. The breed of horses is inferior, and there are few cows or sheep. Swine form the most abundant live stock, and fatten, in a half wild state, on the acorns of the numerous oak forests which cover the mountains.

Sect. X. *Present State of Agriculture in European Turkey.*

750. *The Turkish empire includes a variety of climates and countries*, of most of which so little is correctly known, that we can give no satisfactory account of their agriculture. Asiatic Turkey is nearly three times the extent of the European part; but the latter is better cultivated and more populous. "European Turkey," Thornton observes, "depends upon no foreign country for its subsistence. The labour of its inhabitants produces, in an abundance unequalled in the other countries of Europe, all the alimentary productions, animal and vegetable, whether for use or enjoyment. The corn countries, in spite of the impolitic restrictions of the government, besides pouring plenty over the empire, secretly export their superfluities to foreign countries. Their agriculture, therefore, though neglected and discouraged, is still above their wants." (*Present State of Turkey*, vol. i. p. 66.)

751. *The climate and seasons of European Turkey* vary with the latitude and local circumstances of the different provinces, from the Morea, in lat. 37° and surrounded by the Mediterranean sea, to Moldavia, between Hungary and Russia, in lat. 48°. The surface is generally mountainous, with plains and vales; some rivers, as the Danube in Wallachia, and numerous gulfs, bays, estuaries, and inlets of the Adriatic, the Archipelago, the Mediterranean, and the Black Seas. The soil is in general fertile, alluvial in some of the richest plains of Greece, as Thessaly; and calcareous in many parts of Wallachia and Moldavia. These provinces produce excellent wheat and rich pasture; while those of the south produce maize, wheat, and rice. The vine is cultivated in most provinces; and there are extensive forests, especially in the north. The live stock consists of the horse, ox, camel, sheep, and swine. (*Thornton.*)

752. *Some traits of the agriculture of the Morea*, the southernmost province of European Turkey, have been given by Dr. Pouqueville. The climate holds the exact medium between the scorching heat of Egypt and the cold of more northern countries. The winter is short, but stormy; and the summer is hot, but tempered by breezes from the mountains or the sea. The soil of the mountains is argillaceous; in some places inclining to marl, and in others to peat or vegetable earth: the richest parts are Arcadia and Argos. The plough consists of a share, a beam, and a handle (*fig.* 100.); the share is shaped somewhat like the claw of an anchor, and the edges armed with iron. In some cases it has two wheels. It is drawn by one horse, by two asses, or by oxen or buffaloes, according to the nature of the soil. The corn grown is of excellent quality, though no attention is paid to selecting the seed. The rice of Argolis is held at Constantinople the next in excellence to that of Damietta. The vine is successfully cultivated; but at Corinth, "situated in a most unwholesome atmosphere," the culture of that sort which produces the raisins of Corinth is less attended to than formerly. The olive trees (*O'lea europæ'a*, *fig.* 101.) are the finest in the world; the oil of Maina is the best, and held in esteem at all the principal markets of Europe. The white mulberry is extensively cultivated for the support of the silkworm. Elis yields the best silk. The cotton is cultivated in fields, which are commonly divided by hedges of Nepal or Indian fig, which is eaten, but is here more vapid than in Egypt.

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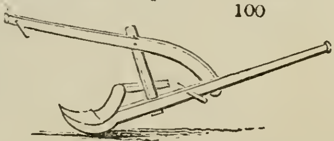

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753. *The figs of the Morea* "are perhaps the most exquisite that can be eaten." The tree is cultivated with particular care, and the practice of caprification adopted. They collect the little figs which have fallen from the trees while very young, and which contain numbers of the eggs of the gnat insect (Cy̆nips). Of these they make chaplets, which are suspended to the branches of the trees. The gnats are soon hatched, and spread themselves over the whole tree. The females, in order to provide a nidus for their eggs, pierce the fruit with their sting, and then deposit them. From this puncture a gummy liquor oozes; and after this the figs are not only not liable to fall, but grow larger and finer than if they had not undergone this operation. It is doubted by some modern physiologists whether this process is of any real use, it being now neglected in most fig countries where it was formerly performed. Some allege that it is merely useful as fecundating the blossoms, which most people are aware are situated inside of the fruit; others that it promotes precocity, which the puncture of an insect will do in any fruit, and which any one may have observed in the gooseberry, apple, or pear.

754. *The almond tree* is very productive. The orange tribe abounds; and the pomegranates, peaches, apricots, grapes, &c., are of the finest flavour. The banana is cultivated in the gardens, as are melons, dates, and many other fruits. Carobs (Ceratònia), quinces, medlars, cherries, &c. are wild in abundance. Bees are found in the hollows of trees; and their excellent white honey is exported.

755. *The oxen of the Morea* are low, and have long white hair. The most fleshy do not weigh more than from 300 to 400 pounds. The cows give little milk, and are much injured by the jackals, who tear away their teats; and by large serpents, which are said to suck the milk. The sheep are small, and have large horns; their wool is considered of the second quality of the wool of the East. Cheese is made from their milk, and that of goats. The horses of the Morea are of a breed between the Moravian and Thracian: their form is not admired; but they are full of fire and courage; and so vigorous, that they run with a firm and rapid step over the mountains without ever stumbling. The asses are miserable.

756. *The forests of the Morea* produce the cork-tree; the kermes oak; the *Quércus E'sculus*, or Velonia oak, the acorns of which are eaten, and their cups used as oak-galls, in preparing black dye; the azarole, plane, larch, wild olive, sweet chestnut, manna ash; grains d'Avignon (*Rhámnus* infectòrius *L.*), from the grains or seeds of which a fine yellow dye is prepared; Lawsònia inérmis, which furnishes a fine aurora colour, with which the women of the East dye their nails; the turpentine tree, barren date trees, silk tree (Mimòsa *Julibrissin*) with its beautiful tufts, pine fir, and a variety of others. Chestnuts were at one period the temporary food of nearly the whole country: on Mount Pholoe, where the peasants are half savages, they form the principal food for the whole year. A variety of plants used in the arts and in pharmacy grow wild in the wastes, and there are venison and game in the woods, and fishes in the rivers, lakes, and the surrounding ocean. The Morea, Dr. Pouqueville concludes, is "a fine country:" and though one does not find the golden age here renewed, yet, "under a better order of things, it will produce abundantly every thing necessary to supply the wants of man." (*Travels, transl. by A. Plumtree*, p. 206.)

757. *Some notices of the agriculture of Thessaly and Albania* have been given by Dr. Holland. The plain of Thessaly (*fig.* 102.) is an immense tract of level country, with a fine alluvial soil, which tradition and external appearance concur in testifying, was once covered with water. "The capabilities," Dr. Holland observes, "are great throughout the whole of this fine province;

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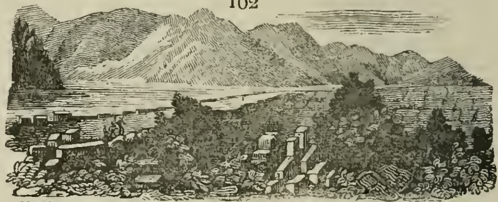
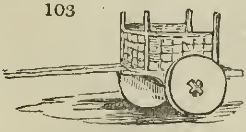


and it would not be easy to fix a limit to the amount and variety of produce which might be raised from its surface. In their present state, the plains of Thessaly form one of the most productive districts of the Grecian peninsula, and their annual produce, in grain of different kinds, cotton, silk, wool, rice, and tobacco, allows a very large amount of regular export from the provinces." The cultivation is not deficient in skill or neatness. Their plough is of a primitive form; and their carts are small cars, some of them, as Dr. Clarke observes, simple enough (*fig.* 103.); both are drawn by oxen or buffaloes. The wool of the sheep is moderately fine; the mulberry is grown in dwarf pollards; and the cotton in drills, well hoed. The men are a stern-looking race, and the women well made, and not unlike the antique. "The circumstances by which the amount of produce might be increased, are chiefly, perhaps, of a more general nature, — a better form of government; greater security to private property; a more uniform distribution of the inhabitants; and the prevention of those monopolies in the export of grain, which have hitherto been exercised by the Turkish rulers of the country. (*Travels*, 2d. edit. p. 281.)

103



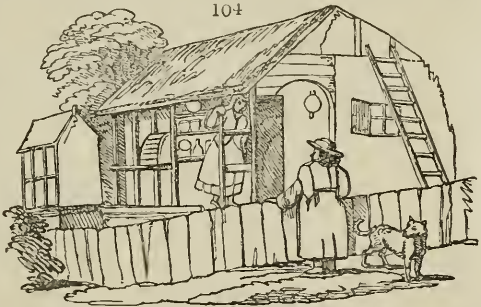
758. *The agriculture of Albania* differs in no essential particular from that of Thessaly. The common tenure on which land is let, is that of paying to the landlord half the produce. The vale of Deropuli is the most fertile and populous in Albania. The tillage, generally speaking, is remarkable for its neatness. The products are chiefly wheat, maize, tobacco, and rice. The returns afford a considerable surplus for exportation; and the tobacco is esteemed the best in Albania. Large flocks of sheep feed on the declivity of the mountains, and afford much coarse wool for the manufactures of the country.

759. *The agriculture of Moldavia and Wallachia*, two the most northerly provinces of European Turkey, has been given by various authors, as Carra, Bauer, and Thornton. The climate of those provinces is very severe in winter. Spring begins in April; summer in June; and in July and August the days are excessively hot, and the nights cold. Heavy rains begin in September, and snows in November. The surface is generally mountainous: but the valleys are dry and rich. The usual grains are cultivated, and also

maize. They plough deep with six oxen, and never employ manure. They take a crop, and leave the land to rest, alternately. The corn is trodden out by horses, and then laid up in pits. Flax and hemp are sown for local manufacture. Newly broken up lands are planted with cabbages, which grow to a great size. The vine is cultivated on the southern declivities of hills, and the wine is said to equal that of Hungary. The mulberry is cultivated for the silkworm; and forests are extensive on the mountains. The common fruit trees are abundant, and an excellent variety of apple, called the doiniasca, grows wild. The olive and fig are too delicate for the climate.

760. *But the pasture lands* are the most valuable parts of these provinces. The oxen are large and fleshy, and so numerous that they form a principal article of export to Russia, Poland, and Germany. The buffalo thrives better here than in most parts of Europe; and is valued for its strength and milk. The sheep winter on the Danube, and pass the summer on the Carpathian mountains; their mutton is excellent, and the annual exportation of the wool into Germany is very considerable. There are various breeds of horses; they are brought up in great numbers, for the Austrian and Prussian cavalry. They are well formed, spirited, docile, and remarkable for the soundness of their hoofs. The carriage and draught horses are small but active, and capable of resisting fatigue. They live in the open air in all seasons, though in winter they are often attacked by wolves. Domestic fowls and game abound, especially hares. The honey and wine are of the finest quality. One author (Carra) mentions a kind of green wax, which, being made into tapers, diffuses an excellent perfume when lighted. Many of the cottages partake of the Swiss character, and are more picturesque than those of Hungary or Russia. (*fig.* 104.)

104



761. *The poorest agriculture in European Turkey* is that of Romelia, including the country round Constantinople. The surface is hilly, and the soil dry and stony, chiefly in pasture or waste. "The capital of the empire," Thornton observes, "as the soil in its immediate vicinity is barren and ungrateful, receives from the neighbouring villages, and from the surrounding coasts of both the seas which it commands, all the culinary herbs and fruits of excellent flavour, which the most fastidious appetites can require; and from the Asiatic coasts of the Black Sea, all materials necessary for fuel, or for the construction of ships and houses."

Chap. V.

Modern History and present State of Agriculture in the British Isles.

762. Having, in the preceding chapter, brought down the history of British agriculture to the revolution, we shall resume it at that period, and continue our view to the present time. As this period may be considered the most interesting of the whole series, we shall, for the sake of distinctness, arrange the matter under the separate sections of the political, professional, and literary history of agriculture in Britain, and submit a separate view of the progress and present state of agriculture in Ireland.

Sect. I. *Political History of Agriculture in Britain, from the Revolution in* 1668 *to the present Time.*

763. *That the agriculture and general prosperity of this country were greatly benefited by the revolution* is an undisputed point. That prosperity, as far as respects agriculture, has been ascribed to the corn-laws then promulgated. "In 1670," a masterly writer on the subject remarks, "exportation was permitted, whatever the price might be; and importation was virtually prohibited, by a duty of 16*s.* per quarter, when wheat did not exceed 53*s.* 4*d.*; of 8*s.* when above that, and not exceeding 80*s.*; and when above 80*s.* the duty of 5*s.* 4d., imposed by the act of 1663, continued to be payable. Still, however, as there was a duty payable on exportation; and as importation, from some defect

in the law respecting the mode of ascertaining the prices at which the different duties were exigible, still continued at the low duty, the system by which exportation was encouraged, and importation in ordinary cases prohibited, was not completely established till 1688 and 1700. In the former of these years, a bounty of 5*s.* a quarter was given on exportation, when the price of wheat did not exceed 48*s.*, and in the latter the duties on exportation were wholly repealed. Under these laws, not only was the excess of exports very considerable, but the prices of grain, down to 1765, were much lower than during an equal number of years preceding 1688. This is not the place to enquire how far these laws had an influence in producing this phenomenon; but the facts themselves are indisputable. Yet the mere circumstance of large exportations of grain does by no means prove the prosperity of agriculture ; far less is its cheapness in the home markets any evidence of the comfortable subsistence of the lower orders. Corn seems to have been raised in such abundance, not merely because the market was extended by means of the bounty, but because there was little demand for other products of the soil, which have, since that time, withdrawn a large portion of the best arable land from the growth of corn. And the price was low, because neither the number nor wealth of the consumers had increased in a proportion corresponding to the supply. Before the accession of his present majesty, the number of acts for enclosure was only two hundred and forty-four ; a clear proof that agricultural improvements proceeded much more slowly than they have done since. And it cannot be disputed, that, owing to the imperfect culture of that period, when ameliorating crops did not enter largely into the courses of management, any given extent of land did not produce so much corn as under the improved rotations of modern husbandry."

764. *The exportation of wool* was prohibited in 1647, in 1660, and in 1668 ; and the prohibition strictly enforced by subsequent statutes. The effect of this on its price, and the state of the wool trade, from the earliest period to the middle of last century, are distinctly exhibited by the learned and laborious author of *Memoirs on Wool*, printed in 1747.

765. *In* 1765 *the corn-laws established in the end of the seventeenth century began to be repealed*, and exportation was prohibited, and importation permitted without payment of duties, by annual acts, during the seven subsequent years. " A new system was established in 1773, allowing importation when the price of wheat was at or above 48*s.* per quarter, at the low duty of 6*d.* Exportation was prohibited when the price was 44*s.* ; and below that the former bounty of 5*s* per quarter continued to be payable."

766. *By an act passed in* 1791, the bounty on exportation, when the price was under 44*s.* per quarter, remained unaltered ; but " exportation was permitted till the price was 46*s.* Importation was virtually prohibited by high duties when the price was below 50*s.* ; and permitted, on payment of a duty of 6*d.*, when at or above 54*s.*"

767. *In* 1804, " the corn-laws were altered for the third time, and the bounty on exportation was paid till the price of wheat was 48*s.* per quarter ; and at 54*s.* exportation was prohibited. The high duty of 24*s.* 3*d.* was payable on importation till the price was 63*s.* ; above 63*s.* and under 66*s.* a duty of 2*s.* 6*d.* ; and above 66*s.* the low duty of 6*d.* By an act in 1805, importation into any part of Britain is to be regulated by the aggregate average price of the twelve maritime districts of England. Importation was never stopped under the law of 1804, till February 1815.

768. *During the twenty-two years* preceding 1821, about sixty millions of pounds sterling have been paid for foreign grain. " In bad seasons the prices have been enhanced to a most alarming degree, notwithstanding large bounties have been paid on importation. The average price of every successive period of ten years, from 1765 to 1814, has risen considerably ; and since 1795, the price has been seldom less than double the average of the first sixty years of the last century."

769. *The corn-laws since* 1814 have undergone a change in almost every session of parliament. According to the corn act of 1828, foreign corn is admitted at 52*s.* per imperial quarter for a duty of 34*s.* 8*d.* per quarter, and from 52*s.* to 73*s.* at a graduated scale of duties, being admitted at the latter price at 1*s.* per quarter. Barley at 24*s.* is admitted on a duty of 25*s.* 10*d.* per quarter, and from 24*s.* to 41*s.* on a graduated scale of duties ; so that at the latter price it is admitted at 1*s.* per quarter. Oats are admitted at 18*s.* per quarter, at a duty of 19*s.* 9*d.* per quarter, and from 18*s.* to 31*s.* on a graduated scale of duties ; so that at the latter price the duty is 1*s.* per quarter. In like manner rye, peas, and beans, when at 29*s.* are admitted at 25*s.* 9*d.* per quarter, and when at 46*s.* at 1*s.* (*Quar. Jour. of Agriculture*, vol. i. p. 228.)

770. *Agriculture in Scotland* was at low ebb at the period of the revolution. " The calamity of that evil had so oppressed the tenantry of Scotland, that many farms remained unoccupied. Proprietors were then as eager in searching after tenants who were able to stock and cultivate the ground, as farmers were assiduous in seeking after farms previously to the late general peace. Improvements began to be made soon after the union, especially by some gentlemen of East Lothian, and by the efforts of the Agricultural Society of Scotland, established in 1723. It was now found beneficial to grant long leases, which were found greatly to increase the skill and industry of the tenants, by rendering them secure of enjoying the benefit of their improvements. A great stimulus was also given to farmers by the money circulated during the rebellion of 1745, which raised prices, and increased the tenants' capital stock."

771. *A desire to improve the roads of Scotland* now began to manifest itself among the proprietors. The first act of parliament for collecting tolls on the highways in Scotland, was passed in 1750, for repairing the road from Dunglass bridge to Haddington. In

ten years after, several acts followed for the counties of Edinburgh and Lanark, and for making the roads between Edinburgh and Glasgow. The benefit which agriculture has derived from good roads it would not be easy to estimate. The want of them was one great cause of the slow progress of the art in former times. At present, all the improvements introduced by M'Adam in the construction and preservation of the roads of England, are spreading with equal rapidity and good effect in Scotland.

772. *The relaxing of the rigour of entails, and abrogating the feudal system*, greatly benefited the agriculture of Scotland. The first was effected by an act in 1770, which relaxed the rigour of strict entails, and extended the powers of proprietors, in so far as regards the improvement of their estates, and the granting of leases.

773. *But the general progress of agriculture in Britain*, from the revolution to the middle of the eighteenth century, was by no means so considerable as from the great exportation of corn we should be led to imagine. "The gradual advance in the price of land produce, soon after the year 1760, occasioned by the increase of population, and of wealth derived from manufactures and commerce, has given a more powerful stimulus to rural industry, augmented agricultural capital in a greater degree, and called forth a more skilful and enterprising race of cultivators, than all the laws for regulating the corn trade could ever have effected. Most of the inventions for increasing produce and economising labour have either been introduced, or improved and greatly extended, since that time; and by means of both, the free surplus has been vastly increased for the supply of the general consumption. The passing of more than three thousand bills of enclosure, in the late reign, is a proof how much more rapidly the cultivation of new land has proceeded than in the former period: and the garden-like appearance of the country, as well as the striking improvement in the condition of all classes of the rural population, display, in the most decided manner, the skill and the success with which this great branch of national industry is now followed throughout the greater part of Britain."

774. *Since the conclusion of the American war in* 1782, "improvement has proceeded with singular rapidity in every district; and while the rental rolls of proprietors have been doubled, tripled, and quadrupled, the condition of the tenantry, and of the lower ranks, has been ameliorated almost in a proportional degree." (*Ed. Ency.* art. *Agr.*)

775. *Since the period of* 1815, *agriculture has sustained a severe shock* from the fall of prices, occasioned by the lessened circulation of currency, the necessary preliminary to a return to a currency of the precious metals. In this shock many hundreds of farmers lost all their capital, and were obliged to become operatives to others; while some, more fortunate, contrived to retain as much of the wreck of their property as enabled them to emigrate to other countries. Cleghorn, whose pamphlet on the depressed state of agriculture was honoured with the prize of the Highland Society of Scotland, thinks this loss cannot have been less than one year's rental of the whole island. "The replies sent to the circular letter of the Board of Agriculture, regarding the agricultural state of the kingdom, in February, March, and April, 1816, furnish a body of evidence which cannot be controverted, and exhibit a picture of widely spread ruin among the agricultural classes, and of distress among all that immediately depend upon them, to which there is probably no parallel." (See *Cleghorn on the Depressed State of Agriculture*, 1822.) After upwards of fourteen years' severe suffering, both by landlords and tenants, things have now assumed a more stationary condition. Rents have been greatly lowered every where in proportion to the fall of prices and the rise of parochial burdens, and both farmers and landlords are beginning gradually to recover themselves.

Sect. II. *Professional History of Agriculture, from the Revolution to the present Time.*

776. *In England, from the restoration to the middle of the eighteenth century*, very little improvement took place, either in the cultivation of the soil, or in the management of live stock. Even clover and turnips (the great support of the present improved system of agriculture) were confined to a few districts, and at the close of this period were scarcely cultivated at all by common farmers in the northern parts of the island. From the *Whole Art of Husbandry*, published by Mortimer in 1706, a work of considerable merit, it does not appear that any improvement was made on his practices till near the end of last century. In those districts where clover and rye-grass were cultivated, they were cut green, and used for soiling as at present. Turnips were sown broadcast, hand-hoed, and used for feeding sheep and cattle, as they were used in Houghton's time, and are still in most districts of England.

777. *In the beginning of the eighteenth century*, a considerable improvement in the process of culture was introduced by Jethro Tull, a cultivator of Berkshire, who began to drill wheat and other crops about the year 1701, and whose *Horse-hoeing Husbandry* was published in 1731. "In giving a short account of the innovations of this eccentric writer, it is

not meant to enter into any discussion of their merits. It will not detract much from his reputation to admit, that, like most other men who leave the beaten path, he was sometimes misled by inexperience, and sometimes deceived by a too sanguine imagination. Had Tull confined his recommendation of drill husbandry to leguminous and bulbous-rooted plants generally, and to the cereal gramina only in particular circumstances; and had he, without puzzling himself about the food of plants, been contented with pointing out the great advantage of pulverising the soil in most cases, and extirpating weeds in every case, he would certainly have deserved a high rank among the benefactors of his country. A knowledge of his doctrines and practice, however, will serve as a necessary introduction to the present approved modes of culture."

778. *Tull's theory* is promulgated with great confidence; and in the controversy which he thought proper to maintain in support of it, he scrupled not to employ ridicule as well as reasoning. Besides the Roman writers *de Re Rustica*, Virgil in particular, whom he treats with high disdain; he is almost equally severe on Dr. Woodward, Bradley, and other writers of his own time.

779. *Tull begins by showing that the roots of plants extended* much farther than is commonly believed; and then proceeds to enquire into the nature of their food. After examining several hypotheses, he decides this to be fine particles of earth. The chief, and almost the only use of dung, he thinks, is to divide the earth; to dissolve the "terrestrial matter which affords nutriment to the mouths of vegetable roots;" and this can be done more completely by tillage. It is therefore necessary, not only to pulverise the soil by repeated ploughings before it be seeded; but, as it becomes gradually more and more compressed afterwards, recourse must be had to tillage or *horse-hoeing*, while the plants are growing; which also destroys the weeds that would deprive the plants of their nourishment.

780. *The leading feature of Tull's husbandry*, is his practice of laying the land into narrow ridges of five or six feet, and upon the middle of these drilling one, two, or three rows; distant from one another about seven inches, when there were three; and ten inches, when only two. The distance of the plants on one ridge from those on the contiguous one, he called an *interval;* the distance between the rows on the same ridge a *space*, or partition; the former was stirred repeatedly by the horse-hoe, and the latter by the hand-hoe.

781. *The extraordinary attention Tull gave to his mode of culture is, perhaps, without a parallel.* "I formerly was at much pains," he says, "and at some charge, in improving my drills, for planting the rows at very near distances; and had brought them to such perfection, that one horse would draw a drill with eleven shares, making the rows at three inches and a half distant from one another; and, at the same time, sow in them three very different sorts of seeds, which did not mix; and these too at different depths. As the barley rows were seven inches asunder, the barley lay four inches deep. A little more than three inches above that, in the same channels, was clover; betwixt every two of these rows, was a row of saintfoin, covered half an inch deep. I had a good crop of barley the first year; the next year two crops of broad clover, where that was sown; and where hop clover was sown, a mixed crop of that and saintfoin; but I am since, by experience, so fully convinced of the folly of these, or any other mixed crops, and more especially of narrow spaces, that I have demolished these instruments (in their full perfection) as a vain curiosity, the drift and use of them being contrary to the true principles and practice of horse-hoeing." (*Horse-hoeing Husbandry*, p. 62. London, 1762.)

782. *In the culture of wheat* he began with ridges six feet broad, or eleven on a breadth of sixty-six feet; but on this he afterwards had fourteen ridges. After trying different numbers of rows on a ridge, he at last preferred two, with an intervening space of about ten inches. He allowed only three pecks of seed for an acre. The first hoeing was performed by turning a furrow from the row, as soon as the plant had put forth four or five leaves; so that it was done before, or at the beginning of, winter. The next hoeing was in spring, by which the earth was returned to the plants. The subsequent operations depended upon the circumstances and condition of the land, and the state of the weather. The next year's crop of wheat was sown upon the intervals which had been unoccupied the former year; but this he does not seem to think was a matter of much consequence. "My field," he observes, "whereon is now the thirteenth crop of wheat, has shown that the rows may successfully stand upon any part of the ground. The ridges of this field were, for the twelfth crop, changed from six feet to four feet six inches. In order for this alteration, the ridges were ploughed down, and then the next ridges were laid out the same way as the former, but one foot six inches narrower, and the double rows drilled on their tops; whereby, of consequence, there must be some rows standing on every part of the ground, both on the former partitions, and on every part of the intervals. Notwithstanding this, there was no manner of difference in the goodness of the rows; and the whole field was in every part of it equal, and the best, I believe, that ever grew on it. It is now the thirteenth crop, likely to be good, though the land was not ploughed cross ways." (*Ibid.*, p. 424.)

783. *According to Tull, a rotation of crops of different species was altogether unnecessary;* and he labours hard to prove, against Dr. Woodward, that the advantages of such a change, under his plan of tillage, were quite chimerical; though he seems to admit the benefit of a change of the seed itself. But the best method of determining the question would have been, to have stated the amount of his crops per acre, and the quality of the grain, instead of resting the superiority of his management on the alleged saving of expense, when compared with the common broadcast husbandry.

784. *On the culture of the turnip*, both his principles and his practice are much more correct. The ridges were of the same breadth as for wheat; but only one row was drilled on each. His management, while the crop was growing, differs very little from the present practice. When drilled on the level, it is impossible, he observes, to hoe-plough them so well as when they are planted upon ridges. But the seed was deposited at different depths, the half about four inches deep, and the other half exactly over that, at the depth of half an inch. "Thus planted, let the weather be never so dry, the deepest seed will come up; but if it raineth immediately after planting, the shallow will come up first. We also make it come up at four times, by mixing our seed, half new and half old, the new coming up a day quicker than the old. These four comings up give it so many chances for escaping the fly; it being often seen that the seed sown over night will be destroyed by the fly, when that sown the next morning will escape, and *vice versâ:* or you may hoe-plough them when the fly is like to devour them; this will bury the greatest part of those enemies; or else you may drill in another row without new ploughing the land."

785. *Drilling, and horse and hand hoeing,* seem to have been in use before the publication of Tull's book. "Hoeing," he says, "may be divided into deep, which is our horse-hoeing; and shallow, which is the English hand-hoeing; and also the shallow horse-hoeing used in some places betwixt rows, where the intervals are very narrow, as

sixteen or eighteen inches. This is but an imitation of the hand-hoe, or a succedaneum to it, and can neither supply the use of dung, nor of fallow, and may be properly called scratch-hoeing." But in his mode of forming ridges, his practice seems to have been original; his implements display much ingenuity; and his claim to the title of father of the present horse-hoeing husbandry of Great Britain seems indisputable. A translation of Tull's book was undertaken at one and the same time in France, by three different persons of consideration, without the privity of each other. Two of them afterwards put their papers into the hands of the third, *M. Du Hamel du Monceau*, of the Royal Academy of Sciences, at Paris, who published a treatise on husbandry, on the principles of Tull, a few years after. But Tull seems to have had very few followers in England for more than thirty years. The present method of drilling and horse-hoeing turnips was not introduced into Northumberland till about the year 1780 (*Northum. Survey*, p. 100.); and it was then borrowed from Scotland, the farmers of which had the merit of first adopting Tull's management in the culture of this root, and improving on it, about 1760, and from them it has since made its way, but slowly, in the southern part of the island. Tull was born in Oxfordshire, was bred a barrister, and made the tour of Europe. He commenced his experiments on his own estate, but being unsuccessful, was obliged to sell it. He afterwards took a farm in Berkshire, where he renewed his operations. He published his book in 1731, and died in 1740, leaving a son, an officer in the army, who ruined himself by projects, and died in the Fleet prison in London in 1764.

786. *In the live stock of British agriculture, very little improvement had been made* previously to the middle of the eighteenth century, or later. About this time, the best breed of cattle and sheep were about Doncaster, in Yorkshire, and in Leicestershire, and the first grand and successful effort to improve them was made by Robert Bakewell, of Dishley, in the latter county. Bakewell was born about 1725 or 26; and soon after arriving at the years of maturity, took an interest in improving the breed of sheep. His father was a farmer, and died in 1760; but the son had taken an active management of the farm for many years before that time, having began, about the year 1755, that course of experiments which terminated in the important improvements for which his name is celebrated. (*Hunt's Agricultural Memoirs*, p. 35; *Fleming's Farmer's Journal*, August, 1828, p. 319.)

787. *By Bakewell's skilful selection* at first, and constant care afterwards, to breed from the best animals, without any regard to their consanguinity, he at last obtained a variety of sheep, which, for early maturity, and the property of returning a great produce of mutton for the food they consume, as well as for the small proportion which the weight of the offal bears to that of the four quarters, are altogether unequalled either in this or any other country. The Dishley or New Leicester sheep, and their crosses, are now spread over the principal corn districts of Britain; and from their quiet domesticated habits, are probably still the most profitable of all the varieties of sheep, on farms where the rearing and fattening of live stock are combined with the best courses of tillage crops.

788. *The practice of Bakewell and his followers* furnishes an instance of the benefits of a division of labour, in a department of business where it was little to be expected. Their male stock was let out every year to breeders from all parts of England; and thus, by judiciously crossing the old races, all the valuable properties of the Dishley variety descended, after three or four generations, to their posterity. By no other means could this new breed have spread so rapidly, nor have been made to accommodate itself so easily to a change of climate and pasture. Another recommendation of this plan was, that the ram-hirer had a choice among a number of males, of somewhat different properties, and in a more or less advanced stage of improvement; from which it was his business to select such as suited his particular object. These were reared by experienced men, who gave their principal attention to this branch alone; and having the best females as well as males, they were able to furnish the necessary supply of young males in the greatest variety, to those farmers whose time was occupied with other pursuits. The prices at which Bakewell's rams were hired appear enormous. In 1789, he received twelve hundred guineas for the hire of three brought at one birth; two thousand for seven; and, for his whole letting, at least three thousand guineas. (*Encyc. Brit.* art. *Agr.*)

789. *Messrs. Matthew and George Culley* carried the improvements of Bakewell into Durham and Northumberland, and perpetuated them in the north of England and south of Scotland. Messrs. Culley were pupils of Mr. Bakewell in 1762 and 1763, and Mr. George Culley soon became Mr. Bakewell's confidential friend, and was always considered his favourite disciple. After practising their improvements for a number of years in the county of Durham, they removed, in 1767, to Fenton farm, near Wooler, in Northumberland, containing upwards of 1100 acres. At this time, the sheep flocks that were kept on the arable and grazing districts of Northumberland were a large, slow-feeding, long-woolled kind; and a mixed breed, between those long-woolled sheep and the Cheviot. These breeds were rarely got fattened before three years old; but the improved Leicesters (which were introduced by Messrs. Culley) were sold fat at little more than a year old; and though they met with much opposition at their first introduction, there is now scarcely a flock to be found that has not been improved by them. Their breed of short-horned, or Teeswater, cattle, was also a great acquisition to the district; and the breed of draught horses was considerably improved by their introducing a stallion of Mr. Bakewell's. They were

always amongst the first to adopt and make experiments of any new mode of culture, new implements of husbandry, or new varieties of grain; and they practised draining, irrigation, fencing, and other improvements, on the most correct principles. Their great attention to minutiæ, unremitting industry, and superior cultivation, not only raised a spirit of exertion and emulation in the surrounding neighbourhood, but gained them such celebrity as first-rate breeders and agriculturists, that they had pupils from various parts of the island, with whom they received considerable premiums, besides being amply paid for their board and instruction. To all those acquirements, they added strict economy; the consequence of which was a great accumulation of wealth, which they applied (as occasions offered) to increasing their farming concerns; and this to such an extent, that for several years they occupied farms to the amount of about 8000*l.* a year. The large capital which such extensive concerns required, applied with so much attention and judgment, could not fail of producing the most lucrative effects. The result is, that, from a small original capital, their respective families are now enjoying landed property to the amount of nearly 4000*l.* a year each (besides a very large sum invested in farming), the well merited reward of unremitting industry and extensive agricultural knowledge. In 1786, Mr. George Culley published his *Observations on Live Stock*, which was the first treatise on the subject that attempted to describe the domesticated animals of Britain, and the principles by which they may be improved. The great merits of this work are evinced by the number of editions it has gone through. In 1793, Mr. G. Culley, in conjunction with Mr. Bailey of Chillingham, drew up the *Agricultural Reports for Durham and Northumberland*, and in 1813 he died at Fowberry Tower, the seat of his son, in the 79th year of his age. (*Farmer's Mag.* vol. xiv. p. 274.)

790. *Merino sheep* were first brought into England in 1788, when His Majesty procured a small flock by way of Portugal. In 1791, another flock was imported from Spain. In 1804, when His Majesty's annual sales commenced, this race began to attract much notice. Dr. Parry, of Bath, has crossed the Ryeland, or Herefordshire sheep, with the merinos, and brought the wool of the fourth generation to a degree of fineness not excelled by that of the pure merino itself; while the carcass, in which is the great defect of the merinos, has been much improved. Lord Somerville, and many other gentlemen, have done themselves much honour by their attention to this race; but it does not appear that the climate of Britain, the rent of land, and the love of good mutton, admit of substituting it for others of native origin. (*Encyc. Brit.* art. *Agr.*)

791. *The agriculture of Scotland*, as we have seen, was in a very depressed state at the revolution, from political circumstances. It was not less so in point of professional knowledge. Lord Kaimes, that excellent judge of mankind and sound agriculturist, declares, in strong terms, that the tenantry of Scotland, at the end of the seventeenth and beginning of the eighteenth century, were so benumbed with oppression or poverty, that the most able instructor in husbandry would have made nothing of them. Fletcher of Saltoun, who lived in the best part of Scotland, and in the end of the seventeenth century, describes their situation as truly deplorable.

792. *John Cockburn, of Ormiston, East Lothian, a spirited individual*, who rose at this time, and to whom the agriculture of Scotland is much indebted, deserves to be mentioned. He was born in 1685, and succeeded to the family estate of Ormiston in 1714. He saw that internal improvement could only be effected by forming and extending a middle rank of society, and increasing their prosperity. In fact, as an able writer, Brown, the founder of the *Farmer's Magazine*, has remarked, "the middling ranks are the strength and support of every nation." In former times, what we now call middling classes were not known, or at least little known in Scotland, where the feudal system reigned longer than in England. After trade was introduced, and agriculture improved, the feudal system was necessarily overturned; and proprietors, like other men, began to be estimated according to their respective merits, without receiving support from the adventitious circumstances under which they were placed.

793. *In* 1723, *a number of landholders*, at the instigation of Mr. Cockburn, formed themselves into a *Society of Improvers in the Knowledge of Agriculture in Scotland.* The Earl of Stair, one of their most active members, is said to have been the first who cultivated turnips in that country. This society exerted itself in a very laudable manner, and apparently with considerable success, in introducing cultivated herbage and turnips, as well as in improving on the former methods of culture: but there is reason to believe, that the influence of the example of its members did not extend to the common tenantry, who are always unwilling to adopt the practices of those who are placed in a higher rank, and supposed to cultivate land for pleasure, rather than profit. Though this society, the earliest in the united kingdom, soon counted upwards of three hundred members, it existed little more than twenty years. Maxwell delivered lectures on agriculture for one or two sessions at Edinburgh, which, from the specimens he has left, ought to have been encouraged.

794. *Draining, enclosing, summer-fallowing; sowing flax, hemp, rape, turnip, and grass seeds;* planting cabbages after and potatoes with the plough, in fields of great extent, are practices which were already introduced: and, according to the general opinion, more corn was now grown where it was never known to grow before, than, perhaps, a sixth of all that the kingdom used to produce at any former period. It is singular that though the practice of summer-fallowing seems to have prevailed in England since the time of the Romans, yet it was neglected in Scotland till about the beginning of the eighteenth century, when it was first practised by John Walker, tenant at Beanston, in East Lothian. The late Lord Milton considered this improvement of so much importance, that he was

" eager to procure the erection of a pillar to the memory of Mr. Walker." (*Farm. Mag.*, vol. i. p. 164.)

795. *The first notice of a threshing machine* is given by Maxwell, in his *Transactions of the Society of Improvers, &c.*; it was invented by Michael Menzies, advocate, who obtained a patent for it. Upon a representation made to the society, that it was to be seen at work in several places, they appointed two of their number to inspect it; and in their report they say that one man would be sufficient to manage a machine which would do the work of six. One of the machines was " moved by a great water wheel and treddles;" and another, " by a little wheel of three feet in diameter, moved by a small quantity of water." This machine the society recommended to all gentlemen and farmers. (*Encyc. Brit.* and *Ed. Encyc.* art. *Agr.*; *Brown's Treatise on Rural Affairs, Introduction, &c.*)

796. *Dawson, of Frogden, in Roxburghshire*, is a man to whom Scottish agriculture is perhaps more indebted than to any other. Findlater, the author of the *Survey of Peeblesshire*, one of the best judges, terms him the " father of the improved system of husbandry in Scotland." Dawson was born at Harperton, in Berwickshire, a farm of which his father was tenant, in 1734. At the age of 16 he was sent to a farm in the neighbourhood of Sheffield, and thence into Essex, where he directed his attention chiefly to grazing. He afterwards travelled through several other counties of England, " accurately examining the best courses of husbandry, and storing up for his own use whatever seemed likely to be introduced with advantage into his own country." On his return to Scotland he tried, with the consent of his father, the culture of turnips on the farm of Harperton, but he did not commence the culture of this root upon a large scale until he entered on the farm of Frogden on his own account in 1759. Great exertions were required in enclosing, draining, liming, and manuring the arable part of this farm; but the soil being sandy, the expense was ultimately more than repaid. It was here that Mr. Dawson perfected the drill-system of cultivating turnips, but not before he had grown them for several years in the broadcast manner. The first drills were drawn in the year 1763, and the extent of turnip crop was about 100 acres annually. In a few years the success which attended Mr. Dawson's management enabled him first to rent two contiguous farms, and afterwards to purchase and improve, in that county, the estate of Graden, a property of considerable extent, adjoining Frogden. On these lands he introduced and exemplified, for the first time in Scotland, what has been called the convertible husbandry; i. e. the growth of clover and sown grasses for three or more years in succession, alternately with corn crops and turnips.

797. *Mr. Dawson was the first to introduce to Scotland the practice of ploughing with two horses abreast without the aid of a driver.* The first ploughman who effected this was James M'Dougal, who, after being 14 years overseer to Mr. Dawson, in 1778 took a farm of his own at West Linton, in Peeblesshire, where he died in 1822, aged 82 years. It was the desire of Mr. Dawson that justice should be done to the memory of this able and worthy man, whose example, as the Rev. Charles Findlater observes, has had more effect in diffusing the improved system of husbandry than all the premiums ever given by landlords. (*Douglas's Surv. of Roxb.*; *Farm. Mag.*, vol. xiii. p. 512.) Mr. Dawson spent the last years of his life in Edinburgh, where he died in January, 1815, in his 81st year, leaving a numerous family in prosperous circumstances.

798. *The character of Dawson* is thus given by his biographer in the *Farmer's Magazine*, and may well be quoted here as a model for imitation. " *He was exceedingly regular in his habits*, and most correct and systematical in all his agricultural operations, which were not only well conducted, but always executed at the proper season. His plans were the result of an enlightened and sober calculation; and were persisted in, in spite of every difficulty and discouragement, till they were reduced to practice. Every one who knows the obstacles that are thrown in the way of all innovations in agriculture, by the sneers of prejudice and the obstinacy of ignorance, and not unfrequently by the evil offices of jealousy and malevolence, must be aware, that none but men of very strong minds, and of unceasing activity, are able to surmount them. Such a man was Mr. Dawson; and to this single individual may be justly ascribed the merit of producing a most favourable change in the sentiments, in regard to the trial of new experiments, as well as in the practice, of the farmers of Scotland. The labouring classes were not less indebted to this eminent person for opening up a source of employment, which has given bread to the young and feeble in almost the only branches of labour of which they are capable in merely rural districts. Most of his servants continued with him for many years; and such as had benefited by his instructions and advice were eagerly engaged to introduce their master's improvements in other places. This benevolence, which often sought for objects at a distance that were not personally known to him, was displayed, not only in pecuniary donations, while the giver frequently remained unknown, but was strikingly evinced in the attention which he paid to the education of the children of his labourers, for whom he maintained teachers at his own expense. If fame were always the reward of great and useful talents, there are few men of any age or country that would live longer in the grateful remembrance of posterity than the subject of this memoir." (*Farm. Mag.*, vol. xvi. p. 168.)

799. *As the leading features of practical agricultural improvement in Britain during the eighteenth century*, and to the present time, we may enumerate the following:—The gradual introduction of a better system of rotation since the publication of Tull's *Horse-hoeing Husbandry*, and other agricultural works, from 1700 to 1750; the improvement of live stock by Bakewell, about 1760; the raised drill system of growing turnips, the use of lime in agriculture, and the convertible husbandry, by Pringle, and more especially by Dawson, about 1765; the improved swing plough, by Small, about 1790; and the improved threshing machine, by Meikle, about 1795. As improvements of comparatively limited application might be mentioned, the art of tapping springs, or what has been called Elkington's mode of draining, which seems to have been discovered by Dr. Anderson, from principle, and Mr. Elkington, by accident, about 1760, or later; and the revival of the art of irrigation, by Boswell, about 1780. The field culture of the potato, shortly after 1750; the introduction of the Swedish turnip, about 1790; of spring wheat, about 1795; of summer wheat, about 1800; and of mangold wurtzel more recently, have, with the introduction of other improved field plants, and improved breeds of animals, contributed to increase the products of agriculture; as the enclosing of common field lands and wastes, and the improvements of mosses and marshes, have contributed to increase the produce and salubrity of the general surface of the country.

800. *The progress of the taste for agriculture in Britain* is shown by the great number of societies that have been lately formed; one or more in almost every county, for the diffusion of knowledge, and the encouragement of correct operations and beneficial discoveries. Among these, the *Bath and West of England Society*, established in 1777, and the *Highland Society of Scotland*, in 1784, hold the first rank. The establishment of the Board of Agriculture, in 1793, ought to have formed a new era in the history of the agriculture and rural economy of Britain; but it effected little beyond the publication of the County Agricultural Surveys, and, to a certain extent, rendering the art fashionable among the higher classes.

Sect. III. *Of the Literature of British Agriculture from the Revolution to the present Time.*

801. *The literature of English agriculture from the revolution* is rich in excellent works. We have already, in detailing the professional improvements, noticed the writings of Mortimer and Tull. To these we now add the numerous works of Bradley, which appeared from 1717 to his death in 1732. They are all compilations, but have been of very considerable service in spreading a knowledge of culture, and a taste for rural improvement. Stephen Switzer, a seedsman in London, in 1729; Dr. Blackwell, in 1741; and Hitt, a few years afterwards, published tracts recommending the burning of clay as manure, in the manner recently done by Governor Beatson, of Suffolk; Craig, of Cally in Kircudbrightshire, and some others. Lisle's useful *Observations on Husbandry* were published in 1757; Stillingfleet's *Tracts*, in which he shows the importance of a selection of grasses for laying down lands, in 1759; and the excellent *Essays* of Harte, canon of Windsor, in 1764. The celebrated Arthur Young's first publication on agriculture, entitled, *The Farmer's Letters to the People of England*, &c., appeared in 1767; and was followed by a great variety of excellent works, including the *Tour in France*, and the *Annals of Agriculture*, till his pamphlet on the utility of the Board of Agriculture, in 1810. Marshall's numerous and most superior agricultural works commenced with his *Minutes of Agriculture*, published in 1787, and ended with his *Review of the Agricultural Reports*, in 1816. Dr. R. W. Dickson's *Practical Agriculture* appeared in two quarto volumes, in 1806, and may be considered as giving a complete view of the present state of agriculture at the time. The last general work we shall mention is the *Code of Agriculture*, by Sir John Sinclair, which may be considered as a comprehensive epitome of the art of farming. It has already been translated into several foreign languages, and passed through more than one edition in this country. In this sketch a great number of useful and ingenious authors are necessarily omitted; but they will all be found in their places in the *Literature of British Agriculture*, given in the Fourth Part of this work.

802. *The Scottish writers on agriculture* confirm our view of the low state of the art in that country in the beginning of the eighteenth century. The first work, written by James Donaldson, was printed in 1697, under the title of *Husbandry Anatomised; or, an Enquiry into the present Manner of Teiling and Manuring the Ground in Scotland.* It appears from this treatise that the state of the art was not more advanced at that time in North Britain, than it had been in England in the time of Fitzherbert. Farms were divided into *infield* and *outfield;* corn crops followed one another, without the intervention of fallow, cultivated herbage, or turnips, though something is said about fallowing the outfield; enclosures were very rare; the tenantry had not begun to emerge from a state of great poverty and depression; and the wages of labour, compared with the price of corn, were much lower than at present; though that price, at least in ordinary years, must appear extremely moderate in our times. Leases for a term of years, however, were not uncommon; but the want of capital rendered it impossible for the tenantry to attempt any spirited improvements.

803. *The Countryman's Rudiments; or, an Advice to the Farmers in East Lothian how to labour and improve their Grounds*, said to have been written by Lord Belhaven, about the time of the union, and reprinted in 1723, is the next work on the husbandry of Scotland. In this we have a deplorable picture of the state of agriculture, in what is now the most highly improved county in Scotland. His Lordship begins with a very high encomium on his own performance. "I dare be bold to say, there never was such a good, easy method of husbandry as this, so succinct, extensive, and methodical in all its parts, published before." And he bespeaks the favour of those to whom he addresses himself, by adding, "neither shall I affright you with hedging, ditching, marling, chalking, paring and burning, draining, watering, and such like, which are all very good improvements indeed, and very agreeable with the soil and situation of East Lothian; but I know ye cannot bear as yet such a crowd of improvements, this being only intended to initiate you in the true method and principles of husbandry." The farm lands in East Lothian, as in other districts, were divided into infield and outfield, the former of which got all the dung. "The infield, where wheat is sown, is generally divided by the tenant into four divisions or breaks, as they call them, viz. one of wheat, one of barley, one of peas, and one of oats; so that the wheat is sowed after the peas, the barley after the wheat, and the oats after the barley. The outfield land is ordinarily made use of promiscuously for feeding their cows, horses, sheep, and oxen: it is also dunged by their sheep, who lay in earthen folds; and sometimes, when they have much of it, they fauch or fallow part of it yearly." Under this management, the produce seems to have been three times the seed; "and yet," says His Lordship, "if in East Lothian they did not leave a higher stubble than in other places of the kingdom, their grounds would be in a much worse condition than at present they are, though bad enough. A good crop of corn makes a good stubble, and a good stubble is the equallest

mucking that is." Among the advantages of enclosures, he observes, " you will gain much more labour from your servants, a great part of whose time was taken up in gathering thistles, and other garbage, for their horses to feed upon in their stables; and thereby the great trampling and pulling up, and other destruction of the corns, while they are yet tender, will be prevented." Potatoes and turnips are recommended to be sown in the yard (kitchen-garden). Clover does not seem to have been known. Rents were paid in corn; and, for the largest farm, which he thinks should employ no more than two ploughs, the rent was " about six chalders of victual, when the ground is very good, and four in that which is not so good. But I am most fully convinced they should take long leases or tacks, that they may not be straitened with time in the improvement of their rooms (farms); and this is profitable both for master and tenant."

804. Maxwell's *Select Transactions of the Society of Improvers of the Knowledge of Agriculture in Scotland* was published in 1743 (see 795.), and his *Practical Husbandman*, in 1757, including an *Essay on the Husbandry of Scotland.* In the latter he lays it down as a rule, that it is bad husbandry to take two crops of grain successively, which marks a considerable progress in the knowledge of modern culture; though he adds that, in Scotland, the best husbandmen after a fallow take a crop of wheat; after the wheat, peas, then barley, and then oats; and after that they fallow again. The want of enclosures was still a matter of complaint. The ground continued to be cropped so long as it produced two seeds for one; the best farmers were contented with four seeds for one, which was more than the general produce. In 1765, *A Treatise on Agriculture* was published by the Rev. Adam Dickson, minister of Dunse, in Berwickshire, which was decidedly the best work on tillage which had then appeared in the English language, and is still held in esteem among the practical farmers of Scotland. In 1777, Lord Kaimes published *The Gentleman Farmer*, being an attempt to improve agriculture by subjecting it to the test of rational principles. His Lordship was a native of Berwickshire; and had been accustomed to farm in that country for several years, and afterwards at Blair Drummond, near Stirling. This work was in part a compilation, and in part the result of his observation; and was of essential service to the cause of agriculture in Scotland. In 1778, appeared Wight's *Present State of Husbandry in Scotland.* This is a valuable work; but the volumes not appearing but at intervals of some years, it was of less benefit than might have been expected. In 1783, Dr. Anderson published his *Essays relating to Agriculture and rural Affairs:* a work of science and ingenuity, which did much good both in Scotland and England. In 1810, appeared *The Husbandry of Scotland*, and, in 1815, *The General Report of the Agricultural State and Political Circumstances of Scotland*, both by Sir John Sinclair, and excellent works. The *Code of Agriculture*, by the same patriotic and indefatigable character, has been noticed as belonging to English publications on agriculture. (801.)

805. *Agricultural Periodicals.* — *The Farmer's Magazine;* a quarterly work, exclusively devoted to agriculture and rural affairs, was commenced in 1800, and has done more to enlighten both the proprietors and tenantry of Scotland than any other book which has appeared. It was at first conducted jointly by Robert Brown, farmer of Markle; and Robert Somerville, M. D. of Haddington. Afterwards, on Dr. Somerville's death, by Brown alone; and subsequently, on the latter gentleman's declining it, by James Cleghorn, one of the most scientific agriculturists of Scotland. The frequent recurrence that will be made to *The Farmer's Magazine* in the course of this work, will show the high value which we set on it. In November 1825, this work terminated with the 26th volume, and has since been succeeded by *The Farmer's Register and Monthly Magazine*, and *The Quarterly Journal of Agriculture*, in Scotland; and by *The British Farmer's Magazine* in England. *The Farmer's Journal* is the first agricultural newspaper which appeared in Britain; it was commenced in 1808, and is still continued. *The Irish Farmer's Journal* was commenced in 1812, but discontinued for want of patronage in 1827. The names and writings of all the British agricultural authors, with abridged biographies of all such as could be procured, will be found in chronological order in Chap. IV. of Book I. of Part IV. of this work. (See *Contents* or *Index.*)

806. *A professorship of agriculture* was established in the university of Edinburgh, in 1790, and the professor, Dr. Andrew Coventry, is well known as a man of superior qualifications for fulfilling its duties. Professorships of agriculture, and even of horticulture, or rather of culture in general, are said to be partly provided for, and partly in contemplation, both in Oxford and Cambridge. The professor of botany in the London University, John Lindley, in the Prospectus of his Lectures, announces " the application of the laws of Vegetable Physiology to the arts of Agriculture and Horticulture."

Sect. IV. *Of the Rise, Progress, and present State of Agriculture in Ireland.*

807. *Of the agriculture of Ireland* very little is known up to a recent period. With a soil singularly prolific in pasture, and rather humid for the easy management of grain, it is probable that sheep and cattle would be the chief rural products for many centuries. In the twelfth century and earlier, various religious establishments were founded, and then it is most probable tillage on something like the Roman mode of culture would be introduced. The monks, says O'Connor, fixed their habitations in deserts, which they cultivated with their own hands, and rendered them the most delightful spots in the kingdom.

808. *During the thirteenth, fourteenth, and fifteenth centuries*, the English were obliged to suppress the numerous rebellions of their Irish subjects by war, and the forfeited estates of the rebels would in part be divided among the troops. This might end in introducing some agricultural improvements; but there is no evidence that such was effected before the time of Elizabeth, when the enormous demesnes of the Earl of Desmond were forfeited, and divided amongst a number of English undertakers, as they were called, who entered into a stipulation to plant a certain number of English families

on their estates, in proportion to the number of acres. Among others who received portions were, Sir Walter Raleigh, and Spenser, the poet. The former is said to have then introduced the potato.

809. *The reign of James I.* was one of comparative tranquillity for Ireland: the power of the judges, and of the English government, was extensively fixed; the Irish laws and customs were abolished, and the English laws were established in all cases without exception, through the whole island. Numerous colonies were also sent from England and Scotland, especially the latter, to occupy the forfeited estates; and seven northern counties were wholly allotted to undertakers. This was called the "plantation of Ulster," and was attended by the introduction of an improved agriculture, and by the linen manufacture, which is still carried on by the descendants of the first colonists in the same counties.

810. *The city of London participated in this distribution of land.* The corporation having accepted of large grants in the county of Derry, they engaged to expend 20,000*l.* on the plantation; to build the cities of Derry and Colerain, and at the same time stipulated for such privileges as might make their settlement convenient and respectable. Under a pretence of protecting this infant settlement, or perhaps with a view of raising money, the king instituted the order of Irish baronets, or knights of Ulster; from each of whom, as was done in Scotland with respect to the knights of Nova Scotia, he exacted a certain sum, as the price of the dignity conferred. (*Wakefield.*)

811. *Of the husbandry of Londonderry* a curious account was published about a century ago, by the archbishop of Dublin. He states that there was little wheat grown, and that of very inferior quality; the soil being considered as unsuitable to its production. Potatoes remained three or four years in the ground, reproducing a crop, which at the best was a very deficient one. Lime was procured by burning sea shells. The application of them in an unburnt state arose from accident. A poor curate, destitute of the means for burning the sea shells which he had collected, more with a view to remove an evidence of his poverty, than in any hope of benefit, spread them on his ground. The success which attended the experiment occasioned surprise, and insured a rapid and general adoption of the practice. (*Wakefield.*) The improvements made since the period of which the archbishop treats, Curwen remarks, are undoubtedly very considerable: and whilst we smile at the very subordinate state of agriculture at that time, may we not on reasonable ground expect that equal progress will at least be made in this century as in the last? (*Letters on Ireland*, vol. ii. p. 246.)

812. *A considerable impulse was given to the agriculture of Ireland after the rebellion of* 1641, which was quelled by Cromwell, as commander of the parliamentary army in 1652. Most of the officers of this army were yeomen, or the sons of English country gentlemen; and they took pleasure in instructing the natives in the agricultural practices to which they were accustomed at home. Afterwards, when Cromwell assumed the protectorship, he made numerous grants to his soldiers, many of whom settled in Ireland; and their descendants have become men of consideration in the country. Happily these grants were confirmed at the restoration. Some account of the state of culture in that country at this time, and of the improvements which it was deemed desirable to introduce, will be found in Hartlib's *Legacy*.

813. *The establishment of the Dublin Society in* 1749 gave the next stimulus to agriculture and general industry in Ireland. The origin of the Dublin Society may be dated from 1731, when a number of gentlemen, at the head of whom was Prior of Rathdowney, Queen's county, associated themselves together for the purpose of improving the agriculture and husbandry of their country. In 1749, Prior, through the interest of the then lord-lieutenant, procured a grant of 10,000*l.* per annum, for the better promotion of its views. Miss Plumtree considers this the first association ever formed in the British dominions expressly for such purposes; but the Edinburgh Agricultural Society, as we have seen (793.), was founded in 1723.

814. *Arthur Young's Tour in Ireland* was published in 1780, and probably did more good than even the Dublin Society. In this work he pointed out the folly of the bounty on the inland carriage of corn. His recommendation on this subject was adopted; and, according to Wakefield, "from that hour may be dated the commencement of extended tillage in Ireland." (*Wakefield's Statistical Account; Curwen's Letters.*)

815. *The state of agriculture of Ireland, in the beginning of the present century,* is given with great clearness and ability in the supplement to the *Encyclopædia Britannica;* and from that source we have selected the following condensed account: —

816. *The climate of Ireland* is considerably more mild than that of England, and the southern and western part of the island greatly more so than the northern. The difference in this respect, indeed, is greater than can be explained by the difference of latitude; and is probably owing to the immediate vicinity of the western ocean. On the mountains of Kerry, and in Bantry Bay, the arbutus and some other shrubs grow in great luxuriance, which are not to be met with again till the traveller reaches the Alps of Italy. The

snow in these parts of the island seldom lies for any time, and frost hardly ever continues beyond a few days, and while it lasts it is by no means intense. The mildness and humidity of the atmosphere produce a luxuriance and rapidity of growth in vegetation, to which no other part of the empire can afford any parallel; and this appears in the most remarkable manner in the ivy, and other evergreens, with which the kingdom abounds. These are not only much more plentiful, but far more luxuriant, and of much quicker growth, than in the most favoured parts of Great Britain. To those who are accustomed to the dry weather of this island, the continued rains of the south and west of Ireland are extremely disagreeable; but it is to this peculiarity in their climate, that the Irish have to attribute the richness of their pasturage, an advantage which, coupled with the remarkable dryness and friability of the soil, points, in an unequivocal manner, to a rotation of crops, in which grazing should occupy a principal place.

817. *The territorial surface of Ireland* affords a pleasing variety, consisting in some parts of rich and fertile plains, in others of little hills and acclivities, which succeed one another in frequent succession. The most elevated ground is to be found in the bog of Allan. Its height above the sea does not exceed 270 feet, yet, from this ridge, the waters of the rivers run to the different seas. This elevated ground is connected with the principal mountains of Ireland, diverging in the north from the hills of Tyrone, and leading in the south to those of Sleeve Bloom and the Galtees. The chains of mountains are neither numerous nor considerable; the most remarkable are, the Kerry mountains, those of Wicklow, the Sleeve Bloom chain between the King's and Queen's county, and the mountains of Mourne, in the south of the province of Ulster.

818. *The soil of Ireland* is, generally speaking, a fertile loam, with a rocky substratum; although there are many exceptions to this description, and many varieties. Generally speaking, it is rather shallow; to which cause the frequent appearance of rocks near the surface, or at no considerable depth, is to be attributed. It possesses a much greater proportion of fertile land, in proportion to its extent, than either England or Scotland. Not only is the island blessed with this extent of cultivable ground, but it is almost all of such a quality as to yield luxuriant crops, with little or no cultivation. Sand does not exist except on the sea shore. Tenacious clay is unknown, at least near the surface. Great part of the land of Ireland throws up a luxuriant herbage, without any depth of soil, or any skill on the part of the husbandman. The county of Meath, in particular, is distinguished by the richness and fertility of its soil; and, in Limerick and Tipperary, there is a dark, friable, sandy loam, which, if preserved in a clean state, will yield crops of corn several years in succession. It is equally well adapted for grazing as for arable crops, and seldom experiences either a winter too wet, or a summer too dry. The vales in many of the bleakest parts of the kingdom, as Donegal and Tyrone, are remarkable for their richness of soil and luxuriance of vegetation, which may be often accounted for by the deposition of the calcareous soil, washed down by the rains of winter, which spreads the richest manure over the soil below, without subjecting the farmer to any labour. (*Wakefield*, i. 79, 80.)

819. *The bogs, or peat mosses, of Ireland*, form a remarkable feature of the country, and have been proved by the parliamentary commissioners to be of great extent. They estimate the whole bogs of the kingdom at 2,330,000 acres, English. These bogs, for the most part, lie together. In form, they resemble a great broad belt, drawn across the centre of Ireland, with its narrowest end nearest to the capital, and gradually extending in breadth as it approaches the western ocean. The bog of Allan is not one contiguous morass, but this name is indiscriminately applied to a great number of bogs, detached from each other, and often divided by ridges of dry country. These bogs are not, in general, level, but most commonly of an uneven surface, swelling into hills, and divided by valleys, which afford the greatest facility to their being drained and improved. In many places, particularly in the district of Allan, the rivulets which these inequalities of surface produce have worn their channels through the substance of the bog, down to the clay or limestone gravel beneath; dividing the bog into distinct masses, and presenting, in themselves, the most proper situations for the main drains, for which purpose, with the assistance of art, they may be rendered effectual.

820. *The commissioners employed by government to report on the bogs of Ireland* found three distinct growths of timber immersed below three distinct strata of bog. The timber was perfectly sound, though deprived of its bark, which has communicated its antiputrescent quality to the water, and of course has preserved every thing embedded in the mass; though, as Miss Plumtree remarks, without "any thing like a process of tanning ever taking place." The bogs of Ireland are never on low ground, and have therefore evidently originated from the decay of woody tracts. (*Plumtree's Residence in Ireland.*)

821. *Landed property in Ireland* is more generally in large estates of some thousands of acres, than in small ones; but in its occupation it is subdivided in a degree far beyond any thing which occurs in any other part of the empire. In some counties, as Mayo for example, there are upwards of 15,000 freeholders on properties of not more than 40s.

value, and who are perhaps not worth 10*l.* each. These are, for the most part, tenants of the great proprietors, possessing a life interest in their little farm.

822. *In Ireland there are no manorial rights* separable from the right to the soil, as in England, nor legal poor rates, which are circumstances materially in favour of the former country. (*Wakefield*, i. 242.)

823. *Leases are generally of long endurance;* and three lives, or thirty-one years, is a common rate. The price of land varies in different parts of Ireland. In the neighbourhood of Belfast, and thence to Armagh, it brings thirty years' purchase; in the greatest part of the island it does not exceed twenty; and, in the richest districts, it may often be bought for sixteen or eighteen. The exposure of landed estates to public sale takes place very seldom, which is, perhaps, one cause of their not bringing so high a price as they would otherwise do. (*Wakefield.*)

824. *Farming in Ireland* is, generally speaking, in a very backward state. With a few exceptions, such as the county of Meath, and some other well cultivated districts, the farmers are destitute of capital, and labour small crofts, which they hold of middlemen interposed between them and the landlord. The fact that in Ireland the landlord never lays out any thing upon repairs or buildings, coupled with the general inability of the farmer to do either in a substantial manner, is very significant as to the state of agriculture. (*Tighe's Survey of Kilkenny*, 412.; *Wakefield*, i. 244.) But the worst features of the rural economy of this island are the entire want of capital in the farmers, and the complete indifference of the landlord to the character, wealth, or industry of his tenant. "Capital," says Wakefield, "is considered of so little importance in Ireland, that advertisements constantly appear in the newspapers, in which it is stated, that the preference will certainly be given to the highest bidder. Bargains are constantly made with a beggar, as a new tenant, who, offering more rent, invariably turns out the old one, however industrious."

825. *The rent of land in Ireland* from these causes, coupled with the excessive competition of the peasantry for small farms, as their only means of subsistence, has risen to a great height. (*Townsend's Cork*, 218.; *Wakefield*, i. 582.)

826. *Ireland is divided, by Wakefield, into nine agricultural districts,* in each of which the mode of culture is somewhat different from what it is in the others.

827. *The first district* comprehends the flat parts of Antrim; the eastern side of Tyrone, Down, Armagh, Monaghan, and Cavan. Throughout this district, the farms are extremely small, and the land is generally dug with a spade. Potatoes, flax, and oats are the crops usually cultivated, and these are grown till the land is exhausted, and suffered to "lie at rest," as they term it, till its strength is recruited by the cow, the goat, two or three sheep, and the poultry lying upon it for some years. The ploughs used in this district are of the rudest structure, and perform their work in the most slovenly manner. Three or four neighbours unite their strength to each plough, every one bringing his horse, his bullock, or his cow. All the other operations of agriculture are performed in an equally slovenly manner. The little wheat that is raised is "lashed," as they call it; that is, the grain is knocked out by striking the sheaf across a beam placed above a cloth: it is, however, afterwards threshed with a flail. The operation of threshing usually takes place in the highway, and it is dressed by letting it fall from a kind of sieve, which, during a pretty strong wind, is held breast-high by a woman. Many cottiers in this district have a cabin with no land attached to it. They hire an acre or two, for grass or potato land, from some cottier in their vicinity. The custom of hiring labourers is unknown. The neighbours all assist each other in their more considerable occupations, such as sowing and reaping. The dwellings here are miserably small; often too small to contain the numerous families that issue from their doors. Land is every where divided into the most minute portions (*Wakefield*, i. 363.; *Dubourdieu's Down*, 39.)

828. *Under the second district* may be comprised the northern part of Antrim, Londonderry, the north and west of Tyrone, and the whole of Donegal. Agriculture here is in a worse state than in the preceding district. There is no clover, and hardly any wheat.

829. *The third district* comprehends the northern parts of Fermanagh. Here the farms are much larger than in the former, and the agricultural system pursued far superior. They plant potatoes on a lea, twice reversing the lands; and flax, oats, and weeds constitute the course. Some wheat is grown, but oats still form the prevalent crop. In the neighbourhood of Enniskillen, the farmers are so rich as to be able to eat butcher's meat daily, and drink smuggled wine. (*Wakefield*, i. 379.)

830. *The fourth district* comprehends Sligo, Mayo, Galway, Clare, and parts of Roscommon, and Longford. In some parts of this district the spade culture is pursued; but, in general, the land is cultivated by a plough drawn by four horses abreast. In Roscommon, the old custom of yoking the horses by the tail is still continued; although, as early as 1634, an act of parliament was passed against this absurd practice. (*Life of the Duke of Ormond*, i. 79.) Oats are chiefly raised in this district, and, along the coast, barley is cultivated. A large portion of the rent depends on the illegal distilleries, and much of the district is let on lease to several persons jointly, according to the village system. (*Ibid.*, i. 381.)

831. *In the fifth district*, which comprehends Limerick, Kerry, the south side and northern part of Cork, and the county of Waterford, cultivation is in a very rude state; little corn is grown here, with the exception of the southern part of Cork. Land is extremely divided, and the farms very small. The greater part is a grazing country. (*Ibid.*, i. 387.)

832. *The sixth district* includes the southern parts of Cork. The spade culture is here almost universal, and the farms unusually small. Hogs constitute the main support of the poor. (*Townsend's Cork*, 194.)

833. *The seventh district* includes part of Tipperary, with Queen's county and King's county. The best farming in Ireland is observable in this district; a systematic course of husbandry being pursued, by which the land is kept in good heart. Oxen and horses are used in the plough, and hedgerows and good wheat fallows are to be seen. Near Roscrea the cultivation of turnips is followed, and they succeed well. Ninety acres are considered a large farm. Leases are generally for three lives. (*Wakefield*, i. 398.)

834. *The eighth district* comprises Wexford and a part of Wicklow. Beans are here sometimes introduced into cultivation, but they are sown broadcast, and never hoed. The mode of ploughing is very awkward: one man holds the plough, another leads the horse, and a third sits on it to keep it down. Notwithstanding this rude culture, however, the rents are enormous, owing to the demand for land created by an excessive population, who, if they had not a portion of land to grow potatoes (getting no employment), could not live. (*Ibid.*, i 407.)

835. *The ninth district* comprehends the northern part of Kilkenny, Kildare, the cultivated parts of Westmeath, Meath, and Louth. Wheat here enters into the system of culture, but the preparatory fallows are very bad. Clover has been introduced into the district, but under the bad system of sowing it upon land exhausted, and covered by weeds. Farms are large, and the mode of culture similar to what is pursued in England, though the details are executed in a slovenly manner. (*Ibid.*, i. 413.)

836. *The agricultural implements and operations* used in Ireland are all of the rudest construction. The plough, the spade, the flail, the car, all equally partake of imperfections and defects. The fallows are not well attended to; three ploughings are usually deemed sufficient, and, from the imperfection of the plough, the ground at the end is generally full of weeds. Trenching land is very general; they form it into beds, and shovel out a deep trench between them, throwing up the earth. The expense of this operation is about eight shillings an acre. Wheat, as will be seen from the preceding details, is not by any means generally cultivated. It is unknown in Monaghan, Tyrone, Derry, Donegal, Sligo, Mayo, Leitrim, and Cavan, though it is grown to a considerable extent in Kilkenny, Carlow, Dublin, Meath, Louth, and parts of Limerick, Tipperary, Clare, and Cork. It is generally sown after potatoes or fallow. The Irish wheat is, for the most part, coarse and of inferior quality, and does not yield so much saccharine matter by twenty per cent, as the English. (*Ibid.*, i. 429. 442.)

837. *Barley is more generally cultivated in Ireland than wheat*, and it is generally sown after potatoes. Oats, however, constitute the species of grain most extensively raised; it is calculated that, throughout the whole kingdom, there are ten acres of oats sown for one of any other species of corn. The Irish oats, however, are decidedly inferior to the English.

838. *The potatoes of Ireland* have long been celebrated, both on account of their quantity and excellent qualities: they are cultivated on every species of soil, either in drills or lazy beds. Potato land lets from six pounds six shillings to ten pounds ten shillings per acre; and the expense of culture, including rent, varies from thirteen pounds to sixteen pounds per acre. The produce is from eight hundred stone to one thousand stone the acre, at twenty-one pounds to the stone; that is, from sixteen thousand eight hundred to twenty-one thousand pounds. (*Ibid.*, i. 450.)

839. *The indigenous grasses of Ireland* are not of any peculiar excellence. Notwithstanding all that has been said of the fiorin grass, its excellence and utility may be called in question. Their hay is seldom from sown grasses, generally consisting of the spontaneous produce of the soil. Clover is almost unknown. Newenham calculates that there are not five thousand acres under this crop in the whole island. (*Newenham*, 314.; *Wakefield*, i. 467.)

840. *There are few live hedges in Ireland;* in the level stone districts, stone walls, and in other places turf banks, are the usual fences.

841. *The dairy is the most extensive and the best managed part of Irish husbandry.* Kerry, Cork, Waterford, Carlow, Meath, Westmeath, Longford, and Fermanagh, as well as the mountains of Leitrim and Sligo, are principally occupied by dairy farms. Butter is the chief produce. The average number of cows on a dairy farm amounts to thirty or forty; three acres of land, of middling quality, are deemed necessary for the subsistence of each cow. A cow produces on an average eight quarts in twenty-four hours in summer, and five in winter; four good milkers will yield a quarter of a cwt. of butter in a week. The best butter is made in Carlow; the worst in Limerick and Meath. Generally speaking, the Irish are very cleanly in making this article; and it is exported to England, the East and West Indies, and Portugal. (*Wakefield*, i. 325. et seq.) The art of salting butter, Chaptal observes, is better known in Ireland than in any other country. (*Chimie appliqué à l'Agriculture.*) The grazing of Ireland is not, as in England, a part of the regular rotation of crops, but is carried on in a country exclusively devoted to the breeding of cattle, like the highlands of Scotland. Great tracts of the country also are devoted to the grazing of sheep. Roscommon, Galway, Clare, Limerick, and Tipperary are the chief breeding counties for sheep; and Galway, Clare, Roscommon, Tipperary, and Meath are the places where they are fattened. The sheep are of the long-woolled kind, and very large: they are never kept in sheepfolds, and hardly ever fed on turnips; which is chiefly owing to the very limited demand for mutton among the labouring people. (*Ibid.*, i. 341.)

842. *The depressed state of the agriculture of Ireland* is considered as proceeding from the depressed state of the people. The main cause of their sufferings is traced by most writers (Young, Dewar, Newenham, Wakefield, Curwen, &c.) to the redundancy of population. In 1791, the population of the whole kingdom amounted to 4,200,000 persons, and it increases at the rate of one forty-sixth part per annum; or, in other words, it doubles itself every forty-six years. As might be expected in a country where the increase in the number of mankind has so far outstripped the progress of its wealth, and the increase of its industry, the condition of the people is in every department marked by extreme indigence. (*Dewar*, 91.; *Young*, ii. 123.) The houses in which they dwell, the furniture in their interior, their clothing, food, and general way of life, all equally

indicate the poverty of the country. The dress of the people is so wretched, that, to a person who has not visited the country, it is almost inconceivable. The Irish poor, indeed, have no conception of the comforts of life; and, if they felt their full value, they could not afford them, for though necessaries are cheap, conveniences of all sorts are very dear.

843. *But while the Irish poor are in general destitute of all the accommodations, they hardly ever, except in years of extraordinary distress, know what it is to want the absolute necessaries, of life.* The unsparing meal of potatoes, at which the beggar, the pig, the dog, the poultry, and the children seem equally welcome, seldom fails the Irish labourer.

844. *Hence the laziness of the lower Irish.* Limited as their wants are to the mere support of animal life, they do not engage in labour with that persevering industry which artificial desires inspire; and the mode in which they are often paid, that is, giving them a piece of potato land by the year, at once furnishes the means of subsistence, and takes away every stimulus to farther exertion. The farm-servants of the English or Scotch farmers, who carry on agriculture upon the improved system, are constantly employed in some species of labour; but, after the potatoes of the Irish cottier are planted, there is hardly any thing to be done about his little croft till the season of digging arrives. During a great portion of the year he is doomed to idleness, and the habits he acquires during the long periods of almost total inaction, are too strong to be overcome when he is transferred to a more regular occupation. Such is the condition of the labouring classes.

845. *Ireland exhibits an assemblage of the most contradictory circumstances.* It is a country in which, under the most distressing circumstances, population has advanced with the most rapid pace, in which cultivation has advanced without wealth, and education without diffusing knowledge; where the peasantry are more depressed, and yet can obtain subsistence with greater facility, than in any other country of Europe. Their miserable condition will not appear surprising, when the numerous oppressions to which they are subject are taken into consideration.

846. *In the foremost rank of their many grievances,* the general prevalence of middlemen must be placed. It is difficult to estimate the extent of the misery which the system of letting and subletting land has brought upon the Irish cultivators. Middlemen have, in every country, been the inseparable attendants of *absent* proprietors: and in such a country as Ireland, where there are numbers of disaffected persons in every quarter, the vigilant eye of a superior inspector is more particularly required.

847. *The system of under-letting lands often proves a great evil in Ireland.* By the law of England, the landlord is entitled to distrain for payment of rent, not only the stock which belongs to his immediate tenant, but the crop or stock of a subtenant; on the principle that whatever grows on the soil ought to be a security to the landlord for his rent: and in Scotland the same rule holds where the landlord has not authorised the subtack; but if he has, the subtenant is free when he has paid to the principal tenant. There is little hardship in such a rule in England, where the practice of subletting is, generally speaking, rare; but when applied to Ireland, where middlemen are universal, it becomes the source of infinite injustice; for the cultivator being liable to have his crop and stock distrained on account of the tenant from whom he holds, and there being often many tenants interposed between him and the landlord, he is thus perpetually liable to be distrained for arrears not his own. The tenant, in a word, can never be secure, though he has faithfully paid his rent to his immediate superior; because he is still liable to have every thing which he has in the world swept off by an execution for arrears due by any of the many leaseholders, who may be interposed between him and the landlord. It is obvious that such a system must prevent the growth of agricultural capital: this, joined to the exactions of the middlemen, has been the true cause of the universal prevalence of the cottage system, and the minute subdivision of farms.

848. *The tithes in Ireland* have long been collected with a severity of which hardly any European state furnishes an example. This has arisen from the wealth and influence of the clergy, joined to the destitute situation of their parishioners. They fall, by the law of that country, only on the tillage land; the greater part of which is held by cottier tenants; and thus the rich are exempted from bearing their share of the burden.

849. *Another grievance,* though not so extensive, is the fine imposed upon a township, for having had the misfortune to have a seizure for illicit distillation made within its bounds.

850. *These evils have been attended with the usual depressing effects* of oppression. They have prevented the growth of any artificial wants, or any desire of bettering their condition, among the mass of the people. Despised by their superiors, and oppressed by all to whom they might naturally have looked for protection, the Irish have felt only the natural instincts of their being. Among the Presbyterians of the north, and the peasantry in the vicinity of manufacturing towns, who are to a certain extent educated, higher notions of comfort may have imposed some restraint on the principle of population; but the humiliated poor of other parts, enjoying no respectability or consideration

in society, have sought only the means of subsistence; and finding, without difficulty, potatoes, milk, and a hovel, have overspread the land with a wretched offspring.

851. *To these causes* of a redundant population, of which the government of the country is, directly or indirectly, the source, are to be added others of a different kind.

852. *The first is the influence of the parish priests*, who encourage marriage, in order to increase their own emoluments, and the superstition of the people, who regard it as a religious duty.

853. *The second cause* is, the general ignorance of the people.

854. *On the influence of education*, in restraining the tendency to early and imprudent marriage, it would be superfluous in this place to enlarge.

855. *Various other circumstances* have combined to multiply to a great degree the facilities of population, and to expand, in this country, beyond almost any other, the means of subsistence.

856. *The fertility of the country* may be mentioned as one of the most obvious of these circumstances. The soil of Ireland is in general so rich, that it will yield an alternate crop of wheat and potatoes for ever, without any very great labour, and with little manure. The introduction of the potato, and its singular adaptation to the soil and climate of Ireland, are other concurring causes. An acre of potatoes, according to Newenham, will yield four times as much nourishment as one of wheat. By thus expanding the means of human subsistence, the potato has greatly promoted the population of Ireland; but as the able writer, from whom we have selected the above remarks, observes, "unless the people are predisposed, from other causes, to press upon the means of subsistence, it has no tendency to augment their redundance. Under the government and political institutions of the Irish, the population of the country would have been equally *redundant*, though much *smaller* that it now is, if they had lived on oats or wheaten bread. The introduction of the potato may be the cause why the population is now six in place of three millions: but it is not the cause why, during the whole period of this increase, the numbers of the people have been greater than, under existing circumstances, could be comfortably maintained." (*Sup. Encyc. Brit.*, art. *Ireland.*)

857. *That agriculture has made considerable progress in Ireland since the above was written*, nearly twenty years ago, is obvious from the increased exports of wheat and other grain from her ports; but it may be questioned whether during this period any advance has taken place in the comforts of the general mass of her population. It is a remarkable fact, that in the year 1823, when great numbers of the labouring class in Ireland were starving from a failure in the potato crop, and when large subscriptions were raising in England, and even on the Continent, for their relief, the exportation of grain was going on from Cork and other Irish ports, as if nothing had happened. Before much improvement can take place in the condition of the mass of Irish population, it is necessary that they should possess such a taste for the comforts of life as will restrain the principle of population, by lessening the number of early marriages, or inducing that degree of restraint rendered expedient by a prudent foresight. At present nothing more is necessary for the happiness of an Irish country labourer and his family than straw and potatoes: if these fail him he is lost, because he can fall no lower; if any thing is superadded to his means, it only increases the desire for these necessaries, produces a greater number of children, and creates an additional demand for straw and potatoes. It is gratifying, however, to be able to state that the time seems arrived for the introduction of domestic improvement among the peasantry of Ireland. At no former period has the British government manifested so much anxiety to discover the real causes of the miseries which afflict that country, and in every session of parliament some enactments are made for its amelioration. The enlightened principles of political economy which are now acted on by ministers, and the knowledge of this science which within these few years has spread among all classes, cannot fail to bring Ireland rapidly forward in civilisation and refinement; and we wish it may be to such a degree, as in a very few years to render the account which we have above given mere matter of history. No one can desire this result more ardently than we do.

Chap. VI.

Of the present State of Agriculture in Ultra-European Countries.

858. *In this department of our history* the reader will not expect more than a very slight outline; not only from our limited space and the comparative scarcity of materials, but because the subject is less interesting to general readers. We shall notice in succession the principal countries of Asia, Africa, Australia, and America.

Sect. I. *Of the present State of Agriculture in Asia.*

859. *The agriculture of Asia* is of a very different character from that of Europe, owing chiefly to the great difference of climate, and partly to the difference of civilisation. The culture of this division of the globe is chiefly of two kinds, water culture and pasturage. Very little can be done without artificial watering, except in the northern and mountainous parts, where the climate resembles that of Europe. Even the palm and other fruit trees are watered in some parts of Persia and Arabia, and several fruit trees are regularly irrigated in India. The grand bread corn of Asia is rice, a watered grain; and the most valuable fruits, those of the palm family; the most useful agricultural labourer is the ox, and his species are also the most valuable as pasturage animals.

Subsect. 1. *Of the present State of Agriculture in Asiatic Turkey.*

860. *Asiatic Turkey* extends from the Archipelago 1050 miles to Ararat in Persia on the east, and from the Euphrates 1100 miles to the Caucasian mountains on the north. It contains a number of provinces differing materially from each other in natural circumstances, and artificial culture; but, unfortunately for us, very little is known of their agriculture. In general, the Asiatic Turks are to be considered as a wandering and pastoral people, cultivating no more corn than what is sufficient for their own maintenance; and scarcely half civilised.

861. *The climate of Asia Minor* has been always considered excellent. The heat of the summer is tempered by numerous chains of high mountains, some of which are covered constantly with snow. The aspect of Asiatic Turkey is mountainous, intermingled with spacious and beautiful plains, which afford pasture to the numerous flocks and herds of the Turkomans. The soil is varied; but the chief agricultural products are wheat, barley, and doura (millet). It abounds also with grapes, olives, and dates. In Syria, the agriculture is deplorable, and the peasants are in a wretched condition, being sold, as in Poland, with the soil, and their constant fare being barley bread, onions, and water.

862. *The numerous mountains of Asiatic Turkey* are frequently clothed with immense forests of pines, oaks, beeches, elms, and other trees; and the southern shores of the Black Sea present many gloomy forests of great extent. The inhabitants are hence supplied with abundance of fuel, in defect of pit-coal, which has not been explored in any part of Asiatic Turkey. Sudden conflagrations arise from the heedless waste of the caravans, which, instead of cutting off a few branches, often set fire to a standing tree. The extensive provinces of Natolia, Syria, and Mesopotamia have been little accessible to European curiosity, since their reduction under the Turkish yoke. In Pinkerton's *Geography* we have a catalogue of those plants and trees that have been found wild in the Asiatic part of the Ottoman territory. Several dyeing drugs and articles of the materia medica are imported from the Levant, among which are madder, and a variety called alizan, which grows about Smyrna, and affords a much finer red dye than the European kind; jalap, scammony, sebesten, the ricinus (*Ricinus communis*, *fig.* 105.) yielding by expression castor oil, squirting cucumber, coloquintida, opium poppy, and spikenard. The best horses in Asiatic Turkey are of Arabian extraction; but mules and asses are more generally used. The beef is scarce and bad, the mutton superior, and the kid a favourite repast. Other animals are the bear, tiger, hyæna, wild boar, jackal, and dogs in great abundance. On the summits of Caucasus is found the ibex, or rock-goat; at Angora, singular goats and cats; the gazel, deer, and hares in great abundance, are found in Asia Minor. The partridges are generally of the red-legged kind, larger than the European; fish is plentiful and excellent.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Subsect. 2. *Of the present State of Agriculture in Persia.*

863. *The climate of Persia* is various in different parts; depending less on difference of latitude than on the nature and elevation of the country, so that it is said to be the country of three climates. The northern provinces on the Caspian are comparatively cold and moist: in the centre of the kingdom, as Chardin observes, the winter begins in November and continues till March, commonly severe, with ice and snow, the latter falling chiefly on the mountains, and remaining on those three days' journey west of Ispahan for eight months in the year. From March to May high winds are frequent; but from May to September the air is serene, refreshed by breezes in the night. The heat,

however, is during this period excessive in the low countries bordering on the Indian Ocean and Persian Gulf, in Chusistan, the deserts of Kerman, and also in some parts of the interior, particularly at Tehraun, the capital. From September to November the winds again prevail. In the centre and south the air is generally dry; thunder and lightning are uncommon, and a rainbow is seldom seen; earthquakes are almost unknown; but heat is often destructive in the spring. Near the Persian Gulf the hot wind, called "samiel," sometimes suffocates the unwary traveller. The summers are, in general, very mild, after ascending the mountains. To the north of Shiraz the winters are severe, insomuch that, in the vicinity of Tehraun and Tabreez, all communication is cut off for several successive weeks between these cities and the adjoining villages. The climate, notwithstanding this sudden transition from heat to cold, is singularly healthy, with the exception of the provinces of Ghilan, and Mazanderam. The air is dry; the dews not insalubrious. The atmosphere is always clear, and at night the planets shine with a degree of lustre unknown in Europe; and as it seldom rains, here are none of those damps or pestiferous exhalations so common in the woody parts of Hindustan.

864. *The surface of Persia* is distinguished by a deficiency of rivers and a multitude of mountains; its plains, where they occur, are generally desert. So that Persia may be divided into two parts by deserts and mountains; and this division, it is said, has generally influenced its history and destinies in all ages. It is every where open, and no where presents a thriving populous appearance. Even the cities and their environs have something of desolation and decay in their aspect, and many of them are actually ruined or neglected, of which Buschire and its territory (*fig.* 106.) is an example. The most fertile and thriving provinces are those on the north.

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865. *The soil* may be regarded as unfertile, and, according to Chardin, not more than one tenth part was cultivated in his time. The mountains of this country, which are for the most part rocky, without wood or plants, are interspersed with valleys, some of which are stony and sandy, and some consisting of a hard dry clay, which requires continual watering; and hence the Persian cultivator is much employed in irrigation. In general the soil of Persia is light and sandy in the south and east; hard and gravelly in the west, and rich and loamy on the borders of the Caspian Sea.

866. *The landed property of Persia,* like that of other despotic countries, is considered as wholly the property of the sovereign; and held by the proprietors and occupiers on certain conditions of military service, and supplies of men and provisions in time of war.

867. *The agricultural products of Persia* are as various as the climate and soils. The wheat is excellent, and is the common grain used in bread-making. Rice, which is in more universal use, is produced in great perfection in the northern provinces, which are well watered. Barley and millet are sown, but oats are little cultivated: in Armenia there is some rye. The vine is generally cultivated; but in the north-west countries they are obliged to bury the shoots to protect them from the frost. The silkworm is cultivated in most parts of the country; cotton and indigo are also grown; and no country in the world equals Persia in the number and excellence of its fruits.

868. *The date tree* is grown in plantations in the proportion of fifty females to two males. The natives begin to impregnate the females with the blossoms of the male in March and April, alleging that their proximity is not sufficient to insure the produce of fruit: this practice has been carried on among them from the earliest ages. (*Scot Waring's Persia*, chap. xxix.)

869. *The most esteemed of the cultivated fruits of Europe are indigenous in Persia,* and have probably been hence diffused over the western world. These are the fig, the pomegranate, the mulberry, the almond, peach, and apricot. Orange trees of an enormous size are found in the sheltered recesses of the mountains, and the deep warm sand on the shore of the Caspian is peculiarly favourable to the culture of the citron and the leguminous fruits. Apples, pears, cherries, walnuts, melons, besides the fruits already mentioned, are every where to be procured at very low prices; the quinces of Ispahan are

the finest in the East; and no grape is more delicious than that of Shiraz. In the provinces bordering on the Caspian Sea and Mount Caucasus, the air is perfumed with roses and other sweet-scented flowers. Among the vegetable productions we may enumerate cabbages, cucumbers, turnips, carrots, peas, and beans; and the potato, which has been lately introduced, thrives remarkably well. Poppies, from which an excellent opium is extracted, senna, rhubarb, saffron, and assafœtida are produced in many parts of the kingdom. The vine grows here luxuriantly, and further to the south cotton and sugar are articles of common cultivation. Poplars, large and beautiful, and the weeping willow, border the courses of the streams, and the marshy tracts abound with the kind of rush that serves for the Persian matting. Ornamental shrubs or herbaceous plants are little known; but the jasmine and the blue and scarlet anemone in the thickets, and the tulip and ranunculus in the pastures, are abundant and beautiful, and give an air of elegance to the country.

870. *The saline deserts of Persia* are for the most part destitute of trees, and support hardly any plants except such as are also found on the sea-shore. On the high mountains they are much the same as those observed on the alps of Switzerland and Italy. The plants on the hills and plains adjoining the Caspian are better known.

871. *The live stock of Persia* is the same as in European countries with some additions. According to Chardin, the Persian horses are the most beautiful in the East; but they yield in speed, and, as some say, in beauty also, to the Arabian; however, they are larger, more powerful, and, all things considered, better calculated for cavalry than those of Arabia. There are several breeds of horses, but the most valuable is that called the Turkoram; these are so hardy that they have been known to travel nine hundred miles in eleven successive days. The Arabian blood has been introduced into this country. Their usual food is chopped straw and barley; their bed is made of dung, dried and pulverised, and every morning regularly exposed to the sun. They are clothed with the greatest attention, according to the climate and season of the year; and during the warm weather are kept in the stable all day, and taken out at night.

872. *Mules* are also here in considerable request, and the ass resembles the European; but a breed of this animal has been brought from Arabia, of an excellent kind, the hair being smooth, the head high, and the motion spirited and agile. Although the mules are small, they are fairly proportioned, carry a great weight, and those that are intended for the saddle are taught a fine amble, which carries the rider at the rate of five or six miles an hour. The camel (*fig.* 107.) is also common; and the animals which are exported from Persia to Turkey have, as Chardin says, only one hunch, while those of India and Arabia have two. The Persian cattle in general resemble the European. Swine are scarce, except in the north-west provinces. The flocks of sheep, among which are those with large tails, are most numerous in the northern provinces of Erivan, or the Persian part of Armenia and Balk. The few forests abound with deer and antelopes; and the mountains supply wild goats, and probably the ibex, or rock goat. Hares are common. The ferocious animals are chiefly concealed in the forests, such as the bear and boar, the lion in the western parts, the leopard, and, as some say, the small or common tiger. Seals occur on the rocks of the Caspian. The hyæna and jackal belong to the southern provinces. The seas abound with fish of various descriptions; the Caspian affords sturgeon and delicious carp. The most common river fish is the barbel. The same sorts of wild and tame fowl are common in Persia and in Europe, with the exception of the turkey, whose nature does not seem to be congenial to this climate. Pigeons are numerous, and partridges are large and excellent. The bul-bul, or Oriental nightingale, enlivens the spring with his varied song. The Persians have been long accustomed to tame beasts of prey and even to hunt with lions, tigers, leopards, panthers, and ounces.

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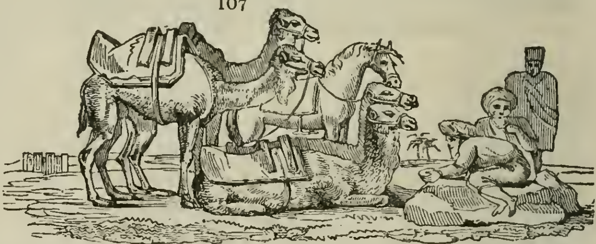

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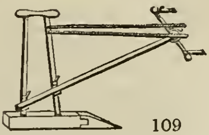
873. *The Persians hunt the quail in a curious manner.* (*fig.* 108.) They stick two poles in their girdle, upon which they place either their outer coat, or a pair of trowsers, and these at a distance are intended to look like the horns of an animal; they then with a hand-net prowl about the fields, and the quail, seeing a form more like a beast than a man, permits it to

approach so near as to allow the hunter to throw his net over it. In this manner they catch these birds with astonishing rapidity.

874. *Of the implements and operations* of Persian agriculture little is known with precision. The plough is said to be small, and drawn by lean cattle, so that it merely scratches the ground. The plough of Erzerum (*fig.* 109) is a clumsy implement, on the share of which the driver stands, both for the sake of being carried along and of pressing down the wedge. After the plough and harrow the spade is used for forming the ground into squares, with ledges or little banks to retain the water. The dung used is chiefly human, and that of pigeons, mingled with earth and preserved for two years to diminish its heat.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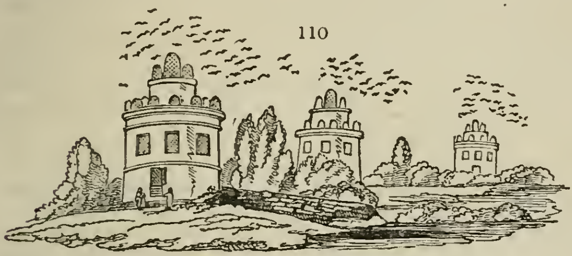
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875. *The dung of pigeons* is so highly prized in Persia that many pigeon-houses (*fig.* 110.) are erected at a distance from habitations, for the sole purpose of collecting their manure. They are large round towers, rather broader at the bottom than at the top, and crowned by conical spiracles through which the pigeons descend. Their interior resembles a honeycomb, forming thousands of holes for nests; and the outsides are painted and ornamented. The dung is applied almost entirely to the rearing of melons, a fruit indispensable to the natives of warm countries during the great heats of summer, and also the most rapidly raised in seasons of scarcity; and hence the reason that during the famine of Samaria a cab of dove's dung was sold for five pieces of silver. (2 *Kings*, vi. 25.) In Persia are grown the finest melons in Asia. The nobles pride themselves in excelling in this fruit, and some are said to keep pigeons to the extent of 10,000, and upwards, solely for their dung, as a manure for this fruit, the pigeon not being eaten by Persians. (*Morier's Second Journey*, 141.)

876. *No arable culture* is carried on in Persia without artificial watering; and various modes are adopted for raising the element from wells and rivers for this purpose. The Persian wheel is well known. The deficiency of rivers in Persia has obliged the natives to turn all their ingenuity to the discovery of springs, and to the bringing of their streams to the surface of the earth. To effect this, when a spring has been discovered, they dig a well until they meet with the water; and if they find that its quantity is sufficient to repay them for proceeding with the work, they dig a second well, so distant from the other as to allow a subterranean communication between both. They then ascertain the nearest line of communication with the level of the plain upon which the water is to be brought into use, and dig a succession of wells, with subterranean communications between the whole suite of them, until the water at length comes to the surface, when it is conducted by banked-up channels into the fields to be irrigated. The extent of country through which such streams are sometimes conducted is quite extraordinary. In making the wells (*fig.* 111.) a shaft is first dug, then a wooden handle is placed over it, from which is suspended a leathern bucket, which is filled with the excavated matter by a man below, and wound up by another above. Where the soil is against the mouth of the wells, they are secured by masonry. This mode of procuring water is common to the whole of Persia, and has the great defect of being easily destroyed by an enemy. (*Morier's Second Journey*, 164.)

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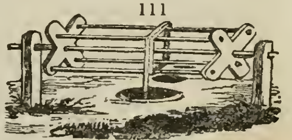


877. *The forests* of Persia are few, and chiefly in the mountains of Mazanderam and Ghilan, and those towards Kurdistan. The trees are several kinds of pines, the cedar and cypress, limes, oaks, acacias, and chestnuts; the sumach is abundant, and used for tanning; manna is procured from the *Fráxinus O'rnus*. Very little fuel is consumed in Persia, and timber is seldom used; in the castles and principal houses, arches are employed instead of timber floors.

Subsect. 3. *Of the present State of Agriculture in Independent Tatary.*

878. *The extent of Independent Tatary* can hardly be considered as well defined; but Pinkerton measures it from the Caspian Sea on the west to the mountains of Belus on the east, a space of 870 miles; and from the mountains of Gaur to the Russian boundaries on the north of the desert of Issim, a distance of 1500 miles. It is occupied by the Bucharian, Tungusian, Kirgusian, and other Tatar hordes; and is a celebrated and interesting country, as being the probable seat of the most ancient Persian kingdoms, and as having given birth to Zoroaster and other men eminent in Oriental literature. Modern travellers represent the more civilised of this nation as indolent, but good-natured. They are easily recognised among other varieties of man.

879. *The climate* of this extensive country appears to be excellent, the heat even of the southern provinces being tempered by the high mountains capped with perpetual snow; and though situated in the parallel of Spain, Greece, and Asiatic Turkey, the proximity of the Siberian deserts and the lofty alps render the summer more temperate.

880. *The surface* of the country presents a great variety; and there are numerous rivers, hills, and mountains.

881. *The soil* near the rivers is very productive, so that the grass exceeds the height of a man. In any other hands but those of the Tatars, this country might rival any European region.

882. *All that is known of the tillage of the Tatars* is, that rice and other grains are cultivated near the towns, but that the great dependence of the people is upon their flocks and herds. Bucharia is the richest country, both in corn and cattle. There they have horses, camels, oxen, sheep, and goats, which some individuals reckon by thousands, and make large sales, especially of horses, to the Persians and Turks. They have also dromedaries, which furnish a considerable quantity of woolly hair, which they clip off periodically and sell to the Russians. The lambskins are celebrated, being damasked, as it were, by clothing the little animal in coarse linen; but the wool of the sheep is coarse, and only used in domestic consumption for felts and thick cloths. The steppes, which are of immense extent, supply them with objects of the chace, wolves, foxes, badgers, antelopes, ermines, weasels, marmots, &c. In the southern and eastern mountains are found wild sheep (*O'vis Músimon*), the ox of Thibet (*Bós grúnniens*, *fig.* 112.) which seems to delight in snowy alps, chamois, tigers, and wild asses. There seems throughout the whole of Tatary to be a deficiency of wood; and the botany of this immense region is as little known as its agriculture.

112

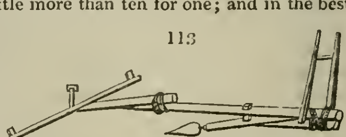
Subsect. 4. *Of the present State of Agriculture in Arabia.*

883. *The extent of Arabia* is somewhat greater than that of Independent Tatary. The climate is hot, but there is a regular rainy season, from the middle of June to the end of September, in some mountainous districts, and from November till February in others. The remaining months are perfectly dry; so that the year in Arabia consists only of two seasons, the dry and the rainy. In the plains, rain is sometimes unknown for a whole year. It sometimes freezes in the mountains, while the thermometer is at 86° in the plains, and hence at a small distance are found fruits and animals which might indicate remote countries.

884. *The general surface* presents a central desert of great extent, with a few fertile oases or isles, and some ridges of mountains, chiefly barren and unwooded. The flourishing provinces are those situated on the shores of the Red and Persian Seas, the interior of the country being sterile for want of rivers, lakes, and perennial streams. The soil is in general sandy, and in the deserts is blown about by the winds.

885. *The agricultural products* are wheat, maize, doura or millet, barley, beans, lentils, and rape, with the sugar-cane, tobacco, and cotton. Rice seems unknown in Yemen, and oats throughout Arabia; the horses being fed with barley, and the asses with beans. They also cultivate "uars," a plant which dyes yellow, and is exported in great quantities from Mocha to Oman; and "fua," used in dyeing red; likewise indigo. The wheat, in the environs of Maskat, yields little more than ten for one; and in the best cultivated districts of Yemen, fifty for one; but the doura sometimes much exceeds this ratio, yielding in the highlands 140, and in the Tehama, or plain, from 200 to 400. By their mode of sowing and watering this grain, the inhabitants of Tehama reap three successive crops from the same field in the same year. The plough (*fig.* 113.) is simple, and the pick is used instead of the spade.

113



886. *The indigenous, or partially cultivated, plants and trees* of Arabia are numerous, and several of them furnish important articles of commerce. The vegetables of the dry barren districts, exposed to the vertical sun, and refreshed merely by nightly dews, belong for the most part to the genera of *A*'loe, Mesembryánthemum, *E*uphórb*ia*, Stapèl*ia*, and Salsòla. On the western side of the Arabian desert, numerous rivulets, descending into the Red Sea, diffuse verdure; and on the mountains from which they run vegetation is more abundant. Hither many Indian and Persian plants, distinguished for their beauty or use, have been transported in former ages, and are now found in a truly indigenous state: such is the case probably with the tamarind, the cotton tree (inferior to the Indian), the pomegranate, the banyan tree or Indian fig, the sugar-cane, and many species of melons and gourds. Arabia Felix may peculiarly boast of two valuable trees, namely, the coffee (*Coffea* arábica), found both cultivated and wild; and the *A*mỳris *O*pobálsamum, which yields the balm of Mecca. Of the palms, Arabia possesses the date, the cocoa-nut, and the great fan-palm. It has also the sycamore fig, the plantain, the almond, the apricot, the peach, the papaw, the bead tree, the Mimòsa nilótica and sensitìva, and the orange. Among its shrubs and herbaceous plants may be enumerated the ricinus, the liquorice, and the senna, used in medicine; and the balsam, the globe amaranth, the white lily, and the greater pancratium, distinguished for their beauty and fragrance.

887. *The live stock* of Arabia is what constitutes its principal riches, and the most valuable are those species of animals that require only succulent herbs for their nourishment. The cow here yields but little milk; and the flesh of the ox is insipid and juiceless. The wool and mutton of the sheep are coarse. The bezoar goat is found in the mountains. The buffalo is unknown; but the camel and dromedary (*fig.* 114.) are both in use as beasts of burden. The civet cat, musk rat, and other mountain animals, are valuable in commerce. Pheasants, partridges, and common poultry abound in Yemen; and there are numerous ferocious animals, birds of prey, and pestiferous insects.

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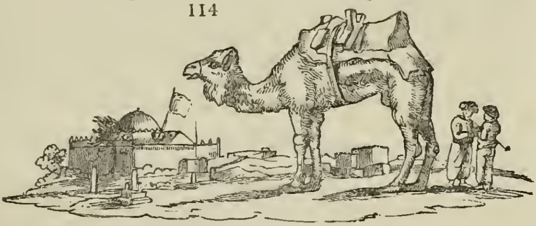

888. *But the horse* is of all the animals of Arabia the most valuable. This animal is said to be found wild in the extensive deserts on the north of Hadramant: this might have been the case in ancient times, unless it should be thought more probable, that the wild horse of Tatary has passed through Persia, and has been only perfected in Arabia. The horses here are distributed into two classes, viz. the *kadischi*, or common kind, whose genealogy has not been preserved, and the *kochlani*, or noble horses, whose breed has been ascertained for 2000 years, proceeding, as their fables assert, from the stud of Solomon. They are reared by the Bedouins, in the northern deserts between Bassora, Merdin, and the frontiers of Syria; and though they are neither large nor beautiful, their race and hereditary qualities being the only objects of estimation, the preservation of their breed is carefully and authentically witnessed, and the offspring of a *kochlani* stallion with an ignoble race is reputed *kadischi*. These will bear the greatest fatigues, and pass whole days without food, living, according to the Arabian metaphor, on air. They are said to rush on a foe with impetuosity; and it is asserted that some of them, when wounded in battle, will withdraw to a spot where their master may be secure; and if he fall, they will neigh for assistance; accordingly, their value is derived from their singular agility, extreme docility, and uncommon attachment to their master. The Arabian steeds are sometimes bought at excessive rates by the English at Mocha. The Duke of Newcastle asserts that the ordinary price of an Arabian horse is 1000*l*., 2000*l*., or even 3000*l*.; and that the Arabs are as careful in preserving the genealogy of their horses, as princes in recording that of their families. The grooms are very exact in registering the names of the sires and dams of these animals; and some of these pedigrees are of very ancient date. It is affirmed that Arabian colts are brought up with camels' milk.

889. *Of the agricultural implements and operations* of Arabia almost nothing is known. Their plough, as we have seen, is a poor implement, and instead of a spade they use the pick. The principal exertion of the husbandman's industry is to water the lands from the rivulets and wells, or by conducting the rains. Barley is reaped near Sana in the middle of July; but the season depends on the situation. At Maskat, wheat and barley are sown in December, and reaped in March; but doura (the great millet) is sown in August, and reaped in the end of November. The Arabians pull up their ripe corn by the roots; but the green corn and grass, as forage for their cattle, are cut with the sickle. In threshing their corn, they lay the sheaves down in a certain order, and then lead over them two oxen dragging a large stone.

Subsect. 5. *Of the present State of Agriculture in Hindustan.*

890. *The climate and seasons* of this extensive region are considerably diversified by difference of latitude and local situation; nevertheless, throughout the wide regions of Hindustan there is some similarity of climate. Although in Thibet the winter nearly corresponds with that of Switzerland and other parts of Europe, in the whole extent of Hindustan, except in Cashmere, there can hardly be said to be a vestige of winter, except the thick fogs similar to those of our November; and excessive rains, or excessive heats, form the chief varieties of the year.

891. *The surface of the country* is much diversified; but there are no mountains of any very great height; the ghauts not being estimated at above three thousand feet. The vast extent of Hindustan consists chiefly of large plains, fertilised by numerous rivers and streams, and interspersed with a few ranges of hills. The periodical rains and intense heats produce a luxuriance of vegetation almost unknown to any other country on the globe; and the variety and richness of the vegetable creation delight the eye of every spectator. Bengal is a low, flat country, like Lower Egypt, watered and fertilised by the Ganges, as the latter country is by the Nile; and, like the Nile, the Ganges forms an immense delta before it falls into the sea. The interior of the country is so flat, that the water runs only at the rate of three miles an hour; and the ground rises from the sea towards the interior, at not more than four inches in a mile.

892. *The soil* varies, but is in most places light and rich: that of Bengal is a stratum of black vegetable mould, rich and loamy, extending to the depth of six feet, and in some places fourteen, and even twenty feet; lying on a deep sand, and interspersed with shells and rotten wood, which indicate the land to have been overflowed, and to have been formed of materials deposited by the rivers. It is easily cultivated without manure, and bad harvests seldom occur. In this country they have two harvests; one in April, called the "little harvest," which consists of the smaller grains, as millet; and the second, called the "grand harvest," is only of rice.

893. *Landed property* in Hindustan, as in all the countries of Asia, is held to be the absolute right of the king. The Hindû laws declare the king to be the lord and proprietor of the soil. All proprietors, therefore, paid a quitrent or military services to the king or rajah, except some few, to whom it would appear absolute grants were made. In general, the tenure was military; but some lands were appropriated to the church and to charitable purposes, and in many places commons were attached to villages as in Europe. Lands in Hindustan, and in Bengal more especially, are very much divided, and cultivated in small portions by the ryots, or peasants, who pay rent to subordinate proprietors, who hold of others who hold of the rajah. The actual cultivators have hardly any secure leases; they are allowed a certain portion of the crop for the maintenance of their families and their cattle; but they are not entrusted with the seed, which is furnished by the proprietor or superior holder. The ryot, or cultivator, is universally poor; his house, clothing, and implements of every kind, do not amount to the value of a pound sterling; and he is considered as a sort of appendage to the land, and sold along with it, like his cattle. So little attention is paid to any agreement made with him, that in a good season, Dr. Tennant informs us, the zemindar, or superior holder, raises his demands to a fourth more than the rent agreed on. Custom has rendered this evil so common, that the miserable ryot has no more idea of obtaining redress from it than from the ravages of the elements. Since Bengal was conquered by the British, the government is, properly speaking, the proprietor of all the lands; and Tennant accordingly observes, that "nine tenths of all the rent of Bengal and the provinces constitute the revenue of the company, who are, in room of the Mogul emperor, the true proprietors of the soil." (*Recr.* ii. 184.)

894. *The agricultural products* of Hindustan are very various. Rice, wheat, and maize are the common grains; but barley, peas, a species of tare or cytisus called dohl, and millet, are also cultivated. Next to them the cotton plant and the sugar-cane are most extensively grown. To these may be added, indigo, silk, hemp, poppy for opium, palma Christi, sesamum, mustard; the cocoa-nut, which supplies a manufacture of cordage, and also a liquor called toddy; guavas, plantains, bananas, pompelos, limes, oranges, and a great variety of other fruits, besides what are cultivated in gardens, where the settlers have all the vegetables of European horticulture. The potato has been introduced, and though it does not attain the same size as in Europe, is yet of good quality. It is not disliked by the natives, but cannot be brought to market at so low a price as rice.

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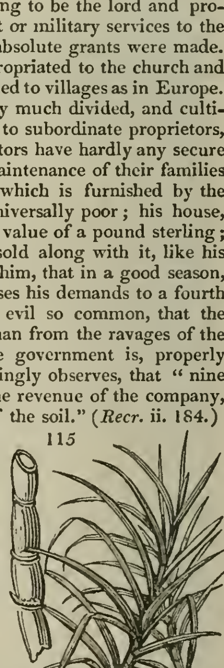

895. *The sugar-cane* (*Sâccharum officinârum*) (*fig* 115.) is cultivated in low grounds that may be flooded. The ground being cleaned and pulverised by one or two years'

fallow is planted with cuttings of two or three buds, in rows four feet apart and eighteen inches wide in the row; as they grow, each stool, consisting of three shoots or more, is tied to a bamboo reed eight or ten feet long, the lower leaves of each cane being first carefully wrapt round it, so as to cover every part, and prevent the sun from cracking it, or side shoots from breaking out. Watering and flooding in the dry season, and keeping open the surface drains during the periodical rains, are carefully attended to. Nine months from the time of planting, the canes are ten feet high, and ready to cut. The process of sugar-making, like all others in this country, is exceedingly simple. A stone mortar and wooden pestle turned by two small bullocks express the juice, which is boiled in pots of earthenware sunk in the ground, and heated by a flue which passes beneath and around them, and by which no heat is lost.

896. *The indigo* (*Indigófera tinctòria, fig.* 116.) is one of the most profitable articles of culture in Hindustan; because an immense extent of land is required to produce but a moderate bulk of the dye; because labour and land here are cheaper than any where else; and because the raising of the plant and its manufacture may be carried on without even the aid of a house. The first step in the culture of the plant is to render the ground, which should be friable and rich, perfectly free from weeds and dry, if naturally moist. The seeds are then sown in shallow drills about a foot apart. The rainy season must be chosen for sowing, otherwise, if the seed is deposited in dry soil, it heats, corrupts, and is lost. The crop being kept clear of weeds is fit for cutting in two or three months, and this may be repeated in rainy seasons every six weeks. The plants must not be allowed to come into flower, as the leaves in that case become dry and hard, and the indigo produced is of less value; nor must they be cut in dry weather, as they would not spring again. A crop generally lasts two years. Being cut, the herb is first steeped in a vat till it has become macerated, and has parted with its colouring matter; then the liquor is let off into another, in which it undergoes the peculiar process of beating, to cause the fecula to separate from the water. This fecula is let off into a third vat, where it remains some time, and is then strained through cloth bags, and evaporated in shallow wooden boxes placed in the shade. Before it is perfectly dry it is cut in small pieces of an inch square; it is then packed in barrels, or sowed up in sacks, for sale. Indigo was not extensively cultivated in India before the British settlements were formed there; its profits were at first so considerable, that, as in similar cases, its culture was carried too far, and the market glutted with the commodity. The indigo is one of the most precarious of Oriental crops; being liable to be destroyed by hail storms, which do comparatively little injury to the sugar-cane and other plants.


116

897. *The mulberry* is cultivated in a different manner from what it is in Europe. It is raised from cuttings, eight or ten of which are planted together in one pit, and the pits are distributed over the field at the distance of two or three feet every way. These cuttings being well firmed at the lower ends soon form stools about the height of a raspberry bush, and from these the leaves are gathered. The stools are cut over once a year to encourage the production of vigorous shoots from the roots.

898. *The poppy* (*Papàver somníferum*) is cultivated on the best soil, well manured. The land sometimes receives as many as fifteen stirrings, and the seed is then dropped into shallow drills about two feet apart. During the growth of the plants the soil is stirred, well watered, and sometimes top-dressed. In two months from the time of sowing, the capsules are ready for incision, which process goes on for two or three weeks; several horizontal cuts being made in the capsule on one day, on the next the milky juice which had oozed out, being congealed, is scraped off. This operation is generally repeated three times on each capsule, and then the capsules are collected for their seed. The raw juice is kneaded with water, evaporated in the sun, mixed with a little poppy oil, and, lastly, formed into cakes, which are covered with leaves of poppy, and packed in chests with poppy husks and leaves.

899. *Tobacco* in Hindustan is cultivated in the same manner as in Europe. The soil must be rich and well pulverised, the plants transplanted, and the earth stirred during their growth; the main stems are broken off, and the leaves are dried by being suspended on beds of withered grass by means of ropes, and shaded from the sun and protected from nightly dews. The leaves afford a much weaker odour than those of the tobacco of Europe or America.

900. *The mustard*, *Sésamum orientàle*, *flax*, *palma Christi*, and some other plants, are grown for their seeds, which are crushed for oil. The use of the flax, as a clothing plant, is not understood in India, hemp supplying its place. The mustard and sesamum are sown on the sand left by the overflowings of the rivers, without any other preparation or culture than that of drawing a bush over the seeds to cover them. The palma Christi is sown in patches three or four feet apart, grows to the size of a little tree, and is cut down with an axe when the seeds are to be gathered. The mill for bruising the seeds of these plants is simply a thick trunk of a tree hollowed into a mortar, in which is placed the pestle, turned by oxen.

901. *Palm trees* of several species are in general cultivation in Hindustan. The most useful is the cocoa-nut tree (*Còcos nucífera*, *fig.* 117.), which grows almost perfectly straight to the height of forty or fifty feet, and is nearly one foot in diameter. It has no branches, but about a dozen leaves spring immediately from the top: these are about ten feet long, and nearly a yard in breadth towards the bottom. The leaves are employed to cover the houses of the natives; and to make mats either for sitting or

lying upon. The leaf when reduced to fine fibres is the material of which a beautiful and costly carpeting is fabricated for those in the higher ranks; the coarser fibres are made into brooms. After these useful materials are taken from the leaf, the stalk still remains, which is about the thickness of the ancle, and furnishes firewood.

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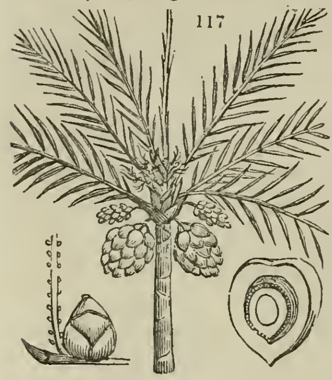

902. *The wood of this palm*, when fresh cut, is spongy; but becomes hard, after being seasoned, and assumes a dark-brown colour. On the top of the tree a large shoot is produced, which when boiled resembles broccoli, but is said to be of a more delicate taste; and, though much liked, is seldom used by the natives; because on cutting it off the pith is exposed, and the tree dies. Between this cabbage-like shoot and the leaves spring several buds, from which, on making an incision, distils a juice differing little from water, either in colour or consistence. It is the employment of a certain class of men to climb to the tops of the trees in the evening, with earthen pots tied to their waists, these they fix at the top to receive the juice, which is regularly carried away before the sun has any influence upon it. This liquor is sold at the bazaars by the natives, under the name of toddy. It is used for yest, and forms an excellent substitute. In this state it is drank with avidity, both by the low Europeans and the natives; and it is reckoned a cooling and agreeable beverage. After being kept a few hours, it begins to ferment, acquires a sharp taste, and a slightly intoxicating quality. By boiling it, a coarse kind of sugar is obtained; and by distillation it yields a strong ardent spirit, which being every where sold, and at a low price, constitutes one of the most destructive beverages to our soldiers. The name given to this pernicious drink by Europeans is pariah arrack, from the supposition that it is only drank by the pariahs, or outcasts that have no rank.

903. *The trees from which the toddy is drawn* do not bear any fruit, on account of the destruction of the buds; but if the buds be left entire, they produce clusters of the cocoa-nut. This nut, in the husk, is as large as a man's head; and when ripe falls with the least wind. If gathered fresh, it is green on the outside; the husk and the shell are tender. The shell, when divested of the husk, may be about the size of an ostrich's egg, and is lined with a white pulpy substance, which contains about a pint and a half of liquor like water; and, though the taste be sweet and agreeable, it is different from that of the toddy.

904. *In proportion as the fruit grows old*, the shell hardens, and the liquor diminishes, till it is at last entirely absorbed by the white milky substance; which gradually acquires the hardness of the kernel of the almond, and is almost as easily detached from the shell. The natives use this nut in their victuals; and from it they also express a considerable quantity of the purest and best lamp oil. The substance which remains after this operation supplies an excellent food for poultry and hogs. Cups and a variety of excellent utensils are made of the shell.

905. *The husk of the cocoa-nut* is nearly an inch thick, and is, perhaps, the most valuable part of the tree; for it consists of a number of strong fibres, easily separable, which furnish the material for the greatest part of the Indian cordage; but is by no means the only substitute which the country affords for hemp. This the natives work up with much skill.

906. *The palmyra*, a species of Córypha, is taller than the cocoa tree; and affords still greater supplies of toddy; because its fruit is in little request, from the smallness of its size; the produce of the tree is therefore generally drawn off in the liquid state. This tree, like the cocoa, has no branches; and, like it too, sends forth from the top a number of large leaves, which are employed in thatching houses, and in the manufacture of mats and umbrellas. The timber of the tree is much used in building.

907. *The date tree* (*Phœ̀nix dactylífera*), being smaller, does not make so conspicuous a figure in the Indian forest as the two last described. Its fruit never arrives at maturity in India, owing to the heat: toddy is drawn from it, but not in such quantity, nor of so good a quality, as that which is produced by the other species of the same genus.

908. *The bamboo* (Bambùsa a*rundinàcea*) is, perhaps, one of the most universally useful trees in the world; at all events it is so in the tropical regions. There are above fifty varieties, all of which are of the most rapid growth, rising from fifty to eighty feet the first year, and the second perfecting its timber in hardness and elasticity. It grows in stools, which are cut over every two years, and thus the quantity of timber furnished by an acre of bamboos is immense. Its uses are almost without end. In building it forms entire houses for the lower orders, and enters both into the construction and furniture of those of the higher classes. Bridges, boats, masts, rigging, agricultural and other implements, and machinery, carts, baskets, ropes, nets, sailcloth, cups, pitchers, troughs, pipes for conveying water, pumps, fences for gardens and fields, &c., are made of it. Macerated in water it forms paper; the leaves are generally put round the tea sent to Europe; the thick inspissated juice is a favourite medicine, is said to be indestructible by fire, to resist acids, and by fusion with alkali to form a transparent permanent glass.

909. *The fruits* of Hindustan may be said to include all those in cultivation; since the hardier fruits of Europe, as the strawberry, gooseberry, apple, &c., are not only grown by the European settlers in cool situations, but even by the native shahs. The indigenous sorts include the mango, the mangostan, and the durion, the noblest of known fruits next to the pine-apple.

910. *The natural pastures* of Hindustan are every where bad, thin, and coarse, and there is no such thing as artificial herbage plants. In Bengal, where the soil is loamy to the depth of nine and ten feet, a coarse bent, or species of *Júncus*, springs up both in

the pasture and arable lands, which greatly deteriorates the former as food for cattle, and unfits the latter for being ploughed. This *Júncus*, Tennant observes, pushes up a single seed stem, which is as hard as a reed, and is never touched by cattle so long as any other vegetable can be had. Other grasses of a better quality are sometimes intermixed with this unpalatable food; but, during the rain, their growth is so rapid that their juices must be ill fitted for nutrition. In Upper Hindustan, during the dry season, and more particularly during the prevalence of the hot winds, every thing like verdure disappears; so that on examining a herd of cattle, and their pasture, you are not so much surprised at their leanness as that they are alive. The grass-cutters, a class of servants kept by Europeans for procuring food for their horses, will bring provender from a field where grass is hardly visible. They use a sharp instrument, like a trowel, with which they cut the roots below the surface. These roots, when cleared of earth by washing, afford the only green food which it is here possible to procure.

911. *The live stock* of Hindustan consists chiefly of beasts of labour, as the natives are by their religion prohibited the use of animal food. The horses are chiefly of Persian or Arabian extraction. The Bengal native horse is thin and ill-shaped, and never equals the Welch or Highland pony, either in figure or usefulness. The buffalo is common, both tame and wild, and generally jet black, with semicircular horns laid backwards upon the neck. They are preferred to the ox for carrying goods, and kept in herds for the sake of their milk, from which ghee, a universal article of Hindoo diet, is made.

912. *The common ox* of Hindustan is white, and distinguished by a protuberance on the shoulder, on which the yoke rests. Those kept for travelling-coaches are capable of performing long journeys nearly in the same time as horses; those kept by the poor ryots work patiently in the yoke, beneath the vertical sun, for many hours, and upon the most wretched food, chaff or dried straw. Cow's milk is used pretty generally in India; but buffalo's milk, or goat's milk, is reckoned sweeter and finer than cow's milk, and preferred at the breakfast table even by the English. Goat's milk is decidedly the best for tea.

913. *The sheep* is small, lank, and thin; and the wool chiefly black or dark grey. The fleece is harsh, thin, and hairy, and only used for a kind of coarse wrappers or blanketing. A somewhat better breed is found in the province of Bengal. The mutton of India is generally good; at Poona, and in the Mahratta country, and in Bengal, it is as fine as any in the world.

914. *The goat* is kept for its milk, which is commonly used at the breakfast table; and also for the flesh of the kids, which is by some preferred to the mutton.

915. *Swine* are pretty common except among Mohammedans. They might be reared in abundance; but only Europeans and the low Hindoos eat pork. Wild hogs are abundant, and do so much injury to the rice fields that it is a material part of the ryot's business to watch them, which he does night and day, on a raised platform of bamboos.

916. *The elephant* is used as a beast of burden, but is also kept by a few European gentlemen, for hunting or show. He is taken by stratagem, and by feeding and gentle usage soon becomes tame, docile, and even attached to his keeper; but does not breed freely in a domesticated state. The leaves and smaller branches of trees, and an allowance of grain, constitute his food. It is a singular deviation from general nature, that an old elephant is easier tamed than one taken young.

917. *The camel* is used chiefly as a beast of burden, and is valued for his uncommon power of abstinence from drink. He is also patient of fatigue, hunger, and watching, to an incredible degree. These qualities have recommended the camel, as an auxiliary to British officers for carrying their baggage; and from time immemorial, he has been used by merchants for conveying goods over extensive tracts of country.

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918. *The predatory* animals are numerous. Of these the jackal (*fig.* 118.) is the most remarkable. He enters at night every farmyard, village, and town, and traverses even the whole of Calcutta. His voracity is indiscriminate, and he acts as a scavenger in the towns; but, in the farmyards he is destructive to poultry, if he can get at their roosts; and in the fields the hare and the wild pig sometimes become his prey. The numerous village dogs, which in general are mangy, are almost as troublesome as the jackal. Apes of different kinds haunt houses, and pilfer food and fruits. The crow, kite, mino, and sparrow hop about the dwellings of man with a familiarity unknown in Europe, and pilfer from the dishes of meat, even as they are carried from the kitchen to the eating-room. The stork is common; and toads, serpents, lizards, and other reptiles and insects, are greatly kept under by him and other birds.

919. *The implements and operations* of Hindustanée agriculture are as simple as can well be imagined. The plough, of which General Beatson has given several forms (*fig.* 119.), is little better than a pointed stick, and is carried to the field on the shoulder like the spade. It scratches the sandy uplands, or the mud left by the rivers, in a tolerable manner; but the strong lands of Bengal, that send up the *Júncus* already mentioned, appear as green after one ploughing as before; "only a few scratches are perceptible here and there, more resembling the digging of a mole than the work of the plough." To accomplish the work of pulverisation, the ploughman repeats the operation from five to fifteen times, and at last succeeds in raising mould enough to cover the seed: one plough and pair is allowed to five acres. From this mode of repeatedly going over the same surface and effecting a little each time, General Beatson has drawn some ingenious arguments in favour of the use of the cultivator in this country, which will be afterwards noticed.

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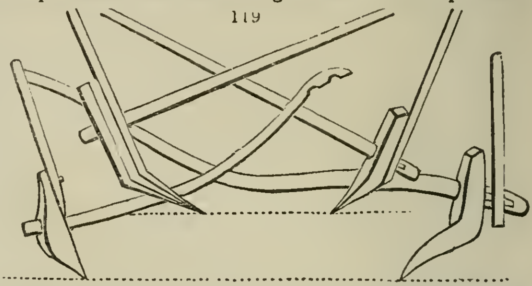

920. *The cart*, or hackery, has two wheels, and is drawn by two bullocks. The wheels are under three feet in diameter, and the body of the carriage consists of two bamboos, united by a few cross-bars, also of bamboo, and approaching each other the whole length of the machine, till they meet at a point between the necks of the cattle, where they are supported by a bar projecting sideways over the shoulders of both. By this the oxen or buffaloes are often galled in a shocking manner, and the suppuration which takes place in consequence is, perhaps, not perfectly cured during the whole life of the animal; the evil being aggravated by the crows, which set upon him as soon as he is relieved from the yoke.

921. *As no department of aration can be carried on without artificial watering*, that operation becomes very expensive and troublesome in elevated districts. In the Mongheer district of Bengal, a deep well is dug in the highest part of the field. The fields, after being ploughed, are divided into little square plots, resembling the checkers of a backgammon table. Each square is surrounded with a shelving border, about four inches high, capable of containing water. Between the square checkers thus constructed small dykes are formed for conveying a rivulet over the whole field. As soon as the water has stood a sufficient time in one square for that portion to imbibe moisture, it is let off into the adjoining one, by opening a small outlet through the surrounding dyke. Thus one square after another is saturated, till the whole field, of whatever extent, is gone over.

922. *The water is raised in large leathern bags*, pulled up by two bullocks yoked to a rope. The cattle are not driven in a gin as ours, but retire away from the well, and return to its mouth, accordingly as the bag is meant to be raised or to descend. When raising the filled skin they walk down hill away from the well, and they ascend backwards as the emptied skin redescends into the water. The earth is artificially raised to suit this process. The rope is kept perpendicular in the pit, by a pulley, over which it runs. From the mouth of the well thus placed, the rivulets are formed to every part of a field

923. *In the district of Patna* the wells are not so deep. Here the leathern bags are raised by long bamboo levers, as buckets are in several parts of this country. In a few places rice is transplanted, which is done with pointed sticks, and the crop is found to be better than what is sown broadcast.

924. *In the hilly districts* they neither plough nor sow; what grain they raise is introduced into small holes, made with a peg and mallet, in a soil untouched by the plough. The only preparation given to it is the turning away of the jungle. In the vicinity of Rajamahl there are many tribes of peasants, who subsist partly by digging roots, and by killing birds and noisome reptiles. In these savage districts ninety villages have been taxed for two hundred rupees; and yet this paltry sum could only be made up by fruits peculiar to the situation. The wretched state of these peasants, Dr. Tennant observes, outdoes every thing which a European can imagine.

925. *Harvests* are gathered in at different seasons of the year; and as often as a particular crop is collected, the ryot sends for the brahmin, or parish priest, who burns ghee and says prayers over the collected heap, and receives one measure of grain for his trouble.

926. *The selections* we have now submitted will give some idea of the aboriginal agri-

culture of Hindustan; not in its details, but as to its peculiar features. It is evidently wretched, and calculated for little more than the bare sustenance of an extensive population: for though the revenue of the state is in fact the land rent, that revenue, notwithstanding the immense tract of country from which it is collected, is known to be very small. The state of agriculture, however, both politically and professionally, is capable of great improvement; and it is believed that the present government has already effected material benefits, both for the natives and for itself. Wherever the British influence is preeminent, there Europeans settle and introduce improvements; and even the more industrious Asiatics find themselves in greater security. The Chinese are known to be a remarkably industrious people, and many of them have established themselves in British-Indian seaports. Wathen (*Voyage, &c.*, 1814) mentions a corn-mill, combining a bake-house, both on a large scale and driven by a powerful stream of water, as having been established at Penang, in the island of that name, by Amee, a Chinese miller. The building is in the Chinese taste, and forms a very picturesque group in a romantic spot. (*fig.* 120.) About sixty people are employed; though great part of the labour is done by machinery, and among other things the kneading of the dough. The shipping is the chief source of consumption.

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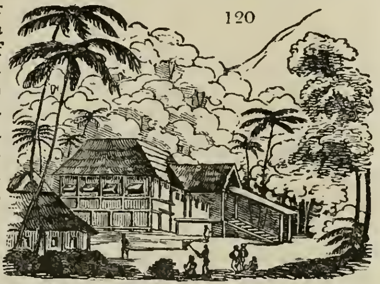

SUBSECT. 6. *Of the Agriculture of the Island of Ceylon.*

927. *The agriculture of Ceylon* is noticed at some length by Dr. Davy, who says the art is much respected by the Singalese. The climate of that country is without seasons, and differs little throughout the year in any thing but in the direction of the wind, or the presence or absence of rain. Sowing and reaping go on in every month.

928. *The soil of Ceylon is generally silicious,* seldom with more than from one to three per cent of vegetable matter. Dr. Davy (*Account, &c.*) found the cinnamon tree in a state of successful culture in quartz sand, as white as snow on the surface, somewhat grey below; containing one part in one hundred of vegetable matter, five tenths of water, and the remainder silicious sand. He supposes the growth of the trees may be owing in a considerable degree to the situation being low and moist.

929. *The cultivation in the interior of Ceylon* is almost exclusively of two kinds; the dry and wet. The former consists of grubbing up woods on the sides of hills, and sowing a particular variety of rice and Indian corn; the latter is carried on in low flat surfaces, which may be flooded with water. Rice is the only grain sown. The ground is flooded previously to commencing the operation of ploughing, and is kept under water

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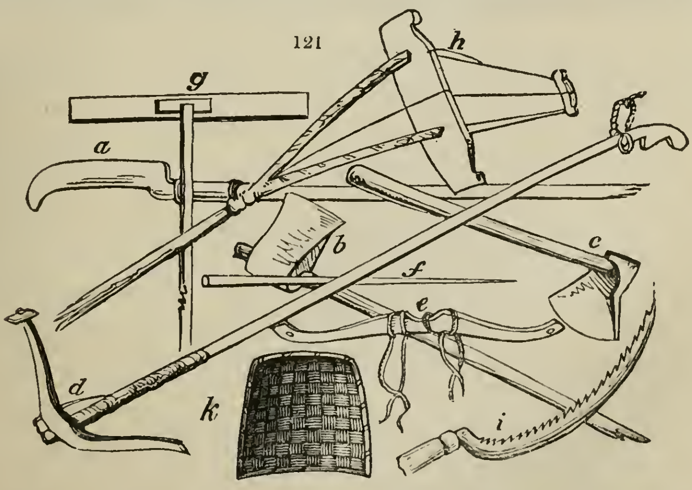

while two furrows are given; the water is then let off, and the rice, being previously steeped in water till it begins to germinate, is sown broadcast. When the seed has taken root, and before the mud has had time to dry, the water is re-admitted: when the plants are two or three inches high, the ground is weeded, and any thin parts made good by transplanting from such as are too thick. The water remains on the field till the rice begins to ripen, which is commonly in seven months: it is then let off and the crop cut down with reaping hooks, and carried to the threshing floor, where it is trod out by buffaloes.

930. *The agricultural implements of the Singalese* are few and simple; they consist of jungle hooks (*fig.* 121. *a*), for cutting down trees and underwood; an axe (*b*); a sort of French spade or *bêche* (*c*); a plough of the lightest kind (*d*), which the ploughman holds with one hand, the beam being attached to a pair of buffaloes, by a yoke (*e*), and with the other, he carries a long goad (*f*), with which, and his voice, he directs and stimulates the animals. A sort of level (*g*) is used for levelling the ground after ploughing, which, like the plough, is drawn by a pair of buffaloes, the driver sitting on it to give it momentum. For smoothing the surface of the mud preparatory to sowing, a sort of light scraper (*h*) is employed. The reaping hook (*i*) is similar to ours; their winnow (*k*) is composed of strong matting, and a frame of rough twigs. The threshing floor is made of beaten clay; and previously to commencing the operation of treading out, a charm (*fig.* 122. *l*) is drawn on the middle of the floor. A forked stick (*m*) is used to gather and stir up the straw under the buffaloes' feet. (*Davy's Ceylon*, 278.)

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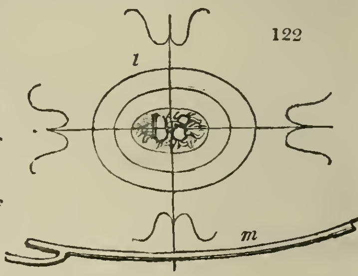

931. *A Singalese farmyard* bears some resemblance to one of this country (*fig.* 123.); but fewer buildings are required, and no barn.

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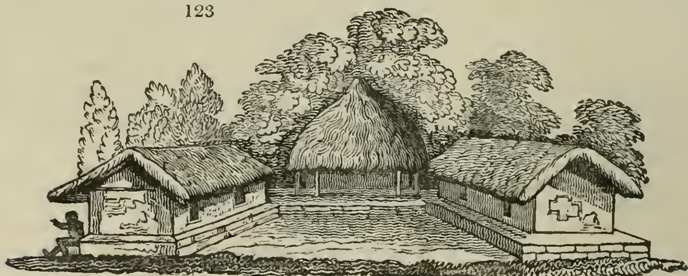

932. *An embankment*, or retaining mound, by which an artificial lake of three or four miles in circumference is dammed up, is described by Dr. Davy. It is nearly a straight line across the valley, twenty feet high, and 150 or 200 feet wide; the side next the water forming an angle of 45°, and faced with large stones, in the manner of steps. This must have been a work of great labour to so rude and simple a people.

SUBSECT. 7. *Of the present State of Agriculture in the Birman Empire, in Java, Malacca, Siam, Cochin-China, Tonquin, Japan, &c.*

933. *The agriculture of these countries*, and of others of minor note adjoining them, differs little, as far as it is known, from that of Hindustan. In all of them the sovereign is the lord of the soil; the operative occupier is wretchedly poor and oppressed. The chief product is rice; the chief animal of labour the buffalo or ox; the chief manure, water; and the chief material for buildings and implements, the bamboo.

934. *The Birman empire* is distinguished for the salubrity of its climate, and the health and vigour of the natives. In this respect they possess a decided preeminence over the enervated natives of the East; nor are the inhabitants of any country capable of greater bodily exertions than the Birmans.

935. *The seasons* of this country are regular, and the extremes of heat and cold are seldom experienced; at least, the duration of that intense heat, which immediately precedes the commencement of the rainy season, is so short that its inconvenience is very little felt. The forests, however, like some other woody and uncultivated parts of India, are extremely pestiferous; and an inhabitant of the champaign country considers a journey thither as inevitable destruction. The wood-cutters, who are a particular class of men, born and bred in the hills, are said to be unhealthy, and seldom attain longevity.

936. *The soil* of the southern provinces of the Birman empire is remarkably fertile, and produces as luxuriant crops of rice as are to be found in the finest parts of Bengal. Towards the north, the face of the country is irregular and mountainous, with headlong torrents and rivers in yawning chasms, crossed by astonishing bridges: but the plains and valleys are exceedingly fruitful; they yield good wheat and various kinds of small grain which grow in Hindustan, together with most of the esculent legumes and vegetables of India. Sugar-canes, tobacco of a superior quality, indigo, cotton, and the different tropical fruits in perfection, are all indigenous products of this country. Besides the teak tree (*Téctona* grándis), which grows in many parts of the Birman empire, as well to the north of Ummerapoora, as in the southern country, there is almost every description of timber that is known in India.

937. *The cattle* used in some parts of the country for tillage and draught are remarkably good; they put only a pair of them to the plough, which is little different from the plough of India, and turns up the soil very superficially. In their large carts they yoke four stout oxen, which proceed with the speed of a hand gallop, and are driven by a country girl, standing up in her vehicle, who manages the reins and a long whip with ease and dexterity. Many of the rising grounds are planted with indigo; but the natives suffer the hills for the most part to remain uncultivated, and only plough the rich levels. They every where burn the rank grass once a year to improve the pasture. The Birmans will not take much pains; they leave half the work to nature, which has been very bountiful to them. In the neighbourhood of Loonghe many fields are planted with cotton, which thrives well; sesamum is also cultivated in this soil, and is found to answer better than rice, which is most productive in low and moist grounds. In the suburbs of Pagahm, there are at least two hundred mills employed in expressing oil from the sesamum seed. In this operation the grain is put into a deep wooden trough, and pressed by an upright timber fixed in a frame; the force is increased by a long lever, on the extremity of which a man sits and guides a bullock that moves in a circle; thus turning and pressing the seed at the same time. The machine is simple, and yet effectually answers the purpose.

938. *Among the vegetable productions of this country*, we may enumerate the white sandal-tree, and the Aloéxylon vèrum, producing the true jet-black ebony wood; the sycamore fig, Indian fig, and banyan tree; the Bignòn*ia* índica, Naúclea orientàlis; Córypha rotundifòlia, one of the loftiest of the palm trees; and Excæcària cochinchinénsis, remarkable for the crimson under-surface of its leaves. To the class of plants used in medicine and the arts, we may refer the ginger and cardamom, found wild on the sides of rivers, and cultivated in great abundance; the turmeric, used by the natives of the coast to tinge and flavour their rice and other food; the betel pepper, *Fagàra* Piperìta, and three or four kinds of Cápsicum; the Justíc*ia* tinctòria, yielding a beautiful green tinge; Moŕinda umbellàta, gamboge, and *Cárthamus*, furnishing yellow dyes; the red wood of the Lawsòn*ia* spinòsa and Cæsalpín*ia* *Sáppan*; and the indigo. The bark of the *N*érium antidysentérica called codagapala, and that of the *L*aúrus *Culilàban*; the fruit of the *S*trýchnos núx vómica, the *C*ássia fístula, the tamarind, and the Cròton *Tíglium*; the inspissated juice of the aloe, the resin of the camphor tree, and the oil of the *R*ícinus, are occasionally imported from this country for the European dispensaries. The cinnamon laurel, sometimes accompanied by the nutmeg, sugar cane, bamboo, and spikenard, is found throughout the whole country; the last on dry hills, and the bamboo and sugar cane in rich swamps. The sweet potato, Ipomœ`a tuberòsa, mad apple and love-apple *S*olànum Melóngena and Lycopérsicon), *N*ymphæ`a, *Nelúmbium*, gourds, melons, water melons, and various other esculent plants, enrich this country by cultivation; and the plantain, cocoa-nut, and sago palm, are produced spontaneously. The vine grows wild in the forests, but its fruit is inferior, from want of cultivation and through excess of heat, to that of the south of Europe; but this country is amply supplied with the mango, pine-apple, Sapíndus edùlis, mangostan plum, Averrhò*a* *Carambòla*, custard-apple, papaw-fig, orange, lemon, lime, and many other exquisite fruits.

939. *The animals of the Birman empire* correspond to those of Hindustan. The wild elephants of Pegu are very numerous; and, allured by the early crops of rice, commit great devastation among the plantations that are exposed to their ravages. The king is the proprietor of these animals; and one of his Birman majesty's titles is "lord of the white elephants and of all the elephants in the world." The forests abound with tigers. The horses are small, but handsome and spirited, hardy and active; and are frequently exported in timber-ships bound for Madras and other parts of the coast, where they are disposed of to considerable advantage. Their cows are diminutive, resembling the breed on the coast of Coromandel; but their buffaloes are noble animals, much superior to those of India, and are used for draught and agriculture: some of them are of a light cream colour, and are almost as fierce as tigers, who dare not molest them. The ichneumon, or rat of Pharaoh, called by the natives ounbaii, is found in this country: ut there is no such animal as the jackal in the Ava dominions, though they are very

numerous in the adjoining country. Among the birds, which are the same with those of other parts of India, is one called the henza, the symbol of the Birman nation, as the eagle was of the Roman empire. It is a species of wild fowl, called in India the Bramin goose; but the natives of Ava do not deify this bird.

940. *The agriculture of Java* has been noticed by Thunberg, and more fully described by Sir Stamford Raffles. *The climate*, like that of other countries situated within about ten degrees of the equator, presents a perpetual spring, summer, and harvest. The distinction of weather is into wet and dry, never hot and cold, and rain depends on the winds. *The surface of the country* is low towards the coast, but hilly in the interior; unhealthy about Batavia, but in most other parts as salubrious as any other tropical country. *The soil* is for the most part rich, and remarkable for its depth; probably, as Governor Raffles conjectures, owing to its volcanic origin.

941. *Landed property* in Java is almost exclusively vested in the king, between whom and the cultivator there are no intermediate holders; and the cultivator is without lease or right beyond the will of the sovereign. The manner in which the king draws his income from the whole surface of the country is by burdening certain "villages or estates with the salaries of particular officers, allotting others for the support of his relatives or favourites, or granting them for the use of particular charitable institutions; in the same manner as before the consolidation act in Britain, the interest of particular loans was paid upon the produce of specific imports." Tradesmen, government officers, priests, and the government, are all alike paid in kind.

942. *The crops raised by the farmer for home consumption* are chiefly rice and maize, some wheat is also grown; but the staple article is rice, of which one pound and a half per day are considered sufficient nourishment for an adult.

943. *The crops raised by the colonists* are coffee, sugar, cotton, tobacco, and a variety of other productions of the East. One of the principal articles is coffee. The coffee plants are first raised in seed-beds, then transplanted under an open shed for the sake of shade, and then in about eighteen months removed into the garden or plantation, where they are destined to yield their fruit. A plantation is laid out in squares, the distance of plant from plant being commonly about six feet, and in the centre of each four trees is placed a *dadap tree*, for the purpose of affording shade, which in Java seems necessary to the health of the plants. They are never pruned, grow to the height of sixteen feet, and will bear for twenty years; but a plantation in Java is seldom continued more than ten years. In general three crops of berries are produced in a season.

944. *The live stock* of the Java farmer consists of the ox and buffalo, used in ploughing, and the horse for burden: they have a few sheep, and goats and poultry.

945. *The implements* are the plough, of which they have a common or rice ground sort, a dry-soil plough, and a garden or plantation plough, all of which are yoked to a pair of buffaloes, or oxen, in the same manner. The harrow (*fig.* 124. *a*), on which the

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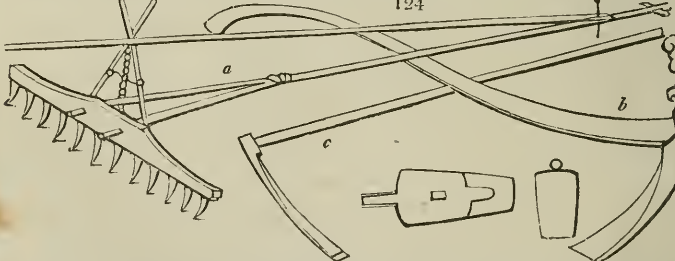

driver sits, is a sort of rake; and they have a sort of strong hoe, which they use as a substitute for a spade (*b*), and a lighter one, used as a draw hoe (*c*). Their knives for weeding, pruning, and reaping (*fig.* 125. *a* to *f*), are very curious; one of them (*g*) is used both as an axe and bill, and another (*h*) as a thrust hoe and pruning hook. It is observed by Governor Raffles, that in reaping they crop off "each separate ear along with a few inches of the straw;" an "operose process" which he was informed had its origin in some religious notions. Crops are generally dibbled or

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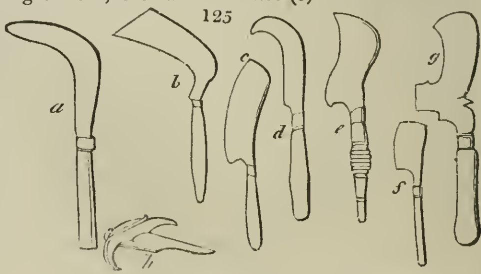

transplanted; no manure is even required or given in Java except water. In ploughing for rice, the land is converted into a semifluid mire, in which the plants are inserted. A curious mode is made use of to scare the birds from ripening crops. An elevated shed is raised in the middle of the plantation or field, within which a child on the watch touches from time to time a series of cords, extending from the shed to the extremities of the field like the radii of a circle, and thus prevents the ravages of birds. The native cart of Java is a clumsy conjunction of boards, running on two solid wheels from five to six feet in diameter, and only from one inch to two inches broad, on a revolving axle. It is drawn by two buffaloes.

946. *The upas, or poison tree* (*Antiàris toxicària*), has been said to be a native of, and peculiar to, Java; but Dr. Horsfield and other botanists have ascertained that there is no tree in the island answering its description: there are two trees used for poisoning war-like instruments, but neither is so powerful as to be used alone; and, indeed, they are in no way remarkable either as poison plants or trees. The Rafflèsia Arnóldi, the most extraordinary parasitic plant known to botanists, is believed to be a native of this island as well as of Sumatra, where it was originally found.

947. *The roads of Java,* Sir Stamford Raffles observes, are of a greater extent and of a better description than in most countries. A high road, passable for carriages at all seasons of the year, runs from the western to the eastern extremity of the island, a distance of not less than eight hundred English miles, with post stations and relays of horses every five miles. The greater part of it is so level that a canal might be cut along its side. There is another high road which crosses the island from north to south, and many intersecting cross roads. The main roads were chiefly formed by the Dutch as military roads, and "so far," Governor Raffles continues, "from contributing to the assistance of the agriculture or trade of Java, their construction has, on the contrary, in many instances been destructive to whole districts. The peasant who completed them by his own labour, or the sacrifice of the lives of his cattle, was debarred from their use, and not permitted to drive his cattle along them, while he saw the advantages they were capable of yielding reserved for his European masters, who thus became enabled to hold a more secure possession of his country." (*History of Java,* i. 198.)

948. *Of the peninsula of Malacca* very little is known. Agriculture is carried on in the marginal districts of the country; but the central parts are covered with unexplored forests, which swarm with lemurs, monkeys, tigers, wild boars, elephants, and other animals. The chief grain cultivated is rice; and the chief exports are, pepper, ginger, gum, and other spices, raisins, and woods. Game and fruits abound. "The lands," Le Pouvre observes, "are of a superior quality; and covered with odoriferous woods; but the culture of the soil abandoned to slaves is fallen into contempt. These wretched labourers, dragged incessantly from their rustic employments by their restless masters who delight in war and maritime enterprises, have rarely time, and never resolution, to give the necessary attention to the labouring of their grounds."

949. *The kingdom of Siam* may be described as a wide vale between two high ridges of mountains; but compared with the Birman empire, the cultivated land is not above half the extent either in breadth or length.

950. *The agriculture of the Siamese* does not extend far from the banks of the river or its branches; so that towards the mountains there are vast aboriginal forests filled with wild animals, whence they obtain the skins which are exported. The rocky and varie-gated shores of the noble Gulf of Siam, and the size and inundations of the Meinam, conspire with the rich and picturesque vegetation of the forests, illumined at night by crowds of brilliant fire-flies, to impress strangers with admiration and delight.

951. *The soil* towards the mountains is parched and infertile; but, on the shores of the river, consists, like that of Egypt, of a very rich and pure mould, in which a pebble can scarcely be found; and the country would be a terrestrial paradise if its government were not so despotic as to be justly reckoned far inferior to that of their neighbours the Birmans Rice of excellent quality is the chief product of their agriculture; wheat is not unknown; peas and other vegetables abound; and maize is confined to their gardens. The fertility of Siam depends in a great degree, like that of Egypt on the Nile, on its grand river Meinam and its tributary streams.

952. *The kingdom of Laos* borders on China, and is surrounded by forests and deserts, so as to be of difficult access to strangers. The climate is so temperate, and the air so pure, that men are said to retain their health and vigour, in some instances, to the age of one hundred years. The flat part of the country resembles Siam. The soil on the east bank of the river is more fertile than that on the west. The rice is preferred to that of other Oriental countries. Excellent wax and honey are produced in abundance, and the poppy, ginger, pepper, and other useful plants are cultivated, and their products exchanged with the Chinese for cloths.

953. *Cambodia,* like Siam, is enclosed by mountains on the east and west; and fertilised by an overflowing river. The climate is so hot that the inhabitants are under

the necessity of residing on the banks of the rivers and lakes, where they are tormented by musquitos. The soil is fertile, and produces abundance of corn, rice, excellent legumes, sugar, indigo, opium, camphor and various medicinal drugs. The most peculiar product is the gamboge gum (Stalagmìtis cambogiöìdes), which yields a fine yellow tint. Ivory, also, and silk are very plentiful, and of little value. Cattle, particularly of the cow kind, are numerous and cheap. Elephants, lions, tigers, and almost all the animals of the deserts of Africa are found in Cambodia. It has several precious woods, among which are the sandal and eagle wood, and a particular tree, in the juice of which they dip their arrows; and it is said, that though a wound from one of the arrows proves fatal, the juice itself may be drank without danger. The country, though fertile, is very thinly peopled.

954. *Cochin-China* presents an extensive range of coast, but few marks of tillage. Besides rice and other grains, sugar, silk, cotton, tobacco, yams, sweet potatoes, pumpkins, melons, and other culinary vegetables, are cultivated; and cinnamon, pepper, ginger, cardamom, silk, cotton, sugar, aula wood, Japan wood, Columbo, and other woods and spice plants, abound in the forests and copses. The horses are small but active; and they have the ox, buffalo, mules, asses, sheep, swine, and goats. Tigers, elephants, and monkeys abound in the forests, and on the shores are found the edible swallows' nests, esteemed a luxury in the East and especially in China. These nests, according to some, are formed of the *Fùcus lichenöìdes*; according to others, of the spawn of fish. A good account of them will be found in the *Farmer's Magazine* (vol. xx.), written by a gentleman who had resided some years on Prince of Wales's Island. Almost every kind of domestic animal, except sheep, appears to be very plentiful. In Cochin-China they have bullocks, goats, swine, buffaloes, elephants, camels, and horses. In the woods are found the wild boar, tiger, rhinoceros, and plenty of deer. They account the flesh of the elephant a great dainty, and their poultry is excellent. They pay little attention to the breeding of bullocks, as the tillage is performed by buffaloes, and bullock's flesh is not esteemed as food. The sea, as well as the land, is a never-failing source of sustenance to those who dwell on the coast. Most of the marine worms distinguished by the name of Mollúsca, are used as articles of food by the Cochin-Chinese. All the gelatinous substances derived from the sea, whether animal or vegetable, are considered by them the most nutritious of all aliments; and on this principle various kinds of sea-weeds, particularly the *Fùci* and *A'lgæ*, are included in their list of edible plants. They likewise collect many of the small succulent, or fleshy, plants, which are usually produced on salt and sandy marshes; these they either boil in their soups, or eat in a raw state, to give sapidity to their rice, which with them is the grand support of existence. In Cochin-China they are almost certain of two plentiful crops of rice every year, one of which is reaped in April, the other in October. Fruits of various kinds, as oranges, bananas, figs, pine-apples, pomegranates, and others of inferior note, are abundantly produced in all parts of the country. They have very fine yams, and plenty of sweet potatoes. Their small breed of cattle does not appear to furnish them with much milk; but of this article they make a sparing use, even with regard to their young children.

955. *Tonquin*, in regard to surface, may be divided into two portions, the mountainous and the plain. The mountains are neither rocky nor precipitous, and are partly covered with forests. The plain is flat like Holland, being intersected by canals and dykes, and varied by lakes and rivers. The chief agricultural product is rice, of which there are two harvests annually in the low country, but in the high lands only one. Wheat and wine are unknown. The mulberry tree is common; and the sugar cane is indigenous; but the art of refining the juice is unknown. The live stock are chiefly oxen, buffaloes, and horses; swine abound, and there are a few goats, but asses and sheep are unknown. Dogs, cats, and rats are eaten. Poultry, ducks, and geese abound, and are found wild in the forests. The eggs of ducks are heated in ovens, and produce young, which swarm on the canals and ponds. The forests contain deer, boars, peacocks, a peculiar kind of partridge, and quails. The tigers are large and destructive; one of them is said to have entered a town, and to have destroyed eighty-five people. The wild elephants are also very dangerous. Apes are found in these forests, and some of them of large size: these and the parrots are not a little destructive to the rice and fruits. The Tonquin plough consists of three pieces of wood, a pole, a handle, and a third piece, almost at right angles with the last, for opening the ground; and they are simply fixed with straps of leather: this plough is drawn by oxen or buffaloes.

956. *The agriculture of Japan* is superior to that of most Eastern countries. The climate is variable. In summer the heat is violent; and, if it were not moderated by sea breezes, would be intolerable. The cold in winter is severe. The falls of rain commence at midsummer, and to these Japan owes its fertility, and also its high state of population. Thunder is not unfrequent: tempests, hurricanes, and earthquakes are very common. From Thunberg's thermometrical observations it appears that the greatest

degree of heat at Negasaki was 98° in August, and the severest cold in January, 35°. The face of the country presents some extensive plains, but more generally mountains, hills, and valleys; the coast being mostly rocky and precipitous, and invested with a turbulent sea. It is also diversified with rivers and rivulets, and many species of vegetables.

957. *The soil of Japan*, though barren, is rendered productive by fertilising showers, by manure, and by the operation of agricultural industry.

958. *Agriculture, Thunberg informs us, is here well understood*, and the whole country, even to the tops of the hills, is cultivated. Free from all feudal and ecclesiastical impediments, the farmer applies himself to the culture of the soil with diligence and vigour. Here are no commons; and it is a singular circumstance, that, if any portion be left uncultivated, it may be seized by a more industrious neighbour. The Japanese mode of manuring is to form a mixture of all kinds of excrements with kitchen refuse, which is carried in pails into the field, and poured with a ladle upon the plants, when they have attained the height of about six inches; so that they thus instantly receive the whole benefit. They are also very attentive to weeding. The sides of the hills are cultivated by means of stone walls, supporting broad plots, sown with rice or esculent roots. Rice is the chief grain; buckwheat, rye, barley, and wheat being little used. A kind of root, used as the potato (Convólvulus edùlis), is abundant, with several sorts of beans, peas, turnips, cabbages, &c. From the seed of a kind of cabbage, lamp oil is expressed; and several plants are cultivated for dyeing, with the cotton shrubs, and mulberry trees for the food of silkworms. The varnish and camphire trees, the vine, the cedar, the tea tree, and the bamboo reed, not only grow wild but are planted for numerous uses.

959. *In respect to live stock*, there are neither sheep nor goats in the whole empire of Japan; and, in general, there are but few quadrupeds. The food of the Japanese consists almost entirely of fish and fowl with vegetables. Some few dogs are kept from motives of superstition; and cats are favourites with the ladies. Hens and common ducks are domesticated for the sake of their eggs.

Subsect. 8. *Of the present State of Agriculture in the Chinese Empire.*

960. *Agricultural improvement in China* has, in all ages, been encouraged and *honoured*. The husbandman is considered an honourable, as well as a useful, member of society; he ranks next to men of letters or officers of state, of whom he is frequently the progenitor. The soldier, in China, cultivates the ground. The priests also are agriculturists, whenever their convents are endowed with land. Notwithstanding all these advantages, however, the Chinese empire is by no means so generally cultivated as Du Halde and other early travellers asserted. Some districts are almost entirely under cultivation; but in many there are extensive wastes.

961. *Dr. Abel is of opinion* that in that part of China passed through by Lord Amherst's embassy, the land "very feebly productive in food for man fully equalled that which afforded it in abundant quantity." He never found extensive tracts of land in general cultivation, but often great industry and ingenuity on small spots; and concludes that "as horticulturists the Chinese may perhaps be allowed a considerable share of merit; but, on the great scale of agriculture, they are not to be mentioned with any European nation." (*Narrative*, 127.)

962. *Livingstone*, an intelligent resident in China, observes, "The statement in the *Encyclopædia Britannica*, that 'Chinese agriculture is distinguished and encouraged by the court beyond all other sciences,' is incorrect, since it is unquestionably subordinate to literature; and it may be well doubted whether it ought to be considered as holding among the Chinese the rank of a science; for, independently of that routine which has been followed, with little variation, from a very high antiquity, they seem to be entirely ignorant of all the principles by which it could have been placed on a scientific foundation." (*Hort. Trans.*, v. 49.)

963. *The climate* of China is in general reckoned moderate, though it extends from the 50th to the 21st degree of south latitude, and includes three climates. The northern parts are liable to all the rigours of a European winter. Even at Pekin, at that season, the average of the thermometer is under 20° during the night, and in the day considerably below the freezing point. The heat of those parts which lie under the tropics is moderated by the winds from the mountains of Tatary. In the southern parts there is neither frost nor snow, but storms are very frequent, especially about the time of the equinoxes; all the rest of the year the sky is serene, and the earth covered with verdure.

964. *The surface of the country*, though in general flat, is much diversified by chains of granite mountains, hills, rivers, canals, and savage and uncultivated districts, towns innumerable, villages, and cottages covered with thatch, reed, or palm leaves, and in some places with their gardens, or fore-courts, fenced with rude pales, as in England.

(*fig.* 126.) China, Dr. Abel observes, from the great extent of latitude contained in its boundaries, and from its extensive plains and lofty mountains, partakes of the advantages and defects of many climates, and displays a country of features infinitely varied by nature. Every thing artificial, however, has nearly the same characters in every province.

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965. *The soil* varies exceedingly: it is in many parts not naturally fertile; but has almost every where been rendered so by the application of culture and manure for successive ages.

966. *The landed property* of China is considered as the absolute right of the emperor: but the sub-proprietor, or first holder, is never turned out of possession as long as he continues to pay about the tenth part of what his farm is supposed capable of yielding; and, though the holder of lands is only considered as a tenant at will, it is his own fault if he is dispossessed. If any one happens to hold more than his family can conveniently cultivate, he lets it to another, on condition of receiving half the produce, out of which he pays the whole of the emperor's taxes. The greater part of the poor peasantry cultivate land on these terms. In China there are no immense estates, no fisheries are let out to farm. Every subject is equally entitled to the free and uninterrupted enjoyment of the sea, of the coasts, of the estuaries, of the lakes and rivers. There are no manor lords with exclusive privileges, nor any game laws.

967. *The agricultural products* of China extend to every useful vegetable. There is scarcely a grain, a fruit, a tree, or a culinary vegetable of Europe, or the rest of the world, that they do not cultivate; and they have a number peculiar to themselves. Fowl and fish are not extensively reared, as the chief articles of diet are vegetables. Rice is the common grain of the country; a species of cabbage, the universal culinary vegetable; swine, the most abundant live stock; and tea, the chief plant of export.

968. *The tea districts* of China extend from the 27th to the 31st degree of latitude. According to the missionaries, it thrives in the more northern provinces; and from Kæmpfer it appears to be cultivated in Japan as far north as lat. 45°. It seems, according to Dr. Abel's observation, to succeed best on the sides of mountains, where there can be but little accumulation of vegetable mould. The soils from which he collected the best specimens consisted chiefly of sandstone, schistus, or granite. The land forming the Cape of Good Hope consisting of the same rocks, and its geographical position corresponding to that of the tea districts of China, Dr. Abel considers it might be grown there, if desirable, to such an extent as to supersede the necessity of procuring it from China. It grows well in St. Helena and Rio Janeiro, and will grow any where in a meagre soil and moderate temperature.

969. *The culture of the tea plant* in China has been given by various authors. It is raised from seeds sown where the plants are to remain. Three or more are dropped into a hole four or five inches deep; these come up without further trouble, and require little culture, except that of removing weeds, till the plants are three years old. The more careful stir the soil, and some manure it; but the latter practice is seldom adopted. The third year the leaves are gathered, at three successive gatherings, in February, April, and June, and so on till the bushes become stinted or tardy in their growth, which generally happens in from six to ten years. They are then *cut-in* to encourage the production of fresh shoots.

970. *The gathering of the leaves* is performed with care and selection. The leaves are plucked off one by one: at the first gathering only the unexpanded and tender are taken; at the second, those that are full grown; and at the third, the coarsest. The first forms what is called in Europe imperial tea; but of this and other names by which tea is designated, the Chinese know nothing; and the compounds and names are supposed to be made and given by the merchants at Canton, who, from the great number of varieties brought to them, have an ample opportunity of doing so. These varieties, though numerous, and some of them very different, are yet not more so than the different varieties of the grape; they are now generally considered as belonging to one species; the *Thèa Bohèa*, now Camèll*ia Bohèa* (*fig.* 127. *a*), of botanists. Formerly it was thought that green tea was gathered exclusively from Camèll*ia* víridis; but that is now doubtful, though it is certain there is what is called the green tea district, and the black tea district; and the varieties grown in the one district differ from those grown in the other. Dr. Abel could not satisfy himself as to there being two species or one; but thinks there are two species. He was told by competent persons that either of the two plants will afford the black or green tea of the shops, but that the broad thin-leaved plant (C. víridis) is preferred for making the green tea.

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971. *The tea leaves* being gathered are cured in houses which contain from five to ten or twenty small furnaces, about three feet high, each having at the top a large flat iron pan. There is also a long low table covered with mats, on which the leaves are laid, and rolled by workmen, who sit round it: the iron pan being heated to a certain degree by a little fire made in the furnace underneath, a few pounds of the fresh-gathered leaves are put upon the pan; the fresh and juicy leaves crack when they touch the pan, and it is the business of the operator to shift them as quickly as possible with his bare hands, till they become too hot to be easily endured. At this instant he takes off the leaves with a kind of shovel resembling a fan, and pours them on the mats before the rollers, who, taking small quantities at a time, roll them in the palms of their hands in one direction, while others are fanning them, that they may cool the more speedily and retain their curl the longer. This process is repeated two or three times or oftener, before the tea is put into the stores, in order that all the moisture of the leaves may be thoroughly dissipated, and their curl more completely preserved. On every repetition the pan is less heated, and the operation performed more slowly and cautiously. The tea is then separated into the different kinds, and deposited in the store for domestic use or exportation.

972. *The different sorts of black and green* are not merely from soil, situation, and age of the leaf: but, after winnowing the tea, the leaves are taken up in succession as they fall; those nearest the machine, being the heaviest, form the gunpowder tea; the light dust the worst, being chiefly used by the lower classes. That which is brought down to Canton undergoes there a second roasting, winnowing, packing, &c., and many hundred women are employed for these purposes.

973. *As more select sorts of tea*, the blossoms of the Camèll*ia Sasánqua* (*fig.* 127. *b*) appear to be collected; since they are brought over land to Russia, and sold by Chinese and Armenians in Moscow at a great price. The buds also appear to be gathered in some cases. By far the strongest tea which Dr. Abel tasted in China, was that called Yu-tien, used on occasions of ceremony. It scarcely coloured the water, and on examination was found to consist of the half-expanded leaves of the plant.

974. *As substitutes for tea*, used by the Chinese, may be mentioned a species of moss common to the mountains of Shan-tung; an infusion of ferns of different sorts, and, Dr. Abel thinks, the leaves of the common camellia and oil camellia may be added. Du Halde observes that all the plants called tea by the Chinese are not to be considered as the true tea plant; and Kæmpfer asserts that in Japan a species of Camèll*ia*, as well as the O'lea fràgrans, is used to give it a high flavour.

975. *The oil-bearing tea plant* (*Camèll*ia *oleífera*) is cultivated for its seeds, from which an oil is expressed, in very general use in the domestic economy of China. It grows best in a red sandy soil; attaining the height of six or eight feet, and producing a profusion of white blossoms and seeds. These seeds are reduced to a coarse powder, either in a mortar by a pestle acted on by the cogs of a water-wheel (*fig.* 128.), or by a horizontal wheel, having small perpendicular wheels, shod with iron, fixed to its circumference, and acting in a groove lined with the same metal. The seeds, when ground, are stewed or boiled in bags, and then pressed, when the oil is yielded. The press is a hollow cylinder, with a piston pressed

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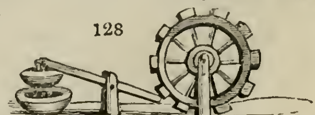

against one end, by driving wedges at the side; it is very simple and yet powerful. (*Dr. Abel's Nar.*, 176.) An oil used as a varnish is extracted from another variety of the Camell*ia*, or tea plant (the Dryándr*a* cordàta of Thunb.), which is used as a varnish for their boats, and coarser articles of furniture.

976. *The tallow tree* (*Cròton sebíferum*) resembles the oak in the height of its stem and the spread of its branches, and its foliage has the green and lustre of the laurel; its flowers are small and yellow, and its seeds white. The latter are crushed either as the camellia seeds, or in a hollow trunk of a tree, lined with iron, by means of a wheel laden with a heavy weight (*fig.* 129.), and suspended from a beam. The bruised matter next undergoes nearly the same process as the camellia seeds, and the oily matter is found to have all the properties of animal tallow. It is mixed with vegetable oil and wax, to give it consistence, and then made into candles, which burn with great flame, emit much smoke, and quickly consume.


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977. *The wax tree*, or *Pe-la*, is a term which is not applicable to any one species of tree, but to such as are attacked by a small worm, which runs up, and fastens to their leaves, covering them with combs. When these worms are once used to the trees of any district, they never leave them, unless something extraordinary drives them away. The wax produced is hard, shining, and considerably dearer than that of bees.

978. *The Sésamum orientàle* and the R*icinus commùnis*, or castor-oil plant, are cultivated for the esculent oils extracted from their seeds. They appear to have some method of depriving the castor oil of its purgative qualities, but Dr. Abel thinks not completely.

979. *The camphire tree* (*Laùrus Camphòra*) grows to the size of our elms or oaks. The camphire is procured by boiling the fresh-gathered branches of the tree, and stirring the whole with a stick, till the gum begins to adhere to it in the form of a white jelly. The fluid is then poured off into a glazed vessel, and left to concrete. "The crude camphire is then purified in the following manner. A quantity of the finely powdered materials of some old wall, built of earth, is put as a first layer at the bottom of a copper basin; on this is placed a layer of camphire, and then another of earth, and so on till the vessel is nearly filled; the series being terminated with a layer of earth: over this is laid a covering of the leaves of the plant Po-tio, perhaps a species of *Méntha*. A second basin is now inverted over the first, and luted on. The whole thus prepared is put over a regulated fire, and submitted to its action for a certain length of time; it is then removed and suffered to cool. The camphire is found to have sublimed, and to be attached to the upper basin, and is further refined by repetitions of the same process." (*Narrative, &c.*, 179.)

980. *The oak* is as much prized in China as in other countries, and is styled the tree of inheritance. There are several species in general use for building, dyeing, and fuel; and the acorns are ground into a paste, which mixed with the flour of corn is made into cakes.

981. *The maidenhair tree* (*Salisbùria adiantifòlia*) is grown for its fruit, which Dr. Abel saw exposed in quantities; but whether as a table fruit, a culinary vegetable, or a medicine, he could not ascertain. Kæmpfer says, the fruit assists digestion.

982. *The cordage plant* (S*ìda tiliæfòlia*) is extensively cultivated for the manufacture of cordage from its fibres. The common hemp is used for the same purpose, but the S*ì*da is preferred. A species of M*ù*s*a* is also grown in some places, and its fibres used for rope and other purposes.

983. *The common cotton*, and also a variety bearing a yellow down, from which, without any dyeing process, the nankeen cloths are formed, are grown in different places. The mulberry is grown in a dwarf state, as in Hindustan.

984. *The ground nut* (*A'rachis hypogæ`a*), the eatable arum (*A*'rum esculéntum), the Tràpa bicórnis, the *S*círpus tuberòsus, and *Nelùmbium*, all producing edible tubers, are cultivated in lakes, tanks, or marshy places.

985. *The Nelùmbium*, Dr. Abel observes, with its pink and yellow blossoms, and broad green leaves, gives a charm and productiveness to marshes, otherwise unsightly and barren. The leaves of the plant are watered in the summer, and cut down close to the roots on the approach of winter. The seeds, which are in size and form like a small acorn without its cup, are eaten green, or dried as nuts, and are often preserved in sweetmeats; they have a nut-like flavour. Its roots are sometimes as thick as the arm, of a pale green without, and whitish within; in a raw state they are eaten as fruit, being juicy and of a sweetish and refreshing flavour; and when boiled are served as vegetables.

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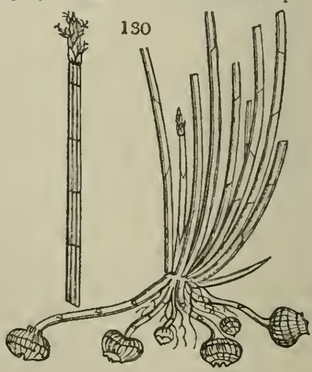

986. *The Scírpus tuberòsus*, or water chestnut (*fig.* 130.), is a stoloniferous rush, almost without leaves, and the tubers are produced on the stolones. It grows in tanks, which are manured for its reception about the end of March. A tank being drained of its water, small pits are dug in its bottom; they are filled with human manure, and exposed to the sun for a fortnight; their contents are next intimately blended with the slimy bottom of the tank, and slips of the plant inserted. The water is now returned to the tank, and the first crop of tubers comes to perfection in six months. (*Rox. Coromandel.*)

987. *The millet* (H*ólcus*) is grown on the banks of rivers, and attains the height of sixteen feet. It is sown in rows, and after it comes up *P*ánicum is sown between, which comes to perfection after the other is cut down.

988. *Among the many esculent vegetables cultivated in China*, the petsai, a species of white cabbage, is in most general use. The

quantity consumed of it over the whole empire is, according to all authors, immense; and, Dr. Abel thinks, it may be considered to the Chinese what the potato is to the Irish. It is cultivated with great care, and requires abundant manuring, like its congeners of the *Brássica* tribe. Boiled, it has the flavour of asparagus; and raw, it eats like lettuce and is not inferior. It often weighs from fifteen to twenty pounds, and reaches the height of two or tree feet. It is preserved fresh during winter by burying in the earth; and it is pickled with salt and vinegar.

989. *Almost every vegetable of use, as food, in the arts, or as medicine, known to the rest of the world, is cultivated in China,* with, perhaps, a very few exceptions of equatorial plants. The bamboo and cocoa-nut tree, as in Hindustan, are in universal use: indigo is extensively cultivated; sugar also in the southern provinces, but it is rather a luxury than an article of common consumption. It is used mostly in a coarse granulated form; but for exportation, and for the upper classes, it is reduced to its crystallised state. Tobacco is every where cultivated, and in universal use, by all ages, and both sexes. Fruits of every kind abound, but they are mostly bad, except the orange and the *lee-tchee* (Dimocárpus *Litchi*), both of which are probably indigenous. The art of grafting is well known, having been introduced by the missionaries; but they do not appear to have taken advantage of this knowledge for the improvement of their fruits. They have also an art which enables them to take off bearing branches of fruit, particularly of the orange and peach, and transfer them, in a growing state, to pots, for their artificial rocks and grottos, and summer-houses. It is simply by removing a ring of the bark, plastering round it a ball of earth, and suspending a vessel of water to drop upon it, until the upper edge of the incision has thrown out roots into the earth.

990. *The live stock of Chinese agriculture* is neither abundant nor various. The greater part of their culture being on a small scale, and performed by manual operations, does not require many beasts of labour: their canals and boats supply the place of beasts of burden: and their general abstemiousness renders animals for the butcher less necessary. They rear, however, though in comparatively small number, all the domestic animals of Europe; the horse, the ass, the ox, the buffalo, the dog, the cat, the pig; but their horses are small and ill-formed. The camels of China are often no larger than our horses; the other breeds are good, and particularly that of pigs. The kind of dog most common in the south, from Canton to Tong-chin-tcheu, is the spaniel with straight ears. More to the north, as far as Pekin, the dogs have generally hanging ears and slender tails.

991. *The Chinese are exceedingly sparing in the use of animal food.* The broad-tailed sheep are kept in the hilly parts of the country, and brought down to the plains; but the two animals most esteemed, because they contribute most to their own subsistence and are kept at the cheapest rate, are the hog and the duck. Whole swarms of the latter are bred in large barges, surrounded with projecting stages covered with coops for the reception of these birds, which are taught, by the sound of the whistle, to jump into the rivers and canals in search of food, and by another call to return to their lodgings. They are usually hatched by placing their eggs, as the ancient Egyptians were wont to do, in small ovens, or sandbaths, in order that the same female may continue to lay eggs throughout the year, which would not be the case if she had a young brood to attend. The ducks, when killed, are usually split open, salted, and dried in the sun; in which state they afford an excellent relish to rice or other vegetables.

992. *The wild animals* are numerous. Elephants are common in the south of China, and extend as far as the thirtieth degree of north latitude in the province of Kiangnau and of Yun-nau. The unicorn rhinoceros lives on the sides of the marshes in the provinces of Yun-nau and Quan-si. The lion, according to Du Halde and Trigault, is a stranger to China; but the animal figured by Neuhoff, under the name of the tiger, seems to be the maneless lion known to the ancients, described by Oppian, and seen by M. Olivier on the Euphrates. Marco Polo saw lions in Fo-kien: there were some at the court of Kublai Khan. The true tiger probably shows himself in the most southerly provinces, where there are also various kinds of monkeys; the long-armed gibbon or *Símia* longimànus; the *Símia* ínfluens, or ugly baboon; and the *Símia* Sylvànus, which mimics the gestures and even the laughter of men. The musk animal, which seems peculiar to the central plateau of Asia, sometimes goes down into the western provinces of China. The deer, the boar, the fox, and other animals, some of which are little known, are found in the forests.

993. *Several of the birds of the country* are distinguished for beauty of form and brilliancy of colour; such as the gold and silver pheasants, which we see often painted on the Chinese papers, and which have been brought to this country to adorn our aviaries; also the Chinese teal, remarkable for its two beautiful orange crests. The insects and butterflies are equally distinguished for their uncommon beauty. Silkworms are common, and seem to be indigenous in the country. From drawings made in China, it appears to possess almost all the common fishes of Europe; and M. Bloch, and M. de Lacepede have made us acquainted with several species peculiar to it. The Chinese gold-fish

(*Cýprinus auratus*), which, in that country, as with us, is kept in basins as an ornament, is a native of a lake at the foot of the high mountain of Tein-king, near the city of Tchang-hoo, in the province of Tché-kiang. From that place it has been taken to all the other provinces of the empire and to Japan. It was in 1611 that it was first brought to England.

994. *The fisheries of China*, as already noticed, are free to all; there are no restrictions on any of the great lakes, the rivers, or canals. The subject is not once mentioned in the *Leu-lee;* but the heavy duties on salt render the use of salt-fish in China almost unknown. Besides the net, the line, and the spear, the Chinese have several ingenious methods of catching fish. In the middle parts of the empire, the fishing corvorant (*Pelicànus piscàtor*) is almost universally in use; in other parts they catch them by torch-light; and a very common practice is, to place a board painted white along the edge of the boat, which, reflecting the moon's rays into the water, induces the fish to spring towards it, supposing it to be a moving sheet of water, when they fall into the boat.

995. *The implements* of Chinese agriculture are few and simple. The plough has one handle, but no coulter; there are different forms: some may be drawn by women, (*fig.* 131. *a*), others are for stirring the soil under water (*b*), and the largest is drawn by a single buffalo or ox (*c*). Horses are never employed for that purpose. The carts are low, narrow, and the wheels so diminutive as often to be made without spokes. A large cylinder is sometimes used to separate the grain from the ear, and they have a winnowing machine similar to that which was invented in Europe about a century ago. The most ingenious machines are those for raising water for the purposes of irrigation. A very ingenious wheel for this purpose has been figured by Sir George Staunton: but the most universally used engine is the chain-pump, worked in various ways by oxen, by walking in a wheel, or by the hand; and next to it buckets worked by long levers (*fig.* 132.), as in the gardens round London, Paris, Constantinople, and most large cities of Europe. For pounding oleiferous seeds they have also very simple and economical machines, in which pestles on the ends of levers are worked by a horizontal shaft put in motion by a water-wheel. (*fig.* 133.) The chief thing to admire in the implements and machines of India and China is their simplicity, and the ease and little expense with which they may be constructed.

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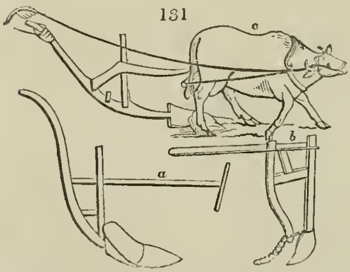

996. *The operations* of Chinese agriculture are numerous, and some of them curious. Two great objects to be procured are water and manure. The former is raised from rivers or wells by the machines already mentioned, and distributed over the cultivated surface in the usual manner, and the latter is obtained from every conceivable source.

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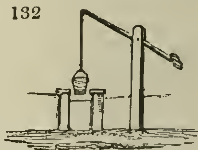

997. *The object of their tillage*, Livingstone observes, " appears to be, in the first instance, to expose the soil as extensively as possible; and this is best effected by throwing it up in large masses, in which state it is allowed to remain till it is finally prepared for planting. When sufficient rain has fallen to allow the husbandman

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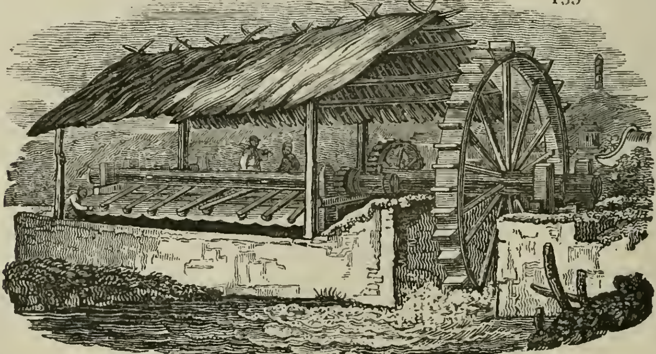

to flood his fields, they are laid under water, in which state they are commonly ploughed again, in the same manner as for fallow, and then a rake, or rather a sort of harrow, about three feet deep and four feet wide, with a single row of teeth, is drawn, by the same animal that draws their plough, perpendicularly through the soil, to break the lumps, and to convert it into a kind of ooze; and as the teeth of their rake or harrow are not set more than from two to three inches apart, it serves, at the same time, very effectually to remove roots and otherwise to clean the ground. For some purposes, the ground thus prepared is allowed to dry; it is then formed into beds or trenches; the beds are made of a convenient size for watering and laying on manure. The intermediate trenches are commonly about nine inches deep, and of the necessary breadth to give to the beds the required elevation; but when the trenches are wanted for the cultivation of water plants, some part of the soil is removed, so that a trench may be formed of the proper dimensions.

998. *For these operations* they use a hoe, commonly ten inches deep, and five inches broad, made of iron, or of wood with an iron border, and for some purposes it is divided into four or five prongs. By constant practice the Chinese have acquired such dexterous use of this simple instrument, that they form their beds and trenches with astonishing neatness and regularity. With it they raise the ground which has not been ploughed, from the beds and trenches, by only changing it from a vertical to a horizontal direction, or employing its edge. It is also used for digging, planting, and in general for every purpose which a Chinese husbandman has to accomplish.

999. *The collection of manure* is an object of so much attention with the Chinese, that a prodigious number of old men, women, and children, incapable of much other labour, are constantly employed about the streets, public roads, and banks of canals and rivers, with baskets tied before them, and holding in their hands small wooden rakes, to pick up the dung of animals, and offals of any kind that may answer the purpose of manure: this is mixed sparingly with a portion of stiff loamy earth, and formed into cakes, dried afterwards in the sun. It sometimes becomes an object of commerce, and is sold to farmers, who never employ it in a compact state. Their first care is to construct very large cisterns, for containing, besides those cakes and dung of every kind, all sorts of vegetable matter, as leaves, roots, or stems of plants, with mud from the canals, and offals of animals, even to the shavings collected by barbers. With all these they mix as much animal water as can be procured, or common water sufficient to dilute the whole; and, in this state, generally in the act of putrid fermentation, they apply it to the ploughed earth. In various parts of a farm, and near the paths and roads, large earthen vessels are buried to the edge in the ground, for the accommodation of the labourer or passenger who may have occasion to use them. In small retiring-houses, built also upon the brink of the roads, and in the neighbourhood of villages, reservoirs are constructed of compact materials, to prevent the absorption of whatever they receive, and straw is carefully thrown over the surface from time to time, to prevent evaporation. Such a value is set upon the principal ingredient, called ta-feu, for manure, that the oldest and most helpless persons are not deemed wholly useless to the family by which they are supported. The quantity of manure collected by every means is still inadequate to the demand.

1000. *Vegetable or wood ashes*, according to Livingstone, are esteemed the very best manure by the Chinese. The weeds which were separated from the land by the harrow, with what they otherwise are able to collect, are carefully burnt, and the ashes spread. The part of the field where this has been done is easily perceived by the most careless observer. Indeed the vigour of the productions of those parts of their land where the ashes have been applied is evident, as long as the crop continues on the ground. The ashes of burnt vegetables are also mixed with a great variety of other matters in forming the compositions which are spread on the fields, or applied to individual plants.

1001. *The plaster of old kitchens* is much esteemed as a manure; so that a farmer will replaster a cook-house for the old plaster, that he may employ it to fertilise his fields.

1002. *Of night-soil* (ta-feu), the Chinese have a high notion: and its collection and formation into cakes, by means of a little clay, clay and lime, or similar substances, give employment to a great number of individuals. They transport these cakes to a great distance. This manure in its recent state is applied to the roots of cauliflowers, cabbages, and similar plants, with the greatest advantage.

1003. *The dung and urine of all animals* are collected with great care; they are used both mixed and separately. The mixture is less valuable than the dung, and this for general purposes is the better the older it is. Horns and bones reduced to powder, the cakes left after expressing several oils, such as of the ground-nut, hemp-seed, and the like, rank also as manures. Small crabs, the feathers of fowls and ducks, soot, the sweepings of streets, and the stagnant contents of common sewers, are often thought sufficiently valuable to be taken to a great distance, especially when water carriage can be obtained.

1004. *Lime* is employed chiefly for the purpose of destroying insects; but the Chinese are also aware of its fertilising properties.

1005. *The Chinese often manure the plant rather than the soil.* The nature of the climate in the southern part of the empire seems to justify fully this very laborious but economical practice. Rain commonly falls in such quantities and with such force as to wash away all the soluble part of the soil, and the manure on which its fertility is supposed to depend; and this often appears to be so effectually done, that nothing meets the eye but sand and small stones. It is therefore proper that the Chinese husbandman should reserve the necessary nourishment of the plant to be applied at the proper time. For this purpose reservoirs of the requisite dimensions are constructed at the corner of every field, or other convenient places.

1006. *With the seed or young plant its proper manure is invariably applied.* It is then carefully watered in dry weather night and morning, very often with the black stagnant contents of the common sewer; as the plants advance in growth the manure is changed, in some instances more than once, till their advance towards maturity makes any further application unnecessary.

1007. *The public retiring-houses* are described by Dr. Abel, as rather constructed for exposure than concealment, being merely open sheds with a rail or spar laid over the reservoir.

1008. *The mixture of soils* is said to be a common practice as a substitute for manure: "they are constantly changing earth from one piece of ground to another; mixing sand with that which appears to be too adhesive, and loam where the soil appears to be too loose," &c.

1009. *The terrace cultivation* is mentioned by Du Halde and others, as carried to great perfection in China: but the observations of subsequent travellers seem to render this doubtful. Lord Amherst's embassy passed through a hilly and mountainous country for many weeks together: but Dr. Abel, who looked eagerly for examples of that system of cultivation, saw none that answered to the description given by authors. Du Halde's description, he says, may apply to some particular cases: but the instances which lie observed lead him to conclude that terrace cultivation is in a great measure confined to their ravines, undulations, and gentlest declivities.

1010. *Rows, or drills, are almost always adopted* in planting or sowing; and for this purpose the lands are laid flat, and not raised into ridges with intervening furrows. They are said to be particular in having the direction of their rows from north to south, which, other circumstances being suitable, is certainly a desirable practice. Before sowing, seeds are generally kept in liquid manure till they germinate. Barrow frequently saw in the province of Keang-see a woman drawing a light plough with a single handle (*fig.* 131. *a*), through ground previously prepared; while a man held the plough with one hand, and with the other cast the seed into the drills.

1011. *Forests of immense extent* exist on the mountains of the western districts of China, and abound in almost every species of tree known in Europe, and many others unknown. Besides timber and fuel, these forests supply many valuable products, as barks, gums, oils, and resins, used in the arts. Rose wood, ebony, sandal wood, iron wood, and a great variety of others are sent to Europe for cabinet work. The Chinese aloe has the height and figure of an olive tree. It contains within the bark three sorts of wood; the first, black, compact, and heavy, is called eagle-wood; it is scarce; the second, called calambooc, is light like rotten wood; the third, near the centre, is called calamba wood, and sells in India for its weight in gold; its smell is exquisite, and it is an excellent cordial in cases of fainting or of palsy.

1012. *The national agricultural fête* of the Chinese deserves to be noticed. Every year on the fifteenth day of the first moon, which generally corresponds to some day in the beginning of our March, the emperor in person goes through the ceremony of opening the ground; he repairs in great state to the field appointed for this ceremony. The princes of the imperial family, the presidents of the five great tribunals, and an immense number of mandarins attend him. Two sides of the field are lined with the officers of the emperor's house, the third is occupied by different mandarins; the fourth is reserved for all the labourers of the province, who repair thither to see their art honoured and practised by the head of the empire. The emperor enters the field alone, prostrates himself, and touches the ground nine times with his head in adoration of *Tien*, the God of heaven. He pronounces with a loud voice a prayer prepared by the court of ceremonies, in which he invokes the blessing of the Great Being on his labour, and on that of his whole people. Then, in the capacity of chief priest of the empire, he sacrifices an ox, in homage to heaven as the fountain of all good. While the victim is offered on the altar, a plough is brought to the emperor, to which is yoked a pair of oxen, ornamented in a most magnificent style. The prince lays aside his imperial robes, lays hold of the handle of the plough with the right hand, and opens several furrows in the direction of north and south; then gives the plough into the hands of the chief mandarins, who, labouring in succession, display their comparative dexterity. The ceremony concludes with a distribution of money and pieces of cloth, as presents among the labourers; the ablest of whom execute the rest of the work in presence of the emperor. After the field has received all the necessary work and manure, the emperor returns to commence the sowing with similar ceremony, and in presence of the labourers. These ceremonies are performed on the same day by the viceroys of all the provinces.

Subsect. 9. *Of the present State of Agriculture in Chinese Tatary, Thibet, and Bootan.*

1013. *Chinese Tatary* is an extensive region, diversified with all the grand features of nature, and remarkable for its vast elevated plain, supported like a table by the mountains of Thibet in the south, and Allusian chain in the north. This prodigious plain is little known; its climate is supposed to be colder than that of France; its deserts to consist chiefly of a black sand; and its agriculture to be very limited and imperfect. Wheat, however, is said to be grown among the southern Mandshurs.

1014. *Thibet or Tibet* is an immense tract of country little known. It consists of two divisions, *Thibet* and *Bootan*. The climate of Thibet is extremely cold and bleak towards the south, for though on the confines of the torrid zone it vies in this respect with that of the Alps of Italy. That of Bootan is more temperate; and the seasons of both divisions are severe compared to those of Bengal.

1015. *With respect to surface*, Bootan and Thibet exhibit a very remarkable contrast. Bootan presents to the view nothing but the most misshapen irregularities; mountains covered with eternal verdure, and rich with abundant forests of large and lofty trees. Almost every favourable aspect of them, coated with the smallest quantity of soil, is cleared and adapted to cultivation, by being shelved into horizontal beds: not a slope or narrow slip of land between the ridges lies unimproved. There is scarcely a mountain whose base is not washed by some rapid torrent, and many of the loftiest bear populous villages, amidst orchards and other plantations, on their summits and on their sides. It combines in its extent the most extravagant traits of rude nature and laborious art.

1016. *Thibet*, on the other hand, strikes a traveller, at first sight, as one of the least favoured countries under heaven, and appears to be in a great measure incapable of culture. It exhibits only low rocky hills, without any visible vegetation, or extensive arid plains, both of the most stern and stubborn aspect, promising full as little as they produce.

1017. *The agriculture of Thibet* has many obstacles to contend with. Its common products are wheat, peas, and barley. Rice grows only in the southern parts. Turnips, pumpkins, and cucumbers are abundant. The greater part of the plants which travellers have noticed are such as are met with also in Europe and in Bengal. At the foot of the mountains are forests of bamboos, bananas, aspens, birches, cypresses, and yew trees. The ash (*O'*rnus floribúnda) is remarkably large and beautiful, but the firs small and stunted. On the snow-clad mountains grows the *R*hèum undulàtum, which the natives use for medicinal purposes. The country contains, both in a wild and cultivated state, peaches and apricots, apples, pears, oranges, and pomegranates. The *C*acàlia saracénica serves for the manufacture of *chong*, a spirituous and slightly acid liquor.

1018. *Thibet abounds in animals*, partly in herds and flocks; but chiefly in a wild state. The tame horses are small, but full of spirit and restive. The cattle are only of middling height. There are numerous flocks of sheep, generally of small breed; their head and legs are black, their wool fine and soft, and their mutton excellent; it is eaten in a raw state, after having been dried in the cold air, and seasoned with garlic and spices. The goats are numerous, and celebrated for their fine hair, which is used in the manufacture of shawls; this grows under the coarser hair. The yak, or grunting ox, furnished with long and thick hair, and a tail singular for its silky lustre and undulating form, furnishes an article of luxury common in all the countries of the East. The musk ox, the ounce, a species of tiger, the wild horse, and the lion, are among the animals of the country.

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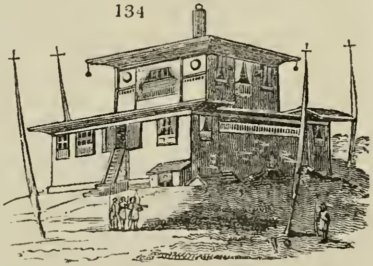

1019. *That elegant specimens of civil architecture*, both in the construction of mansions (*fig.* 134.), or palaces, and in bridges and other public works, should be found in such a country is rather singular. In Turner's journey through this mountainous region, he found bridges of various descriptions generally of timber. Over broad streams, a triple or quadruple depth of stretching timbers project one over the other, their ends inserted into the rock. Piers are almost totally excluded, on account of the extreme rapidity of the rivers. The widest river has an iron bridge, consisting of a number of iron chains which support a matted platform, and two chains are stretched above parallel with the sides, to allow of a matted border for the safety of the passenger. Horses are permitted to go over this bridge, one at a time. There is another bridge of a more simple construction, formed of two parallel chains, round which creepers are loosely twisted, sinking very much in the middle, where suitable planks are placed for a path. Another mode of passing rivers is by two ropes of rattan or stout osier, stretched from one mountain to another, and encircled by a hoop of the same. The passenger places himself between them, sitting in the hoop, and seizing a rope in each hand, slides himself along with facility and speed over an abyss tremendous to behold. Chain and wire bridges, constructed like those of Thibet, are now becoming common in Britain; and it is singular, that one is described in Hutchinson's *Durham* (Newcast. 1785) as having been erected over the Tees.

Subsect. 10. *Of the present State of Agriculture in the Asiatic Islands.*

1020. *The islands of Asia* form a considerable part of our globe; and seem well adapted by nature for the support of civilised man, though at present they are mostly peopled by savages. We shall notice these islands in the order of Sumatra, Borneo, the Manillas, the Celebes, the Loochoo Isles, and the Moluccas.

1021. *Sumatra* is an island of great extent, with a climate more temperate than that of Bengal, a surface of mountains and plains, one third of which is covered with impervious forests, and a soil consisting of a stratum of red clay, covered with a layer of black mould. The most important agricultural product is rice, which is grown both for home consumption and export. Next may be mentioned the cocoa-nut, the areca palm, or betel-nut tree, and the pepper. Cotton and coffee are also cultivated; and the native trees afford the resin benzoin, cassia or wild cinnamon, rattans or small canes (*A*rúndo *R*òtang), canes for walkingsticks, turpentine, and gums; besides ebony, pine, sandal, teak, manchineel, iron wood, banyan, aloe, and other woods.

1022. *The pepper plant* (Pìper nìgrum, *fig.* 135. *a*) is a slender climbing shrub, which also roots at the joints. It is extensively cultivated at Sumatra, and the berries exported to every part of the world. According to Marsden (*Hist. of Sumatra*), the ground chosen by the Sumatrans for a pepper-garden is marked out into regular squares of six feet, the intended distance of the plants, of which there are usually a thousand in each garden. The next business is to plant the chinkareens, which serve as props to the pepper-vines, and are cuttings of a tree of that name, which is of quick growth. When the chinkareen has been some months planted, the most promising perpendicular shoot is reserved for growth, and the others lopped off: this shoot, after it has acquired two fathoms in height, is deemed sufficiently high, and its top is cut off. Two pepper-vines are usually planted to one chinkareen, round which the vines twist for support; and after being suffered to grow three years (by which time they acquire eight or twelve feet in height), they are cut off about three feet from the ground, and being loosened from the prop, are bent into the earth in such a manner that the upper end is returned to the root. This operation gives fresh vigour to the plants, and they bear fruit plentifully the ensuing season. The fruit, which is produced in long spikes, is four or five months in coming to maturity: the berries are at first green, turn to a bright red when ripe and in perfection, and soon fall off if not gathered in proper time. As the whole cluster does not ripen at the same time, part of the berries would be lost in waiting for the latter ones; the Sumatrans, therefore, pluck the bunches as soon as any of the berries ripen, and spread them to dry upon mats, or upon the ground; by drying they become black, and more or less shrivelled, according to their degree of maturity. These are imported here under the name of *black pepper.*

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1023. *White pepper* consists of the ripe and perfect berries of the same species stripped of their outer coats. For this purpose the berries are steeped for about a fortnight in water, till, by swelling, their outer coverings burst; after which they are easily separated, and the pepper is carefully dried by exposure to the sun; or the berries are freed from their outer coats by means of a preparation of lime and mustard-oil, called "chinam," applied before it is dried. Pepper, which has fallen to the ground over-ripe, loses its outer coat, and is sold as an inferior sort of white pepper.

1024. *The betel leaf* (Pìper Bètle, *fig.* 135. *b*) is also cultivated to a considerable extent. It is a slender-stemmed climbing or trailing plant, like the black pepper, with smooth pointed leaves. These leaves serve to enclose a few slices of the nut of the areca palm erroneously called the *betel nut.* The areca being wrapped up in the leaf, the whole is covered with a little chunam or shell-lime to retain the flavour. The preparation has the name of betel, and is chewed by the better sort of southern Asiatics to sweeten the breath and strengthen the stomach; and by the lower classes for the same reasons as ours do tobacco. The consumption is very extensive.

1025. *The areca palm* (Arèca Cátechu) grows to the height of forty or fifty feet with a straight trunk, and is cultivated in the margins of fields for its nut or fruit, which is sold to be prepared as betel.

1026. *Three sorts of cotton are cultivated,* including the silk cotton (Bómbax *Céiba*), a handsome tree, which has been compared by some to a dumb waiter, from the regularity of its branches.

1027. *The live stock of Sumatra* consists of horses, cows, buffaloes, sheep, and swine. They are all diminutive. The horse is chiefly used for the saddle, and the buffalo for labour. The wild animals are numerous, and include the civet cat, monkey, argus pheasant, the jungle or wild fowl, and the small breed of poultry found also at Bantam on the west of Java, and well known in Britain by that name.

1028. *Borneo* is the largest island in the world next to New Holland. It is low and marshy towards the shore, and in this respect and in its climate, is similar to Java. The soil is naturally fertile; but agriculture is neglected, the inhabitants occupying themselves in searching for gold, which they exchange with the Japanese for the necessaries of life.

1029. *The ava,* or *intoxicating pepper* (Pìper methýsticum), is cultivated here. It is a shrub with a forked stem and oblong leaves, bearing a spike of berries, and having thick roots. The root of this plant, bruised or chewed in the mouth, and mixed with the saliva, yields that nauseous, hot, intoxicating juice, which is so acceptable to the natives of the South Sea islands, and which is spoken of with so much just detestation by voyagers. A similar drink is made in Peru from the meal of the maize. They pour the liquor of the cocoa-nut, or a little water, on the bruised or masticated matter, and then a small quantity produces intoxication and sleep. After the use of it for some time, it produces inflammation, leprous ulcers, and consumption. It is cultivated in all the South Sea islands, except the New Hebrides and New Caledonia. (*Spix's Travels.*)

1030. *The Manillas*, or *Phillipine Islands*, are a numerous group, generally fruitful in rice, cotton, the sugar cane, and cocoa. The bread-fruit also begins to be cultivated here.

1031. *The Celebesian Islands* are little known. They are said to abound in poisonous plants; and the inhabitants cultivate great quantities of rice.

1032. *The agriculture of the Loochoo Isles*, as far as it is known, resembles that of China. The climate and soil of the principal island seem to be among the most favourable for man on the face of the globe. The sea breezes, which, from its situation in the midst of an immense ocean, blow continually over it, preserve it from the extremes of heat and cold; while its configuration, rising in the centre into considerable eminences, supplies it with rivers and streamlets of excellent water. The verdant lawns and romantic scenery of Tinian and Juan Fernandez are displayed here in higher perfection; cultivation being added to the beauties of nature. The fruits and vegetable productions are excellent, and those of distant regions are found flourishing together. The orange and the lime, the banyan of India and the Norwegian fir, all thrive in Loochoo. The chief object of cultivation is rice, the fields of which are kept extremely neat, and the furrows regularly arranged by a plough of a simple construction: irrigation is practised. They have also a very nourishing variety of sweet potato. The animal creation is generally of diminutive size, their bullocks seldom weighing more than 350 lbs., though plump and well conditioned, and the beef excellent; their goats and hogs are also diminutive, but the poultry large and excellent. The bull is chiefly used in agriculture. These islands are not infested by any wild animals. The inhabitants seem to be gifted with a natural politeness, good-breeding, and kindness, analogous to their climate and the productions of their country. (*Hall in Edin. Gaz.*, vol. iv.)

1033. *The Moluccas*, or *Spice Islands*, are small, but fertile in agricultural products. In some the bread-fruit is cultivated, also the sago palm, with cloves and nutmegs. The nutmeg-tree (Myrística moschàta) grows to the size of a pear tree, with laurel-like leaves; it bears fruit from the age of ten to one hundred years. The fruit is about the size of an apricot, and when ripe nearly of a similar colour. It opens and discovers the mace of a deep red, growing over, and in part covering, the thin shell of the nutmeg, which is black. The tree yields three crops annually; the first in April, which is the best; the second, in August; and the third, in December; yet the fruit requires nine months to ripen it. When it is gathered, the outer coriaceous covering is first stripped off, and then the inner carefully separated and dried in the sun. The nutmegs in the shell are exposed to heat and smoke for three months, then broken, and the kernels thrown into a strong mixture of lime and water, which is supposed to be necessary for their preservation, after which they are cleaned and packed up; and with the same intention the mace is sprinkled with salt water.

Sect. II. *Of the present State of Agriculture in the Australian Isles.*

1034. *The Islands of Australia* form a most extensive part of the territorial surface of our globe, and the more interesting to Britons as they are likely one day to be overspread by their descendants and language. The important colonies of New Holland and Van Diemen's Land are increasing in a ratio which, if it continue, will at no very distant period spread civilisation over the whole of the islands composing this large division of the earth. The immense population, territorial riches and beauty, commerce, naval power, intellect and refinement, which may then exist in these scarcely known regions are too vast and various for the grasp of the imagination. Their rapid progress to this state, however, is unquestionable; being founded on those grand requisites, temperate climate, culturable soil, ample water intercommunication; and, to take advantage of all these, an advanced state of civilisation in the settlers.

1035. *The principal Australian Isles* are New Holland, Van Diemen's Land, New Guinea, New Britain, and New Zealand.

1036. *New Holland and Van Diemen's Land* are not rich in mines, sugar canes, cochineal, or cottons; but they are blessed with a climate which, though different in different places, is yet, on the whole, favourable to the health, comfort, and industry of Europeans; they exhibit an almost endless extent of surface, various as to aspect and capability, but, taken together, suited in an extraordinary degree to the numerous purposes of rural economy, the plough and spade, the dairy and sheep-walk. The emigrant has not to wage hopeless and ruinous war with interminable forests and impregnable jungle, as he finds extensive plains prepared by the hand of nature, ready for the ploughshare, and capable of repaying manifold in the first season. He is not poisoned by pestiferous swamps, nor frightened from his purpose by beasts of prey and loathsome reptiles; he is not chilled by hyperborean cold, nor scorched and enfeebled by tropical heat; and he is not separated from his kind, nor hardened in his heart, by the debasing influence of open or concealed slavery. It is true, that he is surrounded by those who have the brand of crime and punishment upon them, and who are, therefore, to a certain extent infamous; but he has the satisfaction of knowing that it is his duty and interest to improve, not contribute to the farther degradation of, these fallen beings. (*Widowson's Present State of Van Diemen's Land.* 1829.)

1037. *New Holland, Notasia,* or what may be called the continent of Australia, is of a size nearly equal to the whole of Europe. So extended a surface naturally presents different characters of climate, elevation, and soil. But the climate is said to be every where temperate and salubrious; to the north it may be considered semitropical, to the south not materially different from that of England. The whole country being south of the equator, the seasons are like those of the southern parts of Africa and America, and consequently the reverse of those of Europe. The surface of the country is in general low and level; far northward it is hilly, and a chain of mountains is said to run north and south, very lofty and irregular. Hills and mountains, however, form but a small part of this extensive country. Lakes and rivers are not very frequent; but in the interior there are extensive marshes and savannas, covered with luxuriant grasses. In some places the country is highly beautiful. Mr. Evans, who made a journey of 300 miles into the interior, in 1818, states that "the farther he advanced the more beautiful the scenery became; both hill and dale were clothed with fine grass, the whole appearing at a little distance as if laid out into fields divided by hedge-rows. Through every valley meandered trickling streams of fine water. Many of the hills are capped with forest trees, chiefly of the eucalyptus; and clumps of these, mixed with mimosas and the cassuarina, were interspersed along the declivities of the hills, and in the valleys, so as to wear the appearance of a succession of gentlemen's parks."

1038. *The mineral productions* include coal, limestone, slate, granite, quartz, sandstone, freestone, and iron, the last in great abundance. The coal is of the best quality, often found in hills, and worked from the side like a stone quarry without expensive drainage.

1039. *The soil* towards the south is frequently sandy, and many of the lawns or savannas are rocky and barren. In general the soil towards the sea coast is naturally more fertile than in the interior; but almost every where it may be brought into cultivation with little labour and abundant success. The colony of New South Wales possesses every variety of soil, from the sandy heath and the cold hungry clay, to the fertile loam, and the deep vegetable mould. The prevailing soil hitherto subjected to agriculture is a thin black earth resting on a stratum of yellow clay, which is again supported by a deep bed of schistus.

1040. *The productions of nature* in New Holland present a remarkable sameness among themselves, and a no less remarkable difference from those of the rest of the world. This applies more particularly to the animal and vegetable kingdoms. The rocks, mountains, and earths, resemble nearly the inorganic substances which are met with in other parts of the world; but the animals and plants are decidedly peculiar. The natives are copper-coloured savages of the very lowest description. The quadrupeds are all of the kangaroo or opossum tribe, or resemble these, with one or two exceptions, among which is the Ornithorhýnchus paradóxus, a quadruped with the beak of a bird. The fish are for the most part like sharks. Among the birds are black swans and white eagles, and the emu, supposed to be the tallest and loftiest bird that exists; many of them standing full seven feet high. Every one acquainted in the slightest degree with the plants in our green-houses is aware of the very peculiar appearance of those of Australia, and there is scarcely a gardener who cannot tell their native country at first sight. Mr. Brown, who is better acquainted with these plants than any other botanist, observes that the *A*càcia and Eucalýptus, of each of which genera there are upwards of one hundred species, when taken together, and considered with respect to the mass of vegetable matter which they contain, calculated from the size as well as from the number of individuals, are, perhaps, nearly equal to all the other plants of that country. (*App. to Flinders's Voyage.*)

1041. *There is no indigenous agriculture in any part of New Holland;* but the colony of New South Wales, which was established in 1788, has appropriated extensive tracts of country in that quarter of the island, and subjected them to the field and garden cultivation of Europe. Every thing that can be cultivated in the open air in England can be cultivated in New South Wales; the fruits of Italy and Spain come to greater perfection there than here, with the single exception of the orange, which requires a slight protection in winter. Pine-apples will grow under glass without artificial heat; the apple and the gooseberry are the only fruits which are found somewhat inferior to those produced in Britain. But the great advantage of this colony to the agriculturist is, that it is particularly suited to maize and sheep: maize, it is well known, produces a greater return in proportion to the seed and labour than any other bread-corn; and the wool of the sheep of New South Wales is equal to the best of that produced in Saxony, and can be sent to the British market for about the same expense of transport. This wool forms the grand article of agricultural export from New Holland. According to a calculation made by Mr. Kingdom in 1820 (*British Colonies*, p. 282.), "making the most liberal allowance for all kind of expenses, casualties, and deteriorations, money sunk in the rearing of sheep in this colony will, in the course of three years, double itself besides paying an interest of 75 per cent."

1042. *As a country for an agriculturist to emigrate to*, New South Wales is perhaps one of the best in the world, and its advantages are yearly increasing by the great number of independent settlers who arrive there from Britain. Settlers, on arrival at New South Wales and Van Diemen's Land, have a grant of land allotted to them proportionate to their powers of making proper use of it, with a certain number of convicts as labourers, who with their families are victualed from the public stores for six months. (*Kingdom*, p. 311.) The country seems fully adequate to support itself with every necessary, and almost every luxury, requisite to the present state of human refinement; in this respect it has the advantage over France, in being able to bring to perfection the cotton plant. "As a criterion of the luxuries enjoyed by the inhabitants in fruit, one garden, belonging to a gentleman a few miles from Sydney, contains the following extensive variety: — viz. oranges, citrons, lemons, pomegranates, loquatts, guavas, the olive, grapes of every variety, pine-apples, peaches, nectarines, apricots, apples, pears, plums, figs; English, Cape, and China mulberries; walnuts, Spanish chestnuts, almonds, medlars, raspberries, strawberries, melons, quinces and the caper, with others of minor value; and such is the abundance of peaches, that the swine of the settlers are fed with them." (*Kingdom*, p. 308.) In the *Gardener's Magazine*, vol. v. p. 280., Mr. Fraser, the Colonial botanist, has given a catalogue of upwards of 100 species and varieties of fruit under his care in the open garden at Sydney, including the pine-apple, the date, the plantain, the cocoa, and the mango.

1043. *An Australian Agricultural Society* was established, in the year 1823, for "the promotion both of field and garden cultivation;" and, besides newspapers, there is a quarterly publication entitled the *Australasian Magazine of Agricultural and Commercial Information*. In June 1824, an Act of Parliament was passed creating an "Australian Agricultural Company, for the Cultivation and Improvement of waste Land, in the Colony of New South Wales." This company have an establishment in London, for the purpose of raising a capital of one million of pounds sterling, in shares of 100*l.* each.

1044. *Van Diemen's Island* is about as large as Ireland, and it enjoys a temperate climate resembling that of England, but less subject to violent changes. According to Evans, the deputy surveyor of the colony, the climate is more congenial to the European constitution than any other on the globe. That of New Holland has been commended for its salubrity, but the north-west winds which prevail there are unknown at Van Diemen's Land. Neither the summers nor winters are subject to any great extremes of heat or cold; for though the summits of the mountains are covered during the greater part of the year with snow, yet in the valleys it never remains on the ground more than a few hours. The mean difference of temperature between Van Diemen's Land and New South Wales is ten degrees, the mean temperature of the whole island may be reckoned at about 60°, and the extremes at from 36° to 80°. The spring commences early in September; the summer in December; the autumn in April; and the winter, the severity of which continues about seven weeks, in June.

1045. *The surface of the country* is richly variegated, diversified by ranges of moderate hills and broad valleys, and towards the western part of the island there is a range of mountains, in height 3500 feet; on their summit is a large lake, the source of several rivers. But though there are hills in various other parts of the island, there are not above three or four of them that can be considered mountains. The hills, the ridges or sky outlines of which form irregular curves, are for the greater part wooded; and from their summits are to be seen levels of good pasture land, thinly interspersed with trees, below which is a luxuriant grassy surface. These beautiful plains are generally of the extent of 8000 or 10,000 acres, and, Evans observes, are common throughout the whole island.

1046. *The soil*, as in New Holland, is greatly diversified; but in proportion to the surface of the two countries, this one contains comparatively much less of an indifferent quality. Many fine tracts of land are found upon the very borders of the sea; and the plains and valleys in the interior are composed of rich loamy clay and vegetable mould.

1047. *The animal and vegetable kingdoms* are the same as those of New Holland. The native dog, the agriculturist's great enemy in that country, is unknown here; but there is an animal of the panther family in its stead, which commits as great havoc among the flocks, as the wolf did formerly in Britain. It is very cowardly, and by no means formidable to man. The native savages are, if possible, more uncivilised than those of New Holland; they subsist entirely by hunting, and though the country has the finest rivers, they have no knowledge whatever of the art of fishing. They bear great animosity to the colonists, having been fired upon by them soon after their first settlement, by which numbers were killed. Fortunately, however, the natives seldom act on the offensive, and two persons with muskets may traverse the island from one end to the other in perfect safety.

1048. *The agricultural facilities of Van Diemen's Land* are still greater than those of New South Wales. Large tracts of land, perfectly free from timber or underwood, and covered with the most luxuriant herbage, are to be found in all directions, but more particularly in the environs of Port Dalrymple. These tracts of land are invariably of the very best description, and millions of acres, which are capable of being instantly converted to all the purposes of husbandry, still remain unappropriated. Here the colonist has no expense to incur in clearing his farm : he is not compelled to a great preliminary outlay of capital, before he can expect a considerable return. He has only to set fire to the grass to prepare his land for the immediate reception of the ploughshare ; insomuch that, if he but possesses a good team of horses or oxen, with a set of harness and a couple of substantial ploughs, he has the main requisites for commencing an agricultural establishment, and for insuring a comfortable subsistence for himself and family.

1049. *To this great superiority* which these southern settlements may claim over the parent colony, may be superadded two advantages, which are perhaps of equal magnitude and importance. In the first place, the rivers here have a sufficient fall to prevent any excessive accumulation of water from violent or continued rains, and are, consequently, free from those awful and destructive inundations to which the rivers of New South Wales are perpetually subject. Here, therefore, the industrious colonist may settle on the bank of a navigable river, and enjoy all the advantages of sending his produce to market by water, without running the constant hazard of having the fruits of his labour, the golden promise of the year, swept away in an hour by a capricious and domineering element. Secondly, the seasons are more regular and defined, and those great droughts, which have been so frequent in Port Jackson, are altogether unknown. In the years 1813, 1814, and 1815, when the whole face of the country was there literally burnt up, and vegetation completely at a stand still from the want of rain, an abundant supply of it fell here, and the harvests, in consequence, were never more productive. Indeed, since these settlements were first established, the crops have never sustained any serious detriment from an insufficiency of rain ; whereas, in the parent colony, there have been, since its foundation, I may venture to say, half a dozen dearths occasioned by droughts. and at least as many arising from floods.

1050. *The system of farming in Van Diemen's Land* consists principally of growing one crop year after year. There are a few enterprising individuals who grow the various descriptions of grain ; but wheat is what the old settler grew first, and from that he cannot depart. It is not many years since, when the plough might be said to be unknown in the island, the ground was then broken up with a hoe, similar to those used in the West Indies, and the corn brushed in with thorns. This rude system is now abolished, a pair of bullocks and a plough being within the reach of the smallest landholder. New and old land are generally broken up at the same season of the year. Once ploughed, it is sown and harrowed, and never again interfered with until the crop is cut down. Wheat, barley, and oats may be sown at the same season, namely, about the beginning of August, although wheat is sometimes sown late in November, and a good crop reaped in the early part of March. There is no fear of injuring the grain by sowing early ; I have seen seed sown in the beginning of winter, and flourish surprisingly. From ten to fifteen crops of wheat have been taken in succession, until the land has been completely exhausted. It is then abandoned, and a new piece broken up. The exhausted land generally becomes covered with young mimosas (acacias). (*Widowson.*)

1051. *As a country to emigrate to*, the circumstance of Van Diemen's Land being exempt from those calamitous consequences which are so frequent in New Holland, from a superabundance of rain on the one hand, and a deficiency of it on the other, is a most important point of consideration for all such as hesitate in their choice between the two countries. In the system of agriculture pursued in the two colonies there is not any difference, save that the Indian corn, or maize, is not cultivated here, because the climate is too cold to bring that grain to maturity. Barley and oats, however, arrive at much greater perfection, and afford the inhabitants a substitute, although by no means an equivalent, for this highly valuable product. The wheat, also, which is raised here is of a much superior description to the wheat grown in any of the districts of Port Jackson, and will always command, in the Sydney market, a difference of price sufficiently great to pay for the additional cost of transport. The average produce, also, of the land is greater, although it does not exceed, nor perhaps equal, that of the rich flooded lands on the banks of the Hawkesbury and Nepean. The produce of both colonies, it is stated, would be double what it is, if the operations of agriculture were as well performed as in Britain. At present, however, this can only be the case when a settler is so fortunate as to get what are called country convicts, that is, Irishmen who have been employed as agricultural labourers at home. The system of rearing and fattening cattle is perfectly analogous to that which is pursued at Port Jackson. The natural grasses afford an abundance of pasturage at all seasons of the year, and no provision of winter provender, in the shape either of hay or artificial food, is made by the settler for his cattle; yet, notwithstanding this palpable omission, and the greater length and severity of the winters, all descriptions of stock attain here a much larger size than at Port Jackson. Wool has every promise of becoming a staple commodity of Van Diemen's Land. It was at first thought that the climate was more favourable for the production of carcass than of fleece; but it has been found since the introduction of merinos, that wool can be produced in every respect as good as that of New South Wales. In 1822, upwards of 300,000 lbs. of wool were consigned to London, which sold there at prices equal to those given for the wool of New South Wales and Saxony. Those who are desirous of more ample information respecting this colony, which certainly ranks as the first in the world for a British emigrant, may consult *Kingdom's British Colonies*, 1820; *Evans's Van Diemen's Land*, 1824; *Godwin's Emigrant's Guide to Van Diemen's Land*, 1823; *Widowson's Van Diemen's Land*, 1829.

1052. *New Britain, New Ireland, the Solomon Isles, New Caledonia, and the New Hebrides,* are little known. They are mountainous and woody, with fertile vales and beautiful streams. The nutmeg, cocoa, yam, ginger, pepper, plantains (*fig.* 136.), sugar canes, and other fruit and spice trees, abound.

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1053. *Papua*, or *New Guinea*, partakes of the opulence of the Moluccas (1033.), and their singular varieties of plants and animals. The coasts are lofty, and abound with cocoa trees. In the interior, mountain rises above mountain, richly clothed with woods of great variety of species, and abounding in wild swine. Birds of paradise and elegant parrots abound: they are shot with blunt arrows, or caught with birdlime or nooses. The bowels and breast being extracted, they are dried with smoke and sulphur, and sold for nails or bits of iron to such navigators as touch at the island.

1054. *New Zealand* has scarcely any agriculture, except plantations of yam, cocoa, and sweet potato. There is only one shrub or tree in this country which produces fruit, and that is a kind of a berry almost tasteless; but they have a plant (*Ph*órmium tènax) which answers all the uses of hemp and flax. There are two kinds of this plant, the leaves of one of which are yellow, those of the other deep red, and both resembling the leaves of flags. Of these leaves they make lines and cordage much stronger than any thing of the kind in Europe; they likewise split them into breadths, and tying the slips together form their fishing-nets. Their common apparel, by a simple process, is made from these leaves; and their finer, by another preparation, is made from the fibres. This plant is found both on high and low ground, in dry mould and deep bogs; but as it grows largest in the latter, that seems to be its proper soil. It has lately been found to prosper in the south of Ireland, but not to such an extent as to determine its value.

Sect. III. *Of the present State of Agriculture in Polynesia.*

1055. *This sixth great division of the earth's surface* consists of a number of islands in the northern and southern hemispheres, which, though at present chiefly inhabited by savages, are yet, from their climate and other circumstances, singularly adapted for culture and civilisation. The principal are the Pellew Isles, the Ladrone Isles, the Sandwich Isles, in the northern hemisphere; and the Friendly Isles, the Navigator's Isles, the Society Isles, the Georgian Isles, and the Marquesas, in the southern hemisphere.

1056. *The Pellew Isles* are covered with wood, and encircled by a coral reef. None of these islands has any sort of grain or quadruped; but they are rich in the most valuable fruit and spice trees, including the cabbage tree (*Arèca* oleràcea) (*fig.* 137.), cocoa, plantain, and orange; and abound with wild cocks and hens, and many other birds. The culture of the natives only extends to yams and cocoa-nuts.

1057. *The Ladrones* are a numerous collection of rocky fragments, little adapted to agriculture. The isles of Guam and Tinian are exceptions. The latter abounds in cattle and fruits, the bread-fruit, and orange, but is without agriculture.

1058. *The Marquesas* are in general rocky and mountainous, and include very few spots fit for cultivation. The inhabitants are savages, but rudely cultivate the yam in some places. They have, however, the ava, or intoxicating pepper (1029.); and procure also a strong liquor from the root of ginger, for the same general purpose of accumulating enjoyment, forgetting care, and sinking into profound sleep.

1059. *The Sandwich Isles* resemble those of the West Indies in climate, and the rest of the South Sea islands in vegetable productions. The bread-fruit tree attains great perfection. Sugar canes grow to an unusual size, one being brought to Captain Cook eleven inches and a quarter in circumference, and having fourteen feet eatable. Dogs, hogs, and rats are the only native quadrupeds of these islands, in common with all others that have been discovered in the South Sea. The king of these islands visited England in the time of Geo. II., and again in 1824.

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1060. *The Friendly Islands* are in most respects similar to Otaheite (1061.). Tongataboo appears to be a flat country, with a fine climate, and universally cultivated. The whole of this island is said to consist of enclosures, with reed fences about six feet high, intersected with innumerable roads. The articles cultivated are bread-fruit, plantains, cocoa-nuts, and yams. In the other islands, plantains and yams engage most of their attention; the cocoa-nut and bread-fruit trees are dispersed about in less order than the former, and seem to give them no trouble. Their implements of culture consist of pointed sticks of different lengths and degrees of strength.

1061. *The island of Otaheite* is the principal of the Georgian Islands. It is surrounded by a reef of coral rocks. The surface of the country, except that part of it which borders upon the sea, is very uneven; it rises in ridges that run up into the middle of the island, and there form mountains which may be seen at the distance of sixty miles. Between the foot of these ridges and the sea is a border of low land, surrounding the whole island, except in a few places where the ridges rise directly from the sea. This border is of different breadths in different parts, but no where more than a mile and a half.

1062. *The soil of Otaheite*, except on the very tops of the ridges, is extremely rich and fertile, watered by a great number of rivulets of excellent water, and covered with fruit trees of various kinds. The low land that lies between the foot of the ridges and the sea, and some of the valleys, are the only parts of the island that are inhabited, and here it is populous: the houses do not form villages or towns, but are ranged along the whole border, at the distance of about fifty yards from each other, with little plantations of plantains, the tree which furnishes them with cloth.

1063. *The produce of Otaheite* is the bread-fruit (Artocárpus integrifòlia), cocoa-nuts, bananas of thirteen sorts, plantains; a fruit not unlike an apple, which, when ripe, is very pleasant; sweet potatoes, yams, cocoas (*A*`rum *C*olocàsia, and *Calàdium* esculéntum, both propagated by the leaves); a fruit known here by the name of jambu, and reckoned most delicious; sugar cane, which the inhabitants eat raw; a root of the saloop kind, which the inhabitants call pea; a plant called ethee, of which the root only is eaten; a fruit that grows in a pod, like that of a large kidneybean, which, when it is roasted, eats very much like a chestnut, by the natives called whee; a tree here called wharra, but in the East Indies pandanus, which produces fruit something like the pine-apple; a shrub called nono; the morinda, which also produces fruit; a species of fern, of which the root is eaten, and sometimes the leaves; and a plant called theve, of which the root also is eaten: but the fruits of the nono, the fern, and the theve, are eaten only by the inferior people, and in times of scarcity. All these, which serve the inhabitants for food, the earth produces spontaneously, or with little culture. They had no European fruit, garden stuff, pulse, or legumes, nor grain of any kind, till some seeds of melons and other vegetables were given them by Captain Cook.

1064. *Of tame animals*, the Otaheitans have only hogs, dogs, and poultry; neither is there a wild animal on the island, except ducks, pigeons, parroquets, with a few other birds, and rats, there being no other quadruped, nor any serpent. But the sea supplies them with great variety of most excellent fish, to eat which is their chief luxury, and to catch it their principal labour.

1065. *The remaining Polynesian Islands of the southern hemisphere* are, for the most part, inhabited by savages, and are without agriculture.

Sect. IV. *Of the present State of Agriculture in Africa.*

1066. *The continent of Africa*, in point of agricultural as of political and ethical estimation, is the meanest of the great divisions of the earth; though in one corner of it (Egypt) agriculture is supposed to have originated. The climate is every where hot, and intensely so in the northern parts. The central parts, as far as known, consist of ridges of mountains and immense deserts of red sand. There are very few rivers, inland lakes, or seas, and indeed fully one half of this continent may be considered as either desert or unknown. Some of the African islands are fertile and important, especially Madagascar, Bourbon, Mauritius, &c. We shall take the countries of Africa in the order of Abyssinia, Egypt, Mohammedan states of the north, western coast, Cape of Good Hope, eastern coast, Madagascar and other isles.

Subsect. 1. *Of the present State of Agriculture in Abyssinia.*

1067. *The climate of Abyssinia*, though exceedingly various in different parts, is in general temperate and healthy. The *surface* of the country is generally rugged and mountainous; it abounds with forests and morasses; and it is also interspersed with many fertile valleys and plains adapted both to pasture and tillage. The rivers are numerous and large, and contribute much to general fertility. The soil is not naturally good, being in general thin and sandy; but it is rendered fertile and productive by irrigation and the periodical rains.

1068. *The agricultural products* are wheat, barley, millet, and other grains. They cultivate the vine, peach, pomegranate, sugar cane, almonds, lemons, citrons, and oranges; and they have many roots and herbs which grow spontaneously, and their soil, if properly managed, would produce many more. However, they make little wine, but content themselves with the liquor which they draw from the sugar cane, and their honey, which is excellent and abundant. They have the coffee tree, and a plant called ensete, which produces an eatable nourishing fruit. The country also produces many other plants and fruits adapted both for domestic and medicinal uses. Here is plenty of cotton, which grows on shrubs like that of India. The forests abound with trees of various descriptions, particularly the rock, baobob, cedar, sycamore, &c.

1069. *The live stock* of Abyssinia includes horses, some of which are of a very fine breed, mules, asses, camels, dromedaries, oxen of different kinds (*fig.* 138.), cows, sheep, and goats; and these constitute the principal wealth of the inhabitants. Amongst the wild animals, we may reckon the antelope, the buffalo, the wild boar, the jackal, the elephant, the rhinoceros, the lion, the leopard, the hyæna, the lynx; the ape and baboon which, as well as the common rat, are very destructive to the fields of millet; the zecora, or wild mule, and the wild ass; the jerboa, the fennic, ashkoko, hare, &c. The hare, as well as the wild boar, is deemed unclean, and not used as food. Bruce saw no sparrows, magpies, nor bats; nor many water-fowl, nor any geese, except the golden goose, or goose of the Nile, which is common in every part of Africa; but there are snipes in the marshes. The locusts of this country are very destructive; they have also species of ants that are injurious; but from their bees they derive a rich supply.

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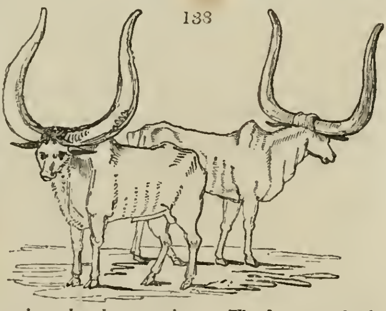

1070. *The agriculture of Abyssinia* is of far less use to the inhabitants than it might be, for want of application and exertion. There are two, and often three, harvests in the year; and where they have a supply of water, they may sow in all seasons; many of their trees and plants retain their verdure, and yield fruit or flowers throughout the year; the west side of the tree blossoms first and bears fruit, then the south side, next the north side, and last of all the east side goes through the same process towards the beginning of the rainy seasons. Their pastures are covered with flocks and herds. They have grass in abundance, but they neglect to make hay of it; and therefore they are obliged to supply this defect by feeding their cattle with barley, or some other grain. Notwithstanding the plenty and frequent return of their crops, they are sometimes reduced almost to famine, either by the devastations of the locusts or grasshoppers which infest the country, or by the more destructive ravages of their own armies, and those of their enemies.

Subsect. 2. *Of the present State of Agriculture in Egypt.*

1071. *The climate of Egypt* has a peculiar character from the circumstance of rain being very uncommon. The heat is also extreme, particularly from March to November; while the cool season, or a kind of spring, extends through the other months.

1072. *The surface of the country* is varied in some regions, but is otherwise flat and uniform. Far the greater part presents a narrow fertile vale, pervaded by the Nile, and bounded on either side by barren rocks and mountains. The soil of Egypt has been variously described by different travellers, some representing it as barren sand, only rendered fertile by watering, and others as "a pure black mould, free from stones, of a very tenacious and unctuous nature, and so rich as to require no manure." The latter appears to prevail only in the Delta.

1073. *The fertility of Egypt* has been generally ascribed to the inundations of the Nile, but this is applicable in a strict sense only to parts of the Delta; whereas, in other districts there are canals, and the adjacent lands are generally watered by machines. Gray's description of Egypt, as immersed under the influx of the Nile, though exquisitely poetical, is far from being just. In Upper Egypt the river is confined by high banks, which prevent any inundation into the adjacent country. This is also the case in Lower Egypt, except at the extremities of the Delta, where the Nile is never more than a few feet below the surface of the ground, and where of course inundation takes place. But the country, as we may imagine, is without habitations. The fertility of Egypt, according to Browne, an intelligent traveller, arises from human art. The lands near the river are watered by machines; and if they extend to any width, canals have been cut. The soil in general is so rich as to require no manure; it is a pure black mould, free from stones, and of a very tenacious unctuous nature. When left uncultivated, fissures have been observed, arising from extreme heat, of such depth that a spear of six feet could not reach the bottom.

1074. *The limits of cultivated Egypt* are encroached upon annually, and barren sand is accumulating from all parts. In 1517, the era of the Turkish conquest, Lake Mareotis was at no distance from the walls of Alexandria, and the canal which conveyed the waters into the city was still navigable. At this day, the lake has disappeared, and the lands watered by it, which, according to historians, produced abundance of corn, wine, and various fruits, are changed into deserts, in which are found neither shrub, nor plant, nor verdure. The canal itself, the work of Alexander, necessary to the subsistence of the inhabitants of the city which he built, is nearly choked up, and preserves the waters only when the inundation is at its greatest height, and for a short time. About half a century ago, part of the mud deposited by the river was cleared out of it, and it retained the water three months longer. Schemes have lately been adopted for opening and perfecting this canal. The Pelusiac branch, which discharges itself into the eastern part of the Lake of Tanais, or Menzalé, is utterly destroyed. With it perished the beautiful province which it fertilised, and the famous canal begun by Necos, and finished by Ptolemy Philadelphus. The famous works, executed by kings who sought their glory and happiness in the prosperity of the people, have not been able to resist the ravages of conquerors, and that despotism which destroys every thing, till it buries itself under the wreck of the kingdoms whose foundations it has sapped. The last of the great works of Egypt, the canal of Amrou, which formed a communication between Fostat and Colzoum, reaches at present no farther than about four leagues beyond Cairo, and loses itself in the Lake of Pilgrims. Upon the whole, it may be confidently affirmed that upwards of one third of the lands formerly in cultivation is metamorphosed into dreary deserts.

1075. *Landed property in Egypt* is for the most part to be considered as divided between the government and the religious bodies who perform the service of the mosques, and have obtained possession of what they hold by the munificence of princes and rich men, or by the measures taken by individuals for the benefit of their posterity. Hence, a large proportion of the tenants and cultivators hold either of the government or the procurators of the mosques. But there is one circumstance common to both, viz. that their lands, when they become unoccupied, are never let but upon terms ruinous to the tenants. Besides the property and influence of the beys, of the Mamelukes, and of the professors of the law, are so extensive, and so absolute, as to enable them to engross into their own hands a very considerable part: the number of the other proprietors is extremely small, and their property liable to a thousand impositions. Every moment some contribution is to be paid, or some damage repaired; there is no right of succession or inheritance for real property, except for that called "wakf," which is the property of the mosques; every thing returns to government, from which every thing must be repurchased. According to Volney, the peasants are hired labourers, to whom no more is left than what is barely sufficient to sustain life; but Browne says, that these terms can be properly applied to very few of them.

1076. *The occupier of the land,* assisted by his family, is the cultivator; and in the operations of husbandry scarcely requires any other aid. He commonly holds no more than he and they can cultivate, and gather the produce of. When, indeed, the Nile rises, those who are employed to water the fields are commonly hired labourers. The rice and corn they gather are carried to their masters, and nothing is reserved for them but dourra, or Indian millet, of which they make a coarse and tasteless bread without leaven; this, with water and raw onions, is their only food throughout the year; and they think themselves happy if they can sometimes procure a little honey, cheese, sour milk, and dates. Their whole clothing consists of a shirt of coarse blue linen and a black cloak. Their head-dress is a sort of cloth bonnet, over which they roll a long handkerchief of red woollen. Their arms, legs, and breasts are naked, and some of them do not even wear drawers. Their habitations (*fig.* 139.) are mud-walled huts, in which they are suffocated with heat and smoke, and in which, besides the experience of other inconveniences, they are perpetually distressed with the dread of the robberies of the Arabs, and the extortions of the Mamelukes, family feuds, and all the calamities of a perpetual civil war.

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1077. *The agricultural products of Egypt* consist of grain of most sorts, and particularly rice. Barley is grown for the horses, but no oats are seen. In the Delta a crop of rice and a crop of barley are obtained within the year on the same ground. Sometimes, instead of barley, a fine variety of clover (*Trifòlium alexandrìnum Forskahl*) is sown without ploughing or harrowing. The seed sinks to a sufficient depth in the moist soil, and produces three cuttings before the time for again sowing the rice.

1078. *Rice* is sown from the month of March to that of May; and is generally six months in coming to maturity. In reaping, it is most commonly pulled up by the roots. As the use of the flail is unknown in Egypt, the rice plants are spread in thick layers on floors formed of earth and pigeon's dung, which are well beaten and very clean; and then, in order to separate the grain from the straw, they make use of a sort of carts, constructed like our sledges with two pieces of wood joined together by two cross bars. Between the longer sides of this sledge are fixed, transversely, three rows of small wheels, made of solid iron, and narrowed off towards their circumference; and on the fore part is fixed a high seat, on which a man sits, for the purpose of driving two oxen that are harnessed to the machine, thus moving it in a circular direction over every part of the heap of rice, till the grain is completely separated from the straw; the grain is then spread in the air to be dried. The dried rice is carried to the mill, where it is stripped of its chaff or husk. This mill consists of a wheel turned by oxen, which sets several levers in motion; and at their extremity is an iron cylinder, about a foot long, and hollow underneath; these cylinders turn in troughs which contain the grain; and at the side of each trough there stands a man, whose business it is to place the rice under the cylinders. The next operation is to sift the rice in the open air, by filling a small sieve, which a man lifts over his head, and thus lets fall, with his face turned to the wind, which blows away the small chaff or dust. This cleaned rice is put a second time into the mill, in order to bleach it; it is afterwards mixed up in troughs with some salt, which contributes very much to its whiteness and also to its preservation, and in this state it is sold. Rice is furnished in great quantities in the Delta; and that which is grown in the environs of Rosetta is more esteemed, on account of its preparation, than that which is produced in the vicinity of Damietta. The produce of the one and the other is equally wonderful. In a good season, that is, when the rise of the Nile occasions a great expansion of its waters, the profit of the proprietors of rice fields is estimated at fifty per cent, clear of all expenses. Savary says that it produces eighty bushels for one.

1079. *Wheat* is sown as soon as the waters of the Nile have retired from the lands appropriated to it; the seed time varies with the latitude, and also the harvest, which is earlier in Upper than in Lower Egypt. Near to Syene they sow the barley and the corn in October, and reap it in January. Towards Girge they cut in February; and in the month of March, in the vicinity of Cairo. This is the usual progress of the harvest in the Said. There is also a number of partial harvests, as the lands are nearer to, or at a greater distance from, the river, lower or more elevated. In Lower Egypt they are sowing and reaping all the year. Where the waters of the river can be procured the earth is never idle, and furnishes three crops annually. In descending from the cataracts in January, the corn is seen almost ripe; lower down it is in ear; and, advancing further, the plains are covered with verdure. The cultivator, in general, merely casts the seed upon the moistened earth; the corn soon springs up from the mud; its vegetation is rapid, and four months after it is sown it is fit to be reaped. In performing this operation, the sickle not being used, the stalks are pulled up by the roots, and carried to large floors, like those which are used for treading out rice; and by a similar operation the corn is separated from the ear. Unripe ears of corn are dried and slackly baked in an oven; and being afterwards bruised and boiled with meat, form a common dish in Lower Egypt, called "ferik."

1080. *Flax* has been cultivated in Egypt from the most remote period, and is still grown in considerable quantities. Indigo is also grown for dyeing it, the colour of the shirt in this country being universally blue.

1081. *From the hemp,* which is abundantly cultivated in this country, the inhabitants prepare intoxicating liquors; and also by pounding the fruit into a paste, which when fermented answers a similar purpose; and they mix the capsules with tobacco for smoking.

1082. *The sugar cane* is also one of the valuable productions of Egypt. The common people do not wait for the extraction of the sugar, but cut the canes green, which are sold in bundles in all the towns. They begin to ripen in October, but are not, in general, fit to be cut till November or December. The skill of the sugar-refiners is in a very imperfect state.

1083. *Fruit trees of various species* abound in this country. Among these we may reckon the olive tree, fig trees which yield figs of an exquisite flavour, and the date tree which is to be found every where in the Thebais and in the Delta, in the sands as well as in the cultivated districts, requiring little or no culture, and yielding a very considerable profit, on account of the immense consumption of its fruit. The species of palm tree that furnishes dates produces also a bark which, together with its leaves and the rind of its fruit, affords filaments from which are manufactured ropes and sails for boats. The leaves are also used for making baskets and other articles. The very long rib of the branches is employed, on account of its lightness and solidity, by the Mamelukes, in their military exercises, as javelins, which they throw at each other from their horses when at full speed. A species of *Cypèrus*, which produces a fruit resembling the earth-nut, but of a much more agreeable flavour, is cultivated in the environs of Rosetta; and the small tubercles are sent to Constantinople and other towns of the Levant, where they are much valued. The Egyptians express from them a milky juice, which they deem pectoral and emollient; and give them to nurses, in order to increase the quantity of their milk. The banana trees, though not natives of the soil of Egypt, are nevertheless cultivated in the northern parts of that country. The papaw, or custard-apple tree (*Anòna*), is also transplanted into the gardens of Egypt, and yields a fruit equally gratifying to the taste and smell. In the shade of the orchards are cultivated various plants, the roots of which are refreshed by the water that is conveyed to them by little trenches; each enclosure having its well or reservoir, from which the water is distributed by a wheel turned by oxen. The mallow (*Málva* rotundifòlia) grows here in abundance: it is dressed with meat, and is one of those herbs that are most generally consumed in the kitchens of Lower Egypt. Two other plants used as food, are the garden Jew's mallow, and the esculent *Hibiscus*. Another tree, which appears to be indigenous in this country, is the "atle," a species of larger tamarisk (*Támarix* orientàlis *Forskahl*). The wood of this tree serves for various purposes; and, among others, for charcoal. It is the only wood that is common in Egypt, either for fuel or for manufactures. Fenu-greek is cultivated for fodder, though for this use a plant called barsim is preferred. The plant called "helbe" is cried about for sale, in November, in the streets of the towns: and it is purchased and eaten with incredible avidity, without any kind of seasoning. It is pretended that it is an excellent stomachic, a specific against worms and the dysentery, and, in short, a preservative against a great number of disorders. Lentils form a considerable article of food to the inhabitants of Upper Egypt, who rarely enjoy the luxury of rice. The Egyptian onions are remarkably mild, more so than the Spanish, but not so large. They are of the purest white, and the laminæ are of a softer and looser contexture than those of any other species. They deteriorate by transplantation; so that much must depend on the soil and climate. They remain a favourite article of food with all classes; and it is usual to put a layer or two of them, and of meat, on a spit or skewer, and thus roast them over a charcoal fire. We need not wonder at the desire of the Israelites for the onions of Egypt. Leeks are also cultivated and eaten in this country; and almost all the species of European vegetables abound in the gardens of Rosetta. Millet and Turkey corn, the vine, the henné or Egyptian privet, and the water-melon are cultivated in Egypt; and the country furnishes a variety of medicinal plants, as *Cárthamus* tinctòrius (*fig.* 140.), senna, coloquintida, &c. Of late years the cotton has been grown on an extensive scale under the care of European and American cultivators, and the raw produce in part manufactured by machinery sent from Britain, and in part exported to Europe.

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1084. *The live stock* of Egyptian agriculture principally consists of the ox, buffalo, horse, ass, mule, and camel. The oxen of Egypt are employed in tillage, and in giving motion to a variety of hydraulic machines; and as they are harnessed so as to draw from the pitch of the shoulder, their withers are higher than those of our country; and, indeed, they have naturally some resemblance to the bison (*Bós* fèrus), or hunched ox. It has been said that the cows of Egypt bring forth two calves at a time; an instance of fecundity which sometimes happens, but is not reckoned very common. Their calves are reared to maturity, veal, which is forbidden by the law of the Mohammedans, and from which the Copts also abstain, not being eaten in Egypt.

1085. *The buffalo* is more abundant than the ox, and is equally domestic. It is easily distinguishable by the constantly uniform colour of the hair, and still more by a remnant of ferocity and intractability of disposition, and a wild lowering aspect, the characteristics of all half-tamed animals. The females are reared for the sake of the milk, and the males to be slaughtered and eaten. The flesh is somewhat red, hard, and dry; and has also a musky smell, which is rather unpleasant.

1086. *The horses of Egypt* rank next to those of the Arabians, and are remarkable for their valuable qualities. Here, as in most countries of the East, they are not castrated either for domestic use or for the cavalry.

1087. *The asses* of Egypt have no less a claim to distinction than the horses; and these, as well as those of Arabia, are esteemed for vigour and beauty the finest in the world. They are sometimes sold for a higher price than even the horses, as they are more hardy, less difficult as to the quality and quantity of their food, and therefore preferred in traversing the deserts. The handsomest asses seen at Cairo are brought from Upper Egypt and Nubia. On ascending the Nile, the influence of climate is perceptible in these animals, which are most beautiful in the Said, but are in every respect inferior towards the Delta. With the most distinguished race of horses and asses, Egypt possesses also the finest mules; some of which, at Cairo, exceed in price the most beautiful horses.

1088. *The camel and dromedary,* as every body knows, are the beasts of burden in Egypt, and not only answer all the purposes of our waggons and public conveyances, but bear the vehicles (*fig.* 141.) in which the females of the higher classes pay their visits on extraordinary occasions.

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1089. *The agricultural implements of Egypt* are simple; but some of them, particularly the contrivances for raising water, very ingenious. The plough is of the rudest kind, as are the cart and spade.

1090. *The operations* of threshing and sowing have been already described (1078, 1079.); that of irrigation is performed as in other countries. At present there are eighty canals in use for this purpose, some of them twenty, thirty, and forty leagues in length. The lands near the river, as the Delta, are watered directly from it: the water is raised by wheels in the dry season; and, when the inundation takes place, it is retained on the fields for a certain time by small embankments made round them.

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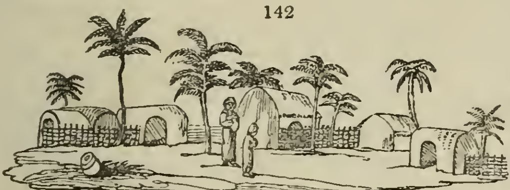

1091. *Nubia,* the Ethiopia of the ancients, is a miserable country or desert, thinly inhabited by a wretched people, who live chiefly on millet, and dwell in groups of mud huts. (*fig.* 142.)

Subsect. 3. *Present State of Agriculture in the Mohammedan States of the North of Africa.*

1092. *These are Tripoli, Tunis, Algiers, and Morocco,* territories chiefly on the southern shore of the Mediterranean; rich and celebrated in the ages of antiquity, but at present depressed by the barbarism and fanaticism of their rulers, who are in general tributary to the Porte.

1093. *Tripoli* is generally distinguished into maritime and inland. In neither is there much agriculture; for the inhabitants of countries on the coast live chiefly by commerce and piracy, and those of the inland parts on plunder and robbery. There are a few fields of grain, chiefly rice, round the capital, date palms, olives, and what is called the lotus tree (Zízyphus Lòtus), whose fruit is reckoned superior to the date, and makes excellent wine.

1094. *The kingdom of Tunis* was formerly the chief seat of Carthaginian power. The soil is in general impregnated with marine salt and nitre, and springs of fresh water are more rare than those of salt. But the Tunisians are much more agriculturists than their neighbours either of Tripoli or Algiers. The southern parts of the country are sandy, barren, and parched by a burning sun: the northern parts enjoy a better soil and temperature, and are more under cultivation: near the sea, the country is rich in olive trees: the western part abounds in mountains and hills, and is watered by numerous rivulets; it is extremely fertile, and produces the finest and most abundant crops. The first rains commonly fall in September, and then the farmers break up the ground, sow their grain, and plant beans, lentils, and garvancos. By May following harvest commences; and we may judge of its productiveness by what the Carthaginians experienced of old. The ox and the buffalo are the principal beasts of labour, and next the ass, mule, and horse. The zebu, or humped ox (*fig.* 143.), considered by many naturalists as a distinct species, is common both in this and other kingdoms of northern Africa.

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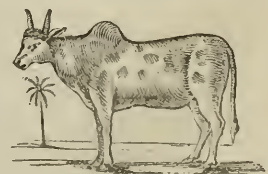

1095. *The territory of Algiers,* in an agricultural point of view, is chiefly distinguished by the fertile plain of Mettijiah, a vast country which stretches fifty miles in length, and twenty in breadth, to the foot of one of the branches of Mount Atlas. This plain is watered by several streams, the soil is light and fertile, and it is better cultivated than any other district of the kingdom. The country-seats and masharcas, as the call the farms of the principal inhatants of Algiers, are found in this plain; and it is chiefly from it that the metropolis is supplied with provisions. Flax, alhenna, roots, potherbs, rice, fruit, and grain of all kinds are produced here to such perfection, that the Mettijiah may be justly reckoned the garden of the whole kingdom.

1096. *In the inland provinces* are immense tracts of country wholly uninhabited and uncultivated. There are also extensive tracts of brushwood, and some timber forests. The fertility of the soil decreases in approaching Sahara or the Desert, although in its borders, and even in the desert itself there are some districts which are capable of cultivation, and which produce corn, figs, and dates. These regions are inhabited by nomadical tribes, who, valuing themselves on their independence, endure with fortitude and resignation the inconveniences attending their condition, and scarcely regret the want of those advantages and comforts that pertain to a civilised state of society.

1097. *The seed-time* here, as in Tunis, is during the months of October and November, when wheat, barley, rice, Indian corn, millet, and various kinds of pulse, are sown. In six months the crops are harvested, trodden out by oxen or horses, winnowed by throwing with a shovel against the wind, and then lodged in subterraneous magazines.

1098. *The empire of Morocco* is an extensive territory of mountains and plains, and chiefly an agricultural country. The mountains consist of limestone or clay, or a mixture of both, and no vestiges appear of granite, on which they are supposed to rest. The climate is temperate and salubrious, and not so hot as the situation would lead us to suppose. The rains are regular in November, though the atmosphere is not loaded with clouds: January is summer; and in March barley harvest commences. The soil consists either of pure sand often passing into quicksand, or of pure clay; and is often so abundantly mixed with iron ochre, that agricultural productions, such as wax, gum, wool, &c., are distinguished by a reddish tint, which, in the wool, cannot be removed by washing or bleaching. Cultivation, in this country, requires little labour, and, in general, no manure; all weeds and herbaceous plants, not irrigated, are, at a certain season, burnt up by the sun, as in some parts of Spain (745.); the ground, being then perfectly clean and dry, is rendered friable and easily pulverised by the rains; and one rude stirring suffices both for preparing the soil and covering the seed. The produce in wheat, rice, millet, maize, barley, and chick-peas (*Cicer arietinum*), is often sixty fold; thirty fold is held to be an indifferent harvest.

1099. *In general* they make use of no manure except that which is left on the fields by their flocks and herds. But the people who inhabit places near forests and woods avail themselves of another method to render the soil productive. A month or two before the rains commence, the farmer sets fire to the underwood, and by this conflagration clears as much land as he intends to cultivate. The soil, immediately after this treatment, if carefully ploughed, acquires considerable fertility, but is liable soon to become barren, unless annually assisted by proper manure. This system of burning down the woods for the sake of obtaining arable land, though not generally permitted in states differently regulated from this, is allowable in a country, the population of which bears so small a proportion to the fertility of the soil, and in which the most beautiful tracts are suffered to remain unproductive from want of hands to cultivate them. In this manner the nomadic Arab proceeds in his conflagrations, till the whole neighbourhood around him is exhausted; he then packs up his tents and travels in search of another fertile place where to fix his abode, till hunger again obliges him to continue his migration. Thus it is computed, that at one and the same time no more than a third part of the whole country is in a state of cultivation.

1100. *The live stock of Morocco* consists of numerous flocks and herds. Oxen of a small breed are plentiful, and also camels; the latter animal being used in agriculture, for travelling, and for food. The horses are formed for fleetness and activity, and taught to endure fatigue, heat, cold, hunger, and thirst. Mules are much used, and the breed is encouraged. Poultry is abundant in Morocco; pigeons are excellent; partridges are plentiful; woodcocks are scarce, but snipes are numerous in the season; the ostrich is hunted both for sport and for profit, as its feathers are a considerable article of traffic; hares are good, but rabbits are confined to the northern part of the empire, from Saracha to Tetuan. Fallow deer, the roebuck, the antelope, foxes, and other animals of Europe, are not very abundant in Morocco; lions and tigers are not uncommon in some parts of the empire; of all the species of ferocious animals found in this empire, the wild boar is the most common: the sow has several litters in the year, and her young, which are numerous, serve as food for the lion.

1101. *The nomadic agriculturists* form themselves into encampments, called douhars (*fig.* 144.), composed of numerous tents, which form a circle or crescent, and their flocks and herds returning from pasture occupy the centre. Each douhar has a chief, who is invested with authority for superintending and governing a number of these encampments; and many of the lesser subdivisions are again reunited under the govern-

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ment of a bashaw; some of whom have 1000 douhars under their command. Their tents, of a conical form, about eight or ten feet high in the centre, and from twenty to twenty-five in length, are made of twine composed of goats' hair, camels' wool, and the leaves of the wild palm, so that they keep out water; but, being black, their appearance at a distance is not agreeable. In camp the Moors live in the utmost simplicity, and present a faithful picture of the earth's inhabitants in the first ages. In the milk and wool of their flocks, they find every thing necessary for their food and clothing. It is their custom to have several wives, who are employed in all domestic affairs. Beneath their ill-secured tents they milk their cows and make butter; they sort and sift their wheat and barley; prepare vegetables; and grind flour with a mill composed of two round stones, eighteen inches in diameter, in the upper one of which is fixed a handle by which it is made to turn upon an axle. They daily make bread, which they bake between two earthen plates, and very often on the ground heated by fire.

1102. *No alteration in the agriculture of Morocco* seems to have taken place for several centuries, owing to the insecurity of its government; every thing being despotic; and property in land, as well as the person and life, being subject to the caprice of the sovereign, and to the laws of the moment.

Subsect. 4. *Of the present State of Agriculture on the Western Coast of Africa.*

1103. *Of the innumerable tribes which occupy the western coast of Africa*, the principal are the Jalefs and Foulahs, and of the former little is known. The remaining part of the country consists of the territories of Benin, Loango, and Congo.

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1104. *The soil of the Foulah country* is fertile. The inhabitants are said to be diligent as farmers and graziers, and to raise millet, rice, tobacco, cotton, peas, carob beans (Ceratònia siliqua) (*fig.* 145.), roots, and fruits in abundance. Their live stock, however, constitutes their chief wealth, and, accordingly, pursuing a kind of wandering life, they roam, from field to field and from country to country, with large droves of cows, sheep, goats, and horses; removing, as the wet and dry seasons require, from the low to the high lands, and continue no longer in one place than the pasture for their cattle will allow. The inconvenience and labour of this roving life are augmented by the defence they are obliged to provide against the depredations of the fierce animals with which the country abounds; as they are molested by lions, tigers, and elephants, from the land, and crocodiles from the rivers. At night they collect their herds and flocks within a circle of huts and tents in which they live, and where they light fires in order to deter these animals from approaching them. During the day they often place their children on elevated platforms of reeds (*fig.* 146.) for security from wild beasts, while they are hunting or pursuing other labours. The elephants are so numerous, that they appear in droves of 200 together, plucking up the small trees, and destroying whole fields of corn; so that they have recourse to hunting, not merely as a pastime, but as the means of self-preservation.

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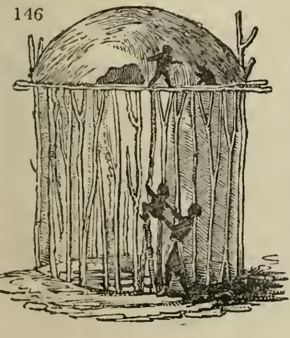

1105. *The English settlement of Sierra Leone* is situated to the west of the country of the Foulahs, on the river Senegal. It was formed in 1787, for the benevolent purpose of promoting African civilisation. A tract of land was purchased from the prince of the country, and a plantation established, in which are cultivated rice, cotton, sugar, pepper, tobacco, and other products. Gum arabic (Mimòsa nilótica) (*fig.* 147.) and other valuable articles are procured from the native woods. In these woods the pine-apple grows wild in the greatest abundance and luxuriance. The fruit is large and highly flavoured, and, when in season, may be purchased by strangers at less than a halfpenny each. A meal in common use by the natives is made from the pounded roots of the manioca (Játropha *Mánihot*). This meal, after being first ground from the root, is made into a pulp and pressed to get rid of a poisonous juice. It is then redried and constitutes a wholesome farina, which forms almost the entire food of the slaves.

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1106. *Benin* is an extensive country, very productive of fruits, trees, and plants, including the orange, cocoa, cotton, &c.; and abounding in animals, among which are enumerated civet cats, and a sort of hairy sheep. Agriculture, however, is little attended to, the chief object being the commerce of slaves.

1107. *The inhabitants of Loango*, instead of cultivating the land, content themselves with bread and fish, and such fruits, greens, and pulse, as the soil naturally produces. Cocoas, oranges, or lemons are not much cultivated; but sugar-canes, cassia, and tobacco, as well as the palm, banana, cotton, and pimento trees, grow here plentifully. They have also a great variety of roots, herbs, fruits, grain, and other vegetables, of which they make bread, or which they use for food. They have few quadrupeds for domestic use, except goats and hogs; but poultry and various sorts of game are abundant. Among the wild beasts they have the zebra, and a great number of elephants, whose teeth they exchange with the Europeans for iron.

1108. *Congo* is an extensive and very fertile country; but the inhabitants are indolent, and neglect its culture. The operations of digging, sowing, reaping, cutting wood, grinding corn, and fetching water, they leave to their wives and slaves. Under their management, several sorts of grain and pulse are cultivated, especially maize, of which they have two crops in a year: but such is the heat of the climate, that wheat will not produce plump seeds; it shoots rapidly up into the straw and ear, the former high enough to hide a man on horseback, and the latter unfilled. Grass grows to a great height, and affords sheltering places for a number of wild animals and noisome reptiles and insects. The Portuguese have introduced a variety of palm and other fruit trees, which are adapted for producing human food in such a climate.

1109. *The baobab* (*Adansònia digitàta*) is a native of Congo. This tree, discovered by the celebrated French botanist, Adanson, is considered the largest in the world: several, measured by this gentleman, were from sixty-five to seventy-eight feet in circumference, but not extraordinarily high. The trunks, at the height of from twelve to fifteen feet, divided into many horizontal branches, which touched the ground at their extremities; these were from forty-five to fifty-five feet long, and were so large that each branch was equal to a monstrous tree; and where the water of a neighbouring river had washed away the earth so as to leave the roots of one of these trees bare and open to the sight, they measured one hundred and ten feet long, without including those parts of the roots which remained covered. It yields a fruit which resembles a gourd, and which serves for vessels of various uses; the bark furnishes them with a coarse thread which they form into ropes, and into a cloth with which the natives cover their middle from the girdle to the knees; and the small leaves supply them with food in a time of scarcity, while the large ones are used for covering their houses, or are by burning manufactured into good soap. At Sierra Leone, this tree does not grow larger than an orchard apple-tree.

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1110. *Of the bark of the infanda tree*, and also of the mulemba, resembling in many respects our laurel, they form a kind of stuff or cloth, which is fine, and used for cloaks and girdles by persons of the highest rank. The butter tree (*fig.* 148.) affords an excellent substitute for that European luxury. With the moss that grows about the trunk, the rich commonly stuff their pillows; and the Giagas apply it to their wounds with good effect: with the leaves the Moors cover their houses, and they draw from these trees, by incision, a pleasant liquor like wine, which, however, turns sour in five or six days.

1111. *Among other fruits and roots*, they have the vine, which was brought thither from Candia, and yields grapes twice a year.

1112. *The live stock* common to other agricultural countries are here much neglected; but the Portuguese settlers have directed their attention to cows, sheep, and goats, chiefly on account of their milk. Like most parts of Africa, this country swarms with wild animals. Among these, the zebra, buffalo, and wild ass are hunted, and made useful as food or in commerce. The dante, a kind of ox, the skin of which is sent into Germany to be tanned and made into targets called dantes, abounds, and also the cameleon, a great variety of monkeys, and all the sorts of domestic poultry and game.

Subsect. 5. *Of the present State of Agriculture at the Cape of Good Hope.*

1113. *The Dutch colonised the Cape of Good Hope* in 1660, and the English obtained possession of it in 1795.

1114. *The climate of this Cape* is not unfriendly to vegetation; but it is so situated, within the influence of periodical winds, that the rains are very unequal, descending in torrents during the cold season, though hardly a shower falls to refresh the earth in the hot summer months, when the dry south-east winds prevail. These winds blast the foliage, blossom, and fruit, of all those trees that are not well sheltered; nor is the human constitution secure against their injurious influence. As a protection from these winds, the colonists who inhabit the nearest side of the first chain of mountains, beyond which their effect does not very sensibly extend, divide that portion of their ground which is appropriated to fruit groves, vineyards, and gardens, by oak screens; but they leave their corn lands altogether open. The temperature of the climate at the Cape is remarkably affected by local circumstances. In summer the thermometer is generally between 70° and 80°, and sometimes between 80° and 90°, but scarcely ever exceeds 95°.

1115. *The surface of the country* consists of some mountains and extensive barren-looking plains. The upper regions of all the chains of mountains are naked masses of sand-stone; the valleys beneath them are clothed with grass, with thickets, and in some cases with impenetrable forests. The inferior hills or knolls, whose surfaces are generally composed of loose fragments of sandstone, as well as the wide sandy plains that connect them, are thinly strewed over with heaths and other shrubby plants, exhibiting to the eye a uniform and dreary appearance. In the lowest part of these plains, where the waters subside, and, filtering through the sand, break out in springs upon the surface, vegetation is somewhat more luxuriant. In such situations the farm-houses are generally placed; and the patches of cultivated ground contiguous to them, like the oases in the sandy deserts, may be considered as so many verdant islands in the midst of a boundless waste.

1116. *Soils*, in this tract of country, are generally either a stiff clay, impenetrable by the plough till they are soaked by much rain; or light and sandy, tinged with red, and abounding with small round quartzose pebbles. A black vegetable mould seldom appears, except in patches of garden-ground, vineyards, and orchards, that surround the habitations, where, by long culture, manure, and the fertilising influence of springs or rills of water, the soil is so far mellowed as to admit the spade at all seasons of the year. The extensive plains, known in the colony by the Hottentot name of karroo, which are interspersed between the great chains of mountains, exhibit a more dismal appearance than the lower plains, which are chequered with patches of cultivated ground; and their hard surfaces of clay, glistening with small crystals of quartz, and condemned to perpetual drought and aridity, are ill adapted to vegetation. The hills that break these barren plains are chiefly composed of fragments of blue slate, or masses of felspar, and argillaceous limestone. However, in those karroo plains that are tinged with iron, and are capable of being watered, the soil is extremely productive. In such situations, more especially in the vicinity of the Cape, they have the best grapes, and the best fruit of every sort. The great scarcity of water in summer is much more unfavourable to an extended cultivation than either the soil or the climate.

1117. *Landed property* was held by the original Dutch from the government of the Cape on four different *tenures*. The first tenure was that of a yearly lease renewable for ever, on condition of payment of a certain rent, not in general exceeding eight tenths of a farthing per acre; the second tenure, a sort of perpetual holding subject to a small rent; the third, a holding on fifteen years' leases at a quit-rent, renewable; and the last was that of real estate or freehold, the settler having purchased his farm at once for a certain sum. The second tenure is the most common in the colony. The lands were originally measured out and allotted in the following manner: a stake was stuck as near the centre of the future estate as could be guessed, and a man, starting thence, walked for half an hour in a straight line, to each of the four points of the compass; giving thus the radii of a circle that comprised a space of about 6000 acres.

1118. *Of these extensive farms*, the greater part is, of course, mere sheep and cattle walks. They break up for tillage, patches here and there, where the plough can be directed with the least difficulty, or the soil is most inviting for the purpose. A slight scattering of manure is sometimes used, but more frequently none at all; and it is astonishing to see the crops this soil, and even the lightest sands, will produce with so little artificial stimulus. Seventeen successive crops of wheat without any manure have been taken. When the land is somewhat exhausted by a succession of crops, they break up fresh ground, and the old is suffered to lie fallow, as they term it, for many years; that is, it is permitted to throw up plentiful crops of huge bushes and heath till its turn comes round again, which may be in about seven years, when there is the trouble of breaking it up anew. The sheep and cattle are permitted to stray at pleasure, or are, perhaps, intrusted to the care of a Hottentot.

1119. *The agricultural products* of the Cape farmers are chiefly wheat and other grains, pulse, wine, and brandy, wool, hides, and skins, dried fruits, aloes, and tobacco. The returns of grain and pulse are from ten to seventy, according to the nature of the soil and the supply of water. Barley, i. e. bere or bigg, is very productive, and is used only for feeding horses. Rye and oats run much to straw, and are chiefly used as green fodder. Indian corn thrives well, and is very productive; and various kinds of millet, kidneybeans, and other pulse, are extensively cultivated. The wheat is generally heavier, and yields a finer flour, than that of England. It is all spring wheat, being sown from the month of April to June. The returns are very various in the different soils; some farmers declare that they have reaped sixty and eighty for one; the average may be from twenty to thirty; but it is impossible to come to a true estimate upon this point, as no farmers can tell you the exact quantity sown upon a given quantity of acres. The crops seem to be remarkably precarious, failing sometimes for three or four years in succession.

1120. *The vine*, however, is the most profitable, and what may be considered the staple article of culture. Better grapes are not produced in any part of the world; but the art of making wine and brandy from them admits of much improvement. Ten or twelve different kinds of wine are at present manufactured, having a distinct flavour and quality, according to the farms on which they are produced.

1121. *The celebrated Constantia wine* is made on two farms of that name, close under the mountains between Table Bay and False Bay. The white wine of that name is made on the farm called Little Constantia, and the other produces the red. The grape is the muscadel, and the rich quality of the wine is owing partly to the situation and soil of the vineyards, and partly to the care taken in manufacturing the wine. No stalks, nor any berries but such as are fully ripe, are suffered to go under the press; precautions rarely taken by the other farmers of the Cape. The muscadel grape grows on every farm; and on some farms in Drakenstein the wine pressed from it is as good as the Constantia, if not superior to it, though sold, on account of the name of the latter, at one sixth part of the price. When they find that the wine is to be sent abroad, they adulterate it with some other wine: for, according to their own returns, the quantity exported and consumed in Cape Town, as in the case of Madeira wine, greatly exceeds the quantity manufactured.

1122. *The almond* is a very productive tree at the Cape; the tree thrives in the driest and worst soil, and the fruit, though small, is of excellent quality. Dried peaches, apricots, pears, and apples, are not only plentiful, but good of their kind; dried grapes, or raisins, are not so well managed. Potash is procured from a species of Salsòla which grows on the deserts; and with this and the fat of sheeps' tails the farmers make their soap. The berries of the candleberry myrtle (*Myrìca cerífera*) supply a vegetable wax sold at Cape Town in large green cakes, from which odoriferous candles are made.

1123. *The A'loe soccotrìna and perfoliàta* cover large tracts of ground, and these afford the inspissated juice or resin of the apothecaries. The leaves of the plant are cut off one by one, and, as they are cut, thrown into tubs. In a day or two after they are thrown in, the juice will have run out of itself, when the leaves are taken out and used as manure. The juice is then either clarified in the sun or by boiling, and when dry, cut into cakes and packed up for sale.

1124. *The tobacco* grown at the Cape is said to be as good as that of Virginia. Enough is grown for home consumption, which is considerable, but none for exportation.

1125. *The live stock* of the Cape farmers chiefly consists of oxen, horses, sheep, swine, and poultry. There are only some districts adapted to grazing; and the farmers who follow this department are in a much less civilised state than the others. The flocks and herds wander over immense tracts, for the use of which a rent or tax according to the number of beasts is paid. At night they are brought home to folds or kraals, which are close to the huts of the farmers, and are represented as places of intolerable filth and stench.

1126. *The native cattle of the Cape* are hardy, long-legged, bony animals, more in the coach-horse line than fitted for the shambles. They are bad milkers, probably from the bad quality and scanty supplies of forage.

1127. *The sheep* are wretched beasts, more resembling goats, with wool that might be taken for frizzly hair, and is in fact only used for stuffing chairs, or for like purposes; the other parts of the body seem drained to supply the accumulation of fat upon the tail which weighs from six to twelve pounds.

1128. *The Merinos*, of which there are a few flocks, do very well: they are much degenerated for want of changing, and a proper selection of rams.

1129. *The Ryeland*, or Southdown sheep, would be a great acquisition here; for the Cape mutton forms a detestable food.

1130. *The Cape horse*, which is not indigenous, but was introduced originally from Java, is a small, active, spirited animal; a mixture of the Spanish and Arabian, capable of undergoing great fatigue; and, as a saddle-horse, excellently adapted to the country. As a draught-horse for the farmer he is too small; and the introduction of a few of the Suffolk punch breed would be a real benefit to the colony, as well as a source of profit to the importer.

1131. *Pigs* are scarce in the colony amongst the farmers; it is difficult to say why, except that there is more trouble in feeding them, and they cannot be turned to graze like sheep. Poultry is, for the same reason, neglected. Indeed, bad mutton may be said to be the only food of the colonists.

1132. *The agricultural implements and operations* of the Cape farmers are said to be performed in the rudest manner, and their crops are thought to depend principally on the goodness of the soil and climate. The plough of the Dutch farmers is a couple of heavy boards nailed together, and armed with a clumsy share, which it requires a dozen oxen to work. Their harrow, if they use any at all, is composed of a few brambles. Their waggons (which will carry about thirty Winchester bushels, or a ton-weight, and are generally drawn by sixteen and sometimes twenty oxen) are well constructed to go tilting up and down the precipitous passes of the kloofs with safety; but they have no variety for the different roads. Burchell has given a portrait of one of these imposing machines. (*fig.* 149.) Their method of beating out the corn is well known; the sheaves

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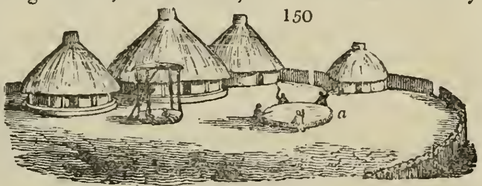
are spread on a circular floor, surrounded by a low wall, with which every farm is supplied. The farmer's whole stock of brood mares and colts are then turned in, and a black man, standing in the centre, with a long whip to enforce his authority, the whole herd are compelled to frisk and canter round till the corn is trampled out of the ear. This is termed tramping out. The winnowing is performed by tossing the trampled grain and dung in the air with shovels, or by exposing it to the wind in a sieve.

1133. *The agriculture of the Cape* appears capable of much improvement, were the farmers less indolent, and more ambitious of enjoying the comforts and luxuries of existence. Barrow is of opinion that there might be produced an abundance of corn, cattle, and wine, for exportation; but that, to effect this, "it will be necessary to procure a new race of inhabitants, or to change the nature of the old ones." At the suggestion of this writer, an attempt was recently made by government to settle a number of British families in the district of the Albany, an immense plain 60 or 70 miles long, by about 30 broad; but after remaining there a year, the greater number of them were obliged to leave that district on account of its unsuitableness for arable culture. A considerable part returned to England, others remained and became servants in the colony, and a few who had some property left, took land in more favourable situations. Pringle, who has given an account of this settlement (1824), describes the deplorable situation of the greater number of 5000 individuals who had fixed themselves there, and ascribes their calamities more to the nature of their situation than to any other cause. Other districts, he contends, might have been chosen much better adapted for the plough and the spade, while the low and fertile region of Albany might have been usefully occupied as a sheep pasture. With all the deficiencies of the country and climate, he says, if things are properly managed, the Cape is not a worse land to live in than any other English colony. Comparing his own account, however, with the description of other colonies, especially Van Diemen's Land and New South Wales, we should be disposed to differ from him in opinion, and to prefer the latter settlements. (*Pringle's Present State of Albany, South Africa*, 12mo, 1824.)

1134. *In the interior of the country* are many tribes of whom little or nothing is known; but some of which are every now and then brought into notice by modern travellers. Some have been visited, for the first time, by the missionary Campbell; and the account he gives of their agriculture, manufactures, and customs is often very curious. It is astonishing how ingenious he found some tribes in cutlery and pottery; and the neatness and regularity of the houses of others are equally remarkable. In one place the houses were even tasteful; they were conical, and enclosed by large circular fences (*fig.* 150.); and he found them threshing out the corn on raised circular threshing-floors (*a*), with flails, much in the same manner as we do.



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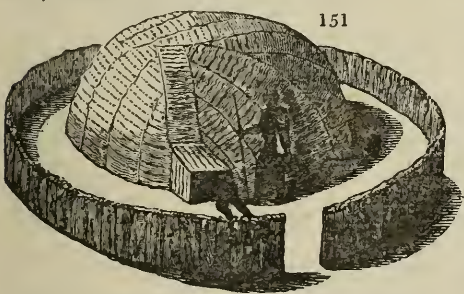
1135. *The unimproved Hottentots* form their huts (*fig.* 151.) of mats bound on a skeleton of poles or strong hoops. (*fig.* 152.) Their form is hemispherical; they are entered by a low door, which has a mat shutter, and they are surrounded by a reed or mat fence to exclude wild animals and retain fuel and cattle. Attempts to introduce European forms of cottages have been made by the missionaries, which, with a knowledge of the more useful arts, will no doubt in time humanise and refine them. The missionary Küshe conducted Burchell along the valley of Genadendal, to exhibit the progress which the Hottentots, under his instruction, had made in horticulture and domestic order. The valley is a continued maze of gardens and fruit trees. "The huts (*fig.* 153.), unlike those of Hottentot construction, are a rude imitation of the quadrangular buildings of the colonist. They are generally from ten to fifteen feet long, and from eight to ten wide, having an earthen floor and walls white-washed on their inside, composed of rough unhewn poles, filled up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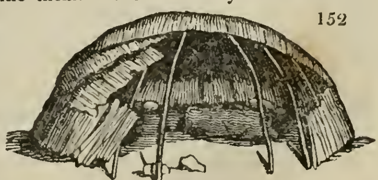
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between with reeds and rushes plastered with mud, and the whole covered with a roof of thatch. The eaves being in general not higher from the ground than four or six feet, the doors could not be entered without stooping. A small unglazed window admitted light, but there was neither chimney nor any other opening in the roof by which the smoke might escape. (*Burchell's Travels*, i. 112.)

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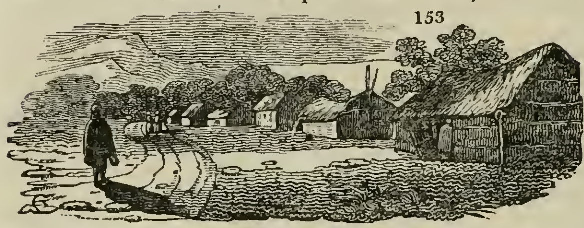

1136. *The cattle of all the Hottentot and other tribes* are kept in circular folds during night; and it is remarkable that these folds are the only burial places known to be in use among that people. "Corn is preserved in what may be termed large jars, of various dimensions, but most commonly between four and five feet high and three wide. The shape of these corn jars is nearly that of an egg shell, having its upper end cut off: sometimes their mouth is contracted in a manner which gives them a great resemblance to a European oil-jar. They are formed with stakes and branches fixed into the ground and interwoven with twigs; this frame-work being afterwards plastered within and without with loam and cow-dung. Frequently, the bottoms of these jars are raised about six inches or a foot above the ground; and the lower part of the stakes, being then uncovered, gives them the appearance of standing on short legs. Their contents are usually protected by a covering of skin or straw." This mode of keeping their corn and beans, Burchell observes, shows a degree of ingenuity equal to that which is displayed in the construction of their houses, and is to be admired for its simplicity and perfect adequateness to the purpose. In the dwellings of the richer inhabitants, the back part of the houses is completely filled with jars of this kind. (*Travels*, ii. 520.)

1137. *The natives of the South of Africa* live much on bulbous roots, of which their country is naturally more productive than any other. Burchell has enumerated a considerable number which he saw them use. One of the most remarkable grows on the mountains of Graf-reynet, and is called Hottentot's bread (Tàmus elephántipes *Herit.*, Testudinària elephántipes *Burch.*). (*fig.* 154.) Its bulb stands entirely above ground, and grows to an enormous size, frequently three feet in height and diameter. It is closely studded with angular ligneous protuberances, which give it some resemblance to the shell of a tortoise. The inside is a fleshy substance, which may be compared to a turnip, both in substance and colour. From the top of this bulb arise several annual stems, the branches of which have a disposition to twine round any shrub within reach. The taste of this bulb is thought to resemble that of the yam of the East Indies, the plant being closely allied to the genus Dioscòrea. (*Burchell's Travels*, ii. 147.)

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1138. *The Bachapins* are a people of the interior of South Africa, who were visited by Burchell. Their agriculture, he says, is extremely simple and artless. It is performed entirely by women. To prepare the ground for sowing, they pick it up to the depth of about four inches, with a kind of hoe or mattock, which differs in nothing from a carpenter's adze but in being twice or thrice as large. The corn they sow is the Caffre corn or Guinea corn, a variety of millet (*Hólcus Sórghum* Caffròrum). They cultivate also a kind of kidneybean, and eat the ripe seeds; they likewise raise water-melons, pumpkins, and the calabash gourd for the use of its shell as a domestic vessel for drinking and other purposes. They are inordinate smokers of tobacco, but they do not cultivate the plant. Burchell gave them some potatoes and peach stones to cultivate, which pleased them exceedingly, and for which they were very thankful. (*Travels*, ii. 518.)

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1139. *The Bushman spade* (*fig.* 155.) is a pointed stick about three feet long, to which there is affixed, about the middle, a stone to increase its power in digging up bulbous roots. This stone is about five inches in diameter, and is cut or ground very regularly to a round form, and perforated with a hole large enough to receive the stick and a wedge by which it is fixed to its place. (*Burchell's Travels*, ii. 30.)

Subsect. 6. *Of the present State of Agriculture on the Eastern Coast of Africa, and in the African Islands.*

1140. *Of the various countries on the eastern coast of Africa* the chief is Mocaranga, the agriculture of which may be considered as a specimen of that of the savage tribes of the other states. The climate is temperate, though the mountains called Supata, or the spine of the world, forming a great chain from north to south, are perpetually covered with snow; the air clear and salubrious; and the soil fertile and well watered, so that its pastures feed a great number of cattle, more valued by the inhabitants than their gold. The inland parts of the country, however, are sandy, dry, and barren. The products of the country on the coast, are rice, millet, and maize, but no wheat; sugar canes and cotton are found both wild and cultivated. They are without the ox and horse, but elephants, ostriches, and a great variety of wild animals abound in the forests. According to the doubtful accounts of this country, the king, on days of ceremony, wears a little spade hanging by his side as an emblem of cultivation.

1141. *The Island of Madagascar* is celebrated for its fertility, and the variety of its productions. Its climate is mild and agreeable; and the surface of the country is divided into the eastern and western provinces by a range of mountains. The summits of these mountains are crowned with lofty trees of long duration, and the low grounds are watered by torrents, rivers, and rivulets, which flow from them. The agricultural products are rice, cotton, indigo, sugar, pulse, the yam, banana, cocoa, pepper, ginger, turmeric, and a variety of other fruits and spices. There are a great number of rare fruits and esculent plants, and many curious woods. Oxen and flocks of sheep abound; but there are no horses, elephants, lions, or tigers. The culture is very imperfect, the soil and the excellence of the seasons supplying the place of labour and skill.

1142. *The Mauritius,* or Isle of France, is a productive island, chiefly indebted to the industry of the French, who have introduced there most of the grains, roots, and fruits of other parts of the world, all of which seem to thrive. The climate is excellent, and similar to that of the Bourbon and Canary Islands. The surface is mountainous towards the sea coast, but within land there are many spots both level and fertile. The soil is, generally speaking, red and stony. The agricultural products are numerous. A crop of maize, succeeded by one of wheat, is procured in one season from the same field. The rice of Cochin China is extensively cultivated; the manioc, or cassava (Játropha *Mánihot*) of Brazil; sugar, which is the chief product for export; cinnamon, clove, and nutmeg trees, &c. Oranges, citrons, and guavas abound; and pine-apples are said to grow spontaneously. Many valuable kinds of woods are found in the forests; and on the banks of the rivers are fed the flocks and herds of the country.

1143. *The Isle of Bourbon* differs little in its natural and agricultural circumstances from that of the Mauritius.

1144. *St. Helena* is a rugged, but beautiful island, occupied by a few farmers, chiefly English. Their chief productions are cattle, hogs, and poultry; and when the India ships arrive every house becomes a tavern.

1145. *The Cape Verd Islands* are, in general, hot and unhealthy as to climate, and stony and barren as to soil. Some, however, produce rice, maize, bananas, oranges, cotton, and sugar-canes, with abundance of poultry.

1146. *The Canary Islands* having been subject to Spain for many centuries, the agriculture of the parent country prevails throughout. The climate is temperate, and the soil generally rich. The stock of the farm belongs to the proprietor of the soil, who lends it to the cultivator, on condition of getting half of the produce. The products are, wheat, barley, rice, oats, flax, anise seeds, coriander, the mulberry, grape, cotton, sugar-cane, dragon's-blood tree (Dracæ̀na), and a variety of esculent plants and fruits. The celebrated Canary wine is made chiefly in the islands of Teneriffe and Canary. Potatoes have been introduced within the last fifty years, and now constitute the chief food of the inhabitants. The archil (*Roccélla* tinctòria) (*fig.* 156. *a*), a moss used in dyeing, grows wild on all the rocks; and kali (Salsòla *Kàli*) (*fig.* 156. *b*), from which soda is extracted, is found wild on the sea-shore. The roots of the male fern (*Ptèris* aquilìna) are, in times of scarcity, ground into flour, and used as food. The live stock of the Canaries consists of cattle, sheep, horses, and asses; and the well-known Canary birds, with a great variety of others, abound in the woods.

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1147. *The Island of Madeira* is chiefly celebrated for its wine. It is the boast of the islanders, that their country produces the best wheat, the purest sugar, and the finest wines in the world, besides being blest with the clearest water, the most salubrious air, and a freedom from all noxious reptiles. The first view of the island is particularly magnificent; the country rising in lofty hills from every part of the coast, so steep as to bring very distant objects into the foreground. The sides of these hills are clothed with vines as high as the temperature will admit; above this they are clothed with woods or verdure to their summits, as high as the sight can distinguish; except those columnar peaks, the soil of which has been washed away by the violent rains to which those latitudes, and especially such elevated parts, are liable. Deep ravines or valleys descend from the hills to the sea, and in the hollow of most of them flows a small river, which in general is rapid and shallow. The soil is clay on the surface; and large masses of it, as hard as brick, are found underneath. The island, it is said, when discovered by the Portuguese, was covered with wood; and the first step taken by the new settlers was to set fire to the wood. This conflagration is said to have lasted seven years, and to have been the chief cause of the fertility of the soil; but whatever may have been the effect at first, this fertility could not have lasted for three centuries.

1148. *The lands of Madeira are cultivated on the metayer system;* in entailed estates leases cannot be granted for a longer period than nine years; but in no case can the tenant be dismissed till he is paid the full value of his improvements.

1149. *The vine* is cultivated chiefly in the French, but partly in the Italian, manner. In the low grounds it is suffered to grow to a considerable height, and tied to trees, poles, or trellises; on the sides of the hills the terrace culture is adopted, and there the plants are kept lower, and tied to single stakes or low trellises. The variety of grape cultivated is what in France is called the Rhenish, a sort of small black cluster; but its character is greatly altered since its transplantation to Madeira. The grape from which the Malmsey Madeira wine is made is the Ciotat of the French, or parsley-leaved muscadine with a white berry. The quantity of genuine malmsey produced annually is very small; and of that a good deal is supposed to be manufactured with refined sugar. The quality of the wine here, as every where else, depends more on the aspect and soil than on the kind of grape. The best is grown on the south side of the island, on the lower declivities which point towards the south-east; the west being always cooled by the sea breeze.

1150. *Wheat* is grown on lands previously prepared by the culture of common broom. This is cut for fuel, and, after a time, grubbed up and burnt on the soil. By these means, a crop of wheat is insured for a succession of years, more or less, according to the soil; after which the same process is again resorted to. For this purpose, the seeds of the broom are collected, and generally bear the same price by measure as wheat.

1151. *The live stock* are not numerous. Animals of all sorts, as in most mountainous countries, are small. The beef and mutton appear to a Briton lean and tasteless; common poultry are small; but ducks and turkeys equal those of England. Pork is rare, but excellent when well fed.

1152. *The tropical fruits* are not readily produced here. In the villages are found guavas, bananas, oranges, and shaddocks. Pine-apples are reared with great difficulty; but neither the granadilla nor the alligator pear, though they grow vigorously, produces fruit.

Sect. V. *Of the present State of Agriculture in North America.*

1153. *The climate* of this region, which extends from the vicinity of the equator to the arctic circle, is necessarily extremely various. In general, the heat of summer and the cold of winter are more intense than in most parts of the ancient continent. The middle provinces are remarkable for the unsteadiness of the weather. Snow falls plentifully in Virginia, but seldom lies above a day or two. Carolina and Florida are subject to insufferable heat, furious whirlwinds, hurricanes, tremendous thunder, and fatal lightnings. The climate of the western parts is least known; that of California seems to be in general moderate and pleasant.

1154. *The surface of North America* is nobly diversified with rivers, lakes, mountains, and extensive plains, covered in many places with forests. Its shores are, in general, low, irregular, with many bays and creeks; and the central parts seem to present a vast fertile plain, watered by the Missouri and its auxiliary streams. New Mexico in surface is an alpine country, resembling Norway and Greenland; Labrador, and the countries round the Hudson Sea, present irregular masses of mountain covered with eternal snow. In general, all the natural features of America are on a larger scale than those of the old world. (*Darby's View of the United States*, 1826.)

1155. *The agriculture of North America* is chiefly that of the north of Europe: but in the provinces near the equator the culture of the southern parts of Europe prevails; and in the West India Islands that of the warmest climates is followed; there being no production of any part of the world which may not be there brought to perfection. —After this general outline of the agricultural circumstances of North America, we shall select some notices of the agriculture of the United States, the Spanish dominions in North America, British possessions, unconquered countries, and North American Islands or West Indies.

Subsect. 1. *Of the present State of Agriculture in the United States.*

1156. *The climate of the United States* must necessarily vary in its different parts. In the north-east the winters are very cold and the summers hot, changing as you proceed southward. In the south-east, and along the Gulf of Mexico, the summers are very hot, and the winters mild and pleasant. Among the mountains it is cold towards the north, and temperate in the south. Beyond the mountains, in the rich valleys of Ohio, Mississippi, and Missouri, the climate is temperate and delightful, till we approach the Rocky Mountains, when it is subject to extremes, the winters being very cold. The climate must be chilled among mountains constantly covered with snow. West of these mountains, the climate changes, until we reach the shores of the Pacific Ocean, where it resembles that of the western parts of Europe. The prevailing winds are from the west, and, as they pass over a wide expanse of water, they cool the air in summer, and in winter deluge the country with frequent rain.

1157. *The seasons* generally correspond with those in Europe, but not with the equality to be expected on a continent, as even during the summer heats single days will occur which require the warmth of a fire. The latitude of Labrador corresponds with that of Stockholm, and that of Canada with France, but the climates of those places are widely different. It would appear from Humboldt, that the difference of temperature between the old and new continents, in the same latitude, is between 4° and 5° in favour of the former.

1158. *The surface* of the country in the United States presents every variety. The north-eastern part of the coast is broken and hilly; and is remarkably indented with numerous bays and inlets. Towards the south, and along the Gulf of Mexico, the land is level and sandy, interspersed with many swamps and numerous islands and inlets. At the outlets of many of the rivers, there is a large portion of alluvial land, which is particularly the case along the Mississippi. Beyond the head of tide-waters, there is a tolerably rich and agreeably uneven country, which extends to the mountains. The mountainous district, on the Atlantic side of the country, is about 150 miles in breadth, and 1200 miles in length. It extends in large ridges, from north-east to south-west, and is known as the Alleghany Mountains. Beyond these the great valley of the Mississippi presents a surface of the finest land in the world. To the westward of this valley are the mountains of Louisiana, and beyond these the bold shores of the Pacific Ocean.

1159. *The soil of the United States*, though of various descriptions, is generally fertile; often, on the east of the Blue Mountains, in Virginia, a rich, brown, loamy earth; sometimes a yellowish clay, which becomes more and more sandy towards the sea. There are considerable marshes and salt-meadows, sandy barrens producing only a few pines, and sometimes entirely destitute of wood. On the west of the Apalachian Mountains the soil is also generally excellent; and in Kentucky some spots are deemed too rich for wheat, but the product may amount to sixty bushels per acre. About six feet below the surface there is commonly a bed of limestone.

1160. *The landed property of the United States* is almost universally freehold, having been purchased or conquered by the different states, or by the general government, from the native savages; and either lotted out to the conquering army, or reserved and sold afterwards according to the demand.

1161. *The mode of dividing and selling lands in the United States* is thus described by Birkbeck. "The tract of country which is to be disposed of is surveyed, and laid out in sections of a mile square, containing six hundred and forty acres, and these are subdivided into quarters, and, in particular situations, half quarters. The country is also laid out in counties of about twenty miles square, and townships of six miles square in some instances, and in others of eight. The townships are numbered in ranges, from north to south, and the ranges are numbered from west to east; and, lastly, the sections in each township are marked numerically. All these lines are well defined in the woods, by marks on the trees. This done, at a period of which public notice is given, the lands in question are put up to auction, except the sixteenth section, which is near the centre, in every township, which is reserved for the support of schools, and for the maintenance of the poor. There are also sundry reserves of entire townships, as funds for the support of seminaries on a more extensive scale, and sometimes for other purposes of general interest. No government lands are sold under two dollars per acre; and I believe they are put up at this price in quarter sections at the auction, and if there is no bidding they pass on. The best lands and most favourable situations are sometimes run up to ten or twelve dollars, and in some late instances much higher. The lots which remain unsold are from that time open to the public, at the price of two dollars per acre; one fourth to be paid down, and the remaining three fourths to be paid by instalments in five years; at which time, if the payments are not completed, the lands revert to the state, and the prior advances are forfeited. When a purchaser has made his election of one, or any number, of the vacant quarters, he repairs to the land-office, pays eighty dollars, or as many times that sum as he purchases quarters, and receives a certificate, which is the basis of the complete title, which will be given him when he pays all; this he may do immediately, and receive eight per cent interest for prompt payment. The sections thus sold are marked immediately on the general plan, which is always open at the land-office to public inspection, with the letters A. P., i. e. advance paid. There is a receiver and a register at each land-office, who are checks on each other, and are remunerated by a per centage on the receipts."

1162. *The price of land*, though low when not cleared, rises rapidly in value after a very slight occupation and improvement. Instances are frequent of a rise of 1000 per cent, in about ten years. Cobbett, who resided in 1817 in Long Island, which may be considered the middle climate of the United States, gives the price of a cultivated farm in that part of the country. "A farm, on this island," he says, "any where not nearer than thirty miles off, and not more distant than sixty miles from New York, with a good farm-house, barn, stables, sheds, and sties; the land fenced into fields with posts and rails, the wood-land being in the proportion of one to ten of the arable land, and there being on the farm a pretty good orchard; such a farm, if the land be in a good state, and of an average quality, is worth *sixty dollars an acre*, or *thirteen pounds sterling*; of course, a farm of a hundred acres would cost 1300*l*. The rich lands on the necks and *bays*, where there are *meadows* and surprisingly productive orchards, and where there is *water carriage*, are worth, in some cases, three times this price. But what I have said will be sufficient to enable the reader to form a pretty correct judgment on the subject. In New Jersey, in Pennsylvania, every where the price differs with the circumstances of water-carriage, quality of land, and distance from market. — When I say a good farm-house, I mean a house a great deal better than the general run of farm-houses in England; more neatly furnished on the inside; more in a parlour sort of style; though round about the house, things do not look so neat and tight as in England."

1163. *The agriculture of the United States* may be considered as entirely European, and chiefly British. Not only is the climate better adapted for the British agriculture, but the great majority of the inhabitants are of British origin. To enter into details of the products and processes of North American agriculture would therefore be superfluous in a work principally devoted to British agriculture. All we shall attempt is, to notice some of the leading peculiarities of North American agriculture, as resulting from national, political and civil circumstances.

1164. *The natural circumstances of lands not under culture* chiefly affect the commencement of farming operations. In general, the lands purchased by settlers are underwood, which must be felled or burned, and the roots grubbed up; a laborious operation, which, however, leaves the soil in so rich a state, that it will bear heavy crops of grain, potatoes, and tobacco, with very little culture and no manure, for several years. Sometimes they are under grass, or partially covered with brushwood, in which the operation of clearing is easier. In either case, the occupier has to drain where necessary; to enclose with a ring fence, if he wishes to be compact; to lay out and make the farm

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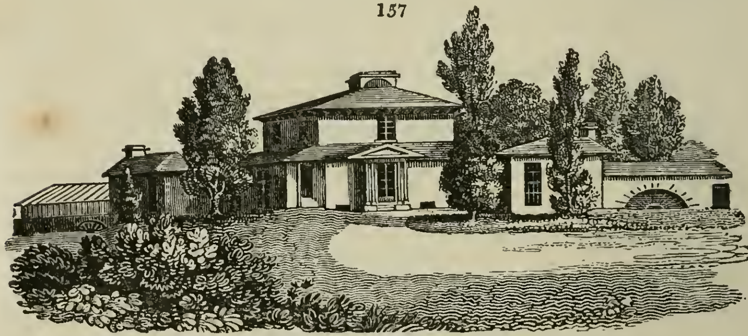

road; and to build a house and farmery. The latter he constructs of timber, sometimes plastered with neatness and taste, as in England (*fig.* 157.), but generally with logs and mud, as in Poland and Russia (*fig.* 158.). With timber he generally forms also his fences, though thorn and other live hedges are planted in some of the earlier-cultivated districts.

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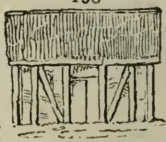

1165. *The usual practice* of settlers with capital may be very well exemplified in the case of Birkbeck. This gentleman having purchased an estate of 1440 acres, in the Illinois, and fixed on that part of it which he intended as his future residence and farm, "the first act was building a cabin, about two hundred yards from the spot where the house was to stand. This cabin is built of round straight logs, about a foot in diameter, lying upon each other, and notched in at the corners, forming a room eighteen feet long, by sixteen; the intervals between the logs 'chunked,' that is, filled in with slips of wood; and 'mudded,' that is, daubed with a plaster of mud: a spacious chimney, built also of logs, stands like a bastion at one end: the roof is well covered with four hundred clap boards of cleft oak, very much like the pales used in England for fencing parks. A hole is cut through the side, called, very properly, the 'door (the through),' for which there is a 'shutter,' made also of cleft oak, and hung on wooden hinges. All this has been executed by contract, and well executed, for twenty dollars. I have since added ten dollars to the cost, for the luxury of a floor and ceiling of sawn boards, and it is now a comfortable habitation."

1166. *An example of a settler who began with capital only sufficient to pay the first instalment* of eighty dollars of the price of 160 acres of land is given by the same author, who had the information from the settler himself. Fourteen years ago, he "unloaded his family under a tree," on his present estate; where he has now two hundred acres of excellent land, cleared and in good cultivation, capable of producing from eighty to one hundred bushels of Indian corn per acre. The poor emigrant, having collected the eighty dollars, repaired to the land-office, and entered his quarter section, then worked his way, without another cent in his pocket, to the solitary spot which was to be his future abode, in a two-horse waggon, containing his family and his little all, consisting of a few blankets, a skillet, his rifle, and his axe. Arrived in the spring, after putting up a little log cabin, he proceeded to clear, with intense labour, a plot of ground for Indian corn, which was to be their next year's support; but for the present, being without means of obtaining a supply of flour, he depended on his gun for subsistence. In pursuit of the game, he was compelled, after his day's work, to wade through the evening dews, up to the waist in long grass or bushes; and, returning, found nothing to lie on but a bear's skin on the cold ground, exposed to every blast through the sides, and every shower through the open roof of his wretched dwelling, which he did not even attempt to close, till the approach of winter, and often not then. Under such distresses of extreme toil and exposure, debarred from every comfort, many valuable lives have sunk, which have been charged to the climate. The individual whose case is here included had to carry the little grain he could procure twelve miles to be ground, and remembers once seeing at the mill a man who had brought his corn sixty miles, and was compelled to wait three days for his turn. Such are the difficulties which these pioneers have to encounter; but they diminish as settlements approach each other, and are only heard of by their successors.

1167. *The political circumstances of the United States* affect the agriculturist both as to the cost of production and the value of produce. It is evident that the want of population must render the price of labour high, and the produce of land low. In this Parkinson, Birkbeck, Cobbett, and all who have written on the agriculture of America, agree. "The simple produce of the soil," Birkbeck observes, "that is to say, grain, is cheap in America; but every other article of necessity and convenience is dear in comparison. Every service performed for one man by another must be purchased at a high rate, much higher than in England." The cheapness of land affords the possession of independence and comfort at so easy a rate, that strong inducements of profit are required to detain men in the condition of servitude. Hence the high price of all commodities, not simply agricultural; of the labour of mechanics of every description; and hence also the want of local markets for grain, because where three fourths of the population raise their own grain (which is the calculation), the remaining fourth will use but a moderate proportion of the spare produce. The low rate of land and taxes and this want of home markets form the reason why the American farmer, notwithstanding the price of labour, affords his grain so cheap for exportation. Although the rate of produce is low, the profits of the American farmers are high, on account of the small capital required. With 2000*l.* Birkbeck calculates that a farm of 640 acres, in the Illinois, may be purchased, stocked, and cultivated, so as to return, after deducting all expenses, twenty-two per cent, besides the value of the improvements made on the land, that is, its increased value, which, as has already been stated (1164.), is incredible, in a very short time.

1168. *The agricultural products of the United States* include all those of Britain and France. The British grains, herbage, plants, and fruits are grown in every district. What appears at first sight very remarkable is, that in America the native pastures (except on the banks of the rivers) consist entirely of annuals; and that is the reason why the country is generally bare and black in winter; but perennial grasses, when sown in the uplands, are found to thrive in many situations. The greatest quantity of wheat is grown in Pennsylvania and New England. Maize ripens in all the districts, except some of the most northerly. Rice is cultivated in Virginia, and on the Ohio; and the vine is indigenous in these and other provinces, though its culture has not yet been much attempted. Some French cultivators are of opinion that the American soil and climate are unfavourable; this, however, is not likely to be the case, it being a native of the country. The government have established a Swiss colony for its culture, at Vevay, in Indiana; and another in Louisiana, for the culture of the olive. The mulberry, the cotton, and the sugar-cane are cultivated in Virginia, but not extensively. Sugar is procured plentifully in the woody districts, by tapping different species of *A*cer, especially the saccharinum, in spring; boiling the juice till it thickens; and then granulating it by letting it stand and drain in a tub, the bottom of which is pierced with small holes. The sugar obtained does little more than pay for the labour.

1169. *Of the live stock of the United States*, the breed of horses of English extraction is, in general, good, as are the cows and hogs. In many cases there is no limit to the number of these that may be grazed in the unoccupied woods: all that the farmer has to do is, to protect them from bears and wolves at particular seasons, and to keep them tame, as in Russia and Switzerland, by giving them salt. Sheep are totally unfit for the climate and state of the country, though a number of proprietors have been at great pains in attempting to introduce the merinos. Mutton, Birkbeck observes, is almost as abhorrent from an American palate or fancy, as the flesh of swine from an Israelite; and the state of the manufactures does not give great encouragement to the growth of wool of any kind, of merino wool less, perhaps, than any other. Mutton is sold in the markets of Philadelphia at about half the price of beef; and the Kentuckian, who would have given a thousand dollars for a merino ram, would dine upon dry bread rather than taste his own mutton. A few sheep on every farm, to supply coarse wool for domestic manufacture, seems to be all that ought at present to be attempted in any part of America that I have yet seen. Deep woods are not the proper abodes of sheep. When America shall have cleared away her forests, and opened her uplands to the breezes, they will soon be covered with fine turf, and flocks will be seen ranging over them here, as in other parts of the world.

1170. *Agricultural operations in America* are skilfully performed by the farmers of capital, who have all the best implements of Europe; by the poorest settlers this is not the case, from want of stock; and by the native American farmers, from indolence, which, according to all accounts, is their general defect. An American labourer is most expert at the use of the axe and the scythe; the spade he handles in a very awkward manner, and has no idea of banking, hedging, clipping or cutting hedges, and many other operations known to every labourer in a highly cultivated and enclosed country like Britain. But the versatility of talent of an American labourer amply compensates for his inexperience in these operations, and is more useful in his circumstances. In handling the saw, the hammer, and even the trowel, the British labourer has no chance with him. Most of them can build a house, mend a plough or waggon and even the harness, and kill and dress sheep and pigs.

1171. *Field labours in America* require to be performed with much greater expedition than in England. The winter is long and severe, and the transition to spring is sudden; this season in many provinces only lasts a few weeks, when summer commences, and the ground becomes too hard and dry for the operations of tillage. The operations of seed-time must therefore be performed with the greatest rapidity. The climate of New York may be reckoned one of the best in North America. There the ground is covered with snow, or rendered black by frost, in the beginning of December, and continues without a speck of green till May. Ploughing generally begins in the last week of April; oats are sown in that month; and maize and potatoes about the middle of May. By the end of May the wheat and rye which has stood the winter, the spring-sown corn, the grass, and the fruit trees appear as forward as they are at the same period in England. There is very little rain during June, July, and August. Cherries ripen in the last week of June; by the middle of July the harvest of wheat, rye, oats, and barley, is half over; pears ripen in the beginning of August; maize (*fig.* 159.), rye, and wheat are sown during the whole of October; corn is cut in the first week of September; peaches and apples are ripe by the end of the month; the general crop of potatoes is dug up in the beginning of November; and also turnips and other roots taken up and housed; a good deal of rain falls in September, October, and November, and severe frosts commence in the first week of December, and, as above stated, continue till the last week of April. Such is the agricultural year in the country of New York. Live stock require particular attention during the long winter; and unless a good stock of Swedish turnip, carrot, or other roots, has been laid up for them, they will generally be found in a very wretched state in April and May.

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1172. *The civil circumstances* of the United States are unfavourable to the domestic enjoyments of a British farmer emigrating thither. Many privations must be suffered at first, and some, probably, for one or two generations to come. The want of society seems an obvious drawback; but this Birkbeck has shown not to be so great as might be imagined. When an emigrant settles among American farmers, he will generally find them a lazy ignorant people, priding themselves in their freedom, and making little use of their privileges; but, when he settles among other emigrants, he meets at least with people who have seen a good deal of the world and of life; and who display often great energy of character. These cannot be considered as uninteresting, whatever may be their circumstances as to fortune; and, when there is something like a parity in this respect and in intellectual circumstances, the social bond will be complete. It must be considered that one powerfully operating circumstance must exist, whatever be the difference of circumstances or intellect; and that is, an agreement in politics both as to the country left and that adopted. For the rest, the want of society may be, to a certain degree, supplied by the press; there being a regular post in every part of the United States, and numerous American and European newspapers and periodical works circulated there. Birkbeck mentions that the Edinburgh and Quarterly Reviews, the Monthly and other Magazines, and the London newspapers are as regularly read by him at the prairie in Illinois, as they were at his farm of Wanborough in Suffolk; and that all the difference is, that they arrive at the prairie three months later than they did at his British residence. We have seen sketches of the houses erected by this gentleman, and by some others who have settled around him, and we consider them as by no means deficient either in apparent commodiousness or effect. They remind us of some of the best houses of Switzerland and Norway. (*fig.* 160.) Birkbeck and part of his family were drowned in crossing the Wabash in 1825, an event which must be deeply lamented by all who knew any thing of this intelligent, enterprising, and benevolent character.

1173. *The want of domestic servants* is a considerable drawback in most parts of the United States; but especially in the new settlements. Families who remove into Western America, Birkbeck observes, should bring with them the power and the inclination to dispense, in a great degree, with servants. To be easy and comfortable there, a man should know how to wait upon himself, and practise it. In other respects, this gentleman and his friends hope to live on their estates at the prairie, "much as they were accustomed to live in England." An interesting account of the house, garden, and domestic economy of Mr. Hall of Wanborough, a neighbour of Mr. Birkbeck's, will be found in the *Gardener's Magazine*, vol. i. p. 327. and vol. iv. p. 155.

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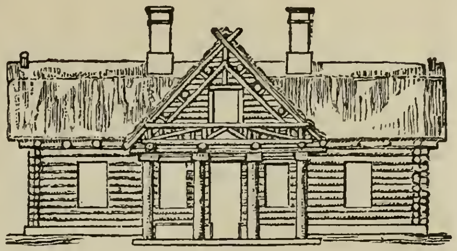

1174. *As a country for a British farmer to emigrate to*, we consider the United States as superior to every other, in two respects: — first, on account of its form of government; by which property is secure, and personal liberty greater than any where else, consistently with public safety, and both maintained at less expense than under any government in the world: secondly, on account of the stock of people being generally British, and speaking the English language. The only objection we have to America is the climate — the long and severe winter, and the rapid and hot spring and summer. Land equally good, and nearly as cheap, may be had in the south of Russia and in Poland; but who that knows any thing of the governments of these countries, would voluntarily put himself in their power while the United States were accessible?

Subsect. 2. *Of the present State of Agriculture in Mexico.*

1175. *The climate of this extensive and recently revolutionised country* is singularly diversified, between the tropical seasons and rains, and the temperature of the southern and even middle countries of Europe. The maritime districts of Mexico are hot and unhealthy, so as to occasion much perspiration even in January; the inland mountains, on the other hand, present snow and ice in the dog-days. In other inland regions, however, the climate is mild and benign, with some snow of short duration in winter; but no artificial warmth is necessary, and animals sleep all the year under the open sky. From April to September there are plentiful rains, generally after noon; hail storms are not unknown; thunder is frequent; and earthquakes and volcanoes occasionally occur. The climate of the capital, in lat. 19° 25′, differs much from that of the parts of Asia and Africa under the same parallel; which difference seems to arise chiefly from the superior height of the ground. Humboldt found that the vale of Mexico is about 6960 feet above the level of the sea, and that even the inland plains are generally as high as Mount Vesuvius, or about 3600 feet. This superior elevation tempers the climate with a greater degree of cold; upon the whole, therefore, it cannot be regarded as unhealthy.

1176. *The surface* of the country is diversified by grand ridges of mountains, numerous volcanoes some of which are covered with perpetual snow, cataracts worthy of the pencil of Rosa, delicious vales, fertile plains, picturesque lakes and rivers, romantic cities and villages, and a union of the trees and vegetables of Europe and America.

1177. *The soil* is often deep clay, surprisingly fertile and requiring no stimulus except irrigation. In some places it is boggy or composed of a soft black earth, and there are barren sands and stony soils in the elevated regions.

1178. *Of the agriculture of Mexico* some account is given by the Abbé Clavigero and the Baron de Humboldt. According to the first author, agriculture was from time immemorial exercised by the Mexicans, and almost all the people of Anahuac. The Toltecan nation employed themselves diligently in it, and taught it to the Thechemecan hunters. With respect to the Mexicans, during the whole of their peregrination, from their native country Atzlan, unto the lake where they founded Mexico, they are said to have cultivated the earth in all the places where they made any considerable stop, and to have lived upon the produce of their labour. When they were brought under subjection to the Colhuan and Tepanecan nations, and confined to the miserable little islands on the lake, they ceased for some years to cultivate the land, because they had none, until necessity and industry together taught them to form movable fields and gardens, which floated on the waters of the lake.

1179. *The method of forming floating fields*, which they still practise, is extremely simple. They plait and twist together willows and roots of marsh plants, or other materials which are light, but capable of supporting the earth of the field firmly united. Upon this foundation they lay the light bushes which float on the lake, and, over all, the mud and dirt which they draw up from the bottom of the same lake. Their regular figure is quadrangular; their length and breadth various; but in general, they are about eight perches long, and not more than three in breadth, and have less than a foot of elevation above the surface of the water. There were the first fields which the Mexicans owned after the foundation of Mexico; there they first cultivated the maize, great pepper, and other plants, necessary for their support. In progress of time as those fields grew numerous from the industry of those people, there were among them gardens of flowers and odoriferous plants, which were employed in the worship of their gods, and served for the recreation of the nobles. At present they cultivate flowers, and every sort of garden herbs upon them. Every day of the year, at sun-rise, innumerable vessels loaded with various kinds of flowers and herbs, which are cultivated in those fields and gardens, are seen arriving by the canal, at the great market-place of that capital. All plants thrive there surprisingly; the mud of the lake is an extremely fertile soil, and requires no water from the clouds. In the largest islands there is commonly a little tree, and even a little hut to shelter the cultivator, and defend him from rain or the sun. When the owner of an island, or the *chinampa*, as he is usually called, wishes to change his situation, to remove from a disagreeable neighbour, or to come nearer to his own family, he gets into his little vessel, and by his own strength alone, if the garden is small, or with the assistance of others, if it is large, he tows it after him, and conducts it wherever he pleases with the little tree and hut upon it. That part of the lake where those floating fields are is a place of infinite recreation, where the senses receive the highest possible gratification. These floating fields, Humboldt informs us, still exist: they are of two sorts; the one mobile and blown here and there by the winds, and the others fixed and united to the shore. The former alone merit the appellation of floating, and they are diminishing day by day. He assigns to them the same origin as the Abbé Clavigero; but thinks it probable that nature also may have suggested the first idea, and gives instances of small pieces of the surface, netted with roots and covered with plants, being detached from the marshy shores of other American lakes, and floating about in the water. The bean, pea, apple, artichoke, cauliflower, and a great variety of other culinary plants, are cultivated on them.

1180. *A floating island, in a small lake in Haverhill*, in New England, is mentioned by Dr. Dwight. It has, he was informed, immemorially floated from one shore to another, whenever it was impelled by a violent wind. Lately it has adhered for a considerable time to a single spot; and may perhaps be so firmly fixed on the shelving bottom, as to move no more hereafter. Several trees and shrubs grow on its surface, and it is covered by a fresh verdure. (*Travels*, vol. i. p. 371.)

1181. *Having neither ploughs nor oxen*, nor any other animals proper to be employed in the culture of the earth, the Mexicans, when they had shaken off the Tepanecan yoke, supplied the want of them by labour, and other more simple instruments. To hoe and dig the ground they made use of the *coatl*, or *coa*, which is an instrument made of copper, with a wooden handle, but different from a spade or mattock. They made use of an axe to cut trees, which was also made of copper, and was of the same form with those of modern times, except that we put the handle in the eye of the axe, whereas they put the axe into an eye in the handle. They had several other instruments of agriculture; but the negligence of ancient writers on this subject has not left in our power to attempt their description.

1182. *They irrigated their fields* with the water of rivers and small torrents which came from the mountains, raising dams to collect them, and forming canals to conduct them. Lands which were high, or on the declivity of mountains, were not sown every year, but allowed to lie fallow until they were over-run with bushes, which they burned, to repair by their ashes the salt which rains had washed away. They surrounded their fields with stone enclosures, or hedges made of the penguin, which makes an excellent fence; and in the month Panquetzaliztli, which began on the third of December, they were repaired if necessary.

1183. *In the sowing of maize*, the method they observed, and which they still practise in some places, is this: the sower makes a small hole in the earth with a stick, or drill probably, the point of which is hardened by fire; into this hole he drops one or two of the grains of maize from a basket which hangs from his shoulder, and covers them with a little earth by means of his foot; he then passes forward to a certain distance, which is greater or less according to the quality of the soil, opens another hole, and continues so in a straight line to the end of the field; thence he returns, forming another line parallel to the first. The rows of plants by these means are as straight as if a line were made use of, and at as equal distances from each other as if the spaces between were measured. This method of sowing, which is now used by a few of the Indians only, though more slow, is, however, of some advantage, as they can more exactly proportion the quantity of seed to the strength of the soil; besides that there is almost none of the seed lost which is sown: in consequence of this, the crops of the fields which are thus cultivated are usually more plentiful. When the maize springs up to a certain height, they cover the foot of the plant round with earth, that it may be better nourished, and more able to withstand sudden gusts of wind.

1184. *In the labours of the field men were assisted by the women.* It was the business of the men to dig and hoe the ground, to sow, to heap the earth about the plants, and to reap; to the women it belonged to strip off the leaves from the ears, and to clear the grain; to weed and to shell it formed the employment of both.

1185. *They had places like farm-yards*, where they stripped off the leaves and shelled the ears, and granaries to preserve the grain. Their granaries were built in a square form, and generally of wood. They made use of the *ojameth* for this purpose, which is a very lofty tree, with but a few and slender branches, and a thin smooth bark; the wood is extremely pliant, difficult to break and slow to rot. These granaries were formed by placing the round and equal trunks of the *ojameth* in a square, one upon the other, without any labour except that of making a small notch towards their extremities, to adjust and unite them so perfectly as not to allow any passage to the light. When the structure was raised to a sufficient height, they covered it with another set of cross-beams, and over these the roof was laid to defend the grain from rains. These granaries had no other door or outlet than two windows; one below, which was small, and another above somewhat wider. Some of them were so large as to contain five or six thousand, or sometimes more, *fanegas* of maize. There are some of this sort of granaries to be met with in a few places at a distance from the capital, and amongst them some so very ancient, that they appear to have been built before the conquest; and, according to information had from persons of intelligence, they preserve the grain better than those which are constructed by the Europeans.

1186. *A little tower of wood*, branches, and mats, they commonly erected close to fields which were sown, in which a man, defended from the sun and rain, kept watch, and drove away the birds which came in flocks to consume the young grain. These little towers are still made use of, even in the fields of the Spaniards, on account of the excessive number of birds.

1187. *The woods* which supplied them with fuel to burn, timber to build, and game for the diversion of the king, were carefully preserved. The woods of King Montezuma were extensive, and the laws of King Nezahualcojotl concerning the cutting of them particular and severe in their penalties. It would be of advantage to that kingdom, says Clavigero, that those laws were still in force, or at least that there was not so much liberty granted in cutting without an obligation to plant a certain number of trees; as many people, preferring their private interest and convenience to the public welfare, destroy the wood in order to enlarge their possessions.

1188. *The breeding of animals* was not neglected by the Mexicans: though there were no sheep, they bred up innumerable species of animals unknown in Europe. Bullock (*Travels*, 1824) informs us, that they are very curious in rearing and feeding swine; and that an essential requisite in a Mexican swineherd is an agreeable voice; in order that he may sing or charm the animals into peace when they quarrel and fight, and lull them to sleep at proper times to promote their fatting. Wind and sounds of every kind have been long known to have a powerful effect on this genus of animals. Private persons brought up *techichis* (quadrupeds similar to little dogs), turkeys, quails, geese, ducks, and other kinds of fowl; in the territories of the lords were bred fish, deer, rabbits, and a variety of birds; and at the royal residences, almost all the species of quadrupeds and winged animals of those countries, and a prodigious number of water animals and reptiles. We may say that in this kind of magnificence Montezuma II. surpassed all the kings of the world, and that there never has been a nation equal in skill to the Mexicans in the care of so many different species of animals, which had so much knowledge of their dispositions, of the food which was most proper for each, and of all the means necessary for their preservation and increase.

1189. *The Mexican cochineal*, so greatly valued in Europe on account of its dyes of scarlet and crimson, demands a great deal more care from the breeder than is necessary for the silkworm. Rain, cold, and strong winds destroy it; birds, mice, and worms persecute it furiously, and devour it: hence it is necessary to keep the rows of Opúntia, or nopal, where those insects are bred, always clean; to attend constantly to drive away the birds, which are destructive to them; to make nests of hay for them among the Opúntia, by the juice of which they are nourished; and when the season of rain approaches, to raise them with a part of the plants, and guard them in houses. Before the females are delivered they cast their skin, to obtain which spoil, the breeders make use of the tail of the rabbit, brushing most gently with it that they may not detach the insects from the plants, or do them any hurt. On every lobe they make three nests, and in every nest they lay about fifteen cochineals. Every year they make three gatherings, reserving, however, each time, a certain number for the future generation; but the last gathering is least valued, the cochineals being smaller then, and mixed with the prickles of the Opúntia. They kill the cochineal most commonly with hot water. On the manner of drying it afterwards the quality of the colour which is obtained from it chiefly depends. The best is that which is dried in the sun. Some dry it in the *comalli*, or pan, in which they bake their bread of maize; and others in the *temazcalli*, a sort of oven. (*Clavigero*, vol. i. p. 357. to 381.)

1190. *The fruits of Mexico* are very numerous. The banana and granadilla are very common; the bread-fruit and cocoa are extensively cultivated; and a number of sorts of anona, or custard apple, and especially the cherimoyer (*A. Cherimòlia*), which is much esteemed. In short, all the fruits of Europe, and most of those of both Indies, are to be found in the gardens of the nobles and the priests.

Subsect. 3. *Present State of Agriculture in the British Possessions of North America.*

1191. *The principal British provinces in America* are Canada, New Brunswick, Nova Scotia, Cape Breton, and the adjacent islands of Newfoundland and the Bermudas.

1192. *Canada* is an extensive country, and the only British province in which agriculture is generally pursued. The climate of this country is extremely irregular; in July and August, the heat is often 96°, while in winter the mercury freezes. The ground is covered with snow from November till May, when it thaws suddenly, and vegetation is instantaneous. The surface of the country is generally mountainous and woody; but there are savannas and plains of great beauty towards Upper Canada.

1193. *The soil* consists principally of a loose dark-coloured earth, ten or twelve inches deep, lying on a bed of cold clay. This thin mould, however, is very fertile, and yields plentiful crops, although it is worked every year by the French Canadians, without being ever manured. The manures chiefly used, since the practice of manuring has been introduced, by those who are the best farmers, are marl and gypsum, the former is found in great quantities in many places along the shores of the river St. Lawrence.

1194. *With respect to the products of Canada*, the low country is peculiarly adapted to the growth of small grain. Tobacco also thrives well in it, but the culture is neglected, except for private use; and more than half of what is used is imported. The snuff produced from the Canadian tobacco is held in great estimation. Culinary vegetables arrive at great perfection in Canada, which is also the case with most of the European fruits. The currants, gooseberries, and raspberries are very fine; the latter are indigenous, and are found very abundantly in the woods. A kind of vine is also indigenous; but the grapes produced by it in its uncultivated state are very poor and sour, and not much larger than fine currants. In the forest there is a great variety of trees; such as beech, oak, elm, ash, pine, sycamore, chestnut, and walnut; and the sugar-maple tree is found in almost every part of the country. Of this tree there are two kinds: the one called the swamp maple, being generally found on low lands; and the other, the mountain or curled maple, from its growing upon high dry ground, and from the grain of its wood being beautifully variegated with little stripes and curls. The former yields more sap than the latter, but its sap affords less sugar. A pound of sugar is frequently procured from two or three gallons of the sap of the curled maple, whereas no more than the same quantity can be had from six or seven gallons of that of the swamp tree. The maple sugar is the only sort of raw sugar used in the country parts of Canada, and it is also very generally used in the towns.

1195. *New Brunswick and Nova Scotia* are intensely cold countries, and only partially civilised. The vale of St. John's river is the principal scene of cultivation in New Brunswick. The upland parts of the country are chiefly covered with forests of pines, hemlock and spruce fir, beech, birch, maple, and some oak. The pines of St. John's river are the largest in British America, and afford a considerable supply of masts for the royal navy. Nova Scotia produces little grain; supplies being sent from England. The soil is thin and barren, except on the banks of the river, where it produces grass, hemp, and flax. A great improvement, however, in the agriculture of Nova Scotia is said to have taken place, in consequence of certain letters written on the subject, which first appeared under the name of Agricola, in the Acadian Recorder, a Halifax newspaper. These letters are by John Young, secretary to the provincial agricultural board, and have since been collected and published in a separate volume. Some account of them, accompanied by extracts, will be found in the *Farmer's Magazine*, vol. xxiv. p. 81.

1196. In the island of *Cape Breton* the soil is mere moss, and has been found unfit for agriculture. Newfoundland seems to be rather hilly than mountainous, with woods of birch, pine, and fir, numerous ponds and morasses, and some dry barrens. The chief produce of these islands, as well as of the other British possessions in America, consists of furs and skins; and the same remark will apply to the Bermudas and the unconquered countries, which need not be further noticed.

Subsect. 4. *Of the present State of Agriculture in the West India Islands.*

1197. *The principal West India Islands* are Cuba, St. Domingo, Jamaica, and Porto Rico; and, next, the Windward Islands, Trinidad, the Leeward Islands of the Spanish, and the Bahamas.

1198. *Cuba* is an extensive and naturally fertile island; but, from the indolence of the Spaniards, not above a hundredth part of it is cleared and cultivated. Like most islands in the West Indies it is subject to storms, but the climate is, upon the whole, healthy, and even temperate; for, though in this latitude there is no winter, the air is refreshed with rains and cooling breezes. The rainy months are July and August; the rest of the year is hot. A chain of mountains extends the whole length of the island from east to west, and divides it into two parts; but the land near the sea is in general level, and flooded in the rainy season. The soil is equal in fertility to any in America, producing ginger, long pepper, and other spices; aloes, mastich, cassia fistula, manioc, maize, cocoa, &c. Tobacco is one of its principal productions, and it is supposed to have the most delicate flavour of any produced in the new world. The cultivation of sugar has lately been introduced; but the indolence of the inhabitants renders it in every respect much less productive than it otherwise might be. The quantity of coffee is inconsiderable; the chief plantations are in the plains, and are cultivated by about 25,000 slaves. Among the trees are oaks, firs, palms, cotton trees, ebony, and mahogany (Swietènia *Mahágoni*). (*fig.* 161.) In 1763 bees were introduced by some emigrants from Florida, and they multiplied so much in the hollows of old trees, that they soon obtained honey enough for their annual consumption. In 1777 they exported honey to the amount of 715,000 pounds. The island abounds with mules, horses, sheep, wild boars, hogs, and fine black cattle. The horned cattle have increased so much that the forests are filled with droves of them, which run wild, and are hunted and killed for their hides and tallow. The chief birds are paroquets, turtle doves, and partridges; water-fowl are numerous; and on the coast turtles are abundant; mullets and shads are the principal fish.

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1199. *Jamaica* has been in possession of the English since the middle of the seventeenth century. The climate is extremely hot throughout the year, though mitigated by various causes. The surface of the country is very irregular: a ridge of mountains from east to west divides it into two parts. At a small distance from the shore it rises into hills with gentle acclivity, which are separated from each other by spacious vales and romantic inequalities. On the southern side of the island there are precipices and inaccessible cliffs, amidst which are vast plains covered with extensive cane fields. To the inequalities of surface that distinguish this island it is owing, that, although the soil in many parts of the island is deep and very fertile, yet the productive land is but of small extent in proportion to the whole. That which is actually cultivated is of a middling quality, and requires labour and manure to make it yield liberally.

1200. *Landed property in Jamaica* is in general freehold without manorial rights, and is chiefly in the enjoyment of individuals, though there is some government and corporation territory. Estates are generally small, few exceeding 1000 acres: formerly they were managed by resident proprietors; but at present, and for some time past, by far the greater number have been managed by agents or attorneys, who are represented by Roughley as a selfish, grasping, unprincipled set of men, "too ignorant to be planters, and too ostentatious, proud, and supine, to contribute to the good of their constituents." (*Planter's Guide*, p. 8.) They often contrive, by getting estates in debt and mortgaging them, ultimately to become the proprietors themselves. Some proprietors are so over-careful as to have what is called a planting attorney, and a mercantile attorney, the latter for the sale of produce, and the purchase of imported stores for the slaves. Besides these there are travelling agents who visit different estates, and make annual or biennial voyages to Europe to the proprietors; an overseer for each estate, who has both free white men and slaves under him; a head driver, a slave; the head cattle and mule man; the head boiler or manufacturer of sugar; head carpenters, coopers, masons, coppersmiths, and watchmen; a hot-house or hospital doctor or doctress midwife; the great gang of able men and women; the second gang of rather weakly habits; and the third, or weeding gang, composed of children; cattle and mule boys, watchmen, invalids, and superannuated, and young children and infants. The qualifications, duties, and treatment of all these classes are discussed at length by Roughley, who gives a picture of culture and management very different from any thing belonging to the management of landed property, or the culture of farm lands, in Britain.

1201. *The overseer*, who is generally known by his hat and pipe (*fig.* 162.), should be a man of intelligence, tempered with experience, naturally humane, steadfast in well-devised pursuits, of settled sober habits, not given to keeping indiscriminate company, or, suffering his subordinate white people to do so, thereby vitiating their manners; presenting a gentleman-like appearance; keeping a regular, well-supplied, comfortable table, without profusion, not only for himself and the white people under him, but for the benefit of such sick and convalescent slaves as require salutary and restoring nourishment. His business hours will be fully occupied by the concerns of the estate, his leisure ones in the innocent enjoyment of some domestic amusement. He must be kind and courteous to the young men under him, but giving or allowing them no opportunity to treat him with disrespect; attentive and hospitable to respectable strangers; cautious and wary how he suffers strollers to tempt his benevolence. He must not capriciously or suddenly discharge his white people (as is very often the case), taking care that no envious or jealous sentiment or idea arises in his mind, if his young men have merit on their side, or are caressed by their superiors. He must keep the slaves strictly to their work, yet not imposing on them unusual hours, or inflicting punishment for every trifling offence; but, when punishment for crimes is necessary, tempering it with prudent mercy. He must be attentive to their real wants, not suffering them to tease him with their trifling complaints, or tamper with him by their arts, but promptly satisfying them, by enquiring into their serious grievances. Above all things, he must not encourage the spirit of Obea in them (which is horrible), nor dishearten them by cohabiting with their wives, annulling thereby their domestic felicities. He must not suffer their provision-grounds to be neglected, trespassed on, or ruined, nor their houses to be out of repair or uncomfortable; for it very often happens, that well-disposed slaves, by such freedoms taken with their wives, their well-established grounds ruined by thieves or cattle, their domestic quiet and comfort intruded upon, or their houses rendered uninhabitable by storm or other casualty, become runaways. Their conduct influences others, till at last the strength of the estate vanishes, the evil becomes notorious, and the plantation, of course, becomes neglected. The magistrates are then obliged to take this growing evil into serious consideration. Hunting parties are sent out (perhaps with little success) to bring in the fugitives; martial law is at last proclaimed throughout the diseased district; all sorts of people are harassed; public trials are instituted; some of the runaways are never caught; others who are brought in undergo trial, and are convicted and sentenced to death or transportation for life. (*Roughley*, 40. 43.)

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1202. *The head driver* is seen carrying with him the emblems of his rank and dignity, a polished staff or wand, with prongy hooks on it to lean on, and a short-handled flexible whip; his office combining within itself a power, derived principally from the overseer, of directing all conditions of slaves, relative to the precise work he wishes each gang or mechanic to undergo or execute. The great gang is comprised of the most powerful field negroes, and is always under his charge. These form the strength with which principally to carry into effect the main work in the field, and to manufacture the sugar and rum. There are so many points to turn to, so many occasions for his skill, vigilance, steadiness, and trust-worthiness, that the selection of a man, fit for such a place, requires circumspection, and an intimate knowledge of his talents and capacity. A bad or indifferent head driver sets almost every thing at variance; injures the negroes, and the culture of the land. He is like a cruel blast that pervades every thing, and spares nothing; but when he is well-disposed, intelligent, clever, and active, he is the life and soul of an estate. He very often is an elderly or middle-aged negro, who has long been so employed. If it should be so ordered, that a new head driver is requisite to be put in commission, I must beg leave to lay before my readers my opinion of the proper choice of one. I may err, but I hope not irretrievably. He should, in my judgment, be an athletic man; sound and hardy in constitution; of well-earned and reputed good character; of an age, and, if possible, an appearance, to carry respect; perhaps about thirty-five years old; clean in his person and apparel; if possible, a native or creole of the island, long used to field work, and marked for his sobriety, readiness, and putting his work well out of his hands. His civility should be predominant, his patience apparent, his mode of inflicting punishment mild. He should be respectful to white people; suffering no freedoms from those under him, by conversation or trifling puerile conduct. It is rare, indeed, to find this mass of perfection in a negro; but you may obtain a combination of most of these virtues; and, as to petty vices, always inherent in some measure in human nature, they must be looked over, when not too full of evil. The junior drivers likewise, if possible, should be men of this description; but having a good master over them in the head driver, they will be induced to behave tolerably. (*Ib.*, 79. 82.)

1203. *The labourers on a Jamaica sugar estate* consist almost entirely of slaves, creoles, natives, or Africans, with some free blacks and men of colour or mixed progeny. The overseers are almost always whites, and sometimes also the head drivers.

1204. *The buildings required for a sugar plantation* are numerous and extensive. In a central situation, by a stream or other supply of water, an extensive set of works, including an overseer's house, hospital or hot-house, mill-house, large mill-yard, mule stable, trash or fuel house, cooper and carpenter's shops, boiling and curing houses, a distilling house, tanks, cisterns, &c., should be built, and so arranged as all to be seen from the overseer's house.

1205. *The overseer's house*, it would appear, must be both a comfortable and elegant building. It should be built compact and convenient, not over roomy; and raised sufficiently high from the foundation, with good masonry work, to admit of suitable stores underneath, to keep all the plantation stores and supplies in. It should be so placed that all the works can be seen from it, and not far from the boiling-house. The rooms should be all on the same floor, and closely boarded with seasoned stuff. Each white man should have a small bed-room to himself, with a glazed sash window on hinges, and a shutter to it. The bed-rooms should be eleven feet by nine each, of which five should be in every overseer's house on a sugar estate, leaving the overseer's room somewhat larger than the book-keeper's. A large well-covered piazza, with comfortable glazed windows (to rise and fall occasionally), will answer all the purposes of a dining and breakfast hall, and for walking in. Large centre halls in such houses are of very little use, take up a great deal of room, are very expensive, and make the house large, without any real convenience. A small back piazza, made comfortable by moving blinds with stops, would be proper for the servants. I think every dwelling-house on a plantation should have a small fire-place in it, with a well-raised chimney, for fire to be made in occasionally in damp weather; it will be wholesome and preservative. The fire-place should be in an extreme angle of the dining piazza, and the overseer's cooking-room, washing-room, &c., should be apart from the house, though not far off, conveniently fitted up, and of moderate size. The little appendages of a hog-sty, fowl-house, &c., to raise small stock in, are easily built at a small expense. (*Roughley*, 184, 185.)

1206. *A lime-kiln* is an essential building for a sugar estate, a considerable quantity of lime being wanted to neutralise the acid of the expressed juice of the cane. A fixed kiln at the works is best, as what lime is wanted can then be burnt at any time; but it often happens that temporary kilns, composed of layers of stones and wood, with a funnel in the centre, are made in the woods, lighted and burnt, and the produce carried home. Such a kiln, twenty feet in diameter, and ten or twelve feet high, will produce lime enough to make sixteen hogsheads of sugar. (*Ib.*, 314.)

1207. *The houses of the slaves* are grouped together on some estates, and scattered in different places in others, generally on the outskirts of the estate. They are low cottages of one or two apartments, with open sheds, and pieces of garden ground of from one eighth to one quarter of an acre attached to each, and some of them are kept neat, and have a clean, not uncomfortable, appearance; they are generally built with stone, and covered with shingles.

1208. *Every building composing the works of a sugar estate* should be formed of the most substantial materials, durable, hard, well-seasoned timber, well put together, and supported by the best mason work. They should be shingled instead of being thatched, and kept free from the hungry destructive ant, who, by his mighty though diminutive efforts, will level a substantial building to the ground in a short time. Poisoning by arsenic is the most expedient mode of getting rid of them, as the living will feed on the dead, so that the whole nest (by devouring one another) are thus killed. (*Ib.*, 194.)

1209. *The live stock of a sugar estate* consists chiefly of oxen, spayed heifers, and mules, as beasts of labour: the overseer generally keeps a riding horse, as does the resident agent or proprietor, if there are such; and there are pigs and poultry, with some sheep for consumption. The cattle and mules are kept on the savannas or open waste pastures, and on Guinea grass (*Pánicum*) and Scotch grass (*Pánicum* hirtéllum) (*fig.* 162. *a*), on which they are folded, tethered, or soiled. Mares and Spanish or Maltese jackasses re kept for breeding the mules; and the cattle are in general reared on the estate. A jack should be from ten to twelve hands high, and either stubbled or put into a close pasture, with high firm walls and gates to it. He should be regularly corned once a day at least; should have pure water to drink, and should not be suffered to cover more than one mare daily. The mares should be put to him in season, and attended by an experienced groom. A proper covering pit should be made for the mare to stand in, with a surmounting stage for the jack to stand on. They should be daily led out to exercise, kept well cleaned, and by no means allowed to stay out in bad weather, but be comfortably stabled, foddered, and littered. (*Ib.*, 141, 142.)

1210. *The agricultural operations of Jamaica* are for the most part performed by the manual labour of indigenous slaves; but there are also free servants, and the period, it is to be hoped, is rapidly approaching when the whole population will be emancipated. The soil is seldom either ploughed or dug, but generally worked with the hoe-pick. The spade the negroes are awkward at using; and they are not more expert at the plough. White ploughmen have been imported by some cultivators; but the prejudices of the overseers, the awkwardness of the oxen and negro drivers, and the effects of the climate in wearing out the spirits of the ploughman, are said to have discouraged its use. Long, in 1774, Dr. Stokes (*Young's Annals of Agr.*, xviii. 148.), and others, have tried the plough, and strongly recommend it, as doing the work better and lessening the necessity of having so many slaves. Roughley, however, who was "nearly twenty years a sugar planter in Jamaica" (*Jamaica Planter's Guide*, 1823), is decidedly against it, whether drawn by negroes or cattle; both because it does not do the work so well as the hoe, and because of the difficulty of getting ploughmen and properly trained beasts. It is probable, however, that necessity may ultimately lead to the use of the plough drawn by oxen, and that the operative man in the West India Islands will in time assume the same attitude as in Europe.

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1211. *The agricultural productions* of Jamaica of the greatest importance are sugar, indigo, coffee, and cotton. The several species of grain cultivated in this island are maize, or Guinea corn, yielding from thirty to sixty bushels an acre; various kinds of calavances, a species of pea; and rice, but in no great quantity. The island abounds also with different kinds of grass of excellent quality: the artificial grass, called "Scots grass" (*Pánicum* hirtéllum) (*fig.* 163. *a*), grows spontaneously in most of the swamps and morasses of the West Indies; and it is so productive, that a single acre of it will maintain five horses for a whole year. The "Guinea-grass" (*P.* polýgamum) (*fig.* 163. *b*) is next in importance to the sugar-cane, as the grazing and breeding farms are chiefly supported by it. Hence arises the plenty of horned cattle, both for the butcher and planter; which is such, that few markets in Europe furnish beef of better quality, and at a cheaper rate, than that of Jamaica. Mutton also is cheap and good. The seeds of the Guinea grass were brought from the coast of Guinea, as food for some birds which were presented to Ellis, chief justice of the islands. The several kinds of kitchen-garden productions, that are known in Europe, thrive in the mountains of this island; and the markets of Kingston and Spanish Town are supplied with cabbages, lettuces, carrots, turnips, parsneps, artichokes, kidneybeans, green peas, asparagus, and various sorts of European herbs, in the greatest abundance. Other indigenous productions, that may be classed among the esculent vegetables, are plantains, bananas, yams of several varieties, collaloo (a species of *A*rum used as spinach), eddoes (*A*rum and *Calàdium*), cassavi, and sweet potatoes. Among the more elegant fruits of the island we may reckon the ananas, or pine-apple, tamarind, papaw, guava, sweet sop, cashew apple, custard apple, Akee tree, cocoa nut, star apple, grenadilla, avocado pear, hog plum, naesberry, mammee sapota, Spanish gooseberry, prickly pear, anchovy pear, and some others, for which Jamaica is probably indebted to the bounty of nature. For the orange, the lemon, lime, shaddock, vine, melon, fig, and pomegranate, the West India Islands are perhaps obliged to their Spanish invaders. The cinnamon has been lately introduced, and the mango is become almost as common as the orange. The mountains are generally covered with extensive woods, containing excellent timber; such as the lignum vitæ, logwood, iron wood, pigeon wood, green-heart braziletto, and bully trees; all of which are to a great degree heavy, as well as compact and impenetrable. Of softer kinds, for boards and shingles, the species are innumerable; and there are many beautiful varieties for cabinet-work; and among these we may enumerate the bread nut, the wild lemon, and the well-known mahogany.

1212. *The culture of the sugar-cane in Jamaica* in some respects resembles that of the hop in this country. The ground being cleared and worked a foot or more in depth, the sets or cuttings of cane, which are the tops of the shoots cut off about a foot long, are planted in rows, generally five feet distant, and from two to five feet apart in the row, according to the quality of the soil; more plants being allowed for poor soil than rich. The ground is kept clear of weeds, frequently stirred, and some earth drawn up to the plants. From each hill a number of shoots are produced: in six months or more these will generally be from seven to ten feet high; the skin smooth, dry, and brittle, heavy with a grey or brown pith, and sweet glutinous juice. In this state the canes are cut, tied in bundles or sheaves, and taken to the mill to be divested of their leaves and decayed parts, and then passed through rollers to express their juice, &c. Cane plantations are made either in May and June, or in December and January, these being the rainy seasons. The first cutting of the canes often does not take place till a year after planting; but an established plantation is cut over every six months. In good soil the plants will last twenty years: in inferior soils not more than half the time. (*Letter to a Young Planter*, London, 1785; *Martin's Essay on Plantership*, in *Young's Annals*, xviii. p. 236.; *Roughley's Jamaica Planter's Guide*, 1823.)

1213. *The cotton plant cultivated in Jamaica* is a different species from that grown in Italy, Malta, and the Levant. It is the Gossýpium barbadénse *Linn.*, a suffruticose biennial, growing from six to fifteen feet in height, with lobed leaves and yellow flowers. It is propagated by the seed, which is set in rows, about five feet asunder, at the end of September or beginning of October; at first but slightly covered, but, after it is grown up, the root is well moulded. The seed is subject to decay, when it is set too deep, especially in wet weather. The soil should not be stiff nor shallow, as this plant has a tap-root. The ground is hoed frequently, and kept very clean about the young plants, until they rise to a moderate height; otherwise they are apt to be destroyed by caterpillars. It grows from four to six feet high, and produces two crops annually; the first in eight months from the time of sowing the seed; the second within four months after the first; and the produce of each plant is reckoned about one pound's weight. The branches are pruned and trimmed after the first gathering; and if the growth is over-luxuriant, this should be done sooner. When great part of the pods are expanded, the wool is picked, and afterwards cleared from the seeds by a machine called a gin, composed of two or three smooth wooden rollers of about one inch in diameter, ranged horizontally, close and parallel to each other, in a frame; at each extremity they are toothed or channelled longitudinally, corresponding one with the other; and the central roller, being moved with a treadle or foot-lathe, resembling that of a knife-grinder, makes the two others revolve in contrary directions. The cotton is laid, in small quantities at a time, upon these rollers, whilst they are in motion, and, readily passing between them, drops into a sack placed underneath to receive it, leaving the seeds, which are too large to pass with it, behind. The cotton thus discharged from the seeds, is afterwards hand-picked, and cleansed thoroughly from any little particles of the pods or other substances which may be adhering to it. It is then stowed in large bags, in which it is well trod down, that it may lie close and compact; and the better to answer this purpose, some water is every now and then sprinkled upon the outside of the bag, the marketable weight of which is usually three hundred pounds. An acre may be expected to produce from two hundred and forty pounds to that quantity, or two hundred and seventy pounds on an average. (*Long's Jam.*, vol. iii. p. 686, et seq.; and *Browne.*)

1214. *The indigo cultivated in the West Indies* is the same species as that grown in the East Indies and other places (Indigófera tinctòria), though there are various species and varieties which afford a similar dye. Indigo thrives best in a free rich soil, and a warm situation, frequently refreshed with moisture. Having first chosen a proper piece of ground, and cleared it, hoe it into little trenches, not above two inches, or two inches and a half, in depth, nor more than fourteen or fifteen inches asunder. In the bottom of these, at any season of the year, strew the seeds pretty thick, and immediately cover them. As the plants shoot, they should be frequently weeded, and kept constantly clean, until they spread sufficiently to cover the ground. Those who cultivate great quantities, only strew the seeds pretty thick in little shallow pits, hoed up irregularly, but generally within four, five, or six inches of one another, and covered as before. Plants raised in this manner are observed to answer as well as the others, or rather better; but they require more care in the weeding. They grow to full perfection in two or three months, and are observed to answer best when cut in full blossom. The plants are cut with reaping hooks, a few inches above the root, tied in loads, carried to the works, and laid by strata in the steeper. Seventeen negroes are sufficient to manage twenty acres of indigo; and one acre of rich land, well planted, will, with good seasons and proper management, yield five hundred pounds of indigo in twelve months; for the plant ratoons (stools, stoles, or tillers, i. e. it sends out stolones, or new growths), and gives four or five crops a year, but must be replanted afterwards. (*Browne.*)


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1215. *The coffee tree* (*fig.* 164.) is less cultivated in Jamaica than in Barbadoes, Domingo, and some other islands: the richness of the soil is found to lessen the flavour of the berry, when compared with those produced in the sandy, dry, hot soil, and arid climate of Arabia. In a rich soil and cool situation in Jamaica, Browne informs us that it produces so great a quantity of fruit, that the branches can hardly sustain the weight; the fruit large and succulent, and the berries lax and clammy. Some affirm, that by keeping these, and other West India berries, for ten or fourteen years, they will become equal to the best now brought from Turkey. Small-grained coffee, or that which is produced in a dry soil and warm situation, will in about three years be as good as that in general use in London.

1216. *In cultivating the coffee*, the berries are sown immediately after being gathered, as they are found to retain their vegetative quality only a few weeks. In three months they are fit to transplant, either to a nursery or to a final plantation. In the low lands they are planted five feet apart, and in the mountains ten feet or more. In three years the plants will produce a crop, and continue bearing for a number of years. The berries are gathered when they are just about to drop; and are immediately carried to sheds, where they are dried upon cloths or mats, till the husk shrivels. They are then passed through between wooden rollers turned by a mule, which separates the husk, after which they are winnowed, sifted, cleaned, exposed to the sun for a few days, and then barrelled up for sale. The produce of a good tree is from one pound and a half to two pounds' weight. (*Browne's Hist. of Jam.*, p. 161.)

1217. *The cocoa-root or eddoe* (A'*rum esculéntum*) and also a species of *Calàdium* produce a root something like the Indian yam (Dioscòrea satìva) (*fig.* 165.), but differ from them in lasting for several years. Both the cocoa-root, and yam are cultivated much in the same way as our potato. They have what they call Bourbon cocoas and country cocoas, and Negro and white yams; the yams have a stake driven in at each hill for the vines to twine on after the manner of hops.


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1218. *The plantain* (*Mùsa paradisìaca*) is cultivated in rows ten feet apart, and the plants seven feet asunder in the row. The following account of the manner of planting and managing will give some idea of the mode in which agricultural operations are carried on by a slave population, and how they are described by a writer who has been " nearly twenty years " at the business. " The ground being all cleared from grass, bushes, and weeds, and lined out and pegged every seven feet, the great gang should be put in with hoes to dig the plantain holes at every peg, a Negro to each row. The holes should be dug deep, two feet long by sixteen inches broad, to give room for the large ponderous plantain sucker to be placed in them. The mould must be hauled up to the edge of the hole, and broken if too large. The plantain suckers being ready and trimmed, each negro should take some, and place one good sucker at every hole in the piece, and begin to plant them, by taking a sucker, and placing it with the but, or rooty end, in the bottom of the hole; make the sucker lie in a leaning, reclining, or half-horizontal position in the hole, with the small, or sucker, end of the plant a little above the ground; and when thus placed, draw the mould from the bank, and cover the plant well with it, leaving a little of the plant above the ground. In this manner the plantain walk should be formed. In a few weeks (if the weather is favourable) the young plantain shoot will be seen rearing its perpendicular head, perhaps three or four growing from the same stock. They should then be carefully moulded, and cleared of grass and weeds when they are a few inches high. No cavities, or water-logging holes, should be near them. The banks must be levelled about them, the holes filled and properly closed up, and some fine mould given them to encourage their growth. There will be no occasion to give them more than two mouldings till they are established; but they must be carefully kept clear from weeds or grass; and when any dry trash happens to be hanging about them, it should be gently cut off with a knife, and placed about their roots, to keep them free from either too much sun or chill. A plantain walk well taken care of will be in bearing in twelve months after it is planted, amply repaying for the labour and trouble of planting it, and giving an almost inexhaustible supply of fine provisions, if the vicissitudes of hurricanes or storms (which this climate is unhappily subject to) do not destroy it, which no human foresight or care can prevent. When a plantain walk is made, there may be a row of cocoas (1217.) in the middle of the ten feet spaces, which will yield a crop by the time the plantain walk bears fruit, but they must then be pulled up. A few banana (Mùsa sapiéntum) suckers can be planted in the plantain row, instead of plantain suckers; sometimes they are much in request, as a luscious wholesome fruit, and for the strong fine-flavoured vinegar which is produced from them. After this piece of ground is thus planted, the whole of it may be sown with corn (maize), which will not injure the plantain suckers or trees, if it be not too close or thick. " (*Roughley*, p. 413, 416.)

1219. *The Indian arrow-root* (*Marànta arundinàcea*) is cultivated, and yields an annual supply of roots, which, being washed, bruised, and compressed, yield a starch esteemed as a very light wholesome food for invalids.

1220. *Other plants*, in great variety, are cultivated both for culinary and medicinal purposes, and in the gardens of the overseers and agents almost every fruit in the world may be raised.

1221. *The pinguin* (*Bromèlia* Pinguin) is grown on the tops of ditches, and forms an impenetrable fence.

1222. *Maize* is grown among the canes, and in fields by itself in rows four feet and a half apart, and the corn dibbled or set in patches of four seeds in a space of six inches square.

1223. *Guinea grass* (*Pánicum polýgamum*) (*fig.* 163. *b*) and Scotch grass (*fig.* 163. *a*) are the clovers or artificial herbage plants of Jamaica. They are perennial, and grow in small enclosures, which are either eaten down or mown. Cane tops, the leaves of maize, millet, and a variety of other herbage, are given to the mules and cattle.

1224. *Rats, ants, and other vermin*, greatly injure the canes; ticks (*A'*carus) of different kinds and flies very much annoy the cattle; and a great variety of evil propensities and diseases assail the negroes and their children, among others *Obea*, and what Roughley calls " eating dirt," which he thus characterises: — " Too much tenderness gives the child a fretful longing for the mother, and her scanty milk engendering disease, and, what is worse than all, often (though secretly) giving it a growing liking for the hateful fatal habit of eating dirt, than which nothing is more horribly disgusting, nothing more to be dreaded; nothing exhibiting a more heart-rending ghastly spectacle, than a negro child possessed of this malady. Such is the craving appetite for this abominable custom, that few, either children or adults, can be broken of it, when once they begin to taste and swallow its insidious slow poison. For, if by incessant care, watchfulness, or keeping them about the dwelling-house, giving them abundance of the best nourishing food, stomachic medicines, and kind treatment, it is possible to counteract the effects and habit of it for some time, the creature will be found wistfully and irresistibly to steal an opportunity of procuring and swallowing the deadly substance. The symptoms arising from it are a shortness of breathing, almost perpetual languor, irregular throbbing, weak pulse, a horrid cadaverous aspect, the lips and whites of the eyes a deadly pale (the sure signs of malady in the Negro), the tongue thickly covered with scurf, violent palpitation of the heart, inordinately swelled belly, the legs and arms reduced in size and muscle, the whole appearance of the body becoming a dirty yellow, the flesh a quivering pellucid jelly. The creature sinks into total indifference, insensible to every thing around him, till death at last declares his victory in his dissolution. This is no exaggerated account of the effects and termination of this vile propensity. (*Ib.*, 118. 120.)

1225. *The agriculture of the other West India Islands* may be considered as similar to that of Jamaica. So many different kinds of East India fruits have not yet been introduced in them; but the great articles of sugar, coffee, cotton, indigo, pepper, &c., are every where cultivated. One of the richest of these islands is St. Domingo, now independent, and known by its original name of Hayti.

Sect. VI. *Of the present State of Agriculture in South America.*

1226. *The climate of South America* combines the most opposite extremes. The southern parts are subject to all the horrors of the antarctic frosts; Terra del Fuego being subject to the almost perpetual winter of Greenland. Even under the torrid zone the cold is extreme on the Andes, and the heat and moisture equally extraordinary in the plains. The surface of the country is remarkably irregular: these are immense chains of mountains which stretch along the western coast from the one extremity of the country to the other. Many parts of the interior are still obscure; wide regions on the great river Maragnon being covered with impenetrable forests, and others flooded by the inundations. In the south there are vast saline plains, and small sandy deserts and savannas. This country being, or having been, almost entirely under the Spaniards and Portuguese, the cultivated parts display a slovenly agriculture, something like that of Spain; the varied and abundant products of the soil depending more on nature than on man. Indeed minerals have always been more the objects of European nations in South America than vegetables. — After this general outline we shall, without regard to the recent political changes, offer such slight notices of South American agriculture as we have been able to collect, under the divisions of Terra Firma, Peru, Chile, Paraguay, Brazil, Cayenne, Colombia, Surinam, Amazonia, and Patagonia.

1227. *The climate of Terra Firma* is extremely hot throughout the year. From the month of May to the end of November, the season called winter by the inhabitants, is almost a continual succession of thunder, rain, and tempests; the clouds precipitating the rain with such impetuosity, that the low lands exhibit the appearance of an ocean. Great part of the country is in consequence almost continually flooded; and this, together with the excessive heat, so impregnates the air with vapours, that in many of the provinces, particularly about Papayan and Portobello, it is extremely unwholesome. The soil of this country is very different, the inland parts being exceedingly rich and fertile, while the coasts are sandy and barren. It is impossible to view, without admiration, the perpetual verdure of the woods, the luxuriance of the plains, and the towering height of the mountains. This country produces corn, sugar, tobacco, and fruits of all kinds: the most remarkable is that of the manzanillo tree; it bears a fruit resembling an apple, but which, under this appearance, contains a most subtile poison. The bean of Carthagena is about the bigness of a common bean, and is an excellent remedy for the bite of the most venomous serpents, which are very frequent all over this country.

1228. *In Peru* the soil is dry and has no rain, vegetation being supported by immense dews. The only spots capable of cultivation are the banks of the rivers, and other places susceptible of being artificially irrigated. The improvement of the mines is, or ought to be, the first object of attention in this singular country.

1229. *Chile* is an extensive, rich, and fertile country. The climate is the most delicious in the new world, and is hardly equalled by that of any region on the face of the earth. Though bordering on the torrid zone, it never feels extreme heat, being screened on the east by the Andes, and refreshed on the west by cooling sea-breezes. The temperature of the air is so mild and equable, that the Spaniards give it the preference to that of the southern provinces of their native country. The fertility of the soil corresponds with the benignity of the climate, and it is wonderfully accommodated to European productions. The most valuable of these, corn, wine, and oil, abound in Chile, as it they had been native to the country. The soil, even that part of it which has been long in tillage, is so little degenerated by producing successive crops, that no manure is necessary. The grain, as some say, yields from 100 to 150; but by a more moderate and just estimate, as it is stated both by Molina and in Peyrouse's *Voyage*, from 60 to 70 in the midland country, and in the maritime 40 or 50.

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1230. *Many of the plants of Chile are the same with those of Europe*, and almost all the potherbs and fruits of our Continent flourish there. The northern provinces produce the sugar-cane, the sweet potato, and other tropical plants. Maize is common and abundant; the magu is a kind of rice, and the tuca a species of barley, both of which were cultivated before the arrival of the Spaniards. Peas and potatoes were also well known to the Chilese. Of the latter they have thirty different kinds: and it is even conjectured that this valuable root was first brought into Europe from this country. The large white strawberry of Chile is well known in English gardens. Many of its plants are valuable as dyes, and others as medicinal. The vira-vira expels the ague; the payco is excellent for indigestion. Wild tobacco abounds in Chile, and also the annotto (*Bixa Orellàna*). (*fig.* 166.) The beautiful flowers and shrubs are infinite. Incense, not inferior to that of Arabia, is produced by a shrub, distilling tears of a whitish yellow, and of a bitter aromatic taste. The trunk of the puvi supplies excellent cork; the Salsòla *Kàli* is plentiful on the shores; and Chile produces seven kinds of beautiful myrtles, one of which yields an excellent stomachic wine, preferred by strangers to any muscatel. The crelon furnishes a tea, which is known as a vermifuge. An acacia of the province of Quillota yields a balsam, which is used in the cure of wounds; and the palqui is esteemed, as a febrifuge, superior to the Peruvian bark. The Cássia *Sénna* grows on the banks of the rivers Maypo and Salvia. Of ninety-seven kinds of trees that diversify the beautiful forests of Chile, only thirteen lose their leaves in winter. Cypresses, pines, and red and white cedars grow in the valleys of the Andes; the red cedars, particularly in the Isle of Chiloe, are of an enormous size, so that from 700 to 800 planks, twenty feet long, may be cut from one tree. The cinnamon tree, which yields what is called Winter's bark, is regarded as sacred by the Araucans, who present it as a token of peace. Beautiful woods of various colours are supplied by the Chilese forests. Vines, though none appear to be natives, flourish admirably well: they are found in the forests, arising from seeds deposited by the birds: on the confines of the river Mauli they are three or four feet high, and supported by stakes; but further to the south they are left loose on the sides of the hills. The best wine is that which is obtained from the banks of the river Itati, and is commonly called wine of Conception; it is red, generous, of an excellent flavour, and equal to the best in Europe. Muscatel wines are also excellent. The vintage is in April and May. All the other European fruits attain the greatest perfection. Most of the European animals have improved in this delicious climate and fertile country. The celebrated Spanish sheep have not lost any of their distinguished qualities: the horned cattle are larger than those of Spain; and the breed of horses surpasses both in beauty and spirit the famous Andalusian race from which they spring.

1231. *Paraguay* is a fertile province, and singularly prolific in native vegetables. The climate is extremely hot: the surface of the country consists generally of extensive plains; but some tracts are very mountainous. The soil is every where rich and deep; and the native pastures so excellent, that the immense herds of wild oxen which feed on them are only valued for their skins; the flesh being left to be consumed by ravenous beasts and birds. Among the agricultural products may be mentioned the potato, of which they have several sorts of a large size; red, white, and yellow cotton; maize, wheat, and the vine. The last is greatly injured by the ants; but where that insect is kept under, the wine of Paraguay is excellent. The bean, pea, melon, cucumber, lettuce, turnip, mustard, cress, leek, onion, asparagus, and other European vegetables, are found wild in the plains. The forests abound in the most valuable trees, among which is the Cinchòna, or Jesuits' bark, so called because the Society of Jesus settled there had originally the monopoly of this medicine; the sarsaparilla, sassafras, guaiacum, dragon's blood, nux vomica, vanilla; Theobròma, or chocolate plant (*fig.* 167.); and several species of the Ceratònia, the seeds of which are ground and made into bread. Palms, figs, peaches, pomegranates, lemons, and oranges are cultivated; and the jujube, mulberry, granadilla, banana, pine-apple, and a great variety of other fruits, are found in a wild state. Of the live stock, the most abundant are the ox and the camel; but there are horses, asses, sheep, many wild swine (*fig.* 168.), and poultry. The bear, elk, deer, ostrich, and others, are in a wild state.

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1232. *Brazil* is the most extensive empire in South America, rivalling Europe in size, while its provinces may be compared to the territories of European sovereigns. It enjoys a climate but little inferior in salubrity to that of Chile, but less variable, as the interior is not traversed by chains of lofty mountains. The climate of the Sertoens (a general name for the inland country) is colder in winter, and warmer in summer, than that of the maritime parts. The first of these peculiarities is caused by its greater elevation; and the second, by its sandy arid nature, and by the air not being cooled by the delicious sea breezes of the coast. During the rainy season (which is the tropical winter) the nights are sometimes chilly; and, although the thermometer is seldom lower than 68° or 65°, the warmth of a fire is found desirable. This coldness is principally felt in Minas Geraes (the most mountainous part in Brazil), and in the other provinces beyond Rio de Janeiro. In comparison of the extent of the country, the rivers are very few; and nearly throughout the interior there is a general deficiency of water, even for the purposes of life. During the dry or summer season the heat is excessive, yet it is neither unhealthy nor very oppressive, being mitigated by the sea breeze, which usually sets in about half past seven or eight o'clock in the morning, and continues until sunset.

1233. *The vegetable productions of Brazil* are numerous and important. The extensive cultivation of the sugar-cane and cotton plant has, of late years, given an importance to its commerce far greater than that of any other neighbouring state. The sugar plantations are confined to a short distance from the coast, on account of the superior quality of the soil (a red clayey loam), and the difficulty of conveyance in a country where regular carriage roads do not exist. Cotton thrives best on those poor, sandy, and dry lands, which are met with at a distance from the sea; it is, therefore, cultivated only in the interior, and is brought to the coast on the backs of mules and horses, frequently from a distance of 150 miles. Coffee has not yet been cultivated very extensively, although it thrives remarkably well, particularly near Rio de Janeiro; wheat is only produced in the milder provinces of the South, and even there but sparingly. Indeed, the "staff of life," throughout the greatest part of Brazil is the mandiocca, known in the West Indies by the name of cassava; the root, being divested of its poisonous juices by pressure, is rasped or ground so as to resemble sago; and, being boiled, forms the principal sustenance of the great mass of the people. The cultivation of the plant is easy; it will thrive both in the richest and poorest soil, and vast quantities are grown in the sandy (or tabulara) tracts of Paraiba, Maranham, and Pernambuco. As we approach the southern provinces, the mandiocca in some measure gives place to the maize or Indian corn, which, although less nutritious, is much esteemed both by man and beast: its culture however is more confined, as it requires a good soil and frequent moisture. Rice is grown but sparingly, and not in sufficient quantities to make it an article of commerce. Besides these esculent vegetables, there are many others, either indigenous, or introduced by the Portuguese from their African possessions; among these may be reckoned the ochro, the different species of Cápsicum, yams, and love apples. I believe the potato is unknown in Brazil; several attempts were made in 1817 by the English residents of Pernambuco and Bahia, to cultivate this root from the English stock; but they were completely unsuccessful. The tobacco of Brazil is well known: very extensive tracts in the vicinity of Bahia are entirely covered with this plant, which flourishes best in a light sandy soil; although great attention is paid to its cultivation, the leaves are dried in a careless way, and the subsequent operations conducted in a most slovenly manner. The fruits are in great variety: besides those common to the West India Islands, and other parts of tropical America, as the cocoa nut, pine-apple, plantain, banana, mango, jack, custard apple, orange, and citron, there are several others peculiar to this country, and only known by Indian names. Those above enumerated are only to be met with near the coast; but the cashew tree, so valuable for the astringent qualities of its fruit, covers extensive tracts in the interior of Pernambuco and Paraiba, where the soil is loose, sandy, and arid. In similar situations are also to be seen many kinds of guava. While the fruit of the larger species of passion flower (Passiflòra) is much esteemed for the coolness and delicacy of its pulp, the European fruits, which thrive so well on the table land of Mexico, and on the sides of the Cordilleras of Chile, wither and die beneath the fervour of a Brazilian sun. The vine, indeed, is sometimes seen in the gardens of the rich; and there is no doubt but that it might be cultivated with complete success in the southern provinces; but this has been hitherto prevented by that short-sighted policy of the mother country, which prohibited both the vine and the olive from being planted in any of the colonies. Agriculture and gardening, in short, are here in their infancy. There is, indeed, a botanical garden both at Rio de Janeiro and Pernambuco; but the first is neglected, and the last, existing (in 1816) only in name, is a wilderness. The private gardens of the higher classes usually consist of orange, citron, and lime trees, planted in rows, intermixed with a few heavy earthen pots of China-asters, pinks, and other common plants of Europe, here esteemed because they are exotic; while, as in other countries, the most lovely creepers and flowering shrubs grow in the thickets and fences, totally disregarded. The woods and forests abound with innumerable medicinal plants, as the castor, two species of contrayerva (Dorstènia rotundifòlia and pernambucàna of Arruda), the pinaõ, the angelim (*Skolemòra* pernambucénsis *Arru.*), and many others, the names and qualities of which, the Brazilians, from some unaccountable fancy, studiously conceal from Europeans, although they willingly administer them as prepared medicaments when applied to. The most valuable dyeing wood is that bearing the name of the country: the monopoly which the crown assumed, of cutting and exporting it, was so arbitrary and vexatious, that it has been used as fire-wood by many of the planters, to conceal from the revenue officers that it was found on their lands. Its produce has long been gradually diminishing, and unless some judicious measures are adopted, this valuable wood will be totally lost in a few years. There are many other beautiful woods fit for ornamental furniture, but none are so well known as the rose wood (said to be a species of *Jacaránda*), which of late years has become so fashionable in this country. Numerous species of laurel and myrtle abound in the forests; the Mimòsa sensitìva, or sensitive plant, will sometimes form impenetrable thickets on the sides of the ponds and rivers; while the various species of Amarýllis, as also the crimson passion flower, are more particularly natives of the southern provinces.

1234. *The botanists of Europe have long been unacquainted with the plant which produces the true Ipecacuana;* and even those who have recently travelled in Brazil appear to have fallen into some mistakes on this subject. In fact, there are two plants essentially very different, but which, from possessing the same medicinal qualities, have long passed under the same name, even in Brazil. The opinion of the accurate Arruda, whose name as a botanist may rank with the first in Europe, but who lived and died in Brazil, may be considered, on this question, as decisive. He considers the true ipecacuana, or Ipecacuanha preta of the natives, as belonging to a new genus. This plant he calls *Ipecacuàna* officinàlis (*Cent. Plant.*); it grows in the southern provinces, and requires shade. The other, called by the Brazilians the white sort (*I. Brânca*), is the Pombàlia *Ipecacuánha* of Vandel: this is found in considerable abundance in the sandy tracts of Pernambuco and Paraiba, and its root, when dried and pounded, is much used in these provinces as a gentle purgative; it likewise promotes perspiration, and possesses stimulant qualities. (*Swainson's MSS.*)

1235. *The pot tree* (*Lécythis ollària*) is one of the greatest ornaments of the woods; its immense stem is above a hundred feet high, and spreads into a majestic and vaulted crown, which is extremely beautiful in the spring when the rose-coloured leaves shoot out, and in the flowering season from the large white blossoms. The nuts, which have a thick shell, are of the size of a child's head, with a lid which is loose all round, and which at length, when the weight of the fruit turns it downwards, separates, and lets the seed fall out. In a high wind it is dangerous to remain in the woods on account of these heavy nuts falling from so great a height. The seeds are collected in great quantities by the Indians, who are extremely fond of them, and either eat them raw, or preserve them roasted and pounded, in pots, and the shells themselves are used as drinking cups. (*Spix*, vol. ii. p. 222.)

1236. *Dr. Arruda has described several of the most valuable of those indigenous plants whose fibres are adapted for economic purposes.* The most important of these are, — 1. The caroà (Bromèlia variegàta *Ar.*), found in great abundance in the Sertoens of Paraiba and of the northern provinces: the fibres of the leaves are of two kinds; from one, a very strong cordage is made, while the other is manufactured by the fishermen into nets, and sometimes into a coarse cloth, when care is taken in preparing the thread. 2. The Crauata de Rede (Bromèlia sagenària *Ar.*) is confined to the maritime parts of Pernambuco and Paraiba; the leaves are from six to nine feet long, and the fibres so strong, and at the same time so fine, that cables made from them are much superior in strength to those of Europe, while they are equally well adapted for sail-cloth or stockings. The most delicate fibres, however, are those procured from the leaves of the ananas (Bromèlia *Anànas*), as they are capable of being manufactured into cloth of a superior quality. Other plants possess the same qualities, though in an inferior degree. The Brazilian government has hitherto paid little attention to these matters. (*Swainson's MSS.*)

1237. *Brazil likewise produces a species of croton,* the leaves of which are sometimes used as a substitute for the tea of China. Some years ago, the government evinced a great desire to introduce and cultivate the genuine tea plant, and actually induced several Chinese to settle near Rio de Janeiro, for the purpose of superintending its culture: the plan, however, from some jealousy or mismanagement, was abandoned before it had received a fair trial. A similar project was formed for introducing the cochineal insect, but which, from similar causes, proved equally abortive. There is every reason to believe, however, that both would have succeeded under proper management. (*Swainson's MSS.*)

1238. *The live stock of Brazil* chiefly consists of horned cattle, which are pastured in great numbers in the interior of the southern provinces. The hides are sent to Europe: and the flesh, after being cut into long stripes and dried in the sun, becomes an article of considerable internal commerce. Paraiba and Rio Grande are particularly celebrated for this traffic. Fresh meat, even in maritime towns, cannot always be had, and is at all times dear. Swine are good, but sheep and goats are almost unknown.

1239. *Cavies of different species, porcupines, armadillos,* and other wild animals, abound in some of the forests; most, if not all, are eaten by the native Indians and the Brazilians: the former do not even reject the monkeys. In some parts of the interior are small ounces, but they seldom show themselves by day. Hammocks made of network are universally preferred to beds; and from being of little value, they are generally possessed by the poorest natives, who suspend them between beams in the house, or trees in the open air. (*fig.* 169.) (*Ib.*)

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1240. *Cayenne or French Guiana,* is a fertile country, and has been long well cultivated by the colonists. The climate is salubrious; the surface of the country is not mountainous, but abounds in hills and forests; the soil is in general uncommonly fertile, and the productions it yields are of excellent quality. The Cayenne pepper (Cápsicum ánnuum, and other species) is a noted produce of this country, and, with sugar, cocoa, coffee, indigo, maize, cassia, and vanilla, forms the chief article of its commerce. The interior parts, though much neglected, and remaining obstructed by thick forests and underwood, feed, nevertheless, a great number of horses, sheep, goats, and cattle, which roam at pleasure: the beef and mutton are reckoned excellent. (*Maison Rustique de Cayenne*, Paris, 1763.)

1241. *Colombia* is a fertile tract of country, with an irregular surface and warm climate. An association was formed in London some years ago to send emigrants thither. A million of acres were granted to it, besides several important exemptions, by the Colombian government. A hundred and ninety-one persons left Scotland to settle there in 1825; but, according to the superintendent, they were such a set of people, with a very few exceptions, as could not have been procured in any country. They had every advantage, but acted as if resolved to avail themselves of none. Yet, by the surgeon's report, the most sickly months in the year were passed over by a population of drunken adults, and a large proportion of children, with a mortality of about one fifth less than that of the most healthy parts of Europe. Mr. Powles is perfectly justified in his declaration, that the defaulters in this transaction are the settlers themselves. They are the parties who have not performed their agreement; and who, by their own misconduct, have brought a very heavy loss upon the association; and what is more to be regretted, have greatly retarded the progress of an undertaking calculated to produce the most extensive advantages both to Colombia and Great Britain. We trust the success of this wise and benevolent experiment is retarded only. The million of acres granted to this company present a very different prospect and security from those golden bubbles which the Reports of Messrs. Head, Andrews, and Beaumont have by this time blown away. (*Ed. Rev.*, Jan. 1828.)

1242. *Surinam* is a low moist country, which has been in part studded with wooden houses (*fig.* 170.), and well cultivated by the Dutch. The climate is hot, and is the most unhealthy and pestilential in South America, although the heat in some measure is tempered by the sea breeze. The surface of the country is little varied by inequalities. The uncultivated parts are covered with immense forests, rocks, and mountains, some of the latter enriched with a great variety of mineral substances; and the whole country is intersected by very deep marshes or swamps, and by extensive heaths or savannas. The soil is, in general, very fertile; and its fertility may be ascribed, not only to the rains and warmth of this climate, but also to the low and marshy situation of the country, which prevents the intense heats from destroying vegetation, and to the extreme richness of the soil, particularly in those parts that are cultivated by European industry.

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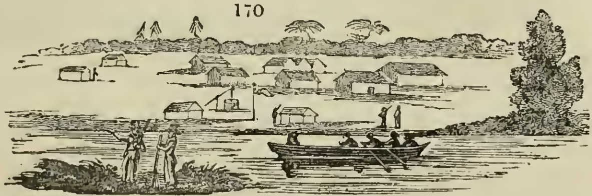

1243. *The principal products of Surinam* are tobacco, sugar, coffee, cocoa, cotton, and indigo. The quassia tree, or bitter drug, used by the porter brewers, grows wild in the woods, and was first exposed for sale by a native called Quassi, after whom the tree is named. The cabbage tree is abundant; and under the rind of the palms is found the Curcŭlio palmărum *Lin.* (*fig.* 171. *a*), the larva of which (*b*) is eaten by the natives as a luxury. A very interesting account of this colony is given by Captain Stedman (*Journal*, 2 vols. 4to, 1794), who filled an important military situation there for several years. This gentleman, in the midst of the most arduous duties, contrived to make himself tolerably comfortable. He built a country house there (*fig.* 172.); kept a wife, pigs, bees, sheep, and cattle, and had children and slaves. He lived by turns with his family in a house, and with strange women in the woods, where he slept in hammocks (*fig.* 173.) and adopted many of the practices of the natives. He made many sketches, and kept a journal; and after many years full of interesting adventures with the rebellious natives, and of endearing scenes with Joanna his local wife, he came home and wrote a very entertaining account of what he had seen and done. (See *Stedman's Surinam*, 2 vols. 4to, 1794.)

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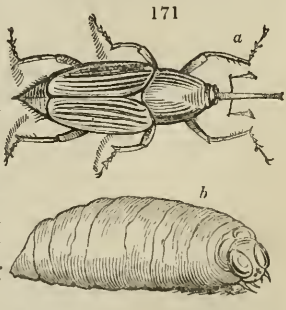

1244. *Amazonia* is an extensive, unconquered, or at least uncivilised, country. In so far as it is known, its climate is more temperate than might be expected from its geographical position. The surface of the country is clothed, in most places, by interminable forests, and its immense river is well known. The soil of a small settlement formed by the Portuguese is very fertile, and produces corn, grain, and all kinds of tropical fruits; besides a variety of timber, as cedar, brazil wood, oak, ebony, iron wood, logwood, and other dyeing woods; and also cocoa, tobacco,

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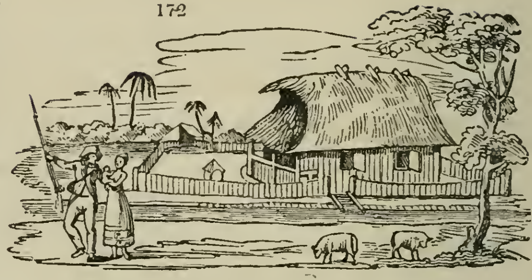

sugar-canes, cotton, cassava root, potatoes, yams, sarsaparilla, gums, raisins, balsams of various sorts, pine-apples, guavas, bananas, &c. The forests abound with wild honey,

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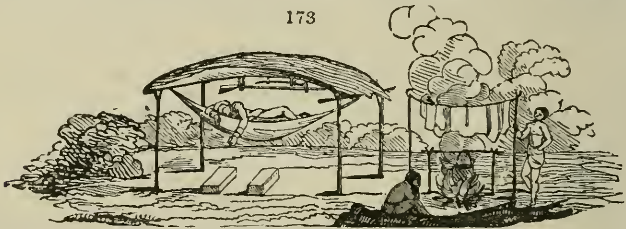

and also with tigers, wild boars, buffaloes, and cavies; while the true Amazonian parrot, with a green plumage and pale yellow front (*fig.* 174.), is found in vast flocks, and annually exported to all parts of Europe. The rivers and lakes afford an ample supply of fish, manattas, and mud-tortoises; but the alligators and water serpents render fishing a dangerous employment. The trees, fields, and plants are verdant throughout the year.

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1245. *Patagonia* consists mostly of open deserts and savannas, with a few willows on the rivers. It seems to enjoy a temperate but rather cool climate; but, separated in the middle by the vast mountains of the Andes, one part of it differs widely from the other. Northward of La Plata, this part of South America is covered with wood, and stored with an inexhaustible fund of large timber: but, southward of that river, there is scarcely a tree or shrub fit for any mechanical purpose; yet even this seemingly barren country has some good pastures. There are numerous droves of wild horned cattle, and abundance of horses, both originally introduced by the Spaniards.

1246. *Of the South American islands*, that of Juan Fernandes abounds in pasture, cattle, and woods; and Terra del Fuego, amidst its horrible snows, exhibits a variety of plants. The Falkland Islands contain number of fowls and plants, somewhat resembling those of Canada. Georgia is a field of ice, in which, or in any of the other islands, there is no cultivation whatever.

BOOK II.

AGRICULTURE AS INFLUENCED BY GEOGRAPHICAL, PHYSICAL, CIVIL, AND POLITICAL CIRCUMSTANCES.

1247. *Agriculture, considered with regard to climate, territorial surface, and society*, presents some features which it may be instructive to contemplate. Whoever has perused with attention the outline which we have now concluded of the field culture of the different nations of the world, must have a general and enlarged view of that art; and must necessarily have observed that there are different species of territorial culture, founded on difference of geographical position or climate, difference of physical circumstances or surface, and difference of civilisation or human wants. The object of the present Book is to characterise these different species, and to refer to them the proper districts throughout the world.

Chap. I.

Agriculture as influenced by Geographical Circumstances.

1248. *The influence of climate* extends not only to the kind of plants and animals to be reared, but also to the mode of rearing. A few useful plants are universal, and but a few. Of those belonging to agriculture, we may enumerate most of the annual pasture or hay grasses, and, of the cereal grasses, the wheat, rye, and barley. The oat, the pea, bean, turnip, potato, and the perennial pasture grasses, will neither thrive in very hot nor in very cold climates; the maize, millet, and rice can only be grown in warm countries, and the oat in temperate regions. The roots and fruits of what are denominated hot climates, as the yam, plantain, bread-fruit, &c., are limited to them; and equally so the timber trees of temperate and torrid regions, as the oak and pine, the mahogany and teak tree.

1249. *Animals as well as plants* are affected by climate. Some animals are universal, as the ox and swine, which are found in every latitude; others are limited in their range, as the rein-deer, camel, elephant, and, considered as a domesticated animal, the sheep. The horse and ass are nearly universal, but cannot be substituted for the rein-deer. The sheep will exist in India and also in Greenland, but loses its useful character in both countries; in Greenland it requires protection during nine months of the year, and in India the wool is changed to hair, and the carcass is too lean for the butcher.

1250. *The management* required for both plants and animals depends materially on climate. It is not easy for a person who has never been out of Britain to conceive a just idea of the aquatic culture even of Italy or Spain. In these countries though most crops, whether of grain or roots, require watering, yet some in the rainy season may be obtained in the usual way, as melons in Italy and onions in Spain. But in Arabia, Persia, and India no culture can be undertaken without water, except in the upper regions of mountains. The fundamental process of culture in these countries is to prepare the surface for the reception of water, and its circulation in trenches and gutters, and to procure the water by raising it from wells or rivers by machinery. Wherever the surface cannot be irrigated, no regular culture need be attempted nor corn crop expected. Nature in such situations produces periodical crops of annual succulents or bulbous-rooted plants; and man might, perhaps, to a certain extent, turn this circumstance of climate to account, by changing the sorts of annual bulbs, &c., from such as are useless, to such as are useful. The onion or edible crocus or cyperus might, perhaps, be substituted for the ixia of the Cape; the sesamum, or some rapid annual, furnishing useful seeds or herbage, for numerous annual weeds; and the cochineal cactus for the showy but useless mesembryanthemums and stapelias of the African wastes. These, however, are only suggestions.

1251. *Culture in the north of Europe* depends for the most part more on draining lands of their superfluous water, than on artificial supplies of that element. When irrigation is applied it is limited entirely to grass lands; and that not for the purpose of supplying such lands with moisture, but for stimulating by manure held in solution by the water, and for increasing or maintaining heat. The greatest care is requisite to prevent this mode of watering from proving more injurious than useful; but little danger results from the application of water in hot countries, and there it is valuable by moderating rather than increasing the temperature of the soil. Water in the north of Europe is generally supplied in more than sufficient quantity by the atmosphere; and, therefore, one great object of the cultivator is to keep the soil thoroughly drained by surface gutters and subterraneous conductors; to keep it pulverised for the moisture to pass through, and for the roots to extend themselves; well stocked with manure to supply nourishment; freed from weeds, to prevent any of this nourishment from being wasted; and to admit the light, air, and weather to the useful plants. In the hot countries keeping the soil free from weeds is generally a duty easily performed, and often rendered unnecessary; for whenever water is withheld, even in the south of Spain (745.), every living plant is burned up with drought. It is remarkable that in the most northerly parts of Europe and America the same effect, especially as to fibrous-rooted perennials, is produced by cold; and in Russia and New England, where there is scarcely any spring, the agriculturist has only to plough once, and sow in the same way as in the hot valleys of the south of Spain, and in South America, where vegetation is as rapid from the accession of moisture, as it is in the cold plains of Russia from the influence of the sun during the long days of a northern summer. In hot countries, putrescent manures are not altogether neglected, but they are much less necessary than in cold countries, and can be done without where there is abundance of water; there, water, intense heat, and light, a consequently moist atmosphere, and a soil well pulverised by art, supply every thing necessary for luxuriant vegetation.

1252. *Hence it is that agriculture considered geographically admits of two grand divisions:* that of the cold climates, which may be called agriculture by draining and manures; and that of the hot climates, which may be called agriculture by irrigation. To the former belong the greater part of Europe, the north of Asia, the north of America, and part of the Australian isles; to the latter, Egypt, Persia, India, China, Africa, great part of the south of America, and part of Australia. As intermediate between *agriculture by watering,* and *agriculture by draining,* may be mentioned that *mixed culture by watering and manuring* which prevails in the south of France, Spain, and Italy; and as opposed to the aquatic culture of the torrid zone, may be placed the rural economy of the arctic circle, which, from the prevalence of cold and ice, precludes all culture of the soil, admits little else than the growth of mosses and lichens, and is therefore limited to fishery and the chase.

1253. *These leading divisions of culture are by no means so absolute as to be determinable by degrees of latitude,* so much depending on physical circumstances, as elevation, soil, aspect, island or continent, &c.; but as an approximation which may impress some general ideas on the mind of the practical agriculturist, we submit the following: —

1254. *The agriculture of irrigation* may be considered as extending thirty-five degrees on each side of the equator.

1255. *The agriculture of manures and irrigation* from the thirty-fifth to the forty-fifth degree north and south of the equator.

1256. *The agriculture of draining and manures* from the forty-fifth degree, north and south of the equator, to the sixty-seventh degree or polar circle.

1257. *The arts of fishing and hunting,* as the only means of subsistence, from the sixty-seventh degree, or polar circle, to the pole.

Chap. II.

Agriculture as influenced by Physical Circumstances.

1258. *The physical circumstances which principally affect agriculture* are temperature, light, elevation, moisture, and soil.

1259. *Temperature and light* have the most powerful influence both on the culture of plants and rearing of animals. Elevation, when not considerable, admits of being rendered subservient to the processes of culture, and to the habits of different plants and animals; moisture may be moderated or increased, soil improved, but temperature and light are in a great measure beyond human control. Hence it is that the plants and animals under the management of the husbandman do not altogether depend on his skill or choice, but on his local situation. Not only the maize, rice and millet, which are such valuable crops in Asia and Africa, are incapable of cultivation in the north of Europe; but even within the extent of the British isles, some kinds of grain, pulse, and roots cannot be grown to such perfection in certain districts as in others. Thus the Angus variety of oat will not come to the same perfection, south of London, that it does north of York; and, of different varieties, the Dutch, Polish, and potato oat will succeed better in a warm climate, than the Angus, black, or moorland oat, which answer best for cold, moist, and elevated districts. The turnip arrives at a greater size in Lancashire, Berwickshire, and Ayrshire, than it does in Kent, Surrey, or Sussex, even admitting the best possible management in both districts. The pea requires a dry soil and climate, and more heat than the bean, and consequently thrives much better in the south of England, in Kent, and Hampshire, than in Scotland or Ireland. Hops cannot be cultivated advantageously in Scotland, nor clover seeds, except, perhaps, in a few very favourable situations. Even wheat does not come to maturity in many parts of that country in ordinary seasons. It is certain that the perennial grasses thrive best where the temperature and light are moderate throughout the year, as on the sea-coast in various countries, where mildness is obtained from the influence of the sea, and light from the absence of a covering of snow; and also in the south of England, where the snow seldom lies, and where the temperature is moderate, and the nights not so long as they are farther north. It is equally certain that in America and Russia, where the cold is intense during winter, and the plants on the surface of the ground are deprived of light for six or seven months together by a covering of snow, all herbaceous vegetation is destroyed. Contrasted with these facts may be mentioned, as equally well ascertained, that annual plants in general attain a greater size, and a higher degree of perfection, where the winters are long, and the summers hot and light; the reason of which seems to be that the alternate action of heat and cold, rain and ice, meliorates the soil and prepares it better for the nourishment of annuals than it can well be in countries where the soil is not only harder naturally (for all countries that have long winters have soft soils), but more or less occupied by perennial weeds, insects, and vermin. In cold countries the insects are generally of that kind whose eggs go through the processes of the larva and chrysalis state under water, and land reptiles are generally rare.

1260. *Elevation*, when considerable, has an absolute influence on agriculture. The most obvious effect is that of obliging the agriculturist to isolate his dwelling from those of other cultivators or villagers in the plains, and to reside on his farm. This is well exemplified in Switzerland and Norway. We have already noticed the judicious reflections of Bakewell on the subject as referable to the former country (337.), and have also referred to those of Dr. Clarke respecting Norway (602.). The latter author has depicted these alpine farms, both with his elegant pen and skilful pencil (*fig.* 175).

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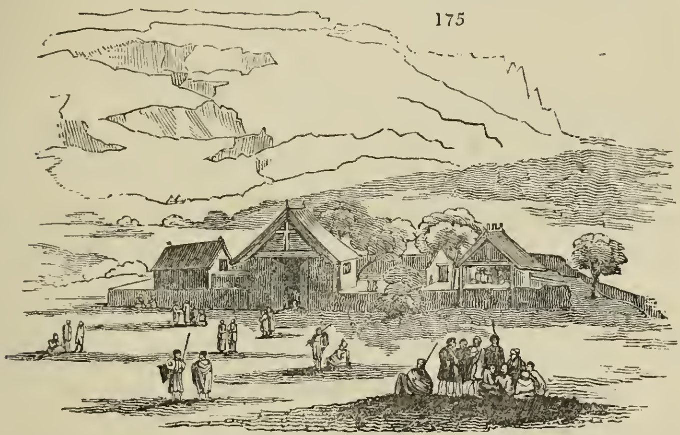

The farmeries are generally built with fir planks, and covered with birch bark and turf. The inhabitants chiefly live by the dairy, and seldom see their neighbours or any human being beyond their own fire-side, except on the Sunday mornings when they go to church, and on the Sunday afternoons in summer when they meet to dance (*fig.* 176.) and amuse themselves.

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1261. *As elevation is known to lessen temperature* in regular gradation according to the altitude above the sea, its influence on plants and animals must correspond. Three hundred feet in height are considered nearly equal to half a degree of latitude, and occasion a difference of temperature of nearly twelve degrees of Fahrenheit. Hence it is that the agriculture of the temperate, may sometimes be adopted in the torrid, zone; and that some of the mountains of Jamaica will produce, between their base and summit, almost all the plants of the world. Hence, also, that even in the limited extent of the island of Britain, a given elevation on mountains in Devonshire will be adapted for an agriculture different from that required by the same elevation on the Cheviot, Grampian, or Sutherland mountains; and while wheat ripens at six hundred feet above the level of the sea in Cornwall, oats will hardly ripen at that height in the Western Isles.

1262. *Elevation exposes plants and animals to the powerful operation of wind*, and in this respect must influence the disposition of the fields, fences, plantations, and buildings of the agriculturist, as well as the plants and animals on the farm. It has some influence also on the density of the air and the supplies of water and vapour, and even in these respects must affect the character of the agriculture. In Switzerland and Norway the upper mountain-farms are completely above the more dense strata of clouds, and their occupiers are often for weeks together without getting a view of the plains or valleys below.

1263. *That soil* must influence the agriculture of a country appears at first sight very obvious; though, if climate is favourable, time and art will render the soil fit for any species of culture. Naturally, however, soil has a powerful influence; and the period, under ordinary management, will be considerable, before strong deep clays on a flat surface can be rendered equally fit for the turnip or potato, with friable loams, or more gravelly or sandy soils.

1264. *The influence of moisture* on the state of lands is naturally very considerable; and though draining or irrigation can effectually remove excesses or supply deficiency, yet fen lands and chalk hills, such as we find in Huntingdonshire, Surrey, and other counties, will ever have a peculiar character of agriculture; the marsh perennial hay grasses will be the characteristic plants of the former, and saintfoin of the latter.

1265. *As the general result* of this outline of the influence of physical circumstances on agriculture, we may form a classification of that of any particular country to whichever of the four universal divisions (1254. to 1257.) it belongs. We submit the following: —

1266. *The agriculture of water-fed lands,* including fens, marshes, and marsh meadows.

1267. *The agriculture of sun-burnt lands,* including chalk, gravel, and sandy hills, where vegetation is annually more or less burned up during two or more of the summer months.

1268. *The agriculture of mountains,* in which the farmery is placed on the farm, as distinguished from those cases in which the whole or a part of the mountain lands is appended to lands on the plain.

1269. *Common agriculture,* or that of the plains, valleys, and hills of a country, in which all the crops and all the animals suitable to the climate may be profitably cultivated and reared.

Chap. III.

Agriculture as affected by Civil, Political, and Religious Circumstances.

1270. *The influence of the state of society and government on agriculture* must, as well as the climate and situation, obviously be very considerable; for it will signify little what a country is capable of producing, if the inhabitants are too barbarous to desire, too ignorant to know, or too much oppressed to attain, these products. Some of the finest lands in the world, capable of producing wheat, maize, rice, and the grape, are inhabited by savages, who live on game, wild fruits, or native roots; or by half-civilised tribes who cultivate maize and yams, or some other local root. Even in Ireland, where the soil is better than in Britain, and with very moderate culture will produce excellent wheat and other corns, with beef, mutton, and wool, the greater part of the inhabitants, from ignorance, oppression, and in part, as we have seen (852.), religious slavery, content themselves with roots and rags, the latter often the cast off refuse of other countries.

1271. *The state of civilisation and refinement of a people* not only influences agriculture by the nature of the products such a state requires, but also by the means of production it affords; by the superior ease with which information on every subject may be attained; and by the existing state of knowledge, for example, in mechanics, chemistry, and physiology, by which the implements and machines are improved, the operations of soils and manures regulated, the influence of water, the atmosphere, and the functions of plants and animals understood. The difference in the means taken to effect the same end in a poor but yet ingenious country, and in one rich and enlightened, is exemplified in China and India, as compared with Britain. Wealth and ignorance, as contrasted with poverty and ingenuity, may also be exemplified in comparing the farmer of Hindustan with the English farmer. The latter, to stir the soil, employs an unwieldy implement drawn by several oxen or horses; the former uses a small light implement drawn by one ox or buffalo, but effects his object by repeating the operation many times. The Englishman effects it at once, often in spite of the worst means, by main force. The processes of Chinese manufacture are exceedingly curious and ingenious, and form a remarkable contrast to the rapid and scientific processes of Britain. There are many curious practices in France and Germany, the result of poverty and ingenuity. In Brittany the whin is used as horse provender: to bruise the spines one man operates on a simple but ingenious machine (*fig.* 177.), and effects his purpose completely. Here the same thing is done by a couple of iron rollers turned by a horse or by water: but the farmer of Brittany, who would purchase a pair of whin-bruising rollers, must first sell the greater part of his stock and crop.

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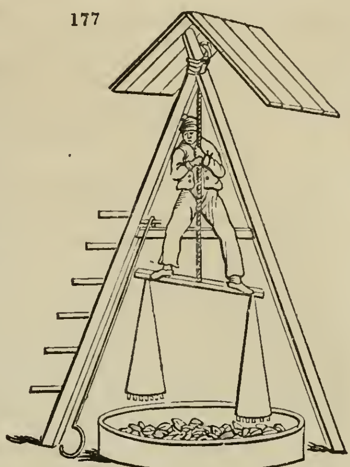

1272. *The political state of a country* will powerfully affect its agriculture. Where security, the greatest object of government, is procured at too high a rate, the taxes will depress the cultivator, and not only consume his profits, but infringe on his capital; where security, either relatively to external circumstances or internal laws, is incomplete, there the farmer who has capital will be unwilling to risk it: in either case, few who have capital will engage in that profession; and if any find it profitable, the fear of exposing himself to exactions from government or from his landlord, will prevent him from making a proper use of his profits either in the way of employment or of consumption. Many instances of this state of things are to be found in the foregoing history. Wherever the metayer system orthat of short leases prevails, whatever may be the nature or practice of the government, these remarks will apply. Security and liberty at a moderate price are essential to the prosperity of agriculture, even more so than to that of manufactures or commerce.

1273. *Religion* may be thought to have very little influence on agriculture: but in a Catholic or Mohammedan country, where the religion enjoins a frequent abstinence from animal food, and long periodical fasts from even the produce of the cow, surely the rearing and feeding of stock for the shambles or the dairy cannot prosper to the same extent as in a country less enslaved by prejudice, or whose religious opinions do not interfere with their cookery. The number of holidays is also a great grievance.

1274. *The natural character of a people* may even have some influence on their agriculture, independently of all the other circumstances mentioned. The essential character of a people is formed by the climate and country in which they live, and their factitious or accidental character by their government and religion for the time being. The latter may alter, but the original or native character remains. Thus the French appear to be the same gay people that they were in the time of Julius Cæsar; and, as far as history enables us to judge, the Greeks and Romans have only lost their accidental character.

1275. *The agriculture of the world, in regard to the state of society,* may perhaps admit of the following divisions:—

1276. *The agriculture of science,* or modern farming, in which the cultivator is secure in his property or possession, both with relation to the government and to the landlord he lives under, as generally in Britain and North America.

1277. *The agriculture of habit,* or feudal culture, in which the cultivator is a metayer, or a tenant at will, or on a short lease, or has covenanted to pursue a certain fixed system of culture.

1278. *Barbarian agriculture,* or that of a semi-barbarous people who cultivate at random, and on land to which they have no defined right of possession, roots or grain, without regard to rotation, order, or permanent advantage.

1279. *The economy of savages,* such as hunting, fishing, gathering fruits, or digging up roots.

Chap. IV.

Of the Agriculture of Britain.

1280. To which of these *geographical, physical, and social divisions of agriculture* that of the British isles may be referred, is the next object to be determined, and we submit the following as its classification:—

1281. *Geographically* it is the agriculture of draining and manures.

1282. *Physically,* those of water-fed and sun-burnt lands, mountains, and variable plains.

1283. *Socially* considered, it is the agriculture of science.

1284. *The following* Parts *of this work,* therefore, are to be considered as treating of a kind of agriculture so characterised; that is, of the agriculture of our own country. Whoever has paid a due attention to what has preceded, can scarcely fail to have formed an idea of the agriculture of every other part of the world.

PART II.

AGRICULTURE CONSIDERED AS A SCIENCE.

285. *All knowledge is founded on experience;* in the infancy of any art, experience is confined and knowledge limited to a few particulars; but as arts are improved and extended, a great number of facts become known, and the generalisation of these, or the arrangement of them according to some leading principle, constitutes the theory, science, or law of an art.

1286. *Agriculture, in common with other arts*, may be practised without any knowledge of its theory; that is, established practices may be imitated: but in this case it must ever remain stationary. The mere routine practitioner cannot advance beyond the limits of his own particular experience, and can neither derive instruction from such accidents as are favourable to his object, nor guard against the recurrence of such as are unfavourable. He can have no resource for unforeseen events but ordinary expedients; while the man of science resorts to general principles, refers events to their true causes, and adapts his measures to meet every case.

1287. *The object of the art of agriculture* is to increase the quantity and improve the quality of such vegetable and animal productions of the earth as are used by civilised man; and the object of the agriculturist is to do this with the least expenditure of means, or, in other words, with profit. The result of the experience of mankind as to other objects may be conveyed to an enquiring mind in two ways: he may be instructed in the practical operations of the art, and their theory, or the reasons on which they are founded, laid down and explained to him as he goes along; or he may be first instructed in general principles, and then in the practices which flow from them. The former mode is the natural and actual mode in which every art is acquired (in so far as acquirement is made) by such as have no recourse to books, and may be compared to the natural mode of acquiring a language without the study of its grammar. The latter mode is by much the more correct and effectual, and is calculated to enable an instructed agriculturist to proceed with the same kind of confidence and satisfaction in his practice, that a grammarian does in the use of language.

1288. In adopting what we consider as *the preferable mode of agricultural instruction*, we shall, as its grammar or science, endeavour to convey a general idea of the nature of vegetables, animals, minerals, mixed bodies, and the atmosphere, as connected with agriculture; of agricultural implements and other mechanical agents; and of agricultural operations and processes.

1289. *The study of the science of agriculture* may be considered as implying a regular education in the student, who ought to be well acquainted with arithmetic and mensuration; and to have acquired the art of sketching objects, whether animals, vegetables, or general scenery, of taking off and laying down geometrical plans: but especially he ought to have studied chemistry, hydraulics, and something of carpentry, smithery, and the other building arts; and, as Professor Von Thaer observes, he ought to have some knowledge of all those manufactures to which his art furnishes the raw materials.

BOOK I.

OF THE STUDY OF THE VEGETABLE KINGDOM WITH A VIEW TO AGRICULTURE.

1290. *The various objects with which we are surrounded* are either organised, having several constituent parts which united form a whole capable of increase by nourishment; or they are unorganised, and only increased by additions to their external parts. To the first division belong the animal and vegetable kingdoms, and their study is founded chiefly on observation: to the second belongs the mineral kingdom, the study of which in masses, or geology and mineralogy, is also founded chiefly on observation; and, with regard to composition and elements, on experiment or chemistry.

1291. *Vegetables are distinguished from animals* in not being endowed with sentiment, or a consciousness of existence. Their study has employed the attention of mankind from a very early period; and has been carried to a high degree of perfection within the last century; more especially by the exertions of Linnæus, and those of Jussieu, Mirbel, and some other French philosophers. This study comprehends systematic botany, vegetable anatomy, vegetable chemistry, physiology, pathology, the distribution of vegetables, and vegetable culture. The study of these branches is of the utmost importance to the agriculturist, especially that of vegetable physiology; and though the limits of this work do not permit us to enter into the subject at great length; yet we shall direct his attention to the leading points, and refer him to the best books.

Chap. I.

Of the Study of Systematic Botany.

1292. *Glossology*, or the study of the names of the parts of plants, is the first step in this department.

1293. *All the arts and sciences require to express with brevity and perspicuity a crowd of ideas unused in common language*, and unknown to the greater part of men: whence that multitude of terms, or technical turns, given to ordinary words, which the public often turn into ridicule, because they do not feel the use of them; but which all are obliged to make use of, who apply themselves to any study whatever. Botany having to describe an immense number of beings, and each of these beings having a great variety of organs, requires a great variety of terms. Nearly all botanists are agreed as to these terms, and in order that they may be universally understood and remain unchanged in meaning, they are taken from a dead or fixed language.

1294. *A plant in flower, surveyed externally*, may be perceived to be composed of a variety of obvious parts, such as the root, the stem, the branch, the leaf, the flower, the fruit, and perhaps the seed; and other parts less obvious, as buds, prickles, tendrils, hairs, glands, &c. These, with their modifications, and all the relative circumstances which enter into the botanical description of a plant, constitute the subject of glossology, or the study of the language of botany. The reader may consult Smith's *Introduction to Botany*, or almost any recent work on the elements of botanical science.

1295. *Phytography, or the naming and describing of plants*, is the next part of the subject to be considered. Before botany became a regular science, plants were named as individual beings, without regard to any relation which they had to one another. But from the great number of names to be retained on the memory, and the obvious affinities existing among certain individuals or natural families, some method was soon found necessary, and it was then deemed requisite to give such composite names as might recall to mind something of the individuals to which they were applied. Thus we had *Anagállis flòre cærùleo*, *Méspilus aculeàta pyrifòlia*, &c. In the end, however, the length of these phrases became inconvenient, and Linnæus, struck with this inconvenience, proposed that the names of plants should henceforth consist of two words only, the one the generic or family name, and the other the specific or individual name.

1296. *The names of classes and orders* were originally primitive or without meaning, as the *Grasses* of Tragus, *Poppies* of Bauhin, &c.; and afterwards so compounded as to be long and complex, as the *Polloplostemonopétalæ*, *Eleutheromacrostémones*, &c., of Wachendorf. Linnæus decided that the names of classes and orders should consist of a single word, and that word not simple or primitive, but expressive of a certain character or characters found in all the plants which compose it.

1297. *In applying names to plants, three rules are laid down by botanists:* 1st, That the languages chosen should be fixed and universal, as the Greek and Latin. 2d, That these languages should be used according to the general laws of grammar, and compound words always composed from the same language, and not of entire words, &c. 3d, That the first who discovers a being, and enregisters it in the catalogue of nature, has the right of giving it a name; and that that name ought to be received and admitted by naturalists, unless it belongs to a being already existing, or transgresses the rules of nomenclature. Every one who discovers a new plant may not be able to enregister it according to these laws, and in that case has no right to give it a name; but the botanist who enregisters it, and who is in truth the discoverer, may give it the name proposed by the finder, if he chooses.

1298. *The whole vegetable kingdom is divided into classes, orders, genera, species, and varieties.* A class is distinguished by some character which is common to many plants; an order is distinguished by having some character limited to a few plants belonging to a class; a still more limited coincidence constitutes a genus; and each individual of a genus, which continues unchanged when raised from seed, is called a species. A variety is formed by an accidental deviation from the specific character, and easily returns by seed to the particular species from which it arose.

1299. *For the purposes of recording and communicating botanical knowledge* plants are described; and this is done either by the use of language alone, or by language and figures, models, or dried plants, conjoined. The description of plants may be either abridged or complete. The shortest mode of abridgement is that employed in botanical catalogues, as in those of Donn or of Sweet. The most exact descriptions are deficient without *figures* or *a herbarium*. Hence the advantage of being able to see plants at pleasure, by forming dried collections of them. Most plants dry with facility between the leaves of books, or between sheets of paper, the smoother the better. If there is plenty of paper, they often dry best without shifting; but if the specimens are crowded, they must be taken out frequently, and the paper dried before they are replaced.

1300. *The language of botany* may be acquired by two methods, analogous to these by which common languages are acquired. The first is the natural method, which begins with the great and obvious classes of vegetables, and distinguishes trees, grasses, &c., next individuals among these, and afterwards their parts or organs: this knowledge is acquired insensibly, as we acquire our native tongue. The second is the artificial method, and begins with the parts of plants, as the leaves, roots, &c., ascending to nomenclature and classification, and is acquired by particular study, aided by books or instructors, as one acquires a dead or foreign language. This method is the fittest for such as wish to attain a thorough knowledge of plants, so as to be able to describe them; the other mode is easier, and the best suited for cultivators, whose object does not go beyond that of understanding their descriptions, and studying their physiology, history, and application. A very good method, for a person at a distance from botanists, is to form a collection of dried specimens of all the plants of which he wishes to know the names, and to send them to the curator of the nearest botanic garden, requesting him to write the name below each specimen, and to refer to some work easily procured, such as Lindley's *Vasculares*, or Withering or Gray's *Arrangement of British Plants*, in which are given its description, uses, history, &c. We know of no work in which an attempt has been made to comprehend so much, both of theoretical and practical botany, as is comprised in our *Encyclopædia of Plants*; and to those therefore who cannot afford to have many books, and especially to gardeners, for whose convenience it is more especially intended, it may be confidently recommended.

1301. *Taxonomy, or the classification of plants,* is the last part of the study of technological botany. It is very evident, that, without some arrangement, the mind of man would be unequal to the task of acquiring even an imperfect knowledge of the various objects of nature. Accordingly, in every science, attempts have been made to classify the different objects that it embraces, and these attempts have been founded on various principles: some have adopted artificial characters; others have endeavoured to detect the natural relations of the beings to be arranged, and thus to ascertain a connection by which the whole may be associated. In the progress of zoology and botany, the fundamental organs on which to found a systematic arrangement have been finally agreed on. In both, those which are essential, and which discover the greatest variety, form the basis of classification. Animals are found to differ most from each other in the organs of nutrition, plants in the organs of reproduction.

1302. *Two methods of arranging vegetables* have been distinguished by botanists, the natural and the artificial. A natural method is that which, in its distribution, retains all the natural classes; that is, groups into which no plants enter which are not connected by numerous relations, or which can be disjoined without doing a manifest violence to nature. An artificial method is that whose classes are not natural, because they collect together several genera of plants which are not connected by numerous relations, although they agree in the characteristic mark or marks assigned to that particular class or assemblage to which they belong. An artificial method is easier than the natural, as in the latter it is nature, in the former the writer, who prescribes to plants the rules and order to be observed in their distribution. Hence, likewise, as nature is ever uniform, there can be only one natural method; whereas artificial methods may be multiplied almost *ad infinitum*, according to the different relations under which bodies are viewed.

1303. *The object of the natural method* is to promote our knowledge of the vegetable kingdom by generalising facts and ideas; the object of the artificial method is to facilitate the knowledge of plants as individual objects. The merits of the former method consist in the perfection with which plants are grouped together in natural families or orders, and these families grouped among themselves; the merits of the latter consist in the perfection with which they are arranged according to certain marks by which their names may be discovered. Plants arranged according to the natural method may be compared to words arranged according to their roots or derivations; arranged according to an artificial method they may be compared to words in a dictionary. The success attending attempts at botanical arrangement, both natural and artificial, has been singularly striking. Linnæus has given the most beautiful artificial system that has ever been bestowed by genius on mankind; and Jussieu has, with unrivalled ability, exhibited the natural affinities of the vegetable kingdom. For the study of this department we refer to the works of Smith, Lindley, Decandolle, and Gray, but especially to the *Encyclopædia of Plants.*

Chap. II.

Vegetable Anatomy, or the Structure and Organisation of Plants.

1304. *Vegetables may be classed for the study of their anatomy and physiology,* accordingly as they are distinguished by a structure or organisation more complicated or more simple. The former will constitute what may be denominated perfect plants, and will form a class comprehending the principal mass of the vegetable kingdom; the latter will constitute what may be denominated imperfect plants, and will form a class comprehending all such vegetables as are not included in the foregoing class. We shall first consider their external, and next their internal, organisation.

Sect. I. *Of the External Structure of Perfect Plants.*

1305. *The parts of perfect plants* may be distributed into conservative and reproductive, as corresponding to their respective functions in the economy of vegetation.

1306. *The conservative organs* are such as are absolutely necessary to the growth and preservation of the plant, and include the root, trunk, branch, leaf, and frond.

1307. *The root* is that part of the plant by which it attaches itself to the soil in which it grows, or to the substance on which it feeds, and is the principal organ of nutrition.

1308. *The trunk* is that part of the plant which, springing immediately from the root, ascends in a vertical position above the surface of the soil, and constitutes the principal bulk of the individual.

1309. *The branches* are the divisions of the trunk, originating generally in the upper extremity, but often also along the sides.

1310. *The leaf,* which is a temporary part of the plant, is a thin and flat substance of a green colour, issuing generally from numerous points towards the extremities of the branches, but sometimes also immediately from the stem or root, and distinguishable by the sight or touch into an upper and under surface, a base and apex, with a midrib and lateral veins or nerves.

1311. *The frond,* which is to be regarded as a compound of several of the parts already described, consists of a union or incorporation of the leaf, leaf-stalk, and branch or stem, forming, as it were, but one organ, of which the constituent parts do not separate spontaneously from one another by means of the fracture of any natural joint, as in the case of plants in general, but adhere together even in their decay. It is found in palms and ferns.

1312. *The conservative appendages* are such accessory or supernumerary parts as are found to accompany the conservative organs occasionally, but not invariably. They are permanent in whatever species they are found to exist, some being peculiar to one species, and some to another; but they are never found to be all united in the same species, and are not necessarily included in the general idea of the plant. They are denominated gems, glands, tendrils, stipulæ, ramenta, armature, pubescence, and anomalies.

1313. *Gems or bulbs* are organised substances issuing from the surface of the plant, and containing the rudiments of new and additional parts which they protrude; or the rudiments of new individuals, which they constitute by detaching themselves ultimately from the parent plant, and fixing themselves in the soil.

1314. *Glands* are small and minute substances of various forms, found chiefly on the surface of the leaf and petiole, but often also on the other parts of the plant, and supposed to be the organs of secretion.

1315. *The tendril* is a thread-shaped and generally spiral process issuing from the stem, branch, or petiole, and sometimes even from the expansion of the leaf itself, being an organ by which plants of weak and climbing stems attach themselves to other plants or other substances for support; for which purpose it seems to be well fitted by nature, the tendril being much stronger than a branch of the same size.

1316. *The stipulæ* are small foliaceous appendages accompanying the real leaves, and assuming the appearance of leaves in miniature.

1317. *Ramenta* are thin, oblong, and strap-shaped appendages, of a brownish colour, issuing from the surface of the plant, and somewhat resembling the stipulæ, but not necessarily accompanying the leaves.

1318. *The armature* consists of such accessory and auxiliary parts as seem to have been intended by nature to defend the plant against the attacks of animals.

1319. *The pubescence* is a general term, including under it all sorts of vegetable down or hairiness, with which the surface of the plant may be covered, finer or less formidable than the armature.

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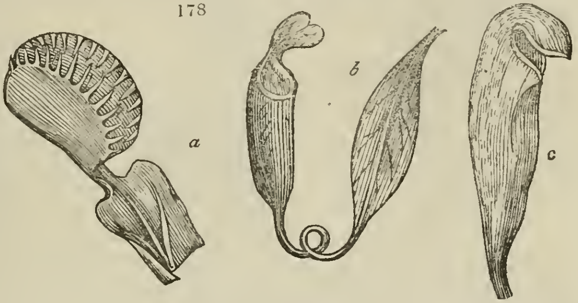

1320. *Anomalies.* There are several other appendages proper to conservative organs, which are so totally different from all the foregoing, that they cannot be classed with any of them; and so very circumscribed in their occurrence, that they do not yet seem to have been designated by any peculiar appellation. The first anomaly, affecting the conservative appendages, occurs in Dionæ'*a* muscípula, Venus's fly-trap. (*fig.* 178. *a*) A second is that which occurs in Sarracèn*ia* purpùrea or purple side-saddle-flower (*b*). A third, which is still more singular, occurs in *N*epénthes distillatòria (*c*). The last anomaly is a small globular and membranaceous bag, attached as an appendage to the roots and leaves of some of the aquatics. It is confined to a few genera, but it is to be seen in great abundance on the roots or leaves of the several species of Utriculària inhabiting the ponds and ditches of this country; and on the leaves of Aldrovánd*a* vesiculòsa, an inhabitant of the marshes of Italy. In Utriculària vulgàris this appendage is pear-shaped, compressed, with an open border at the small end, furnished with several slender fibres originating in the margin, and containing a transparent and watery fluid and a small bubble of air, by means of which it seems to acquire a buoyancy that suspends it in the water.

1321. *The reproductive organs* are such parts of the plant as are essential to its propagation, whose object is the reproduction of the species, terminating the old individual, and beginning the new. It includes the flower, with its immediate accompaniments or peculiarities, the flower-stalk, receptacle, and inflorescence, together with the ovary or fruit.

1322. *The flower*, like the leaf, is a temporary part of the plant, issuing generally from the extremity of the branches, but sometimes also from the root, stem, and even leaf, being the apparatus destined by nature for the production of the fruit, and being also distinguishable, for the most part, by the brilliancy of its colouring or the sweetness of its smell.

1323. *The flower-stalk* is a partial trunk or stem, supporting one or more flowers, if the flowers are not sessile, and issuing from the root, stem, branch, or petiole, and sometimes even from the leaf.

1324. *The receptacle* is the seat of the flower, and point of union between the different parts of the flower, or between the flower and the plant, whether immediate and sessile, or mediate and supported upon a flower-stalk.

1325. *The inflorescence*, mode of flowering, is the peculiar mode of aggregation in which flowers are arranged or distributed upon the plant.

1326. *The fruit* is the ripened ovary, or seed-vessel which succeeds the flower. In popular language the term is confined chiefly to such fruits as are esculent, as the apple, the peach, and the cherry; but with the botanist the matured ovary of every flower, with the parts contained, constitutes the fruit.

1327. *Appendages.* The reproductive organs, like the conservative organs, are often found to be furnished with various additional and supernumerary parts, not at all essential to their constitution, because not always present, and hence denominated appendages. Many of them are precisely of the same character with that of the conservative appendages, except that they are of a finer and more delicate texture; such are the glands, down, pubescence, hairs, thorns, or prickles, with one or other of which the parts of the fructification are occasionally furnished: but others are altogether peculiar to the reproductive organs, and are to be regarded as constituting, in the strict acceptation of the term, true reproductive appendages. Some of them are found to be proper to the flower, as the involucre, spathe, bractea, &c.; and others to the fruit, as the persisting calyx, exemplified in the pomegranate.

Sect. II. *Of the External Structure of Imperfect Plants.*

1328. *Plants apparently defective* in one or other of the more conspicuous parts or organs, whether conservative or reproductive, are denominated imperfect. The most generally adopted division of imperfect plants is that by which they are distributed into *F*ílices, *E*quisetàceæ, Lycopodíneæ, *M*úsci, Hepáticæ, *A'*lgæ, *L*ichènes, and *F*úngi.

1329. *The* Fílices, Equisetàceæ, *and* Lycopodíneæ *are for the most part herbaceous*, and die down to the ground in the winter; but they are furnished with a perennial root, from which there annually issues a frond bearing the fructification. The favourite habitations of many of them are heaths and uncultivated grounds, where they are found intermixed with furze and brambles; but the habitations of such as are the most luxuriant in their growth are moist and fertile spots, in shady and retired situations, as on mossy dripping rocks, or by fountains and rills of water. Some of them will thrive even on the dry and barren rock, or in the chinks and fissures of walls; and others only in wet and marshy situations where they are half immersed in water.

1330. *The* Músci (*fig.* 179. *a b*) *form a tribe of imperfect plants* of a diminutive size, often consisting merely of a root, surmounted with a tuft of minute leaves, from the centre of which the fructification springs; but furnished for the most part with a stem and branches, on which the leaves are closely imbricated, and the fructification terminal or lateral They are perennials and herbaceous, approaching to shrubby; or annuals, though rarely so, and wholly herbaceous, the perennials being also evergreens.

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1331. *The Hepáticæ* (*fig.* 179. *c*) *form a tribe of small herbaceous plants resembling the mosses*, but chiefly with frondose herbage, and producing their fruit in a capsule that splits into longitudinal valves. In their habitations, they affect for the most part the same sort of situations as the mosses, being found chiefly in wet and shady spots, by the sides of springs and ditches, on the shelving brinks of rivulets, or on the trunks of trees. Like the mosses, they thrive best also in cold and damp weather, and recover their verdure though dried, if moistened again with water.

1332. *The* A'*lgæ, or sea-weeds*, include not merely marine and many other submersed plants, but also a great variety of plants that are not even aquatics. All the *A'*lgæ agree in the common character of having their herbage frondose, or but rarely admitting of the distinction of root, stem, and leaf.

1333. *The utility of the* A'*lgæ* is obviously very considerable, whether we regard them as furnishing an article of animal food, or as applicable to medicine and the arts. The Laminària saccharìna (*fig.* 180 *a*), Halymènia palmàta (*b*) and edùlis (*c*), and several other *F*ùci, are eaten, and much relished by many people, whether raw or dressed; and it is likely that some of them are fed upon by various species of fish. The *F*ùcus *l*ichenöìdes (*Turner*, c. 118.) is now believed to be the chief material of the edible nests of the East India swallows, which are so much esteemed for soups, that they sell in China for their weight in silver. (*Far. Mag.*, vol. xx.) When disengaged from their place of growth and thrown upon the sea-shore, the European *A'*lgæ are often collected by the farmer and used as manure. They are also often employed in the preparation of dyes, as well as in the lucrative manufacture of kelp, a commodity of the most indispensable utility in the important arts of making soap and glass.

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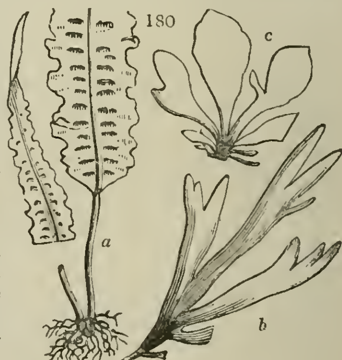
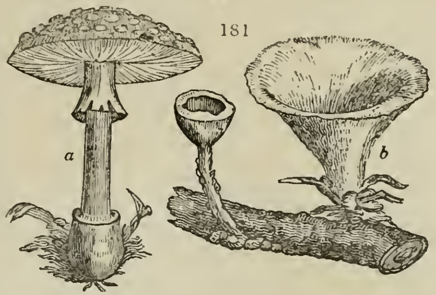


1334. *The utility of the Lichènes* is also worthy of notice. The *L*ìchen rangiferìnus forms the principal nourishment of the reindeer during the cold months of winter, when all other herbage fails. The *L*íchen islándicus is eaten by the Icelanders instead of bread, or used in the preparation of broths; and, like the *L*ìchen pulmonàrius, has been lately found to be beneficial in consumptive affections. Many of them are also employed in the preparation of some of our finest dyes or pigments; and it is from the Lecanòra parélla that the chemical analyst obtains his litmus. The lichens and the mosses seem instituted by nature to provide for the universal diffusion of vegetable life over the whole surface of the terrestrial globe. The powdery and tuberculous lichens attach themselves even to the bare and solid rock. Having reached the maturity of their species, they die and are converted into a fine earth, which forms a soil for the leathery lichens. These again decay and moulder into dust in their turn; and the depth of soil, which is thus augmented, is now capable of nourishing and supporting other tribes of vegetables. The seeds of the mosses lodge in it, and spring up into plants, augmenting also by their decay the quantity of soil, and preparing it for the support of plants of a more luxuriant growth, so that, in the revolution of ages, even the surface of the barren rock is covered with a soil capable of supporting the loftiest trees.

1335. *The* Fúngi *form a tribe of plants whose herbage is a frond of a fleshy or pulpy texture*, quick in its growth and fugacious in its duration, and bearing seeds or gems in an appropriate and exposed membrane, or containing them interspersed throughout its mass. This assemblage of plants may be regarded as the lowest in the vegetable scale, exhibiting a considerable resemblance to the tribe of zoophites, and thus forming the connecting link between the vegetable and animal kingdoms. The habitations they affect are very various, many of them vegetating on the surface of the earth (*fig.* 181. *a*), and some of them even buried under it; others on stumps and trunks of rotten trees (*b*); others on decayed fruit; others on damp and wet walls; and others on animal ordure.



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1336. *Uses of the* Fúngi. The powder of the lycoperdons is said to be an excellent styptic; and is remarkable also for its property of strongly repelling moisture. If a basin be filled with water, and a little of the powder strewed upon the surface so as to cover it only, the hand may be plunged into it and thrust down to the bottom without being wetted with a single drop of water. Several of the boleti, when dried, afford a very useful tinder; and several of the agarics and tubers are used as articles of food, or as ingredients in the preparation of seasoning. The truffle is much esteemed for the rich and delicate flavour which it imparts to soups and sauces; and the mushroom and morel for their esculent property, and their utility in the preparation of catsup.

Sect. III. *Of the Internal Structure of Plants.*

1337. *The organs of plants discoverable by external examination* are themselves reducible into component organs, which are again resolvable into constituent and primary organs. These are called the decomposite, the composite, and the elementary.

Subsect. 1. *Decomposite Organs.*

1338. *The decomposite organs* are distinguishable on external examination, and constitute the vegetable individual; to the dissection of which we will now proceed, in the order of the seed, pericarp, flower, leaf, gem, and caudex, with their decomposite appendages.

1339. *The seed.* The mass of the seed consists of two principal parts, distinguishable without much difficulty; namely, the integuments and nucleus, or embryo and its envelopes.

1340. *The integuments* proper to the seed are two in number, an exterior integument and an interior integument.

1341. *The exterior integument*, or *testa*, is the original cuticle of the nucleus, not detachable in the early stages of its growth, but detachable at the period of the maturity of the fruit, when it is generally of a membranaceous or leathery texture; though sometimes soft and fleshy, and sometimes crustaceous and bony. It may be very easily distinguished in the transverse or longitudinal section of the garden bean or any other large seed

1342. *The interior integument*, or *membrana*, lines the exterior integument, or testa, and immediately envelopes the nucleus. Like the testa, to which indeed it adheres, it may be easily distinguished in the garden bear (*fig.* 182.), or in a ripe walnut; in which latter it is a fine transparent and netlike membrane.

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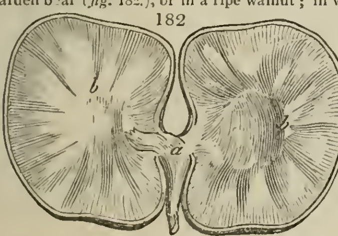

1343. *The nucleus* is that part of the seed which is contained within the proper integuments, consisting of the albumen with the vitellus, when present, and embryo.

1344. *The albumen* is an organ resembling in its consistence the white of an egg, and forming, in most cases, the exterior portion of the nucleus, but always separable from the interior or remaining portion.

1345. *The vitellus* is an organ of a fleshy but firm contexture, situated, when present, between the albumen and embryo; to the former of which it is attached only by adhesion, but to the latter by incorporation of substance, so as to be inseparable from it, except by force.

1346. *The embryo*, which is the last and most essential part of the seed, and the final object of the fructification, as being the germ of the future plant, is a small and often very minute organ, enclosed within the albumen and occupying the centre of the seed.

1347. *The cotyledon*, or seed-lobe (*b*), is that portion of the embryo that encloses and protects the plantlet, and springs up during the process of germination into what is usually denominated the seminal leaf, if the lobe is solitary; or seminal leaves, if there are more lobes than one. In the former case the seed is said to be monocotyledonous; in the latter case, it is said to be dicotyledonous. Dicotyledonous seeds, which constitute by far the majority, are well exemplified in the garden bean. As there are some seeds whose cotyledon consists of one lobe only, falling short of the general number, so there are also a few whose cotyledon is divisible into several lobes, exceeding the general number. These have been denominated polycotyledonous seeds, and are exemplified in the case of *Lepidium sativum* or common garden cress, in which the lobes are six in number; as in that also of the different species of the genus *Pinus*, in which they vary from three to twelve.

1348. *The plumule* (*a*), the future plant in miniature, is the interior and essential portion of the embryo, and seat of vegetable life. In some seeds it is so minute as to be scarcely perceptible; while in others it is so large as to be divisible into distinct parts, as in the garden bean.

1349. *The pericarp*, which in different species of fruit assumes so many varieties of contexture, acquires its several aspects, not so much from a diversity of substance as of modification.

1350. *The valves of the capsule*, but particularly the partitions by which it is divided into cells, are composed of a thin and skinny membrane, or of an epidermis covering a pulp more or less indurated, and interspersed with longitudinal fibres. The capsule of the mosses is composed of a double and netlike membrane, enclosed within a fine epidermis.

1351. *The pome* is composed of a fine but double epidermis, or, according to Knight, of two skins, enclosing a soft and fleshy pulp, with bundles of longitudinal fibres passing through it, contiguous to, and in the direction of, its longitudinal axis.

1352. *The valves of the legume* are composed of an epidermis enclosing a firm but fleshy pulp lined for the most part with a skinny membrane, and of bundles of longitudinal fibres forming the seam.

1353. *The nutshell*, whether hard and bony, or flexible and leathery, is composed of a pulp more or less highly indurated, interspersed with longitudinal fibres, and covered with an epidermis.

1354. *The drupe* is composed of an epidermis enclosing a fleshy pulp, which is sometimes so interwoven with a multiplicity of longitudinal fibres as to seem to consist wholly of threads, as in the cocoa-nut.

1355. *The berry* is composed of a very fine epidermis enclosing a soft and juicy pulp.

1356. *The scales of the strobile* are composed of a tough and leathery epidermis, enclosing a spongy but often highly indurated pulp interspersed with longitudinal fibres that pervade also the axis.

1357. *The flower-stalk*, or peduncle supporting the flower, which is a prolongation of the stem or branch, or rather a partial stem attached to it, if carefully dissected with the assistance of a good glass, will be found to consist of the following parts: — 1st, An epidermis, or external envelope; 2dly, A parenchyma, or soft and pulpy mass; 3dly, Bundles of longitudinal threads or fibres, originating in the stem or branch, and passing throughout the whole extent of the parenchyma. The several organs of the flower are merely prolongations of the component parts of the flower-stalk, though each organ does not always contain the whole of such component parts, or at least not under the same modifications. The epidermis, however, and parenchyma are common to them all; but the longitudinal threads or fibres are seldom, if ever, to be found, except in the calyx or corolla.

1358. *The leaf-stalk*, or petiole supporting the leaf, which is a prolongation of the branch or stem, or rather a partial stem attached to it, exhibits upon dissection the same sort of structure as the peduncle, namely, an epidermis, a pulp or parenchyma, and bundles of longitudinal threads or fibres.

1359. *Gems.* There exist among the different tribes of vegetables four distinct species of gems, two peculiar to perfect plants, the bud and bulb, and two peculiar to imperfect plants, the propago and gongylus; the latter being denominated simple gems, because furnished with a single envelope only; and the former being denominated compound gems, because furnished with more than a single envelope.

1360. *Buds* are composed externally of a number of spoon-shaped scales, overlapping one another and converging towards a point in the apex, and often cemented together by means of a glutinous or mucilaginous substance exuding from their surface. If these scales are stripped off and dissected under the microscope, they will be found to consist, like the leaves or divisions of the calyx, of an epidermis enclosing a pulp interspersed with a network of fibres, but unaccompanied with longitudinal threads. If the scales of a leaf-bud are taken and stripped off, and the remaining part carefully opened up, it will be found to consist of the rudiments of a young branch terminated by a bunch of incipient leaves embedded in a white and cottony down, being minute but complete in all their parts and proportions, and folded or rolled up in the bud in a peculiar and determinate manner.

1361. *Bulbs*, which are either radical or caulinary, exhibit in their external structure, or in a part of their internal structure that is easily detected, several distinct varieties, some being solid, some coated, and some scaly; but all protruding in the process of vegetation the stem, leaf, and flower, peculiar to their species.

1362. *The propago*, which is a simple gem, peculiar to some genera of imperfect plants, and exemplified by Gærtner in the lichens, consists of a small and pulpy mass forming a granule of no regular shape, sometimes naked, and sometimes covered with an envelope, which is a fine epidermis.

1363. *The gongylus*, which is also a simple gem peculiar to some genera of imperfect plants, and exemplified by Gærtner in the fuci, consists of a slightly indurated pulp moulded into a small and globular granule of a firm and solid contexture, and invested with an epidermis.

1364. *The caudex* includes the whole mass or body both of the trunk and root; its internal structure, like its external aspect or habit, is materially different in different tribes of plants.

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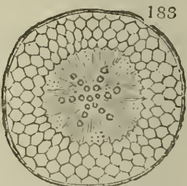

1365. *The first general mode of the internal structure of the caudex* is that in which an epidermis encloses merely a *homogeneous mass* of pulp or slender fibre. This is the simplest mode of internal structure existing among vegetables; it is exemplified in the lower orders of imperfect plants, particularly the *A'lgæ* and *Fúngi*.

1366. *The second general mode of internal structure of the caudex* is that in which an epidermis encloses two or more substances, or assemblages of substances, totally *heterogeneous* in their character. A very common variety of this mode is that in which an epidermis or bark encloses a *soft and pulpy* mass, interspersed with a number of longitudinal nerves or fibres, or bundles of fibres, extending from the base to the apex, and disposed in a peculiarity of manner characteristic of a tribe or genus. This mode prevails chiefly in herbaceous and annual or biennial plants. (*fig.* 183.) A second variety of this mode is that in which a strong and often thick bark encloses a circular layer of longitudinal fibres, or several such circular and concentric layers, interwoven with thin transverse and divergent layers of pulp, so as to form a *firm and compact* cylinder, in the centre of which is lodged a pulp or pith. This mode is best exemplified in trees and shrubs (*fig.* 184.), though it is also applicable to many plants whose texture is chiefly or almost wholly herbaceous, forming as it were the connecting link between such plants as are purely herbaceous on the one hand, and such as are purely woody on the other. In the latter case the wood is perfect; in the former case it is imperfect. The wood being imperfect in the root of the beet, the common bramble, and burdock; and perfect in the oak or alder.

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1367. *The appendages* of the plant, whether conservative or reproductive, exhibit nothing in their internal structure that is at all essentially different from that of the organs that have been already described.

Subsect. 2. *Composite Organs.*

1368. *The composite organs* are the epidermis, pulp, pith, cortical layers, ligneous layers, and vegetable fibre, which may be further analysed, as being still compound, with a view to reach the ultimate and elementary organs of the vegetable subject.

1369. *Structure of the vegetable epidermis.* The epidermis of the vegetable, which, from its resemblance to that of the animal, has been designated by the same name, is the external envelope or integument of the plant, extending over the whole surface, and covering the root, stem, branches, leaves, flower, and fruit, with their appendages; the summit of the pistil only excepted. But although it is extended over the whole surface of the plant, it is not of equal consistence throughout. In the root and trunk it is a tough and leathery membrane, or it is a crust of considerable thickness, forming a notable portion of the bark, and assuming some peculiar shade of colour; while in the leaves, flowers, and tender shoots, it is a fine, colourless, and transparent film, when detached; and when adherent, it is always tinged with some peculiar shade, which it borrows from the parts immediately beneath it.

1370. *The pulp* is a soft and juicy substance, constituting the principal mass of succulent plants, and a notable proportion of many parts even of woody plants. It constitutes the principal mass of many of the Fúngi and Fùci, and of herbaceous plants in general. Mirbel compares it to clusters of small hexagonal cells or bladders, containing for the most part a coloured juice, and formed apparently of the foldings and doublings of a fine and delicate membrane, in which no traces of organisation are to be distinguished.

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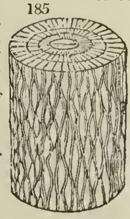

1371. *The pith* is a soft and spongy, but often succulent, substance, occupying the centre of the root, stem, and branches, and extending in the direction of their longitudinal axis, in which it is enclosed as in a tube. The structure of the pith is precisely similar to that of the pulp, being composed of an assemblage of hexagonal cells containing a watery and colourless juice, or of cellular tissue and a parenchyma.

1372. *The cortical layers*, or interior and concentric layers, constituting the mass of the bark, are situated immediately under the cellular integument, where such integument exists, and where not, immediately under the epidermis; or they are themselves external. They are distinguishable chiefly in the bark of woody plants, but particularly in that of the lime tree. They are composed of two elementary parts; bundles of longitudinal fibres constituting a network (*fig.* 185.), and a mass of pulp more or less indurated filling up the meshes. The innermost of the layers is denominated the liber, and was used by the ancients to write on before the invention of paper. It is the finest and most delicate of them all, and often most beautifully reticulated (*fig.* 186. *a*) and varied by bundles of longitudinal fibre (*b*). But the liber of *Dáphne Lagétto* is remarkable beyond that of all other plants for the beauty and delicacy of its network, which is not inferior to that of the finest lace, and at the same time so very soft and flexible that, in countries of which the tree is a native, the lace of the liber is often made to supply the place of a neckcloth. If the cortical layers are injured or destroyed by accident, the part destroyed is again regenerated, and the wound healed up without a scar; but if the wound penetrates beyond the liber, the part destroyed is no longer regenerated. Or if a tree is bent so as to break part of the cortical fibres, and then propped up in its former position, the fractured fibres will again unite. Or if a portion of the stem is entirely decorticated and covered with a piece of bark, even from another tree, the two different barks will unite. Hence the practicability of ascertaining how far the liber extends; and hence also the origin of grafting, which is always effected by a union of the liber of the graft and stock.

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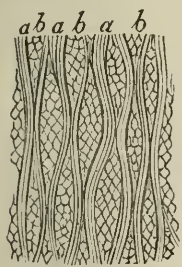

1373 *The ligneous layers*, or layers constituting the wood, occupy the intermediate portion of the stem between the bark and pith; and are distinguishable into two sorts, concentric layers and divergent layers. (*fig.* 185.)

1374. *The concentric layers*, which constitute by far the greater part of the mass of the wood, are sufficiently conspicuous for the purpose of exemplification on the surface of a horizontal section of most trunks or branches, as on that of the oak and elm. But though they are generally described as being concentric, they are not always strictly so. For they are often found to extend more on the one side of the axis of the stem or branch, than on the other. Some authors say the excess is on the north side, but others say it is on the south side. The former account for it by telling us it is because the north side is sheltered from the sun; and the latter by telling us it is because the south side is sheltered from the cold; and thus from the operation of contrary causes alleging the same effect, which has been also thought to be sufficiently striking and uniform to serve as a sort of compass, by which the bewildered traveller might safely steer his course, even in the recesses of the most extensive forest. But Du Hamel has exposed the futility of this notion, by showing that the excess is sometimes on the one side of the axis, and sometimes on the other, according to the accidental situation of the great roots and branches; a thick root or branch producing a proportionably thick layer of wood on the side of the stem from which it issues. The layers are indeed sometimes more in number on the one side than on the other, as well as thicker; but this is the exception, and not the rule. They are thickest, however, on the side on which they are fewest, though not of the same thickness throughout. Du Hamel, after counting twenty layers on the one side of the transverse section of the trunk of an oak, found only fourteen on the other; but the fourteen exceeded the twenty in thickness by one fourth part. But the layers thus discoverable on the horizontal section of the trunk are not at all of an equal consistence throughout, there being an evident diminution in their degree of solidity from the centre, where they are hardest, to the circumference, where they are softest. The outermost layer, which is the softest of all, is denominated the alburnum, perhaps from its being of a brighter white than any of the other layers, either of wood or bark; by which character, as well as by its softer texture, it is also easily distinguished. It does not acquire its utmost degree of solidity till after a number of years; but if a tree is barked a year before it is cut down, then the alburnum is converted into wood in the course of that year.

1375. *The divergent layers*, which intersect the concentric layers in a transverse direction, constitute also a considerable proportion of the wood, as may be seen in a horizontal section of the fir or birch, or of almost any woody plant, on the surface of which they present an appearance like that of the radii of a circle.

1376. *The structure of the concentric layers* will be found to consist of several smaller and component layers, which are themselves composed of layers smaller still, till at last they are incapable of farther division. The concentric layers are composed of longitudinal fibres, generally forming a network; and the divergent layers, of parallel threads or fibres of cellular tissue, extending in a transverse direction, and filling up the interstices of the network.

1377. *The structure of the stem, in plants that are purely herbaceous*, and in the herbaceous parts of woody plants, is distinguished by a number of notable and often insulated fibres passing longitudinally throughout its whole extent, as in the stipe of Aspídium Fílix-más or in the leaf-stalk of the alder. These fibres, when viewed superficially, appear to be merely individuals, but when inspected minutely, and under the microscope, they prove to be groups or bundles of fibres smaller and minuter still, firmly cemented together, and forming in the aggregate a strong and elastic thread, but capable of being split into a number of component fibres, till at last you can divide them no longer. If the fibres of the bark are separated by the destruction of a part, the part is again regenerated, and the fibres are again united, without leaving behind them any traces of a wound: but, if the fibres of the wood are separated by the destruction of a part, the part is never regenerated, and the fibres are never united.

Subsect. 3. *Elementary, or Vascular, Organs.*

1378. *Fibre, cellular tissue with or without parenchyma, and reticulated membrane* are the ultimate and elementary organs of which the whole mass of the plant is composed.

If it be asked of what are the elementary organs themselves composed, the reply is, they are composed, as it appears from the same analysis, of a fine, colourless, and transparent membrane, in which the eye, aided by the assistance even of the best glasses, can discover no traces whatever of organisation ; which membrane we must also regard as constituting the ultimate and fundamental fabric of the elementary organs themselves, and, by consequence, of the whole of the vegetable body. It has been asked by some phytologists whether or not plants are furnished with vessels analogous to the blood-vessels of the animal system. But if it be admitted that plants contain fluids in motion, which cannot possibly be denied, it will follow, as an unavoidable consequence, that they are furnished with vessels conducting or containing such fluids. If the stem of a plant of marigold is divided by means of a transverse section, the divided extremities of the longitudinal fibres, arranged in a circular row immediately within the bark, will be distinctly perceived, and their tubular structure demonstrated by means of the orifices which they present, particularly when the stem has begun to wither. Regarding it, therefore, as certain, that plants are furnished with longitudinal tubes, as well as with cells or utricles for the purpose of conveying or containing their alimentary juices, we proceed to the specific illustration of both, together with their peculiarities and appendages.

1379. *The utricles* are the fine and membranous vessels constituting the cellular tissue of the pith and pulp already described, whether of the plant, flower, or fruit. Individually they resemble oblong bladders inflated in the middle, as in the case of some plants ; or circular or hexagonal cells, as in the case of others. Collectively they have been compared to an assemblage of threads of contiguous bladders, or vesicles, or to the bubbles that are found on the surface of liquor in a state of fermentation.

1380. *The tubes* are the vessels formed by the cavities of the longitudinal fibres, whether as occurring in the stem of herbaceous plants, or in the foot-stalk of the leaf and flower, or in the composition of the cortical and ligneous layers, or by longitudinal openings pervading the pulp itself, as in the case of the vine.

1381. *The large tubes* are tubes distinguishable by the superior width of the diameter which they present on the horizontal section of the several parts of the plant.

1382. *Simple tubes* (*fig.* 187.) are the largest of all large tubes, and are formed of a thin and entire membrane, without any perceptible disruption of continuity. They are found chiefly in the bark, though not confined to it, as they are to be met with also in the alburnum and matured wood, as well as in the fibres of herbaceous plants.

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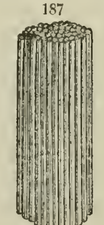


1383. *Porous tubes* resemble the simple tubes in their general aspect ; but differ from them in being pierced with small holes or pores, which are often distributed in regular and parallel rows. They are found in most abundance in woody plants, and particularly in wood that is firm and compact, like that of the oak ; but they do not, like the simple tubes, seem destined to contain any oily or resinous juice.

1384. *Spiral tubes* are fine, transparent, and thread-like substances occasionally interspersed with the other tubes of the plaot, but distinguished from them by being twisted from right to left, or from left to right, in the form of a corkscrew. They occur in most abundance in herbaceous plants, particularly in aquatics.

1385. *False spiral tubes* are tubes apparently spiral on a slight inspection, but which, upon minute examination, are found to derive their appearance merely from their being cut transversely by parallel fissures.

1386. *Mixed tubes* are tubes combining in one individual two or more of the foregoing varieties. Mirbel exemplifies them in the case of the Bùtomus umbellàtus, in which the porous tubes, spiral tubes, and false spiral tubes, are often to be met with united in one.

1387. *The small tubes* are tubes composed of a succession of elongated cells united, like those of the cellular tissue. Individually they may be compared to the stem of the grasses, which is formed of several internodia, separated by transverse diaphragms ; and collectively to a united assemblage of parallel and collateral reeds.

1388. *Pores* are small and minute openings of various shapes and dimensions, that seem to be destined to the absorption, transmission, or exaltation of fluids. They are distinguishable into perceptible pores and imperceptible pores.

1389. *Gaps*, according to Mirbel, are empty, but often regular and symmetrical, spaces formed in the interior of the plant by means of a partial disruption of the membrane constituting the tubes or utricles. In the leaves of herbaceous plants the gaps are often interrupted by transverse diaphragms formed of a portion of the cellular tissue which still remains entire, as may be seen in the transparent structure of the leaves of Tŷpha and many other plants. Transverse gaps are said to be observable also in the bark of some plants, though very rarely.

1390. *There are various appendages* connected with the elementary organs, such as internal glands, internal pubescence, &c. : the latter occurs in dissecting the leaf or flower-stalk of Nùphar lùtea.

Chap. III.

Vegetable Chemistry, or Primary Principles of Plants.

1391. *As plants are not merely organised beings, but beings endowed with a species of life,* absorbing nourishment from the soil in which they grow, and assimilating it to their own substance by means of the functions and operations of their different organs, it is plain that no progress can be made in the explication of the phenomena of vegetable life, and no distinct conception formed of the rationale of vegetation, without some specific knowledge of the primary principles of vegetables, and of their mutual action upon one another. The latter requisite presupposes a competent acquaintance with the elements of chemistry ; and the former points out the necessity of a strict and scrupulous analysis of the several compound ingredients constituting the fabric of the plant, or contained within it. If the object of the experimenter is merely that of extracting such compound ingredients as may be known to exist in the plant, the necessary apparatus is simple, and the process easy : but if it be that of ascertaining the primary and radical principles of which the compound ingredients are themselves composed, the apparatus is then complicated, and the process extremely difficult, requiring much time and labour, and much previous practice in analytical research. But whatever may be the object of analysis, or the particular view of the experimenter, the processes which he employs are either mechanical or chemical.

1392. *The mechanical processes* are such as are effected by the agency of mechanical powers, and are often indeed the operation of natural causes; hence the origin of gums and other spontaneous exudations. But the substances thus obtained do not always flow sufficiently fast to satisfy the wants or necessities of man; and men have consequently contrived to accelerate the operations of nature by means of artificial aid in the application of the wimble or axe, widening the passages which the extravasated fluid has forced, or opening up new ones. It more frequently happens, however, that the process employed is wholly artificial, and altogether effected without the operation of natural causes. When the juices are enclosed in vesicles lodged in parts that are isolated or may easily be isolated, the vesicles may be opened by means of rasps or graters, and the juices expressed by the hand, or by some other fit instrument. Thus the volatile oil may be obtained that is lodged in the rind of the lemon. When the substance to be extracted lies more deeply concealed in the plant, or in parts which cannot be easily detached from the rest, it may then become necessary to pound or bruise the whole or a great part of the plant, and to subject it, thus modified, to the action of the press. In this manner seeds are sometimes treated to express their essential oils. If, by the action of bruising or pressing, heterogeneous ingredients have been mixed together, they may generally be separated with considerable accuracy by means of decantation, when the substances held in suspension have been precipitated. Thus the acid of lemons, oranges, gooseberries, and other fruits, may be obtained in considerable purity, when the mucilage that was mixed with them has subsided.

1393. *The chemical processes* are such as are effected by the agency of chemical powers, and may be reduced to the following: distillation, combustion, the action of water, the action of acids and alkalies, the action of oils and alcohols, and lastly fermentation. They are much more intricate in their nature than the mechanical processes, as well as more difficult in their application,

1394. *Of the products of vegetable analysis*, as obtained by the foregoing processes, some consist of several heterogeneous substances, and are consequently *compound*, as being capable of farther decomposition; and some consist of one individual substance only, and are consequently *simple*, as being incapable of further decomposition.

Sect. I. *Compound Products.*

1395. *The compound products of analysis* are very numerous in themselves, and much diversified in their qualities. They are gum, sugar, starch, gluten, albumen, fibrine, extract, tannin, colouring matter, bitter principle, narcotic principle, acids, oils, wax, resins, gum resins, balsams, camphor, caoutchouc, cork, woody fibre, sap, proper juice, charcoal, ashes, alkalies, earths, and metallic oxides.

1396. *Gum* is an exudation that issues spontaneously from the surface of a variety of plants, in the state of a clear, viscid, and tasteless fluid, that gradually hardens upon being exposed to the action of the atmosphere, and condenses into a solid mass. It issues copiously from many fruit trees, but especially from such as produce stone-fruit, as plum and cherry trees. From plants or parts of plants containing it, but not discharging it by spontaneous exudation, it may be obtained by the process of maceration in water.

1397. *The uses of gum* are considerable. In all its varieties it is capable of being used as an article of food, and is highly nutritive, though not very palatable. It is also employed in the arts, particularly in calico-printing, in which the printer makes choice of it to give consistence to his colours, and to prevent them from spreading. The botanist often uses it to fix his specimens upon paper, for which purpose it is very well adapted. It forms likewise an ingredient in ink; and in medicine it forms the basis of many mixtures, in which its influence is sedative and emollient.

1398. *Sugar* is the produce of the Sáccharum officinárum. The canes or stems of the plant, when ripe, are bruised between the rollers of a mill, and the expressed juice is collected and put into large boilers, in which it is mixed with a small quantity of quicklime, or strong ley of ashes, to neutralise its acid, and is then made to boil; the scum, which gathers on the top during the process of boiling, being carefully cleared away. When the juice has been boiled down to the consistence of a syrup, it is drawn off and allowed to cool in vessels which are placed above a cistern, and are perforated with small holes through which the impure and liquid part, known by the name of molasses, escapes; while the remaining part is converted into a mass of small and hard granules of a brownish or whitish colour, known by the designation of raw sugar, which when imported into Europe is further purified by an additional process, and converted by filtration or crystallisation into what is called loaf sugar, refined sugar, or candied sugar. The juice of the *A*'cer saccharínum, or American maple, yields sugar in such considerable abundance as to make it an object with the North American farmer to manufacture it for his own use. A hole is bored in the trunk of the vegetating tree early in the spring, for the purpose of extracting the sap; of which a tree of ordinary size, that is, of from two to three feet in diameter, will yield from one hundred and fifty to two hundred pints and upwards, in a good season. The sap, when thus obtained and neutralised by lime, deposits, by evaporation, crystals of sugar in the proportion of about a pound of sugar to forty pints of sap. It is not materially different in its properties from that of the sugar-cane. The juice of the grape, when ripe, yields also a sugar by evaporation and the action of potashes, which is known by the appellation of the sugar of grapes, and has lately been employed in France as a substitute for colonial sugar, though it is not so sweet or agreeable to the taste. The root of *B*èta vulgàris, or common beet, yields also, by boiling and evaporation, a sugar which is distinguished by a peculiar and slightly bitter taste, owing perhaps to the presence of a bitter extractive matter which has been found to be one of the constituents of the beet. Sugar has been extracted from the following vegetables also, or from their productions: from the sap of the birch, sycamore, bamboo, maize, parsnep, cow-parsnep, American aloe, dulse, walnut tree, and cocoa-nut tree; from the fruit of the common arbutus, and other sweet-tasted fruits; from the roots of the turnip, carrot, and parsley; from the flower of the Euxine rhododendron; and from the nectary of most other flowers.

1399. *The utility of sugar*, as an aliment, is well known; and it is as much relished by many animals as by man. By bees it is sipped from the flowers of plants, under the modification of nectar, and converted into honey; and also seems to be relished by many insects, even in its concrete state; as it is also by many birds. By man it is now regarded as being altogether indispensable, and though used chiefly to give a relish or seasoning to food, is itself highly nutritive. It is also of much utility in medicine, and celebrated for its anodyne and antiseptic qualities, as well as thought to be peculiarly efficacious in preventing diseases by worms.

1400. *Starch.* If a quantity of wheaten flour is made into a paste with water, and kneaded and washed under the action of a jet, till the water runs off colourless, part of it will be found to have been taken up and to be still held in suspension by the water, which will, by and by, deposit a sediment that may be separated by decantation. This sediment is starch, which may be obtained also immediately from the grain itself, by means of a process well known to the manufacturer, who renders it finally fit for the market by washing and edulcorating it with water, and afterwards drying it by a moderate heat. Starch, when thrown upon red-hot iron, burns with a kind of explosion, and leaves scarcely any residuum behind. It has been found, by the analysis of Gay Lussac and Thenard, to be composed of carbon 43·55; oxygen 49·68; hydrogen 6·77; total 100. This result is not very widely different from that of the analysis of sugar, into which, it seems, starch may be converted by diminishing the proportion of its carbon, and increasing that of its oxygen and hydrogen. This change is exemplified in the case of the malting of barley, which contains a great proportion of starch, and which absorbs during the process a quantity of oxygen, and evolves a quantity of carbonic acid; and accordingly part of it is converted into sugar. Perhaps it is exemplified also in the case of the freezing of potatoes, which acquire in consequence a sweet and sugary taste, and are known to contain a great deal of starch, which may be obtained as follows. Let the potatoes be taken and grated down to a pulp, and the pulp placed upon a fine sieve, and water made to pass through it: the water will be found to have carried off with it an infinite number of particles, which it will afterwards deposit in the form of a fine powder, separable by decantation; which powder is starch, possessing all the essential properties of wheaten starch. It may be obtained from the pith of several species of palms growing in the Moluccas and several other East India islands, by the following process: the stem, being first cut into pieces of five or six feet in length, is split longitudinally so as to expose the pith, which is now taken out and pounded, and mixed with cold water, which, after being well stirred up, deposits at length a sediment that is separated by decantation, and is the starch which the pith contained, or the sago of the shops.

1401. *Salop is also a species of starch* that is prepared, in the countries of the East, from the root of the O'rchis mòrio, máscula, bifòlia, and pyramidàlis; and, in the Isle of Portland, from the A'rum maculàtum. So also is cassava, which is prepared from the root of *Jánipha Mánihot*, a native of America, the expressed juice of which is a deadly poison used by the Indians to poison their arrows; but the sediment which it deposits is a starch that is manufactured into bread, retaining nothing of the deleterious property of the juice. So also is sowans, which is prepared from the husk of oats, as obtained in the process of grinding.

1402. *Starch may be extracted from a number of plants;* as A'rctium Láppa, A'tropa *Belladónna*, Polýgonum bistórta, Bryònia álba, Cólchicum autumnàle, Spiræ'a Filipéndula, Ranúnculus bulbòsus, Scrophulària nodòsa, Sambùcus E'bulus and nìgra, O'rchis mòrio and máscula, Imperatòria Ostrùthium, Hyoscýamus nìger, Rumex obstusifòlius, acùtus, and aquáticus, A'rum maculàtum, I'ris Pseudácorus and fœtidissima, O'robus tuberòsus, and Bunium Bulbocástanum. It is found also in the following seeds: wheat, barley, oats, rice, maize, millet seed, chestnut, horsechestnut, peas, beans, and acorns.

1403. *Starch is an extremely nutritive substance*, and forms one of the principal ingredients in almost all articles of vegetable food used by man or by the inferior animals. The latter feed upon it in the state in which nature presents it; but man prepares and purifies it so as to render it pleasing to his taste, and uses it under the various modifications of bread, pastry, and confectionary. Its utility is also considerable in medicine and in the arts; in the preparation of anodyne and strengthening medicaments; in the composition of cements; in the clearing and stiffening of linen; and in the manufacture of hair-powder.

1404. *Gluten* is that part of the paste formed from the flour of wheat, which remains unaffected by the water, after all the starch contained in it has been washed off. It is a tough and elastic substance, of a dull white colour, without taste, but of a very peculiar smell. It is soluble in the acids and alkalies, but insoluble in water and in alcohol. Gluten has been detected, under one modification or other, in a very considerable number of vegetables or vegetable substances, as well as in the flour of wheat.

1405. *Gluten is one of the most important of all vegetable substances*, as being the principle that renders the flour of wheat so fit for forming bread, by its occasioning the panary fermentation, and making the bread light and porous. It is used also as a cement, and is capable of being used as a varnish and a ground for paint.

1406. *Albumen*, which is a thick, glairy, and tasteless fluid, resembling the white of an unboiled egg, is a substance that has been but lately proved to exist in the vegetable kingdom. Its existence was first announced by Fourcroy, and finally demonstrated by the experiments of Vauquelin on the dried juice of the papaw tree. It is nearly related to animal gluten.

1407. *Fibrine* is a peculiar substance which chemists extract from the blood and muscles of animals. This substance constitutes the fibrous parts of the muscles, and resembles gluten in its appearance and elasticity. A substance possessing the same properties has been detected by Vauquelin in the juice of the papaw tree, which is called vegetable fibrine.

1408. *Extract*. When vegetable substances are macerated in water, a considerable portion of them is dissolved; and if the water is again evaporated, the substance held in solution may be obtained in a separate state. This substance is denominated extract. But it is evident that extract thus obtained will not be precisely the same principle in every different plant, but will vary in its character according to the species producing it, or the soil in which the plant has grown, or some other accidental cause. Its distinguishing properties are the following: — It is soluble in water as it is obtained from the vegetable, but becomes afterwards insoluble in consequence of the absorption of oxygen from the atmosphere It is soluble in alcohol; and it unites with alkalies, and forms compounds which are soluble in water. When distilled it yields an acid fluid impregnated with ammonia, and seems to be composed principally of hydrogen, oxygen, carbon, and a little nitrogen. Extract, or the extractive principle, is found in a greater or less proportion in almost all plants whatever, and is very generally an ingredient of the sap and bark, particularly in barks of an astringent taste; but still it is not exactly the same in all individual plants, even when separated as much as possible from extraneous substances. It may therefore be regarded as constituting several species, of which the following are the most remarkable: —

1409. *Extract of catechu.* This extract is obtained from an infusion of the wood or powder of catechu in cold water. Its colour is pale brown; and its taste slightly astringent. It is precipitated from its solution by nitrate of lead, and yields by distillation carbonic and carburetted hydrogen gas, leaving a porous charcoal.

1410. *Extract of senna.* This extract is obtained from an infusion of the dried leaves of Cássia *Sénna* in alcohol. The colour of the infusion is brownish, the taste slightly bitter, and the smell aromatic. It is precipitated from its solution by the muriatic and oxymuriatic acids; and, when thrown on burning coals, consumes with a thick smoke and aromatic odour, leaving behind a spongy charcoal.

1411. *Extract of quinquina.* This extract was obtained by Fourcroy, by evaporating a decoction of the bark of the quinquina of St. Domingo in water, and again dissolving it in alcohol, which finally deposited by evaporation the peculiar extractive. It is insoluble in cold water, but very soluble in boiling water; its colour is brown, and its taste bitter. It is precipitated from its solution by lime water, in the form of a red powder; and when dry it is black and brittle, breaking with a polished fracture.

1412. *Extract of saffron.* This extract is obtained in great abundance from the summits of the pistils of Cròcus sativus, which are almost wholly soluble in water.

1413. *Extracts were formerly much employed in medicine;* though their efficacy seems to have been overrated. But a circumstance of much more importance to society is that of their utility in the art of dyeing. By far the greater part of colours used in dyeing are obtained from vegetable extracts, which have a strong affinity to the fibres of cotton or linen, with which they enter into a combination that is rendered still stronger by the intervention of mordants.

1414. *Colouring matter*. The beauty and variety of the colouring of vegetables, chemists have ascribed to the modifications of a peculiar substance which they denominate the colouring principle, and which they have accordingly endeavoured to isolate and extract; first, by means of maceration or boiling in water, and then by precipitating it from its solution. The chemical properties of colouring matter seem to be as yet but imperfectly known, though they have been considerably elucidated by the investigations of Berthollet, Chaptal, and others. Its affinities to oxygen, alkalies, earths, metallic oxides, and cloths fabricated of animal or vegetable substances, such as wool or flax, seem to be among its most striking characteristics. But its affinity to animal substances is stronger than its affinity to vegetable substances;

and hence wool and silk assume a deeper dye, and retain it longer, than cotton or linen. Colouring matter exhibits a great variety of tints, as it occurs in different species of plants; and as it combines with oxygen, which it absorbs from the atmosphere, it assumes a deeper shade; but it loses at the same time a portion of its hydrogen, and becomes insoluble in water; and thus it indicates its relation to extract. Fourcroy reduced colours to the four following sorts: extractive colours, oxygenated colours, carbonated colours, and hydrogenated colours; the first being soluble in water, and requiring the aid of saline or metallic mordants to fix them upon cloth; the second being insoluble in water, as altered by the absorption of oxygen, and requiring no mordant to fix them upon cloth; the third containing in their composition a great proportion of carbon, but soluble in alkalies; and the fourth containing a great proportion of resin, but soluble in oils and alcohol. But the simplest mode of arrangement is that by which the different species of colouring matter are classed according to their effect in the art of dyeing. The principal and fundamental colours in this art are the blue, the red, the yellow, and the brown.

1415. *The finest of all vegetable blues* is that which is known by the name of indigo. It is the produce of the Indigófera tinctòria *Lin.*, a shrub which is cultivated in Mexico and the East Indies for the sake of the dye it affords. The plant reaches maturity in about six months, when its leaves are gathered and immersed in vessels filled with water till fermentation takes place. The water then becomes opaque and green, exhaling an odour like that of volatile alkali, and evolving bubbles of carbonic acid gas. When the fermentation has been continued long enough, the liquid is decanted and put into other vessels, where it is agitated till blue flakes begin to appear. Water is now poured in, and flakes are precipitated in the form of a blue powdery sediment, which is obtained by decantation; and which, after being made up into small lumps and dried in the shade, is the indigo of the shops. It is insoluble in water, though slightly soluble in alcohol; but its true solvent is sulphuric acid, with which it forms a fine blue dye, known by the name of liquid blue. It affords by distillation carbonic acid gas, water, ammonia, some oily and acid matter, and much charcoal; whence its constituent principles are most probably carbon, hydrogen, oxygen, and nitrogen. Indigo may be procured also from several other plants besides Indigófera tinctòria, and particularly from *Isàtis* tinctòria or woad, a plant indigenous to Britain, and thought to be the plant with the juice of which the ancient Britons stained their naked bodies, to make them look terrible to their enemies. If this plant is digested in alcohol, and the solution evaporated, white crystalline grains, somewhat resembling starch, will be left behind; which grains are indigo, becoming gradually blue by the action of the atmosphere. The blue colour of indigo, therefore, is owing to its combination with oxygen.

1416. *The principal red colours* are such as are found to exist in the root, stem, or flower, of the five following plants: *Rùbia* tinctòrum, *Roccélla* tinctòria, Lecanòra parélla, *Cárthamus* tinctòrius, Cæsalpínia crísta, and Hæmatóxylon campechiànum.

1417. *Yellow*, which is a colour of very frequent occurrence among vegetables, and the most permanent among flowers, is extracted for the purpose of dyeing, from a variety of plants. It is extracted from the *Reseda* Luteòla *Lin.*, by the decoction of its dried stems. The colouring matter is precipitated by means of alum, and is much used in dyeing wool, silk, and cotton. It is also obtained from the *Mòrus* tinctòria, *Bíxa Orellàna* or arnotta, *Serrátula* tinctòria, *Genísta* tinctòria, *Rhús* Cótinus, *Rhámnus* infectòrius, and *Quércus* tinctòria, or quercitron, the bark of which last affords a rich and permanent yellow at present much in use.

1418. *The brown colouring matter of vegetables* is very abundant, particularly in astringent plants. It is obtained from the root of the walnut tree, and rind of the walnut; and also from the sumach and alder, but chiefly from nut-galls, which are excrescences formed upon the leaves of a species of *Quércus*, indigenous to the south of Europe, in consequence of the puncture of insects. The best in quality are brought from the Levant. They are sharp and bitter to the taste, and extremely astringent; and soluble in water by decoction when ground or grated to a powder. The decoction strikes, with the solution of iron, a deep black, that forms the basis of ink, and of most dark colours used in dyeing cloths.

1419. *Tannin.* If a quantity of pounded nut-galls, or bruised seeds of the grape, is taken and dissolved in cold water, and the solution evaporated to dryness, there will be left behind a brittle and yellowish substance of a highly astringent taste, which substance is tannin, or the tanning principle. It is soluble both in water and alcohol, but insoluble in ether. With the salts of iron it strikes a black; and when a solution of gelatine is mixed with an aqueous solution of tannin, the tannin and gelatine fall down in combination, and form an insoluble precipitate. When tannin is subjected to the process of distillation, it yields charcoal, carbonic acid, and inflammable gases, with a minute quantity of volatile alkali, and seems accordingly to consist of the same elements with extract, from which, however, it is distinguished by the peculiar property of its action upon gelatine. Tannin may be obtained from a great variety of other vegetables also, as well as those already enumerated, but chiefly from their bark; and of barks, chiefly from those that are astringent to the taste. The following table exhibits a general view of the relative value of different species of bark, as ascertained by Sir Humphry Davy. It gives the average obtained from 480 lbs. of the entire bark of a middle-sized tree of the different species, taken in the spring, when the quantity of tannin is the largest: —

	lb.		*lb.*		*lb.*
Oak	29	Beech	10	Blackthorn	16
Spanish chestnut	21	Horsechestnut	9	Coppice oak	32
Leicester willow (large)	33	Sycamore	11	Inner rind of oak bark	72
Elm	13	Lombardy poplar	15	Oak cut in autumn	21
Common willow (large)	11	Birch	8	Larch cut in autumn	8
Ash	16	Hazel	14		

1420. *Tannin is of the very first utility in its application to medicine and the arts;* being regarded by chemists as the general principle of astringency. The medical virtues of Peruvian bark, so celebrated as a febrifuge and antiseptic, are supposed to depend upon the quantity and quality of its tannin. In consequence of its peculiar property of forming an insoluble compound with gelatine, the hides of animals are converted into leather, by the important art of tanning. The bark of the oak tree, which contains tannin in great abundance, is that which is most generally used by the tanner. The hides to be tanned are prepared for the process by steeping them in lime water, and scraping off the hair and cuticle. They are then soaked, first in weaker and afterwards in stronger infusions of the bark, till at last they are completely impregnated, This process requires a period of from ten to eighteen months, if the hides are thick; and four or five pounds of bark are necessary on an average to form one pound of leather.

1421. *Bitter principle.* The taste of many vegetables, such as those employed in medicine, is extremely bitter. The quassia of the shops, the roots of the common gentian, the bark and wood of common broom, the calyx and floral leaves of the hop, and the leaves and flowers of chamomile, may be quoted as examples. This bitter taste has been thought to be owing to the presence of a peculiar substance, different from every other vegetable substance, and has been distinguished by the name of the bitter principle. When water has been digested for some time over quassia, its colour becomes yellow, and its taste intensely bitter; and if it is evaporated to dryness, it leaves behind a substance of a brownish yellow, with a slight degree of transparency, that continues for a time ductile, but becomes afterwards brittle. This substance Dr. Thompson regards as the bitter principle in a state of purity. It is soluble in water and in alcohol; but the solution is not much affected by re-agents. Nitrate of silver and acetate of lead are the only two that occasion a precipitate. The bitter principle is of great importance, not only in the practice of medicine, but also in the art of brewing; its influence being that of checking fermentation, preserving the fermented liquor, and when the bitter of the hop is used, communicating a peculiar and agreeable flavour. The bitter principle appears to consist principally of carbon, hydrogen, and oxygen, with a little nitrogen.

1422. *Narcotic principle.* There is a species of medical preparations known by the name of narcotics, which have the property of inducing sleep; and, if administered in large doses, of occasioning death. They are obtained from the milky and proper juices of some vegetables, and from the infusion of the leaves or stem of others, all which have been supposed to contain in their composition some common ingredient, which chemists have agreed to designate by the name of the narcotic principle. It exists in great abundance in opium, which is the concrete juice of *Papàver* somníferum var. álbum, or the white poppy, from which it is obtained pure, in the form of white crystals. It is soluble in boiling water and in alcohol, as well as in all acid menstrua; and it appears that the action of opium on the animal subject depends on this principle. When distilled it emits white vapours, which are condensed into a yellow oil; some water and carbonate of ammonia pass into a receiver; and at last carbonic acid gas, ammonia, and carburetted hydrogen are disengaged, and a bulky charcoal left behind. Many other vegetable substances besides opium possess narcotic qualities though they have not yet been minutely analysed. The following are the most remarkable :—The inspissated juice of lettuce, which resembles opium much in its appearance, is obtained by the same means, and possesses the same medical virtues ; the leaves of A'tropa *Belladónna*, or deadly nightshade, and indeed the whole plant; the leaves of Digitàlis purpùrea, or foxglove ; and lastly, the following plants, *H*yoscỳamus nìger, *C*ònium maculàtum, *Datùra Stramònium*, and *L*edum palústre, with many others belonging to the Linnean natural order of Lùridæ.

1423. *Acids.* Acids are a class of substances that may be distinguished by their exciting on the palate the sensation of sourness. They exist not only in the animal and mineral, but also in the vegetable, kingdom ; and such of them as are peculiar to vegetables have been denominated vegetable acids. Of acids peculiar to vegetables chemists enumerate the following : the oxalic, acetic, citric, malic, gallic, tartaric, benzoic, and prussic, which exist ready formed in the juices or organs of the plant, and are accordingly denominated native acids ; together with the mucous, pyromucous, pyrotartarous, pyrolignous, camphoric, and suberic, which do not exist ready formed in the plant, and are hence denominated artificial acids. They are consequently not within the scope of the object of the present work.

1424. *Oxalic acid.* If the expressed juice of the O'xalis Acetosélla is left to evaporate slowly, it deposits small crystals of a yellowish colour and saltish taste, which are known by the name of the acidulum of sorrel, that is, a salt with excess of acid, from which the acid may be obtained pure by processes well known to the chemist. It is not used in medicine or the arts, except in its state of acidulum, in which it is employed to make a sort of lemonade, and to discharge stains of ink. It has been found also in O'xalis corniculàta, Pelargònium ácidum, in the several species of *R*ùmex, and in the pubescence of Cìcer arietìnum.

1425. *Acetic acid.* The acetic acid, or vinegar, which is generally manufactured from wine in a certain stage of fermentation, has been found also ready formed in the sap of several trees, as analysed by Vauquelin ; and also in the acid juice of the Cìcer arietìnum, of which it forms a constituent part. It was obtained by Scheele from the sap of the Sambùcus nigra ; and is consequently to be regarded as a native vegetable acid. It is distinguished from other vegetable acids by its forming soluble salts with the alkalies and earths.

1426. *Citric acid.* Citric acid is the acid which exists in the juice of lemon. Its taste is very sour in a state of purity, but exceedingly pleasant when diluted with water. By a red heat it yields carbonic acid gas and carbonated hydrogen gas, and is reduced to a charcoal; nitric acid converts it into oxalic and acetic acid, and with lime it forms a salt insoluble in water. It has been found unmixed with other acids in the following vegetable substances : in the juice of oranges and lemons, and in the berries of Oxycóccus palústris, *V*accínium *V*itis Idæ'a, *C*érasus Pàdus, *S*olànum Dulcamàra, and *R*òsa canìna. It has been found also in many other fruits, mixed with other acids.

1427. *Malic acid.* Malic acid is found chiefly in the juice of unripe apples, whence it derives its name; but it is found also in the juice of barberries, alderberries, gooseberries, plums, and common house-leek.

1428. *Gallic acid.* Gallic acid, as it is obtained in the greatest abundance, so it derives its name, from the nut-gall, from which it may be extracted by exposing a quantity of the powder of nut-galls to a moderate heat in a glass retort ; when the acid will sublime and form crystals of an octahedral figure. Its taste is austere and astringent. It strongly reddens vegetable blues. It is soluble both in water and alcohol ; and is distinguished by its property of communicating to solutions of iron a deep purple colour. When exposed to a gentle heat it sublimes without alteration, but a strong heat decomposes it. Nitric acid converts it into the malic and oxalic acids. It is of great utility in the art of dyeing, and forms the basis of all black colours, and of colours with a dark ground. It forms also the basis of ink ; and chemists use it as a test to detect the presence of iron.

1429. *Tartaric acid.* If wine is kept for a length of time in a cask or other close vessel, a sediment is precipitated which adheres to the sides or bottom, and forms a crust known by the name of tartar, which is a combination of potass and a peculiar acid in excess. The compound is tartrate of potass, and the acid, in its state of purity, is the tartaric acid. It is characterised by its property of forming with potass a salt that is soluble with difficulty. It has been found in the following vegetable substances also : in the pulp of tamarinds, in the juice of the grape, and mulberries, sorrel, and sumach, and the roots of Agropỳrum rèpens and Leóntodon Taráxacum. It is not much used except among chemists ; but the tartrate, from which it is usually obtained, is well known for its medical virtues under the name of cream of tartar.

1430. *Benzoic acid.* From the Stỳrax *Benzòin* there exudes a resinous substance, known in the shops by the name of benzoin, and in which the benzoic acid is contained. It is distinguished from the other acids by its aromatic odour and extreme volatility. It has been obtained also from the balsams of tolu and storax ; and is used in pharmacy, in the preparation of boluses and electuaries.

1431. *Prussic acid.* The prussic acid is generally classed among the animal acids, because it is obtained in the greatest abundance from animal substances. But it has been proved to exist in vegetable substances also, and it is procured by distilling laurel leaves, or the kernels of the peach and cherry, or bitter almonds. When pure, it exists in the form of colourless fluid, with an odour resembling that of peach tree blossoms. It does not redden vegetable blues ; but it is characterised by its property of forming a bluish-green precipitate, when it is poured, with a little alkali added to it, into solutions containing iron.

1432. *All vegetable acids contain carbon, oxygen, and hydrogen, in one proportion or other ;* and the prussic acid contains also a portion of nitrogen. The gallic acid contains more of carbon than any other vegetable acid, and the oxalic more of oxygen.

1433. *Vegetable oils* are of two kinds, the fixed and the volatile. The former are not suddenly affected by the application of heat ; the latter are very inflammable.

1434. *Fixed oils.* Fixed oils are but seldom found, except in the seeds of plants, and chiefly in such as are dicotyledonous. They are found also, though rarely, in the pulp of fleshy fruits, as in that of the olive, which yields the most abundant and valuable species of all fixed oils. But dicotyledonous seeds, which contain oil, contain also at the same time a quantity of mucilage and fecula, and form, when bruised in water, a mild and milky fluid, known by the name of emulsion ; and on this account they are sometimes denominated emulsive seeds. Some seeds yield their oil merely by means of pressure, though it is often necessary to reduce them first of all to a sort of pulp, by means of pounding them in a mortar : others require to be exposed to the action of heat (which is applied to them by means of pressure between warm plates of tin,) or of the vapour of boiling water, or of roasting, before they are subjected to the press. Fixed oil, when pure, is generally a thick and viscous fluid, of a mild or insipid taste, and without smell ; but it is never entirely without some colour, which is for the most part green or yellow. Its specific gravity is to water as 9·403 or 1·000. It is insoluble in water ; it is decomposed in the acids, but with the alkalies it forms soap. When exposed to the atmosphere it becomes inspissated and opaque, and assumes a white colour and a resemblance to fat. This is in consequence of the absorption of oxygen ; but owing to the appearance of a quantity of water in oil that is exposed to the action of the air, it has been thought that the oxygen absorbed by it is not yet perhaps assimilated to its substance. When exposed to cold it congeals and crystallises, or assumes a solid and granular form ; but not till the thermometer has indicated a degree considerably below the freezing point. When exposed to the action of heat it is not volatilised till it begins to boil, which is at 600° of Fahrenheit. By distillation it is converted into water, carbonic acid, and carburetted hydrogen gas, and charcoal ; the product of its combustion is nearly the same ; and hence it is a compound of carbon, oxygen, and hydrogen. Fixed oils are generally divided into two sorts, fat oils and drying oils. The former are readily inspissated by the action of the air, and converted into a sort of fat. The latter are capable of being dried by the action of the air, and converted into a firm and transparent substance.

1435. *The principal species of fat oils* are the following : —

1436. *Olive oil,* which is expressed from the pulpy part of the fruit of O'lea europæ'a. The fruit is first broken in a mill, and reduced to a sort of paste. It is then subjected to the action of a press, and the oil, which is now easily separated, swims on the top of the water in the vessel beneath. It is manufactured chiefly in France and in Italy, and is much used throughout Europe instead of butter, and to give a seasoning to food.

1437. *Oil of almonds,* which is extracted from the fruit of the *A*mýgdalus commùnis or common almond. The almonds are first well rubbed or shook in a coarse bag or sack, to separate a bitter powder which covers their epidermis. They are then pounded in mortars of marble into a paste, which is afterwards subjected to the action of the press ; and the oil is now obtained as in the olive.

1438. *Rapeseed oil,* which is extracted from the *B*rássica *N*àpus and campéstris. It is less fixed and less liable to become rancid than the two preceding, and is manufactured chiefly in Flanders.

1439. *Oil of behen,* which is extracted from the fruit of the *Moringa* pterygospérma, common in Egypt and Africa. It is apt to become rancid ; but it is without odour, and is on this account much used in perfumery.

1440. *The principal species of drying oils* are linseed oil, nut oil, poppy oil, and hempseed oil.

1441. *Linseed oil* is obtained from the seeds of flax, which are generally roasted before they are subjected to any other process, for the purpose of drying up their mucilage and separating more oil.

1442. *Nut oil* is extracted from the fruit of Córylus Avellàna, or Júglans règia. The kernel is first slightly roasted, and the oil then expressed. It is used in paintings of a coarser sort; and also in the seasoning of food, by many of the inhabitants of the middle departments of France; but it is apt to become rancid.

1443. *Poppy oil* is extracted from the seeds of Papàver somníferum, which is cultivated in France and Holland for this purpose. It is clear and transparent, and dries readily; and when pure it is without taste or odour. It is used for the same purposes as the olive oil, for which it is often sold, and possesses nothing of the narcotic properties of the poppy.

1444. *Hempseed oil* is extracted from the seed of the hemp. It has a harsh and disagreeable taste, and is used by painters in this country, and very extensively for food in Russia.

1445. *Volatile oils.* Volatile oils, which are known also by the name of essential oils, are of very common occurrence in the vegetable kingdom, and are found in almost all the different organs of the plant. They are found in many roots, to which they communicate a fragrant and aromatic odour, with a taste somewhat acrid. The roots of Corvisártia Helènium, Genísta canariénsis, and various other plants, contain essential oils. They are found also in the bark of Cinnamòmum vèrum, of Laúrus Sássafras, and of Pìnus; and in the leaves of labiate plants, such as mint, rosemary, marjoram; of the odorous Umbelliferæ, such as chervil, fennel, angelica; and of plants which compound flowers, such as wormwood. They are found also in the flower itself, as in the flowers of chamomile, and the rose; in the fruit, as in that of pepper and ginger; and in the external integuments of many seeds, but never in the cotyledon. They are extracted by means of expression or distillation, and are extremely numerous; and perhaps every plant possessing a peculiar odour possesses also a peculiar and volatile oil. The aroma of plants, therefore, or the substance from which they derive their odour, and which is cognisable only to the sense of smell, is perhaps merely the more volatile and evaporable part of their volatile oil, disengaging itself from its combinations. Volatile oils are characterised by their strong and aromatic odour, and rather acrid taste. They are soluble in alcohol, but are not readily converted into soaps by alkalies. They are very inflammable, and are volatilised by a gentle heat. Like fixed oils, their specific gravity is generally less than that of water, on the surface of which they will float; though in some cases it is found to be greater than that of water, in which they consequently sink. They are much in request on account of their agreeable taste and odour, and are prepared and sold by apothecaries and perfumers, under the name of distilled waters or essences; as well as employed also in the manufacture of varnishes and pigments.

1446. *Wax.* On the upper surface of the leaves of many trees there may often be observed a sort of varnish, which, when separated by certain chemical processes, is found to possess all the properties of bees' wax, and is consequently a vegetable wax. It exudes, however, from several other parts of the plant besides the leaf, and assumes a more waxy and concrete form, as from the catkins of the poplar, the alder, and the fir; from the fruit of the Myrìca cerífera and Stillingia sebífera; but particularly from the anthèræ of the flowers, from which it is probable that the bees extract it unaltered. It was the opinion of Reaumur, however, that the pollen undergoes a digestive process in the stomach of the bee before it is converted into wax, though a late writer on the subject endeavours to prove that the wax is elaborated from the honey extracted by the bee, and not from the pollen. It is found also in the interior of many seeds, from which it is extracted, by means of pounding them and boiling them in water. The wax is melted and swims on the top. Wax, when pure, is of a whitish colour, but without taste and without smell. The smell of bees' wax is indeed somewhat aromatic, and its colour yellow: but this is evidently owing to some foreign substance with which it is mixed; because it loses its smell and colour by means of bleaching, and becomes perfectly white. This is done merely by drawing it out into thin stripes, and exposing it for some time to the atmosphere. Bleached wax is not affected by the air. Its specific gravity is 0·9600. It is insoluble in water and in alcohol. It combines with the fixed oils, and forms with them a composition known by the name of cerate. It combines also with the fixed alkalies, and forms with them a compound possessing the properties of common soap. The acids have but little action on it, and for this reason it is useful as a lute to confine them, or to prevent them from injuring cork. When heat is applied to wax it becomes soft, and melts at the temperature of 142° if unbleached, and of 155° if bleached, into a colourless and transparent fluid, which, as the temperature diminishes, concretes again and resumes its former appearance. At a higher temperature it boils and evaporates, and the vapour may be set on fire by the application of red heat; hence its utility in making candles, and hence an explication of the singular phenomenon observable in the Dictámnus Fraxinélla. This plant is fragrant, and the odour which it diffuses around forms a partial and temporary atmosphere, which is inflammable; for if a lighted candle or other ignited body is brought near to the plant, especially in the time of drought, its atmosphere immediately takes fire. This phenomenon was first observed by the daughter of the celebrated Linnæus, and is explained by supposing the partial and temporary atmosphere to contain a proportion of wax exuded from the plant, and afterwards reduced to vapour by the action of the sun. The result of its combustion in oxygen gas was, according to Lavoisier, carbonic acid and water, in such proportion as to lead him to conclude that 100 parts of wax are composed of 82·28 of carbon and 17·72 of hydrogen; but, owing to the little action of acids upon it, there seems reason to believe that it contains also oxygen as an ingredient.

1447. *Wax possesses all the essential properties of a fixed oil;* and fixed oils have the property of becoming concrete, and of assuming a waxy appearance when long exposed to the air, in consequence, as it seems, of the absorption of oxygen. Wax therefore may be considered as a fixed oil rendered concrete, perhaps by the absorption of oxygen during the progress of vegetation. But if this theory is just, the wax may be expected to occur in a considerable variety of states according to its degrees of oxygenation; and this is accordingly the case. Sometimes it has the consistency of butter, and is denominated butter of wax, as butter of cocoa, butter of galam. Sometimes its consistency is greater, and then it is denominated tallow, as tallow of croton; and when it has assumed its last degree of consistency, it then takes the appellation of wax. The following are its principal species: butter of cacao, butter of cocoa, butter of nutmeg, tallow of croton, and wax of myrtle.

1448. *The butter of cacao* is extracted from the seeds of the Theobròma Cacào or chocolate plant, either by boiling them in water, or by subjecting them to the action of the press after having exposed them to the vapour of boiling water.

1449. *Butter of cocoa* is found in the fruit of Còcos nucífera or cocoa-nut tree. It is expressed from the pulp of the nut, and is even said to separate from it when in a fluid state, as cream separates from milk.

1450. *Butter of nutmeg* is obtained from the seeds of the Myrística officinàlis, or nutmeg tree.

1451. *Tallow of croton* is obtained from the fruit of the Stillíngia sebífera.

1452. *The wax of myrtle* is obtained from the berry of the Myrìca cerífera.

1453. *Resins.* Resins are volatile oils rendered concrete by means of the absorption of oxygen, or rather perhaps by the abstraction of part of their hydrogen. They have a slight degree of transparency, and their colour is generally yellowish. Their taste is somewhat acrid; but they are without smell when pure. Their specific gravity varies from 1·0180 to 1·2289. They are non-conductors of electricity, and when excited by friction their electricity is negative. The species of resins are numerous.

1454. *Rosin* is a species of resin, of which there are several varieties. From different species of the pine, larch, and fir tree, there exudes a juice which concretes in the form of tears. Its extrication is generally aided by means of incisions, and it receives different appellations, according to the species from which it is obtained. If it is obtained from the Pìnus sylvéstris, it is denominated *common turpentine*; from Làrix europæ'a *Venice turpentine*; from Amỳris toxífera, *balsam of Canada*. This juice consists of two ingredients, oil of turpentine and rosin. The oil is extricated by distillation, and the rosin remains behind. If the distillation is continued to dryness, the residuum is *common rosin* or colophonium; but if water is mixed with it while yet fluid, and incorporated by violent agitation, the residuum is *yellow rosin*. The yellow rosin is the most ductile, and the most generally used in the arts.

1455. *Pitch and tar* are manufactured from the resinous juices of the fir. The trunk is cut or cleft into pieces of a convenient size, which are piled together in heaps, and covered with turf. They are then set on fire, and the resinous juice which is thus extricated, being prevented from escaping in a volatile state by means of the turf, is precipitated and collected in a vessel beneath. It is partly converted into an empyreumatic oil, and is now tar, which, by being further inspissated, is converted into pitch.

1456. *Mastich* is extracted from the Pistàcia Lentíscus.
1457. *Sandarach* is obtained from the Juníperus commùnis, by spontaneous exudation.
1458. *Elemi* is extracted from the Amỳris elemífera.
1459. *Tacamhac* is the produce of the *Fagàra* octándra and Pópulus balsamífera.
1460. *Labdanum* is obtained from the Cístus créticus.
1461. *Opobalsamum, or balm of Gilead*, which has been so much famed for its medical virtues, is the produce of the Balsamodéndron gileadénse, a shrub which grows in Judea and in Arabia; but it is so much valued by the Turks that its importation is prohibited. This is the balm of Gilead so much celebrated in Scripture. Pliny says it was first brought to Rome by the generals of Vespasian. It is obtained in a liquid state from incisions made in the bark, and is somewhat bitter to the taste.
1462. *Copaiva, or balsam of copaiva* is obtained from the Copaífera officinàlis.
1463. *Dragon's blood* is obtained from the Dracæ'na dràco, Pterocárpus dràco, and Cálamus *Rotang*.
1464. *Guaiac* is the produce of the *Guaíacum* officinàle.
1465. *Botany Bay resin*, the produce of the Eucalỳptus resinífera, a native of New Holland, and found in great abundance about Botany Bay.
1466. *Green resin* constitutes the colouring matter of the leaves of trees and of almost all vegetables. It is insoluble in water, but soluble in alcohol. When treated with oxymuriatic acid, it assumes the colour of a withered leaf, and exhibits the resinous properties more distinctly.
1467. *Copal* is the produce of the *Rhús* copállinum, a tree which is found in North America.
1468. *Animé*, is obtained from the Hymenæ'a *Coúrbaril*, or locust tree, a native of North America.
1469. *Lac* is the produce of the Aleurites laccífera, a native of the East Indies.
1470. *Bloom*. Upon the epidermis of the leaves and fruit of certain species of plants, there is to be found a fine, soft, and glaucous powder. It is particularly observable upon cabbage leaves, and upon plums, to which it communicates a peculiar shade. It is known to gardeners by the name of bloom. It is easily rubbed off by the fingers; and when viewed under the microscope seems to be composed of small opaque and unpolished granules, somewhat similar to the powder of starch; but with a high magnifying power it appears transparent. When rubbed off, it is again reproduced, though slowly. It resists the action of dews and rains, and is consequently insoluble in water; but it is soluble in spirits of wine; from which circumstance it has been suspected, with some probability, to be a resin.

1471. *The use of resins* in the arts is very considerable; but their medical virtues are not quite so great as has been generally supposed. They are employed in the arts of painting, varnishing, embalming, and perfumery; and they furnish us with two of the most important of all materials to a naval power, pitch and tar.

1472. *Gum-resins.* This term is employed to denote a class of vegetable substances, which have been regarded by chemists as consisting of gum and resin. They are generally contained in the proper vessels of the plant, whether in the root, stem, branches, leaves, flowers, or fruit. But there is this remarkable difference between resins and gum-resins, that the latter have never been known, like the former, to exude spontaneously from the plant. They are obtained by means of bruising the parts containing them, and expressing the juice, which is always in the state of an emulsion, generally white, but sometimes of a different colour; or they are obtained by means of incisions from which the juice flows. This juice, which is the proper juice of the plant, is then exposed to the action of the sun, by which, in warm climates, it is condensed and inspissated, and converted into the gum-resin of commerce. Gum-resins, in their solid state, are brittle, and less transparent than resins. They have generally a strong smell, which is sometimes alliaceous, and a bitter and nauseous taste. They are partially soluble both in water and in alcohol. When heated, they do not melt like the resins, nor are they so combustible; but they swell and soften by heat, and at last burn away with a flame. By distillation they yield volatile oil, ammonia combined with an acid, and have a bulky charcoal. The principal species of gum-resins which have been hitherto applied to any useful purpose are: —

1473. *Galbanum*, obtained from the stem of the Bùbon galbànum.
1474. *Ammoniac*, brought from Africa, in the form of small tears; the plant which yields it is thought to be a species of Férula.
1475. *Scammony*, the produce of the Convólvulus Scammònia.
1476. *Opoponax*, obtained from the Pastinàca opóponax.
1477. *Euphorbium*, the produce of the Euphórbia officinàlis. Its taste is caustic; it is considered as a poison, but is occasionally employed in medicine.
1478. *Olibanum* is obtained from the Boswéllia serràta, which grows in Arabia, particularly by the borders of the Red Sea. It is the frankincense of the ancients. It exudes from incisions made in the tree, and concretes into masses about the size of a chestnut.
1479. *Sagapenum* is supposed to be obtained from the Férula pérsica.
1480. *Gamboge*, or gumgutt, the produce of the Garcínia *Cambògia*.
1481. *Myrrh*, the plant yielding which grows in Abyssinia and Arabia. Bruce says it belongs to the genus Mimòsa; but however this may be, myrrh is the juice of the plant concreted in the form of tears. Its colour is yellow, its odour strong but agreeable, and its taste bitter; it is employed in medicine, and is esteemed an excellent stomachic.
1482. *Assafœtida*, a substance which is well known for its strong and fetid smell, is obtained from the Férula assafœ'tida. At four years old the plant is dug up by the root. The root is then cleaned, and the extremity cut off; a milky juice exudes, which is collected; and when it ceases to flow another portion is cut off, and more juice extricated. The process is continued till the root is exhausted. The juice which has been collected soon concretes, and constitutes assafœtida. It is brought to Europe in small agglutinated grains of different colours, white, red, yellow. It is hard, but brittle. Its taste is bitter, and its smell insufferably fetid; the Indians use it as a seasoning for their food, and call it the food of the gods. In Europe, it is used in medicine as an antispasmodic.

1483. *Balsams.* The substances known by the name of balsams are resins united to the benzoic acid. They are obtained by means of incisions made in the bark, from which a viscous juice exudes, which is afterwards inspissated by the action of the fire or air, or they are obtained by means of boiling the part that contains them. They are thick and viscid juices, but become readily concrete. Their colour is brown or red; their smell aromatic when rubbed; their taste acrid; their specific gravity 1·090. They are unalterable in the air after becoming concrete. They are insoluble in water, but boiling water abstracts part of their acid; they are soluble in the alkalies and nitric acid. When heated they melt and swell, evolving a white and odorous smoke. The principal of the balsams are the following: benzoin, storax, styrax, balsam of tolu, and balsam of Peru.

1484. *Benzoin* is the produce of the Stỳrax *Benzòin*.
1485. *Storax* is obtained from the Stỳrax officinàle.
1486. *Styrax* is a semi-fluid juice, the produce of a tree said to be cultivated in Arabia.
1487. *Balsam of tolu* is obtained from the Toluífera *Bálsamum*.
1488. *Balsam of Peru* is obtained from the Myrospérmum peruíferum.

1489. *Camphor.* The substance known by the name of camphor is obtained from the root and stem of the Laúrus *Cámphora* and Dryobálanops *Cámphora*, by distillation. When pure it is a white brittle substance, forming octagonal crystals or square plates. Its taste is hot and acrid; its odour strong but aromatic; its specific gravity 0·9887. When broken into small fragments and put into water, on the surface of which it swims, a singular phenomenon ensues. The water surrounding the fragments is immediately put into commotion, advancing and retiring in little waves, and attacking the fragments with violence. The minuter fragments are driven backwards and forwards upon the surface as if impelled by contrary winds. If a drop of oil is let fall on the surface of the water it produces an immediate calm. This phenomenon has been attributed to electricity. Fourcroy thinks it is merely the effect of the affinities of the camphor, water, and air, entering into combination. Though camphor is obtained chiefly from the Laúrus *Cámphora*, yet it is known to exist in a great many other plants, particularly labiate plants, and has been extracted from the roots of zodoary, sassafras, thyme, rosemary, and lavender.

1490. *Caoutchouc.* The substance denominated caoutchouc was first introduced into Europe about the beginning of the eighteenth century; but, from a use to which it is very generally applied of rubbing out the marks made upon paper by a black-lead pencil, it is better known to most people in this country by the name of Indian rubber. It is obtained chiefly from Siphònia *Cahùchu*, a tree indigenous to South America; but it has been obtained also from several trees which grow in the East Indies, such as Fícus índica and elástica, Artocárpus integrifòlia, and Urcèola elástica. If an incision is made into the bark of any of these plants a milky juice exudes, which, when exposed to the air, concretes and forms caoutchouc. As the object of the natives in collecting it had been originally to form it into vessels for their own use, it is generally made to concrete in the form of bags or bottles. This is done by applying the juice, when fluid, in thin layers to a mould of dry clay, and then leaving it to concrete in the sun or by the fire. A second layer is added to the first, and others in succession, till the vessel acquires the thickness that is wanted. The mould is then broken and the vessel fit for use, and in this state it is generally brought into Europe. It has been brought, however, even in its milky state, by being confined from the action of the air. If the milky juice is exposed to the air, an elastic pellicle is formed on the surface. If it is confined in a vessel containing oxygen gas, the pellicle is formed sooner. If oxymuriatic acid is poured into the milky juice, the caoutchouc precipitates immediately. This renders it probable that the formation of the caoutchouc is owing to the absorption of oxygen. Caoutchouc, when pure, is of a white colour, without taste and without smell. The black colour of the caoutchouc of commerce is owing to the method of drying the different layers upon the moulds on which they are spread. They are dried by being exposed to smoke. The black colour of the caoutchouc, therefore, is owing to the smoke or soot alternating with its different layers. It is soft and pliable like leather, and extremely elastic, so that it may be stretched to a very great length, and still recover its former size. Its specific gravity is 0·9335. Gough, of Manchester, has made some curious and important experiments on the connection between the temperature of caoutchouc and its elasticity, from which it results that ductility as well as fluidity is owing to latent heat. Caoutchouc is not altered by exposure to the air. It is perfectly insoluble in water; but if boiled in water for some time its edges become so soft that they will cement, if pressed and kept for a while close together. It is insoluble in alcohol, but soluble in ether. It is soluble also in volatile oils and in alkalies. And from the action operated upon by acids it is thought to be composed of carbon, hydrogen, oxygen, and azote. It seems to exist in a great variety of plants combined with other ingredients. It may be separated from resins by alcohol. It may be separated from the berries of the mistletoe by means of water, and from other vegetable substances by other processes. It is said to be contained both in opium and in mastic; but from these substances it cannot be extracted in sufficient quantities to make it worth the labour. It is applied to a great many useful purposes both in medicine and the arts, to which, from its great pliability and elasticity, it is uncommonly well adapted. In the countries where it is produced the natives make boots and shoes of it, and often use it by way of candle.

1491. *Cork.* The substance known by the name of cork is the outer and exfoliated bark of the *Quércus Súber* or cork tree, a species of oak that grows in great abundance in France, Spain, and Italy: but to prevent its natural exfoliation, which is always irregular, and to disengage it in convenient portions, a longitudinal incision is made in the bark from the root to the top of the stem; and a transverse and circular incision at each extremity. The outer layer, which is cork, is then stripped off, and to flatten and reduce it to sheets it is put into water and loaded with weights. The tree continues to thrive, though it is thus stripped of its cork once in two or three years. Cork is a light, soft, and elastic substance, distinguished by the following properties: — Its colour is a sort of light tan. It is very inflammable, and burns with a bright white flame, leaving a black and bulky charcoal behind. When distilled it yields a small quantity of ammonia. Nitric acid corrodes and dissolves it, changing its colour to yellow; and finally decomposes it, converting it partly into an acid, and partly into a soft substance resembling wax or resin. The acid which is thus formed is denominated the suberic acid, and has been proved by the experiments of Lagrange to be an acid of a peculiar nature. It seems probable that cork exists in the bark of some other trees, as well as that of the *Quércus Súber*. The bark of the *U'lmus suberòsa* assumes something of the external appearance of cork, which it resembles in its thickness, softness, and elasticity, and in its loose and porous texture, as well as also in its chemical properties. Fourcroy seems, indeed, to regard the epidermis of all trees whatever to be a sort of cork, but does not say on what grounds his opinion is founded.

1492. *Woody fibre.* The principal body of the root, stem, and branches of trees, is designated by the appellation of wood; but the term is too general for the purpose of analytical distinction, as the part designated by it often includes the greater part of the substances that have been already enumerated. It remains, therefore, to be ascertained whether there exists in the plant any individual substance different from those already described, and constituting more immediately the fabric of the wood. If a piece of wood is well dried and digested, first in water and then in alcohol, or such other solvent as shall produce no violent effects upon the insoluble parts; and if the digestion is continued till the liquid is no longer coloured, and dissolves no more of the substance of the plant, there remains behind a sort of vegetable skeleton, which constitutes the basis of the wood, and which has been denominated woody fibre. It is composed of bundles of longitudinal threads, which are divisible into others still smaller. It is somewhat transparent. It is without taste and smell, and is not altered by exposure to the atmosphere. It is insoluble in water and alcohol; but the fixed alkalies decompose it with the assistance of heat. When heated in the open air it blackens without melting or frothing, and exhales a thick smoke and pungent odour, leaving a charcoal that retains the form of the original mass. When distilled in a retort it yields an empyreumatic oil, carburetted hydrogen gas, carbonic acid, and a portion of ammonia, according to Fourcroy, indicating the presence of nitrogen as constituting one of its elementary principles; and yet this ingredient does not appear in the result of the later analysis of Gay Lussac and Thenard, which is, carbon, 52·53; oxygen, 41·78; hydrogen, 5·69; total 100.

1493. *Charcoal.* When wood is burnt with a smothered flame, the volatile parts are driven off by the heat, and there remains behind a substance exhibiting the exact form, and even the several layers of the original mass. This process is denominated charring, and the substance obtained charcoal. As it is the woody fibre alone which resists the action of heat, while the other parts of the plants are dissipated, it is plain that charcoal must be the residuum of woody fibre, and that the quantity of the one must depend upon the quantity of the other, if they are not rather to be considered as the same. Charcoal may be obtained from almost all parts of the plants, whether solid or fluid. It often escapes, however, during combustion, under the form of carbonic acid, of which it constitutes one of the elements. From a variety of experiments made on different plants and on their different parts, it appears that the green parts contain a greater proportion of charcoal than the rest; but this proportion is found to diminish in autumn, when the green parts begin to be deprived of their glutinous and extractive juice. The wood contains more charcoal than the alburnum, the bark more than both; but this last result is not constant in all plants; because the bark is not a homogeneous substance, the outer parts being affected by the air and the inner parts not. The wood of the *Quércus Ròbur*, separated from the alburnum, yielded from 100 parts of its dried substance 19·75 of charcoal; the alburnum, 17·5; the bark, 26; leaves gathered in May, 80; in September, 26. But the quantity of charcoal differs also in different plants, as well as in different parts of the same. According to the experiments of Mushet, 100 parts of the following trees afforded as follows: —

Lignum vitæ	26·8	Walnut	20·6	Norway fir	19·2
Mahogany	25·4	Holly	19·9	Sallow	18·4
Laburnum	24·5	Beech	19·9	Ash	17·9
Chestnut	23·2	American maple	19·9	Birch	17·4
Oak	22·6	Elm	19·5	Scotch pine	16·4
American black birch	21·4				

1494. *The properties of charcoal* are insolubility in water, of which, however, it absorbs a portion when newly made, as also of atmospheric air. It is incapable of putrefaction. It is not altered by the most violent heat that can be applied, if all air and moisture are excluded; but when heated to about 800 it burns in atmospheric air or oxygen gas, and if pure, without leaving any residuum. It is regarded by chemists as being a triple compound, of which the ingredients are carbon, hydrogen, and oxygen. Charcoal is of great utility both to the chemist and artist as a fuel for heating furnaces, as well as for a variety of other purposes. It is an excellent filter for purifying water. It is a very good tooth-powder; and is also an indispensable ingredient in the important manufacture of gunpowder.

1495. *The sap.* If the branch of a vine is cut asunder early in the spring, before the leaves have begun to expand, a clear and colourless fluid will issue from the wound, which gardeners denominate the tears of the vine. It is merely, however, the ascending sap, and may be procured from almost any other plant by the same or similar means, and at the same season; but particularly from the maple, birch, and walnut tree, by means of boring a hole in the trunk. It issues chiefly from the porous and mixed tubes of the alburnum; though sometimes it does not flow freely till the bore is carried to the centre. A small branch of a vine has been known to yield from twelve to sixteen ounces, in the space of twenty-four hours. A maple tree of moderate size yields about 200 pints in a season, as has been already stated; and a birch tree has been known to yield, in the course of the bleeding season, a quantity equal to its own weight. In the sap of *F*àgus sylvática Vauquelin found the following ingredients: — Water, acetate of lime with excess of acid, acetate of potass, gallic acid, tannin, mucous and extractive matter, and acetate of alumina. In 1039 parts of the sap of the *U*'lmus campéstris he found 1027 parts of water and volatile matter, 9·240 of acetate of potass, 1·060 of vegetable matter, 0·796 of carbonate of lime, besides some slight indications of the presence of sulphuric and muriatic acids; and at a later period of the season he found the vegetable matter increased, and the carbonate of lime and acetate of potass diminished. From the above experiments therefore, as well as from those of other chemists, it is plain that the sap consists of a great variety of ingredients, differing in different species of plants; though there is too little known concerning it to warrant the deduction of any general conclusions, as the number of plants whose sap has been hitherto analysed is but very limited. It is the grand and principal source of vegetable aliment, and may be regarded as being somewhat analogous to the blood of animals. It is not made use of by man, at least in its natural state: but there are trees, such as the birch, whose sap may be manufactured into a very pleasant wine; and it is well known that the sap of the American maple tree yields a considerable quantity of sugar.

1496. *The proper juice.* When the sap has received its last degree of elaboration from the different organs through which it has to pass, it is converted into a peculiar fluid, called the proper juice. This fluid may be distinguished from the sap by means of its colour, which is generally green, as in periwinkle; or red, as in logwood; or white, as in spurge; or yellow, as in celandine; from the last two of which it may readily be obtained by breaking the stem asunder, as it will then exude from the fracture. Its principal seat is in the bark, where it occupies the simple tubes; but sometimes it is situated between the bark and wood, as in the juniper tree; or in the leaf, as in the greater parts of herbs; or it is diffused throughout the whole plant, as in the fir and hemlock; in which case, either the proper juice mixes with the sap, or the vessels containing it have ramifications so fine as to be altogether imperceptible. It is not, however, the same in all plants, nor even in the different parts of the same plant. In the cherry tree it is mucilaginous; in the pine it is resinous; in spurge and celandine it is caustic, though resembling in appearance an emulsion. In many plants the proper juice of the bark is different from that of the flower; and the proper juice of the fruit different from both. Its appearance under the microscope, according to Senebier, is that of an assemblage of small globules connected by small and prism-shaped substances placed between them. If this juice could be obtained in a state of purity, its analysis would throw a considerable degree of light upon the subject of vegetation; but it seems impracticable to extract it without a mixture of sap. Senebier analysed the milky juice of *E*uphórb*ia* *C*yparíssias, of which, though its pungency was so great as to occasion an inflammation of the eyes to the person employed to procure it, he had obtained a small quantity considerably pure. It mixed readily with water, to which it communicated its colour. When left exposed to the air, a slight precipitation ensued; and, when allowed to evaporate, a thin and opaque crust remained behind. Alcohol coagulated it into small globules. Ether dissolved it entirely, as did also oil of turpentine. Sulphuric acid changed its colour to black; nitric acid to green. The most accurate experiments on the subject are those of Chaptal. When oxymuriatic acid was poured into the peculiar juice of *E*uphórb*ia*, a very copious white precipitate fell down, which, when washed and dried, had the appearance of starch, and was not altered by keeping. Alcohol, aided by heat, dissolved two thirds of it, which the addition of water again precipitated. They had all the properties of resin. The remaining third part possessed the properties of woody fibre. The same experiment was tried on the juice of a variety of other plants, and the result uniformly was that oxymuriatic acid precipitated from them woody fibre.

1497. *The virtues of plants have generally been thought to reside in their proper juices*, and the opinion seems indeed to be well founded. It is at least proved by experiment in the poppy, spurge, and fig. The juice of the first is narcotic, of the last two corrosive. The diuretic and balsamic virtues of the fir reside in its turpentine, and the purgative property of jalap in its resin. If sugar is obtained from the sap of the sugar-cane and maple, it is only because it has been mixed with a quantity of proper juice. The bark certainly contains it in greatest abundance, as may be exemplified in cinnamon and quinquina. But the peach tree furnishes an exception to this rule: its flowers are purgative, and the whole plant aromatic; but its gum is without any distinguished virtues. Malpighi regarded the proper juice as the principle of nourishment, and compared it to the blood of animals; but this analogy does not hold very closely. The sap is perhaps more analogous to the blood, from which the proper juice is rather a secretion. In one respect, however, the analogy holds good, that is, with regard to extravasated blood and peculiar juices. If the blood escapes from the vessels it forms neither flesh nor bones, but tumours; and if the proper juices escape from the vessels containing them, they form neither wood nor bark, but a lump or deposit of inspissated fluid. To the sap or to the proper juice, or rather to a mixture of both, we must refer such substances as are obtained from plants under the name of expressed juices, because it is evident that they can come from no other source. In this state they are generally obtained in the first instance, whether with a view to their use in medicine or their application to the arts. It is the business of the chemist or artist to separate and purify them afterwards, according to the peculiar object he may happen to have in view, and the use to which he purposes to apply them. They contain, like the sap, acetate of potass or of lime, and assume a deeper shade of colour when exposed to the fire or air. The oxymuriatic acid precipitates from them a coloured and flaky substance as from the sap, and they yield by evaporation a quantity of extract; but they differ from the sap in exhibiting no traces of tannin or gallic acid, and but rarely of the saccharine principle.

1498. *Ashes.* When vegetables are burnt in the open air the greatest part of their substance is evaporated during the process of combustion; but ultimately there remains a portion which is altogether incombustible, and incapable of being volatilised by the action of fire. This residuum is known by the name of ashes. Herbaceous plants, after being dried, yield more ashes than woody plants; the leaves more than the branches; and the branches more than the trunk. The alburnum yields also more ashes than the wood; and putrefied vegetables yield more ashes than the same vegetables in a fresh state, if the putrefaction has not taken place in a current of water. The result of Saussure's experiments on 1000 parts of different plants was as follows: —

Gathered in May, dried leaves of the oak	53	*parts of ashes.*
green leaves of the oak	13	
dried leaves of the *R*hododéndron	50	
dried leaves of the *Æ*'sculus Hippocástanum	72	
trunk and branches of *Æ*'sculus Hippocástanum	35	
Gathered in September, dried leaves of the *Æ*'sculus Hippocástanum	86	
dried leaves of the oak	55	
green leaves of the oak	24	
Gathered when in flower, leaves of *P*ìsum satìvum	95	
Gathered when in fruit, leaves of *P*ìsum satìvum	81	
leaves of *F*àba vulgàris	20	
Gathered before coming into flower, the leaves of the *F*àba vulgàris	16	
Oak, the dried bark 60, the alburnum 4, wood	2	

1499. *The analysis of the ashes* of plants, with a view to the discovery of the ingredients of which they are composed, produces alkalies, earths, and metals, which must therefore be considered as ingredients in the composition of the vegetable. But vegetable ashes contain also a variety of other principles, occurring, however, in such small proportions as generally to escape observation. Perhaps they contain also substances not capable of being volatilised by the action of fire.

1500. *Alkalies.* The alkalies are a peculiar class of substances, distinguished by a caustic taste and the property of changing vegetable blues to green. They are generally regarded as being three in number, potass, soda, and ammonia, of which the two former only are found in the ashes of vegetables. Ammonia is, indeed, often obtained from vegetable substances by means of distillation, but then it is always formed during the process. If the ashes of land vegetables, burnt in the open air, are repeatedly washed in water, and the water filtered and evaporated to dryness, potass is left behind. The potass of commerce is manufactured in this manner, though it is not quite pure: but it may be purified by dissolving it in spirits of wine, and evaporating the solution to dryness in a silver vessel. When pure it is white and semi-transparent, and is extremely caustic and deliquescent. It dissolves all soft animal substances, and changes vegetable blues into green. It dissolves alumina, and also a small quantity of silex, with which it fuses into glass by the aid of fire. It had been long suspected by chemists to be a compound substance: and according to the notable discovery by Sir H. Davy, its component parts are at last ascertained to be oxygen and a highly inflammable metal, which he denominates potassium, one proportion of each. Soda is found chiefly in marine plants, from the ashes of which it is obtained by means of lixiviation. It exists in great abundance in Salsòla *Sòda*, Zostèra maritima, and various species of *Fùci*. It is generally obtained in the state of a carbonate, but is purified in the same manner as potass, to which it is similar in its properties; but from which it is easily distinguished by its forming a hard soap with oil, while potass forms a soft soap. It consists, according to Sir H. Davy, of one proportion of a metal which he denominates sodium, and two proportions of oxygen. Such are the only vegetable alkalies, and the modes of obtaining them. They are found generally in the state of carbonates, sulphates, or muriates, salts which form, beyond all comparison, the most abundant ingredient in the ashes of green herbaceous plants whose parts are in a state of vegetation. The ashes of the golden rod, growing in an uncultivated soil, and of the bean, turnsole, and wheat, were found by Saussure to contain at least three fourths of their weight of alkaline salts. This was nearly the case also with the leaves of trees just bursting from the bud. But the proportion of alkaline salts is found to diminish, rather than to augment, as the parts of the plant are developed. The ashes of the leaves of the oak, gathered in May, yielded 47 parts in the 100 of alkaline salts; and, in September, only 17.

1501. *The utility of the alkalies*, as obtained from vegetables, is of the utmost importance in the arts, particularly in the formation of glass and of soaps. If a mixture of soda, or potass, and silex, or sand, in certain proportions, is exposed to a violent heat, the ingredients are melted down into a fluid mass, which is glass in a state of fusion. In this state it may be moulded into almost any form, at the pleasure of the artist: and, accordingly, we find that it is manufactured into a great variety of utensils and instruments, under the heads of flint glass, crown glass, bottle glass. Bottle glass is the coarsest; it is formed of soda and common sand, and is used in the manufacture of the coarser sort of bottles. Crown glass is composed of soda and fine sand: it is moulded into large plates for the purpose of forming window-glasses and looking-glasses. Flint glass is the finest and most transparent of all: that which is of the best quality is composed of 120 parts of white silicious sand, 40 parts of pearl-ash, 35 of red oxide of lead, 13 of nitrate of potass, and 25 of black oxide of manganese. It is known also by the name of crystal, and may be cut and polished so as to serve for a variety of ornamental purposes, as well as for the more important and more useful purpose of forming optical instruments, of which the discoveries made with the telescope and the microscope are the curious or sublime results. If a quantity of oil is mixed with half its weight of a strong solution of soda or potass, a combination takes place which is rendered more complete by means of boiling. The new compound is soap. The union of oil with potass forms a soft soap, and with soda hard soap; substances of the greatest efficacy as detergents, and of the greatest utility in the washing and bleaching of linen. The alkalies are used also in medicine, and found to be peculiarly efficacious in the reduction of urinary calculi.

1502. *Earths.* The only earths which have hitherto been found in plants are the following: lime, silica, magnesia, and alumina.

1503. *Lime* is by far the most abundant earth. It is generally combined with a portion of phosphoric, carbonic, or sulphuric acid, forming phosphates, or carbonates, or sulphates of lime. The phosphate of lime is, next to the alkaline salt, the most abundant ingredient in the ashes of green herbaceous plants whose parts are all in a state of vegetation. The leaf of a tree, bursting from the bud, contains in its ashes a greater portion of earthy phosphate than at any other period: 100 parts of the ashes of the leaves of the oak, gathered in May, furnished 24 parts of earthy phosphate; in September, only 18·25. In annual plants the proportion of earthy phosphate diminishes from the period of their germination to that of their flowering. Plants of the bean, before flowering, gave 14·5 parts of earthy phosphate; in flower, only 13·5. Carbonate of lime is, next to phosphate of lime, the most abundant of the earthy salts that are found in vegetables. But if the leaves of plants are washed in water the proportion of carbonate is augmented. This is owing to the subtraction of their alkaline salts and phosphates in a greater proportion than their lime. In green herbaceous plants whose parts are in a state of increase, there is but little carbonate of lime; but the ashes of the bark of trees contain an enormous quantity of carbonate of lime, and much more than the alburnum, as do also the ashes of the wood. The ashes of most seeds contain no carbonate of lime; but they abound in phosphate of potass. Hence the ashes of plants, at the period of the maturity of the fruit, yields less carbonate of lime than at any previous period.

1504. *Silica* is not found to exist in a great proportion in the ashes of vegetables, unless they have been previously deprived of their salts and phosphates by washing; but, when the plants are washed in water, the proportion of their silica augments. The ashes of the leaves of the hazel, gathered in May, yielded 2·5 parts of silica in 100. The same leaves, washed, yielded four parts in 100. Young plants, and leaves bursting from the bud, contain but little of silica in their ashes; but the proportion of silica augments as the parts are developed. Perhaps this is owing to the diminution of the alkaline salts. The ashes of some stalks of wheat gathered a month before the time of flowering, and having some of the radical leaves withered, contained 12 parts of silica and 65 of alkaline salts in 100. At the period of their flowering, and when more of their leaves were withered, the ashes contained 32 parts of silica and 54 of alkaline salts. Seeds divested of their external covering, contain less silica than the stem furnished with its leaves; and it is somewhat remarkable that there are trees of which the bark, alburnum, and wood contain scarcely any silica, and the leaves a great deal, particularly in autumn. This is a phenomenon that seems inexplicable. The greater part of the grasses contain a very considerable proportion of silica, as do also the plants of the genus *Equisètum*. Sir H. Davy has discovered that it forms a part of the epidermis of these plants, and in some of them the principal part. From 100 parts of the epidermis of the following plants the proportions of silica were, in bonnet cane, 90; bamboo, 71·4; common reed, 48·1; stalks of corn, 66·5. Owing to the silica contained in the epidermis, the plants in which it is found are sometimes used to give a polish to the surface of subtances where smoothness is required. The Dutch rush (*Equisètum hyemàle*), a plant of this kind, is used to polish even brass.

1505. *Magnesia* does not exist so abundantly in the vegetable kingdom, as the two preceding earths. It has been found, however, in several of the marine plants, particularly the *Fùci*; but Salsòla *Sòda* contains more of magnesia than any other plant yet examined. According to Vauquelin, 100 parts of it contain 17·929 of Magnesia.

1506. *Alumina* has been detected in several plants, but never except in very small quantities.

1507. *Metallic oxides.* Among the substances found in the ashes of vegetables, we must class also metals. They occur, however, only in small quantities, and are not to be detected except by the most delicate experiments. The metals hitherto discovered in plants are iron, manganese, and perhaps gold. Of these iron is by far the most common. It occurs in the state of an oxide; and the ashes of hard and woody plants, such as the oak, are said to contain nearly one twelfth of their own weight of this oxide. The ashes of Salsòla contain also a considerable quantity. The oxide of manganese was first detected in the ashes of vegetables by Scheele, and afterwards found by Proust in the ashes of the pine, calendula, vine, green oak, and fig tree. Beecher, Kunckel, and Sage, together with some other chemists, contend also for the existence of gold in the ashes of certain plants; but the very minute portion which they found, seems more likely to have proceeded from the lead employed in the process, than from the ashes of the plant. It has been observed by Saussure, that the proportion of the oxides of iron and of manganese augments in the ashes of plants as their vegetation advances. The leaves of trees furnish more of these principles in autumn than in spring, as do those of annual plants. Seeds contain metals in less abundance than the stem; and if plants are washed in water, the proportions of their metallic oxides are augmented.

1508. *Such are the principal ingredients* that enter into the vegetable composition. They are indeed numerous, though some of them, such as the metallic oxides, occur in such small proportions as to render it doubtful whether they are in reality vegetable productions or not. The same thing may be said of some of the other ingredients that have been found in the ashes of plants, which it is probable have been absorbed ready formed by the root, and deposited unaltered, so that they can scarcely be at all regarded as being the genuine products of vegetation.

1509. *Other substances.* Besides the substances above enumerated, there are also several others which have been supposed to constitute distinct and peculiar genera of vegetable productions, and which might have been introduced under such a character; such as the mucus, jelly, sarcocol, asparagin, inulin, and ulmin, of Dr. Thomson, as described in his well known *System of Chemistry;* but as there seems to be some difference of opinion among chemists with regard to them, and a belief entertained that they are but varieties of one or other of the foregoing ingredients, it is sufficient for the purposes of this work to have merely mentioned their names. Several other substances, of a distinct and peculiar character, have been suspected to exist in vegetable productions: such as the febrifuge principle of Seguin, as discovering itself in Peruvian bark; the principle of causticity or acridity of Senebier, as discovering itself in the roots of *R*anúnculus bulbòsus, *S*cílla marítima, *B*ryònia álba, and *A*'rum maculàtum, in the leaves of Digitàlis purpùrea, in the bark of *D*áphne *M*ezèreon, and in the juice of the spurges: to which may be added the fluid exuded from the sting of the common nettle, the poisons inherent in some plants, and the medical virtues inherent in others; together with such peculiar principles as may be presumed to exist in such regions of the vegetable kingdom as remain yet unexplored. The important discoveries which have already resulted from the chemical analysis of vegetable substances encourage the hope that further discoveries will be the result of further experiment; and, from the zeal and ability of such chemists as are now directing their attention to the subject, every thing is to be expected.

Sect. II. *Simple Products.*

1510. *A very few constituent and uncompounded elements* include all the compound ingredients of vegetables. The most essential of such compounds consist of carbon, oxygen, and hydrogen; a small proportion of nitrogen is said to be found only in cruciform plants. The remaining elementary principles which plants have been found to contain, although they may be necessary in the vegetable economy, yet they are by no means principles of the first importance, as occurring only in small proportions, and being dependent in a great measure on soil and situation; whereas the elements of carbon, oxygen, and hydrogen form as it were the very essence of the vegetable subject, and constitute by their modifications the peculiar character of the properties of the plant. This is conspicuously exemplified in the result of the investigations of Gay Lussac, and Thenard, who have deduced from a series of the most minute and delicate experiments the three following propositions, which they have dignified by the name of Laws of Vegetable Nature (*Traité de Chem. Element.*, tom. iii. chap. iii.): — 1st, Vegetable substances are always acid, when the oxygen they contain is to the hydrogen in a greater proportion than in water; 2dly, Vegetable substances are always resinous, or oily, or spirituous, when the oxygen they contain is to the hydrogen in a smaller proportion than in water; 3dly, Vegetable substances are neither acid nor resinous, but saccharine, or mucilaginous, or analogous to woody fibre or starch, when the oxygen and hydrogen they contain are in the same proportion as in water. (See *Dr. Thomson's System of Chemistry.*)

Chap. IV.

Functions of Vegetables.

1511. *The life, growth, and propagation of plants* necessarily involve the several following topics: germination, nutriment, digestion, growth and developement of parts, anomalies of vegetable developement, sexuality of vegetables, impregnation of the vegetable germen, changes consequent upon impregnation, propagation and dispersion of the species, causes limiting the dispersion of the species, evidence and character of vegetable vitality.

Sect. I. *Germination of the Seed.*

1512. *Germination* is that act or operation of the vegetative principle, by which the embryo is extricated from its envelopes, and converted into a plant. This is universally the first part of the process of vegetation; for it may be regarded as an indubitable fact, that all plants spring originally from seed. The conditions necessary to germination relate either to the internal state of the seed itself, or to the circumstances in which it is placed with regard to surrounding substances.

1513. *The first condition necessary to germination is,* that the seed must have reached maturity. Unripe seeds seldom germinate, because their parts are not yet prepared to form the chemical combinations on which germination depends. There are some seeds, however, whose germination is said to commence in the very seed-vessel, even before the fruit is ripe, and while it is yet attached to the parent plant. Such are those of the *Tangekólli* of Adanson, and Agàve vivípara of East Florida, as well as those of the Cȳamus *Nelúmbo* of Sir J. E. Smith, or sacred bean of India; to which may be added the seeds of the comcom garden radish, pea, lemon, &c. But these are examples of rare occurrence; though it is sometimes necessary to sow or plant the seed almost as soon as it is fully ripe, as in the case of the coffee-bean; which will not germinate unless it is sown within five or six weeks after it has been gathered. Most seeds, however, if guarded from external injury, will retain their germinating faculty for a period of many years. This has been proved by the experiment of sowing seeds which have been long so kept; as well as by the deep ploughing up of fields which have been long left without cultivation. A field which was thus ploughed up, near Dunkeld, in Scotland, after a period of forty years' rest, yielded a considerable blade of black oats without sowing. This could have only been by the plough's bringing up to the surface seeds which had been formerly too deeply lodged for germination.

1514. *The second condition is,* that the seeds sown must be *defended from the action of the rays of light.* This has no doubt been long known to be a necessary condition of germination, if we regard the practice of the harrowing or raking in of the grains or seeds sown by the farmer or gardener as being founded upon it.

1515. *A third condition* necessary to germination is the *access of heat.* No seed has ever been known to germinate at or below the freezing point. Hence seeds do not germinate in winter, even though lodged in their proper soil: but the vital principle is not necessarily destroyed in consequence of this exposure; for the seed will germinate still, on the return of spring, when the ground has been again thawed, and the temperature raised to the proper degree. This degree varies considerably in different species of seeds, as is obvious from observing the times of their germination, whether in the same climate or in different ones: for if seeds, which naturally sow themselves, germinate in different climates at the same period, or in the same climate at different periods, the temperature necessary to their germination must of consequence be different. Now these cases are constantly occurring and presenting themselves to our notice; and have also been made the subject of particular observation. Adanson found that seeds which will germinate in the space of twelve hours in an ordinary degree of heat, may be made to germinate in the space of three hours by exposing them to a greater degree of heat; and that seeds transported from the climate of Paris to that of Senegal, have their periods of germination accelerated from one to three days. (*Familles des Plantes*, vol. i. p. 84.) Upon the same principle, seeds transported from a warmer to a colder climate, have their periods of germination protracted till the temperature of the latter is raised to that of the former. This is well exemplified in the case of green-house and hot-house plants, from which it is also obvious that the temperature must not be raised beyond a certain degree, otherwise the vital principle is totally destroyed.

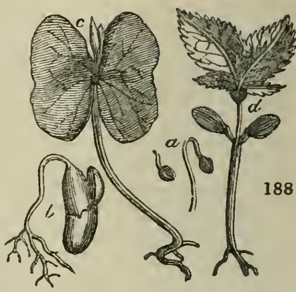
1516. *A fourth condition* necessary to germination is the *access of moisture.* Seeds will not germinate if they are kept perfectly dry. Water, therefore, or some liquid equivalent to it, is essential to germination. Hence rain is always acceptable to the farmer or gardener, immediately after he has sown his seeds; and, if no rain falls, recourse must be had, if possible, to artificial watering. But the quantity of water applied is not a matter of indifference. There may be too little or there may be too much. If there be too little, the seed dies for want of moisture; if there be too much, it then rots. The case is not the same, however, with all seeds. Some can bear but little moisture, though others will germinate even when partially immersed; as was proved by an experiment of Du Hamel's, at least in the case of peas, which he placed merely upon a piece of wet sponge, so as to immerse them by nearly the one half, and which germinated as if placed in the soil. But this was found to be the most they could bear; for when totally immersed in the water they rotted. There are some seeds, however, which will germinate even when wholly submersed. The seeds of aquatics must of necessity germinate under water; and peas have been known to do so under certain conditions.

1517. *A fifth condition* necessary to germination is the *access of atmospheric air.* Seeds will not germinate if placed in a vacuum. Ray introduced some grains of lettuce-seed into the receiver of an air-pump, which he then exhausted. The seeds did not germinate. But they germinated upon the readmission of the air, which is thus proved by consequence to be necessary to their germination. Achard proved that no seed will germinate in nitrogen gas, or carbonic acid gas, or hydrogen gas, except when mixed with a certain proportion of oxygen gas; and hence concluded that oxygen gas is necessary to the germination of all seeds, and the only constituent part of the atmospheric air which is absolutely necessary. Humboldt found that the process of germination is accelerated by means of previously steeping the seed in water impregnated with oxymuriatic acid. Cress-seed treated in this manner germinated in the space of three hours, though its ordinary period of germination is not less than thirty-two hours.

1518. *The period necessary to complete the process of germination* is not the same in all seeds, even when all the necessary conditions have been furnished. Some species require a shorter, and others a longer period. The grasses are among the number of those plants whose seeds are of the most rapid germination; then perhaps cruciform plants; then leguminous plants; then labiate plants; then umbelliferous plants; and in the last order rosaceous plants, whose seeds germinate the slowest. The following table indicates the periods of the germination of a considerable variety of seeds, as observed by Adanson: —

	Days.		Days.		Days.
Wheat, Millet-seed	1	Radish, Beet-root	6	Hyssop	30
Spinach, Beans, Mustard	3	Barley from	4 to 7	Parsley	40 or 50
Lettuce, Aniseed	4	Orache	8	Almond, Chestnut, Peach	1 year
Melon, Cucumber, Cress seed	5	Purslane	9	Rose, Hawthorn, Filbert	2 years.
		Cabbage	10		

1519. *Physical phenomena.* When a seed is committed to the soil under the conditions which have been just specified, the first infallible symptom of germination is to be deduced



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from the prolongation of the radicle (*fig.* 188. *a*), bursting through its proper integuments, and directing its extremity downwards into the soil. The next step in the process of germination is the evolution of the cotyledon or cotyledons (*c*), unless the seed is altogether acotyledonous, or the cotyledons hypogean, as in the oak (*b*). The next step, in the case of seeds furnished with cotyledons, is that of the extrication of the plumelet (*c*), or first real leaf, from within the cotyledon or from between the cotyledons, and its expansion in the open air. The developement of the rudiments of a stem(*d*), if the species is furnished with one, is the last and concluding step, and the plant is complete. Whatever way the seed may be deposited, the invincible tendency of the radicle is to descend and fix itself in the earth ; and of the plumelet, to ascend into the air. Many conjectures have been offered to account for this. Knight accounts for it on the old but revived principle of gravitation. Keith conjectures that it takes place from a power inherent in the vegetable subject, analogous to what we call instinct in the animal subject, infallibly directing it to the situation best suited to the acquisition of nutriment and consequent developement of its parts.

1520. *The chemical phenomena* of germination consist chiefly in the changes which are effected in the nutriment destined for the support and developement of the embryo till it is converted into a plant. This nutriment either passes through the cotyledons, or is contained in them; because the embryo dies when they are prematurely cut off. But the farinaceous substance of the cotyledons, at least in exalbuminous seeds, is a proof that they themselves contain the nutriment. They are to be regarded, therefore, as repositories of the food destined for the support of the embryo in its germinating state ; and, if the seed is furnished with a distinct and separate albumen, then is the albumen to be regarded as the repository of food, and the cotyledon or cotyledons as its channel of conveyance. But the food thus contained in the albumen or cotyledons is not yet fitted for the immediate nourishment of the embryo : some previous preparation is necessary; some change must be effected in its properties. This change is effected by the intervention of chemical agency. The moisture imbibed by a seed placed in the earth is immediately absorbed by the cotyledons or albumen, which it readily penetrates, and on which it immediately begins to operate a chemical change, dissolving part of their farina, or mixing with their oily particles, and forming a sort of emulsive juice. The consequence of this change is a slight degree of fermentation, induced, perhaps, by the mixture of the starch and gluten of the cotyledons in the water which they have absorbed, and indicated by the extraction of a quantity of carbonic acid gas, as well as by the smell and taste of the seed. This is the commencement of the process of germination, which takes place even though no oxygen gas is present. But if no oxygen gas is present, then the process stops ; which shows that the agency of oxygen gas is indispensable to germination. Accordingly, when oxygen gas is present, it is gradually inhaled by the seed; and the farina of the cotyledons is found to have changed its savour. Sometimes it becomes acid, but generally sweet, resembling the taste of sugar ; and is consequently converted into sugar or some substance analogous to it. This is a further proof that a degree of fermentation has been induced; because the result is precisely the same in the process of the fermentation of barley when converted into malt, as known by the name of the saccharine fermentation; in which oxygen gas is absorbed, heat and carbonic acid evolved, and a tendency to germination indicated by the shooting of the radicle. The effect of oxygen, therefore, in the process, is that of converting the farina of the albumen or cotyledons into a mild and saccharine food, fit for the nourishment of the infant plant by diminishing the proportion of its carbon, and in augmenting, by consequence, that of its oxygen and hydrogen. The radicle gives the first indications of life, expanding and bursting its integuments, and at length fixing itself in the soil : the plumelet next unfolds its parts, developing the rudiments of leaf, branch, and trunk : and, finally, the seminal leaves decay and drop off; and the embryo has been converted into a plant, capable of abstracting immediately from the soil or atmosphere the nourishment necessary to its future growth.

Sect. II. *Food of the vegetating Plant.*

1521. *The substances which plants abstract from the soil or atmosphere,* or the food of the vegetating plant, have long occupied the phytological enquirer. What then are the component principles of the soil and atmosphere? The investigations and discoveries of modern chemists have done much to elucidate this dark and intricate subject. Soil, in general, may be regarded as consisting of earths, water, vegetable mould, decayed animal substances, salts, ores, alkalies, gases, perhaps in a proportion corresponding to the order in which they are now enumerated ; which is at any rate the fact with regard to the first three, though their relative proportions are by no means uniform. The atmosphere has been also found to consist of at least four species of elastic matter, nitrogen, oxygen, carbonic acid gas, and vapour ; together with a multitude of minute particles detached from the solid bodies occupying the surface of the earth, and wafted upon the winds. The two former ingredients exist in the proportion of about four to one ; carbonic acid gas in the proportion of about one part in 100; and vapour in proportion still less. Such then are the component principles of the soil and atmosphere, and the sources of vegetable nourishment. But the whole of the ingredients of the soil and atmosphere are not taken up indiscriminately by the plant and converted into vegetable food, because plants do not thrive indiscriminately in all varieties of soil. Part only of the ingredients are selected, and in certain proportions : as is evident from the analysis of the vegetable substance given in the foregoing chapter, in which it was found that carbon, hydrogen, oxygen, and nitrogen, are the principal ingredients of plants; while the other ingredients contained in them occur but in very small proportions. It does not however follow, that these ingredients enter the plant in an uncombined and insulated state, because they do not always so exist in the soil and atmosphere; it follows only that they are inhaled or absorbed by the vegetating plant, under one modification or another. The plant then does not select such principles as are the most abundant in the soil and atmosphere; nor in the proportions in which they exist; nor in an uncombined and insulated state. But what are the substances actually selected; in what state are they taken up; and in what proportions? In order to give arrangement and elucidation to the subject, it shall be considered under the following heads: Water, Gases, Vegetable Extracts, Salts, Earths, Manures.

1522. *Water*. As water is necessary to the commencement of vegetation, so also is it necessary to its progress. Plants will not continue to vegetate unless their roots be supplied with water; and if they be kept long without it, the leaves will droop and become flaccid, and assume a withered appearance. Now this is evidently owing to the loss of water; for if the roots be again well supplied with water, the weight of the plant is increased, and its freshness restored. But many plants will grow, and thrive, and effect the developement of all their parts, if the root be merely immersed in water, though not fixed in the soil. Tulips, hyacinths, and a variety of plants with bulbous roots, may be so reared, and are often to be met with so vegetating; and many plants will also vegetate though wholly immersed. Most of the marine plants are of this description. It can scarcely be doubted, therefore, that water serves for the purpose of a vegetable aliment. But, if plants cannot be made to vegetate without water; and if they will vegetate, some when partly immersed without the assistance of soil, and some even when totally immersed, so as that no other food seems to have access to them; does it not follow that water is the sole food of plants, the soil being merely the basis on which they rest, and the receptacle of their food? This opinion has had many advocates; and the arguments and experiments adduced in support of it were, at one time, thought to have completely established its truth. It was indeed the prevailing opinion of the seventeenth century, and was embraced by several philosophers even of the eighteenth century; but its ablest and most zealous advocates were Van Helmont, Boyle, Du Hamel, and Bonnet, who contended that water, by virtue of the vital energy of the plant, was sufficient to form all the different substances contained in vegetables. Du Hamel reared in the above manner plants of the horsechestnut and almond to some considerable size, and an oak till it was eight years old. But though he informs us that they died at last only from neglect of watering, yet it seems extremely doubtful whether they would have continued to vegetate much longer, even if they had been watered ever so regularly: for he admits, in the first place, that they made less and less progress every year; and, in the second place, that their roots were found to be in a very bad state. The result of a great variety of experiments is, that water is not the sole food of plants, and is not convertible into the whole of the ingredients of the vegetable substance, even with the aid of the vital energy; though plants vegetating merely in water do yet augment the quantity of their carbon.

1523. *Gases*. When water was found to be insufficient to constitute the sole food of plants, recourse was next had to the assistance of the atmospheric air; and the vital energy of the plant was believed to be at least capable of furnishing all the different ingredients of the vegetable substance, by means of decomposing and combining, in different ways, atmospheric air and water. But as this extravagant conjecture is founded on no proof, it is consequently of no value. It must be confessed, however, that atmospheric air is indispensably necessary to the health and vigour of the plant, as may be seen by looking at the different aspects of plants exposed to a free circulation of air, and plants deprived of it: the former are vigorous and luxuriant; the latter weak and stunted. It may be seen also by means of experiment even upon a small scale. If a plant be placed under a glass to which no new supply of air has access, it soon begins to languish, and at length withers and dies: but particularly if it be placed under the exhausted receiver of an air-pump; as might indeed be expected from the failure of the germination of the seed in similar circumstances. The result of experiments on this subject is, that atmospheric air and water are not the only principles constituting the food of plants. But as in germination, so also in the progress of vegetation, it is part only of the component principles of the atmospheric air that are adapted to the purposes of vegetable nutrition, and selected by the plant as a food. Let us take them in the order of their reversed proportions.

1524. *The effect of the application of carbonic acid gas* was found to be altogether prejudicial in the process of the germination of the seed: but in the process of subsequent vegetation its application has been found, on the contrary, to be extremely beneficial. Plants will not indeed vegetate in an atmosphere of pure carbonic acid, as was first ascertained by Dr. Priestley, who found that sprigs of mint growing in water, and placed over wort in a state of fermentation, generally became dead in the space of a day, and did not even recover when put into an atmosphere of common air. Of a number of experiments the results are: 1st, That carbonic acid gas is of great utility to the growth of plants vegetating in the sun, as applied to the leaves and branches, and whatever increases the proportion of this gas in their atmosphere, at least within a given degree, forwards vegetation; 2d, That, as applied to the leaves and branches of plants, it is prejudicial to vegetation in the shade, if administered in a proportion beyond that in which it exists in atmospheric air; 3d, That carbonic acid gas, as applied to the roots of plants, is also beneficial to their growth, at least in the more advanced stages of vegetation.

1525. As *oxygen* is essential to the commencement and progress of germination, so also it is essential to the progress of vegetation. It is obvious, then, that the experiment proves that it is beneficial to the growth of the vegetable as applied to the root; necessary to the developement of the leaves; and to the developement of the flower and fruit. The flower-bud will not expand if confined in an atmosphere deprived of oxygen, nor will the fruit ripen. Flower-buds confined in an atmosphere of pure nitrogen faded without expanding. A bunch of unripe grapes introduced into a globe of glass which was luted by its orifice to the bough, and exposed to the sun, ripened without effecting any material alteration in its atmosphere: but when a bunch was placed in the same circumstances, with the addition of a quantity of lime, the atmosphere was contaminated, and the grapes did not ripen. Oxygen, therefore, is essential to the developement of the vegetating plant, and is inhaled during the night.

1526. Though *nitrogen gas* constitutes by far the greater part of the mass of atmospheric air, it does not seem capable of affording nutriment to plants; for as seeds will not germinate, so neither will plants vegetate, in it, but for a very limited time, with the exception of the *V*inca mlnor, *L*ythrum Salicària, *I*nula dysentérica, Epilòbium hirsùtum, and *P*olýgonum Persicària, which seem to succeed equally well in an atmosphere of nitrogen gas as in an atmosphere of common air. Nitrogen is found in almost all vegetables, particularly in the wood, in extract, and in their green parts, derived, no doubt, from the extractive principle of vegetable mould.

1527. *Hydrogen gas.* A plant of the Epilòbium hirsùtum, which was confined by Priestley in a receiver filled with inflammable air or hydrogen, consumed one third of its atmosphere and was still green. Hence Priestley inferred, that it serves as a vegetable food, and constitutes even the true and proper pabulum of the plant. But the experiments of later phytologists do not at all countenance this opinion. The conclusion from various experiments is, that hydrogen is unfavourable to vegetation, and does not serve as the food of plants. But hydrogen is contained in plants, as is evident from their analysis: and if they refuse it when presented to them in a gaseous state, in what state do they then acquire it? To this question it is sufficient for the present to reply, that if plants do not acquire their hydrogen in the state of gas, they may at least acquire it in the state of water, which is indisputably a vegetable food, and of which hydrogen constitutes one of the component parts.

1528. *Vegetable extract.* When it was found that atmospheric air and water are not, even conjointly, capable of furnishing the whole of the aliment necessary to the developement of the plant, it was then alleged that, with the exception of water, all substances constituting a vegetable food must at least be administered to the plant in a gaseous state. But this also is a conjecture unsupported by proof; for even with regard to such plants as grow upon a barren rock, or in pure sand, it cannot be said that they receive no nourishment whatever besides water, except in a gaseous state. Many of the particles of decayed animal and vegetable substances, which float on the atmosphere and attach themselves to the leaves, must be supposed to enter the plant in solution with the moisture which the leaves imbibe; and so also similar substances contained in the soil must be supposed to enter it by the root: but these substances may certainly contain vegetable nourishment; and they will perhaps be found to be taken up by the plant in proportion to their degree of solubility in water, and to the quantity in which they exist in the soil. Now one of the most important of these substances is vegetable extract. When plants have attained to the maturity of their species, the principles of decay begin gradually to operate upon them, till they at length die and are converted into dust or vegetable mould, which, as might be expected, constitutes a considerable proportion of the soil. The chance then is, that it is again converted into vegetable nourishment, and again enters the plant. But it cannot wholly enter the plant, because it is not wholly soluble in water. Part of it, however, is soluble, and consequently capable of being absorbed by the root, and that is the substance which has been denominated extract.

1529. *Saussure* filled a large vessel with pure mould of turf, and moistened it with distilled or rain water, till it was saturated. At the end of five days, when it was subjected to the action of the press, 10,000 parts in weight of the expressed and filtered fluid yielded, by evaporation to dryness, 26 parts of extract. In a similar experiment upon the mould of a kitchen-garden which had been manured with dung, 10,000 parts of a fluid yielded 10 of extract; and, in a similar experiment upon mould taken from a well-cultivated corn field, 10,000 parts of fluid yielded 4 parts of extract. Such was the result in these particular cases. But the quantity of extract which may be separated from the common soil is not in general very considerable. After twelve decoctions, all that could be separated was about one eleventh of its weight; and yet this seems to be more than sufficient for the purposes of vegetation: for a soil containing this quantity was found by experiment to be less fertile, at least for peas and beans, than a soil containing only one half or two thirds of the quantity. But if the quantity of extract must not be too much, neither must it be too little. Plants that were put to vegetate in soil deprived of its extract, as far as repeated decoctions could deprive it, were found to be much less vigorous and luxuriant than plants vegetating in soil not deprived of its extract: and yet the only perceptible difference between them is, that the former can imbibe and retain a much greater quantity of water than the latter. From this last experiment, as well as from the great proportion in which it exists in the living plant, it evidently follows that extract constitutes a vegetable food. But extract contains nitrogen; for it yields by distillation a fluid impregnated with ammonia. The difficulty, therefore, of accounting for the introduction of nitrogen into the vegetating plant, as well as for its existence in the mature vegetable substance, is done away; for, although the plant refuses it when presented in a gaseous state, it is plain that it must admit it along with the extract. It seems also probable that a small quantity of carbonic acid gas enters the plant along with the extractive principle, as it is known to contain this gas also.

1530. *Salts*, in a certain proportion, are found in most plants, such as nitrate, muriate, and sulphate of potass or soda, as has been already shown. These salts are known to exist in the soil, and the root is supposed to absorb them in solution with the water by which the plant is nourished. It is at least certain that plants may be made to take up by the roots a considerable proportion of salts in a state of artificial solution. But if salts are thus taken up by the root of the vegetating plant, does it appear that they are taken up as a food? Some plants, it must be confessed, are injured by the application of salts, as is evident from the experiments of Saussure; but others are as evidently benefited by it. Trefoil and lucerne have their growth much accelerated by the application of sulphate of lime, though many other plants are not at all influenced by its action. The parietaria, nettle, and borage will not thrive, except in such soils as contain nitrate of lime, or nitrate of potass; and plants inhabiting the sea-coast, as was observed by Du Hamel, will not thrive in a soil that does not contain muriate of soda. It has been thought, however, that the salts are not actually taken up by the root, though converted to purposes of utility, by acting as astringents or corrosives in stopping up the orifices of the vessels of the plant, and preventing the admission of too much water: but it is to be recollected that the salts in question are found by analysis in the very substance of the plant, and must consequently have entered in solution. It has been also thought that salts are favourable to vegetation, only in proportion as they hasten the putrefaction of vegetable substances contained in the soil, or attract the humidity of the atmosphere. But sulphate of lime is not deliquescent; and if its action consists merely in accelerating putrefaction, why is its beneficial effect confined but to a small number of plants? Grisenthwaite (*New Theory of Agriculture*, 1819, p. 111.) answers this question by stating, that as in the principal grain crops which interest the agriculturist, there exists a particular saline substance peculiar to each, so, if we turn our attention to the clovers and turnips, we shall still find the same discrimination. Saintfoin, clover, and lucerne have long been known to contain a notable quantity of gypsum (sulphate of lime); but such knowledge, very strange to relate, never led to the adoption of gypsum as a manure for these crops, any more than that of phosphate of lime for wheat, or nitrate of soda or potassa for barley. It is true that gypsum has been long, and in various places, recommended as a manure, but its uses not being understood, it was recommended without any reference to crop, or indeed to the accomplishment of any fixed object. It is very well known that some particular ingredient may be essential to the composition of a body, and yet constitute but a very small proportion of its mass. Atmospheric air contains only about one part in the 100 of carbonic acid; and yet no one will venture to affirm that carbonic acid gas is merely an adventitious and accidental element existing by chance in the air of the atmosphere, and not an essential ingredient in its composition. Phosphate of lime constitutes but a very small proportion of animal bodies, perhaps not one part in 500; and yet no one doubts that it is essential to the composition of the bones. But the same salt is found in the ashes of all vegetables; and who will say that is not essential to their perfection.

1531. *Earths.* As most plants have been found by analysis to contain a portion of alkaline or earthy salts, so most plants have been found to contain also a portion of earths: and as the two substances are so nearly related, and so foreign in their character from vegetable substances in general, the same enquiry has consequently been made with regard to their origin. Whence are the earths derived that have been found to exist in plants? Chiefly from the soil. But in what peculiar state of combination do they enter the vessels of the plant? The state most likely to facilitate their absorption is that of their solution in water, in which all the earths hitherto found in plants are known to be in a slight degree soluble. If it be said that the proportion in which they are soluble is so very small that it scarcely deserves to be taken into the account, it is to be recollected that the quantity of water absorbed by the plant is great, while that of the earth necessary to its health is but little, so that it may easily be acquired in the progress of vegetation. Such is the manner in which their absorption seems practicable; and Woodward's experiments afford a presumption that they are actually absorbed by the root.

1532. *The proportion of earths contained in the ashes of vegetables* depends upon the nature of the soil in which they grow. The ashes of the leaves of the *Rhododéndron ferrugineum*, growing on Mount Jura, a calcareous mountain, yielded 43·25 parts of earthy carbonate, and only 0·75 of silica: but the ashes of the leaves of a plant of the same species, growing on Mount Breven, a granitic mountain, yielded two parts of silica, and only 16·75 of earthy carbonate. It is probable, however, that plants are not indebted merely to the soil for the earthy particles which they may contain. They may acquire them partly from the atmosphere. Margray has shown that rain-water contains silica in the proportion of a grain to a pound; which, if it should not reach the root, may possibly be absorbed along with the water that adheres to the leaves. But although the earths are thus to be regarded as constituting a small proportion of vegetable food, they are not of themselves sufficient to support the plant, even with the assistance of water. Giobert mixed together lime, alumine, silica, and magnesia, in such proportions as are generally to be met with in fertile soils, and moistened them with water. Several different .grains were then sown in this artificial soil, which germinated indeed, but did not thrive; and perished when the nourishment of the cotyledons was exhausted. It is plain, therefore, that the earths, though beneficial to the growth of some vegetables, and perhaps necessary to the health of others, are by no means capable of affording any considerable degree of nourishment to the plant.

1533. *Supply of food by manures and culture.* With regard to the food of plants derived from the atmosphere, the supply is pretty regular, at least, in as far as the gases are concerned; for they are not found to vary materially in their proportions on any part of the surface of the globe: but the quantity of moisture contained in the atmosphere is continually varying, so that in the same season you have not always the same quantity, though in the course of the year the deficiency is perhaps made up. From the atmosphere, therefore, there is a regular supply of vegetable food kept up by nature for the support of vegetable life, independent of the aid of man: and if human aid were even wanted, it does not appear that it could be of much avail. But this is by no means the case with regard to soils; for if soils are less regular in their composition, they are at least more within the reach of human management. The supply of food may be increased by altering the mechanical or chemical constitution of soils; and by the addition of food in the form of manures. The mechanical constitution of soils may be altered by pulverisation, consolidation, draining, and watering; their chemical properties by aeration and torrification; both mechanical and chemical properties, by the addition of earths or other substances; and manures, either liquid or solid, are supplied by the distribution of prepared fluids, dungs, and other nourishing matters, with or without their interment. (See Book III.)

1534. *Soils in a state of culture, though consisting originally of the due proportion of ingredients, may yet become exhausted of the principle of fertility by means of too frequent cropping;* whether by repetition of the same, or rotation of different, crops. In this case, it should be the object of the phytologist, as well as of the practical cultivator, to ascertain by what means fertility is to be restored to an exhausted soil, or communicated to a new one. In the breaking up of new soils, if the ground has been wet or marshy, as is frequently the case, it is often sufficient to prepare it merely by means of draining off the superfluous and stagnant water, and of paring and burning the turf upon the surface. If the soil has been exhausted by too frequent a repetition of the same crop, it often happens that a change of crop will answer the purpose of the cultivator; for, although a soil may be exhausted for one sort of grain, it does not necessarily follow that it is also exhausted for another. Accordingly, the practice of the farmer is to sow his crops in rotation, having in the same field a crop, perhaps, of wheat, barley, beans, and tares in succession; each species selecting in its turn some peculiar nutriment, or requiring, perhaps, a smaller supply than the crop which has preceded it. But even upon the plan of rotation, the soil becomes at length exhausted, and the cultivator is obliged to have recourse to other means of restoring its fertility. In this case, an interval of repose is considerably efficacious, as may be seen from the increased fertility of fields that have not been ploughed up for many years, such as those used for pasture; or even from that of the walks and paths in gardens when they are again broken up. Hence also the practice of fallowing, and of trenching, or deep ploughing which in some cases has nearly the same effect as trenching.

1535. *The fertility of a soil is restored,* in the case of draining, by means of its carrying off all such superfluous moisture as may be lodged in the soil, which is well known to be prejudicial to plants not naturally aquatics, as well as by its rendering the soil more firm and compact. In the case of burning, the amelioration is effected by means of the decomposition of the vegetable substances contained in the turf, and subjected to the action of the fire, which disperses part also of the superfluous moisture, but leaves a residue of ashes favourable to future vegetation. In the case of the rotation of crops, the fertility is not so much restored, as more completely developed and brought into action; because the soil, though exhausted for one species of grain, is yet found to be sufficiently fertile for another, the food necessary to each being different, or required in less abundance. In the case of the repose of the soil, the restored fertility may be owing to the decay of vegetable substances which are not now carried off in the annual crop, but left to augment the proportion of vegetable mould; or to the accumulation of fertilising particles conveyed to the soil by rains; or to the continued abstraction of oxygen from the atmosphere. In the case of fallows, it is owing undoubtedly to the action of the atmospheric air upon the soil, whether in rendering it more friable, or in hastening the putrefaction of noxious plants; or it is owing to the abstraction and accumulation of oxygen. In the case of trenching, or deep ploughing, it is owing to the increased facility with which the roots can now penetrate to the proper depth, by which their sphere of nourishment is increased. But it often happens that the soil can no longer be ameliorated by any of the foregoing means, or not at least with sufficient rapidity for the purposes of the cultivator; and in this case there must be a direct and actual application made to it of such substances as are fitted to restore its fertility. Hence the indispensable necessity of manures, which consist chiefly of animal and vegetable remains that are buried and finally decomposed in the soil, from which they are afterwards absorbed by the root of the plant, in a state of solution.

1536. But as *carbon is the principal ingredient furnished by manures,* as contributing to the nourishment of the plant, and is not itself soluble in water, nor even disengaged by fermentation in a state of purity; under what state of chemical combination is its solution effected? Is it effected in the state of charcoal? It has been thought, indeed, that carbon in the state of charcoal is soluble in water; because water from a dunghill, when evaporated, constantly leaves a residuum of charcoal, as was first ascertained by the experiments of Hassenfratz. But there seem to be reasons for doubting the legitimacy of the conclusion that has been drawn from it; for Senebier found that plants whose roots were immersed in water took up less of the fluid in proportion as it was mixed with water from a dunghill. Perhaps then the charcoal of water from a dunghill is held merely in suspension, and enters the plant under some other modification. But if carbon is not soluble in water in the state of charcoal, in what other state is it soluble? It is soluble in the state of carbonic acid gas. But is this the state in which it actually enters the root? On this subject phytologists have been somewhat divided in opinion. Senebier endeavours to prove that carbonic acid gas, dissolved in water, supplies the roots of plants with almost all their carbon, and founds his arguments upon the following facts: — In the first place, it is known that carbonic acid gas is soluble in water; in the second place, it is known to be contained in the soil, and generated by the fermentation of the materials composing manures; and, in the next place, it is known to be beneficial to vegetation when applied artificially to the roots, at least in a certain degree. This is evident from the following experiment of Ruckert, as well as from several experiments of Saussure's previously related. Ruckert planted two beans in pots of equal dimensions, filled with garden mould; the one was moistened with distilled water, and the other with water impregnated with carbonic acid gas. But the latter appeared above ground nine days sooner than the former, and produced twenty-five beans; while the former produced only fifteen. Now the result of this experiment, as well as the preceding facts, is evidently favourable to the presumption of Senebier, and shows that if carbonic acid is not the state in which carbon enters the plant, it is at least a state preparatory to it; and there are other circumstances tending to corroborate the opinion, resulting from the analysis of the ascending sap of plants. The tears of the vine, when analysed by Senebier, yielded a portion of carbonic acid and earth; and as the ascending sap could not be supposed to have yet undergone much alteration, the carbonic acid, like the earth, was probably taken up from the soil. But this opinion, which seems to be so firmly established upon the basis of experiment, Hassenfratz strenuously controverts. According to experiments which he had instituted with an express view to the investigation of this subject, plants which were raised in water impregnated with carbonic acid differed in no respect from such as grew in pure water, and contained no carbon that did not previously exist in the seed. Now if this were the fact, it would be decisive of the point in question. But it is plain from the experiments of Saussure, as related in the preceding section, that Hassenfratz must have been mistaken, both with regard to the utility of carbonic acid gas as furnishing a vegetable aliment, and with regard to the augmentation of carbon in the plant. The opinion of Senebier, therefore, may still be correct. It must be acknowledged, however, that the subject is not yet altogether satisfactorily cleared up; and that carbon may certainly enter the plant in some state different from that either of charcoal in solution, or of carbonic acid gas. Is not carbonic acid of the soil decomposed before entering the plant? This is a conjecture of Dr. Thomson's, founded upon the following facts: — The green oxide of iron is capable of decomposing carbonic acid; and many soils contain that oxide. Most soils, indeed, contain iron, either in the state of the brown or green oxide, and it has been found that oils convert the brown oxide into green. But dung and rich soils contain a quantity of oily substance. One effect of manures, therefore, may be that of reducing the brown oxide of iron to the green, thus rendering it capable of decomposing carbonic acid gas, so as to prepare it for some new combination, in which it may serve as an aliment for plants. All this, however, is but a conjecture; and it is more probable that the carbonic acid of the soil enters the root in combination with some other substance, and is afterwards decomposed within the plant itself.

Sect. III. *Process of Vegetable Nutrition.*

1537. *Plants are nourished in a manner in some degree analogous to that in which animals are sustained.* The food of plants, whether lodged in the soil, or wafted through the atmosphere, is taken up by introsusception in the form of gases or other fluids; it is then known as their sap: this sap ascends to the leaves, where it is elaborated as the blood of animals is in the lungs; it then enters into the general circulation of the plant, and promotes its growth.

1538. *Introsusception.* As plants have no organ analogous to the mouth of animals, they are enabled to take up the nourishment necessary to their support only by absorption or inhalation, as the chyle into the animal lacteals, or the air into the lungs. The former term is applied to the introsusception of non-elastic fluids; the latter to that of gaseous fluids. The absorption of non-elastic fluids by the epidermis of plants does not admit of a doubt. It is proved indisputably, that the leaves not only contain air, but do actually inhale it. It was the opinion of Priestley that they inhale it chiefly by the upper surface; and it has been shown by Saussure that their inhaling power depends entirely upon their organisation. It has been a question, however, among phytologists, whether it is not also effected by the epidermis of the other parts of the plant. We can scarcely suppose it to be effected by the dry and indurate epidermis of the bark of aged trunks, of which the original organisation is obliterated; nor by that of the larger and more aged branches. But it has been thought that there are even some of the soft and succulent parts of the plant by which it cannot be effected, because no pores are visible in their epidermis. Decandolle found no pores in the epidermis of fleshy fruits, such as pears, peaches, and gooseberries; nor in that of roots, or scales of bulbs; nor in any part not exposed to the influence of air and light. It is known, however, that fruits will not ripen, and that roots will not thrive, if wholly deprived of air; and hence it is probable that they inhale it by their epidermis, though the pores by which it enters should not be visible. In the root, indeed, it may possibly enter in combination with the moisture of the soil; but in the other parts of the plant it enters no doubt in the state of gas. Herbs, therefore, and the soft parts of woody plants, absorb moisture and inhale gases from the soil or atmosphere by means of the pores of their epidermis, and thus the plant effects the introsusception of its food.

1539. *Ascent of the sap.* The means by which the plant effects the introsusception of its food, is chiefly that of absorption by the root. But the fluids existing in the soil when absorbed by the root, are designated by the appellation of sap or lymph; which, before it can be rendered subservient to the purposes of vegetable nutrition, must either be intermediately conveyed to some viscus proper to give it elaboration, or immediately distributed throughout the whole body of the plant. Our present object, therefore, is that of tracing out the progress of its distribution or ascent. The sap is in motion in one direction or other, if not all the year, at least at occasional periods, as the bleeding of plants in spring and autumn sufficiently illustrates. The plant always bleeds most freely about the time of the opening of the bud; for in proportion as the leaves expand the sap flows less copiously, and when they are fully expanded it entirely ceases. But this suspension is only temporary, for the plant may be made to bleed again in the end of the autumn, at least under certain conditions. If an incision is now made into the body of the tree, after the occurrence of a short but sharp frost, when the heat of the sun or mildness of the air begins to produce a thaw, the sap will again flow. It will flow even where the tree has been but partially thawed, which sometimes happens on the south side of a tree, when the heat of the sun is strong and the wind northerly. At the seasons now specified, therefore, the sap is evidently in motion; but the plant will not bleed at any other season of the year. It has been the opinion of some phytologists, that the motion of the sap is wholly suspended during the winter. But though the great cold of winter, as well as the great heat of summer, is by no means so favourable to vegetation as the milder though more changeable temperature of spring and autumn, yet it does not wholly suspend the movement of the sap. Palms may be made to bleed at any season of the year; and although this is not the case with plants in general, yet there is proof sufficient that the colds of winter do not, even in this climate, entirely prevent the sap from flowing. Buds exhibit a gradual developement of parts throughout the whole of the winter, as may be seen by dissecting them at different periods. So also do roots. Evergreens retain their leaves; and many of them, such as the arbutus, laurustinus, and the beautiful tribe of the mosses, protrude also their blossoms, even in spite of the rigour of the season. But all this could not possibly be accomplished, if the motion of the sap were wholly suspended.

1540. *Thus the sap is in perpetual motion, with a more accelerated or more diminished velocity, throughout the whole of the year;* but still there is no decided indication exhibited in the mere circumstance of the plant's bleeding, of the direction in which the sap is moving at the time; for the result might be the same whether it was passing from the root to the branches, or from the branches to the root. But as the great influx of the sap is effected by means of the pores of the epidermis of the root, it follows that its motion must, at least in the first place, be that of ascent; and such is its direction at the season of the plant's bleeding, as may be proved by the following experiment: — If the bore or incision that has been made in the trunk is minutely inspected while the plant yet bleeds, the sap will be found to issue almost wholly from the inferior side. If several bores are made in the same trunk, one above another, the sap will begin to flow first from the lower bore, and then from those above it. If a branch of a vine be lopped, the sap will issue copiously from the section terminating the part that remains yet attached to the plant; but not from the section terminating the part that has been lopped off. This proves indubitably that the direction of the sap's motion, during the season of the plant's bleeding, is that of ascent. But if the sap flows so copiously during the season of bleeding, it follows that it must ascend with a very considerable force; which force has accordingly been made the subject of calculation. To the stem of a vine cut off about two feet and a half from the ground, Hales fixed a mercurial gauge which he luted with mastic; the gauge was in the form of a siphon, so contrived that the mercury might be made to rise in proportion to the pressure of the ascending sap. The mercury rose accordingly, and reached, at its maximum, to a height of thirty-eight inches. But this was equivalent to a column of water to the height of forty-three feet three and one third inches; demonstrating a force in the motion of the sap that, without the evidence of experiment, would have seemed altogether incredible.

1541. *Thus the sap, in ascending from the lower to the upper extremity of the plant, is propelled with a very considerable force*, at least in the bleeding season. But is the ascending sap propelled indiscriminately throughout the whole of the tubular apparatus, or is it confined in its course to any particular channel? Before the anatomy of plants had been studied with much accuracy, there was a considerable diversity of opinion on the subject. Some thought it ascended by the bark; others thought it ascended by the bark, wood, and pith, indiscriminately; and others thought it ascended between the bark and wood. The first opinion was maintained and supported by Malpighi; and Grew considered that the sap ascends by the bark, wood, and pith, indiscriminately. Du Hamel stripped several trees of their bark entirely, which continued, notwithstanding, to live for many years, protruding new leaves and new branches as before. Knight stripped the trunks of a number of young crab trees of a ring of bark half an inch in breadth; but the leaves were protruded, and the branches elongated, as if the operation had not been performed. Du Petit Thouars removed the central wood and pith from the stems of several young sycamore trees, leaving the upper part to be supported only by four pillars of bark: in others he removed the bark, liber, and alburnum, leaving the upper part of the tree to be supported solely by the central wood. In each case the tree lived, so that he concludes that both the bark and wood are competent to act as conductors to the sap. (*Hist. d'un Morceau de Bois, Hort. Tour*, 481.)

1542. That *the sap does not ascend exclusively by the bark* is thus rendered sufficiently evident. But it is equally evident that it does not ascend by the pith, at least after the first year; for then, even upon Grew's own supposition, it becomes either juiceless or wholly extinct: and even during the first year it is not absolutely necessary, if at all subservient to the ascent of the sap, as is proved by an experiment of Knight's. Having contrived to abstract from some annual shoots a portion of their pith, so as to interrupt its continuity, but not otherwise materially to injure the fabric of the shoot, Knight found that the growth of the shoots which had been made the subject of experiment was not at all affected by it.

1543. *The sap ascends neither by the bark nor pith, but by the wood only.* But the whole mass of the wood throughout is not equally well adapted for the purpose of conveying it. The interior and central part, or that which has acquired its last degree of solidity, does not in general afford it a passage. This is proved by what is called the girdling of trees, which consists in making a circular gap or incision quite round the stem, and to the depth of two or three inches, so as to cut through both the bark and alburnum. An oak tree on which Knight had performed this operation, with a view to ascertain the channel of the sap's ascent, exhibited not the slightest mark of vegetation in the spring following. The sap then does not ascend through the channel of the matured wood. But if the sap ascends neither through the channel of the bark, nor pith, nor matured wood, through what other channel does it actually ascend? The only remaining channel through which it can possibly ascend is that of the alburnum. In passing through the channel of the alburnum, does the sap ascend promiscuously by the whole of the tubes composing it, or is it confined in its passage to any peculiar set? The earliest conjectures recorded on this subject are those of Grew and Malpighi, who, though they maintained that the sap ascends chiefly by the bark, did not yet deny that it ascends also partly by the alburnum or wood. It occurred to succeeding phytologists that the progress of the sap, and the vessels through which it passes, might be traced or ascertained by means of making plants vegetate in coloured infusions. Du Hamel steeped the extremities of branches of the fig, elder, honeysuckle, and filbert in common ink. In examining the two former, after being steeped for several days, the part immersed was found to be black throughout, but the upper part was tinged only in the wood, which was coloured for the length of a foot, but more faintly and partially in proportion to the height. The pith, indeed, exhibited some traces of ink, but the bark and buds none. In some other examples the external layers of the wood only were tinged. In the honeysuckle the deepest shade was about the middle of the woody layers; and in the filbert there was also observed a coloured circle surrounding the pith, but none in the pith itself, nor in the bark.

1544. *Thus it is proved that the sap ascends through the vessels of the longitudinal fibre composing the alburnum of woody plants, and through the vessels of the several bundles of longitudinal fibre constituting the woody part of herbaceous plants.* But it has been already shown that the vessels composing the woody fibre are not all of the same species. There are simple tubes, porous tubes, spiral tubes, mixed tubes, and interrupted tubes. Through which of these, therefore, does the sap pass in its ascent? The best reply to this enquiry has been furnished by Knight and Mirbel. Knight prepared some annual shoots of the apple and horsechestnut, by means of circular incisions, so as to leave detached rings of bark with insulated leaves remaining on the stem. He then placed them in coloured infusions obtained by macerating the skins of very black grapes in water; and, on examining the transverse section at the end of the experiment, it was found that the infusion had ascended by the wood beyond his incisions, and also into the insulated leaves, but had not coloured the pith nor bark, nor the sap between the bark and wood. From the above experiment, Knight concludes that the sap ascends through what are called the common tubes of the wood and alburnum, at least till it reaches the leaves. Thus the sap is conveyed to the summit of the alburnum. But Knight's next object was to trace the vessels by which it is conveyed into the leaf. The apple tree and horsechestnut were still his subjects of experiment. In the former the leaves are attached to the plants by three strong fibres, or rather bundles of tubes, one in the middle of the leaf-stalk, and one on each side. In the latter they are attached by means of several such bundles. Now the coloured fluid was found in each case to have passed through the centre of the several bundles, and through the centre only, tinging the tubes throughout almost the whole length of the leaf-stalk. In tracing their direction from the leaf-stalk upwards, they were found to extend to the extremity of the leaves; and in tracing their direction from the leaf-stalk downwards, they were found to penetrate the bark and alburnum, the tubes of which they join, descending obliquely till they reach the pith which they surround. From their position Knight calls them central tubes, thus distinguishing them from the common tubes of the wood and alburnum, and from the spiral tubes with which they were every where accompanied as appendages, as well as from a set of other tubes which surrounded them, but were not coloured, and which he designates by the appellation of external tubes. The experiment was now transferred to the flower-stalk, and fruit-stalk, which was done by placing branches of the apple, pear, and vine, furnished with flowers not yet expanded, in a decoction of logwood. The central vessels were rendered apparent as in the leaf-stalk. When the fruit of the two former was fully formed, the experiment was then made upon the fruit-stalk, in which the central vessels were detected as before; but the colouring matter was found to have penetrated into the fruit also, diverging round the core, approaching again in the eye of the fruit, and terminating at last in the stamens. This was effected by means of a prolongation of the central vessels, which did not however appear to be accompanied by the spiral tubes beyond the fruit-stalk. Such then are the parts of the plant through which the sap ascends, and the vessels by which it is conveyed. Entering by the pores of the epidermis, it is received into the longitudinal vessels of the root by which it is conducted to the collar. Thence it is conveyed by the longitudinal vessels of the alburnum, to the base of the leaf-stalk, and peduncle; from which it is further transmitted to the extremity of the leaves, flower, and fruit. There remains a question to be asked intimately connected with the sap's ascent. Do the vessels conducting the sap communicate with one another by inosculation or otherwise, so as that a portion of their contents may be conveyed in a lateral direction, and, consequently, to any part of the plant; or do they form distinct channels throughout the whole of their extent, having no sort of communication with any other set of tubes, or with one another? Each of the two opinions implied in the question has had its advocates and defenders: but Du Hamel and Knight have shown that a branch will still continue to live, though the tubes leading directly to it are cut in the trunk; from which it follows that the sap, though flowing the most copiously in the direct line of ascent, is at the same time also diffused in a transverse direction.

1545. *Causes of the sap's ascent.* By what power is the sap propelled? Grew states two hypotheses: its volatile nature and magnetic tendency, aided by the agency of fermentation. Malpighi was of opinion that the sap ascends by means of the contraction and dilatation of the air contained in the air-vessels. M. De la Hire attempted to account for the phenomenon by combining together the theories of Grew and Malpighi; and Borelli, who endeavoured to render their theory more perfect, by bringing to its aid the influence of the condensation and rarefaction of the air and juices of the plant.

1546. *Agency of heat.* Du Hamel directed his efforts to the solution of the difficulty, by endeavouring to account for the phenomenon from the agency of heat, and chiefly on the following grounds: because the sap begins to flow more copiously as the warmth of spring returns; because the sap is sometimes found to flow on the south side of a tree before it flows on the north side, that is, on the side exposed to the influence of the sun's heat sooner than on the side deprived of it; because plants may be made to vegetate, even in the winter, by means of forcing them in a hot-house; and because plants raised in a hot-house produce their fruit earlier than such as vegetate in the open air. There can be no doubt of the great utility of heat in forwarding the progress of vegetation; but it will not therefore follow that the motion and ascent of the sap are to be attributed to its agency. On the contrary, it is very well known that if the temperature exceeds a certain degree, it becomes then prejudicial both to the ascent of the sap and also to the growth of the plant. Hales found that the sap flows less rapidly at mid-day than in the morning; and every body knows that vegetation is less luxuriant at midsummer than in the spring. So also, in the case of forcing, it happens but too often that the produce of the hot-house is totally destroyed by the unskilful application of heat. If heat is actually the cause of the sap's ascent, how comes it that the degree necessary to produce the effect is so very variable, even in the same climate? For there are many plants, such as the arbutus, laurustinus, and the mosses, which will continue not only to vegetate, but to protrude their blossoms and mature their fruit, even in the midst of winter, when the temperature is at the lowest; and, in the case of submarine plants, the temperature can never be very high: so that, although heat does no doubt facilitate the ascent of the sap by its tendency to make the vessels expand, yet it cannot be regarded as the efficient cause, since the sap is proved to be in motion even throughout the whole of the winter. Du Hamel endeavours, however, to strengthen the operation of heat by means of the influence of humidity, as being also powerful in promoting the ascent of the sap, whether as relative to the season of the year or time of the day. The influence of the humidity of the atmosphere cannot be conceived to operate as a propelling cause, though it may easily be conceived to operate as affording a facility to the ascent of the sap in one way or other; which under certain circumstances is capable of most extraordinary acceleration, but particularly in that state of the atmosphere which forbodes or precedes a storm. In such a state a stalk of wheat was observed by Du Hamel to grow three inches in three days; a stalk of barley six inches, and a shoot of a vine almost two feet; but this is a state that occurs but seldom, and cannot be of much service in the general propulsion of the sap. On this intricate but important subject Linnæus appears to have embraced the opinion of Du Hamel, or an opinion very nearly allied to it; but does not seem to have strengthened it by any new accession of argument; so that none of the hitherto alleged causes can be regarded as adequate to the production of the effect.

1547. *Irritability.* Perhaps the only adequate cause ever suggested, prior to the hypothesis of Dutrochet, is that alleged by Saussure. According to Saussure the cause of the sap's ascent is to be found in a peculiar species of irritability inherent in the sap-vessels themselves, and dependent upon vegetable life; in consequence of which they are rendered capable of a certain degree of contraction, according to the affection of the internal surface by the application of stimuli, as well as of subsequent dilatation according to the subsidence of the action of the stimulus; thus admitting and propelling the sap by alternate dilatation and contraction. In order to give elucidation to the subject, let the tube be supposed to consist of an indefinite number of hollow cylinders united one to another, and let the sap be supposed to enter the first cylinder by capillary attraction, or by any other adequate means; then the first cylinder being excited by the stimulus of the sap, begins gradually to contract, and to propel the contained fluid into the cylinder immediately above it. But the cylinder immediately above it, when acted on in the same manner, is affected in the same manner; and thus the fluid is propelled from cylinder to cylinder till it reaches the summit of the plant. So also when the first cylinder has discharged its contents into the second, and is no longer acted upon by the stimulus of the sap, it begins again to be dilated to its original capacity, and prepared for the introsusception of a new portion of fluid. Thus a supply is constantly kept up, and the sap continues to flow. The above is by far the simplest as well as most satisfactory of all theories accounting for the ascent of the sap.

1548. *Contraction and dilatation.* Knight has presented us with a theory which, whatever may be its real value, merits at least our particular notice, as coming from an author who stands deservedly high in the list of phytological writers. This theory rests upon the principle of the contraction and dilatation, not of the sap-vessels themselves, as in the theory of Saussure, but of what Knight denominates the *silver grain*, assisted perhaps by heat and humidity expanding or condensing the fluids. (*Phil. Trans*, 1801.) Keith considers this theory of Knight as beset with many difficulties, and the agency of the alleged cause as totally inadequate to the production of the effect to be accomplished.

1549. *Necessity of an equilibrium in the plant.* Du Petit Thouars attributes the motion of the sap to an inherent power, with which nature has been pleased to endow vegetables. But the cause of the renewal of its motion in the spring, after remaining in a quiescent state for several months, he ascribes to the necessity of maintaining a perfect equilibrium in the system of a plant. So that, if a consumption of sap is produced at any given point, the necessity of making good the space so occasioned consequently throws all the particles of sap into motion; and the same effect will continue to operate as long as any consumption of sap takes place. The first cause of this consumption of sap he declares to be the developement of the buds, and already formed young leaves, by the stimulating action of light and heat, but particularly of the latter. As soon as this developement occurs, an assimilation and absorption of sap is occasioned for the support of the young leaves, a vacancy in the immediate vicinity of the leaves is produced, and a motion immediately takes place. (*London Encyc.*, art. *Bot.*)

1550. *Electricity.* The most satisfactory hypothesis for the ascent of the sap is that of M. Dutrochet. This philosopher, by careful examination with a microscope, found that the minute conical termination of the radicle was furnished with other projecting bodies, like sponges, which perform the office of the piston of a syringe, and have the power of introducing into their cavity, and through their sides, the water which comes in contact with the exterior surface, and which spongioles oppose, at the same time, the exit of any fluid which they may imbibe. The motions of the sap and juice in plants take place, according to this author, in consequence of the operations of two distinct currents of electricity: the one negative, by which the vessels have the power of absorption, which M. Dutrochet calls endosmose, and by which the vessels become turgid; and the other positive, by which the vessels exude or secrete, which power M. Dutrochet calls exosmose. (*Gardener's Mag.*, vol. iii. p. 78.; *Dutrochet*, *Agent Immediat du mouvement vital*, Paris, 8vo, 1826.)

1551. *Elaboration of the sap.* The moisture of the soil is no sooner absorbed into the plant than it begins to undergo a change. This is proved by the experiment of making a bore or incision in the trunk of a tree during the season of bleeding; the sap that issues from the wound possesses properties very different from the mere moisture of the soil, as is indicated by means of chemical analysis and sometimes also by means of a peculiar taste or flavour, as in the case of the birch tree. Hence the sap has already undergone a certain degree of elaboration; either in passing through the glands of the cellular tissue, which it reaches through the medium of a lateral communication, or in mingling with the juices contained in the cells, and thus carrying off a portion of them; in the same manner, we may suppose, that water, by filtering through a mineral vein, becomes impregnated with the mineral through which it passes. But this primary and incipient stage of the process of elaboration must always of necessity remain a mystery to the phytologist, as being wholly effected in the interior of the plant, and consequently beyond the reach of observation. All he can do, therefore, is to trace out its future progress, and to watch its succeeding changes, in which the *rationale* of the process of elaboration may be more evident.

1552. *The process of elaboration is chiefly operated in the leaf:* for the sap no sooner reaches the leaf, than part of it is immediately carried off by means of perspiration, perceptible or imperceptible; effecting a change in the proportion of its component parts, and by consequence a change in its properties.

1553. *Hales* reared a sun-flower in a pot of earth till it grew to the height of three feet and a half; he then covered the mouth of the pot with a plate of lead, which he cemented so as to prevent all evaporation from the earth contained in it. In this plate he fixed two tubes, the one nine inches in length and of but small diameter, left open to serve as a medium of communication with the external air; the other two inches in length and one in diameter, for the purpose of introducing a supply of water, but kept always shut except at the time of watering. The holes at the bottom of the pot were also shut, and the pot and plant weighed for fifteen successive days in the months of July and August: hence he ascertained not only the fact of transpiration by the leaves, from a comparison of the supply and waste; but also the quantity of moisture transpired in a given time, by subtracting from the total waste the amount of evaporation from the pot. The final result proved that the absorbing power of the root is greater than the transpiring power of the leaves, in the proportion of five to two. Similar experiments were also made upon some species of cabbage, whose mean transpiration was found to be 1 lb. 3 oz. per day; and on some species of evergreens, which were found, however, to transpire less than other plants. The same is the case also with succulent plants, which transpire but little in proportion to their mass, and which as they become more firm transpire less. It is known, however, that they absorb a great deal of moisture, though they give it out thus sparingly; which seems intended by nature for the purpose of resisting the great droughts to which they are generally exposed, inhabiting, as they do for the most part, the sandy desert or the sunny rock. Along with his own experiments Hales relates also some others that were made by Miller of Chelsea; the result of which was that, other circumstances being the same, transpiration is in proportion to the transpiring surface, and is affected by the temperature of the air; sunshine or drought promoting it, and cold and wet diminishing or suppressing it entirely. It is also greatest from six o'clock in the morning till noon, and is least during the night. But when transpiration becomes too abundant, owing to excess of heat or drought, the plant immediately suffers and begins to languish; and hence the leaves droop during the day, though they are again revived during the night. For the same or for a similar reason, transpiration has been found also to increase as the heat of summer advances; being more abundant in July than in June, and still more in August than in either of the preceding months, from which last period it begins again to decrease.

1554. *A fluid little different from common water is exhaled,* according to the experiments of Hales and Guettard; in some cases it had the odour of the plant; but Du Hamel found that it became sooner putrid than water. Such then are the facts that have been ascertained with regard to the imperceptible perspiration of plants, from which it unavoidably follows that the sap undergoes a very considerable modification in its passage through the leaf.

1555. *Perceptible perspiration,* which is an exudation of sap too gross or too abundant to be dissipated immediately, and which hence accumulates on the surface of the leaf, is the cause of its further modification. It is very generally to be met with, in the course of the summer, on the leaves of the maple, poplar, and lime tree; but particularly on the surface exposed to the sun, which it sometimes wholly covers.

1556. *The physical as well as chemical qualities of perspired matter* are very different in different species of plants; so that it is not always merely an exudation of sap, but of sap in a high state of elaboration, or mingled with the peculiar juices or secretions of the plant. Sometimes it is a clear and watery fluid conglomerating into large drops, such as are said to have been observed by Miller, exuding from the leaves of the Mùsa paradisìaca, or plantain tree; and such as are sometimes to be seen in hot and calm weather exuding from the leaves of the poplar or willow, and trickling down in such abundance as to resemble a slight shower. This phenomenon was observed by Sir J. E. Smith, under a grove of willows in Italy, and is said to have occurred even in England. Sometimes it is glutinous, as on the leaf of the lime tree; sometimes it waxy, as on the leaves of rosemary; sometimes it is saccharine, as on the orange leaf; or resinous, as on the leaves of the Cístus créticus. The cause of this excess of perspiration has not yet been altogether satisfactorily ascertained; though it seems to be merely an effort and institution of nature to throw off all such redundant juices as may have been absorbed, or secretions as may have been formed, beyond what are necessary to the due nourishment or composition of the plant, or beyond what the plant is capable of assimilating at the time. Hence the watery exudation is perhaps nothing more than a redundancy of the fluid thrown off by imperceptible perspiration, and the waxy and resinous exudations nothing more than a redundancy of secreted juices; all which may be still perfectly consistent with a healthy state of the plant. But there are cases in which the exudation is to be regarded as an indication of disease, particularly in that of the exudation known by the name of honey-dew, a sweet and viscid substance covering the leaves like a varnish, and sometimes occasioning their decay. Such at least seems to be the fact with regard to the honey-dew of the hop, which, according to the observations of Linnæus, is the consequence of the attacks of the caterpillar of the ghost-moth injuring the root; and such seems also to be the fact with regard to the honey-dew of the beech tree, and perhaps also the honey-dew of the oak. The sap then, in the progress of its ascent from the extremity of the root to the extremity of the leaf, undergoes a considerable change, first in its mixing with the juices already contained in the plant, and then in its throwing off a portion at the leaf.

1557. *The sap is further affected by means of the gases* entering into the root along with the moisture of the soil, but certainly, by means of the gases inhaled into the leaf; the action and elaboration of which shall now be elucidated.

1558. *Elaboration of carbonic acid.* The utility of carbonic acid gas, as a vegetable food, has been already shown; plants being found not only to absorb it by the root along with the moisture of the soil, but also to inhale it by the leaves, at least when vegetating in the sun or during the day. But how is the elaboration of this gas effected? Is it assimilated to the vegetable substance immediately upon entering the plant, or is its assimilation effected by means of intermediate steps? The gas thus inhaled or absorbed is not assimilated immediately, or at least not wholly: for it is known that plants do also evolve carbonic acid gas when vegetating in the shade, or during the night. Priestley ascertained that plants vegetating in confined atmospheres evolve carbonic acid gas in the shade, or during the night, and that the vitiated state of their atmospheres after experiment is owing to that evolution; and Saussure that the elaboration of carbonic acid gas is essential to vegetation in the sun; and, finally, Senebier and Saussure proved that the carbonic acid gas contained in water is abstracted and inhaled by the leaf, and immediately decomposed; the carbon being assimilated to the substance of the plant, and the oxygen in part evolved and in part also assimilated. The decomposition of carbonic acid gas takes place only during the light of day, though Saussure has made it also probable that plants decompose a part of the carbonic acid gas, which they form with the surrounding oxygen, even in the dark. But the effect is operated chiefly by means of the leaves and other green parts of vegetables, that is, chiefly by the parenchyma; the wood, roots, petals, and leaves that have lost their green colour, not being found to exhale oxygen gas. It may be observed, however, that the green colour is not an absolutely essential character of the parts decomposing carbonic acid; because the leaves of a peculiar variety of the A'triplex horténsis, in which all the green parts change to red, do still exhale oxygen gas.

1559. *Elaboration of oxygen.* It has been already shown that the leaves of plants abstract oxygen from confined atmospheres, at least when placed in the shade, though they do not inhale all the oxygen that disappears; and it has been further proved, from experiment, that the leaves of plants do also evolve a gas in the sun. From a great variety of experiments relative to the action and influence of oxygen on the plant, and the contrary, the following is the sum of the results: — The green parts of plants, but especially the leaves, when exposed in atmospheric air to the successive influence of light and shade, inhale and evolve alternately a portion of oxygen gas mixed with carbonic acid. But the oxygen is not immediately assimilated to the vegetable substance; it is first converted into carbonic acid by means of combining with the carbon of the plant, which withers if this process is prevented by the application of lime or potass. The leaves of aquatics, succulent plants, and evergreens consume, in equal circumstances, less oxygen than the leaves of other plants. The roots, wood, and petals, and in short all parts not green, with the exception of some coloured leaves, do not effect the successive and alternate inhalation and extrication of oxygen; the inhale it indeed, though they do not again give it out, or assimilate it immediately, but convey it under the form of carbonic acid to the leaves, where it is decomposed. Oxygen is indeed assimilated to the plant but not directly, and only by means of the decomposition of carbonic acid; when part of it, though in a very small proportion, is retained also and assimilated along with the carbon. Hence the most obvious influence of oxygen, as applied to the leaves, is that of forming carbonic acid gas, and thus presenting to the plants elements which it may assimilate; and perhaps the carbon of the extractive juices absorbed even by the root, is not assimilated to the plant till it is converted by means of oxygen into carbonic acid. But as an atmosphere composed of nitrogen and carbonic acid gas only is not favourable to vegetation, it is probable that oxygen performs also some other function beyond that of merely presenting to the plant, under the modification of carbonic acid, elements which it may assimilate. It may affect also the disengagement of caloric by its union with the carbon of the vegetable, which is the necessary result of such union. But oxygen is also beneficial to the plant from its action on the soil; for when the extractive juices contained in the soil have become exhausted, the oxygen of the atmosphere, by penetrating into the earth and abstracting from it a portion of its carbon, forms a new extract to replace the first. Hence we may account for a number of facts observed by the earlier phytologists, but not well explained. Du Hamel remarked that the lateral roots of plants are always the more vigorous the nearer they are to the surface; but it now appears that they are the most vigorous at the surface because they have there the easiest access to the oxygen of the atmosphere, or to the extract which it may form. It was observed, also, by the same phytologist, that perpendicular roots do not thrive so well, other circumstances being the same, in a stiff and wet soil as in a friable and dry soil; while plants with slender and divided roots thrive equally well in both: but this is, no doubt, owing to the obstacles that present themselves to the passage of the oxygen in the former case, on account of the greater depth and smaller surface of the root. It was further observed, that roots which penetrate into dung or into pipes conducting water, divide into immense numbers of fibres, and form what is called the fox-tail root; but it is because they cannot continue to vegetate, except by increasing their points of contact, with the small quantity of oxygen found in such mediums. Lastly, it was observed that plants, whose roots are suddenly overflowed with water remaining afterwards stagnant, suffer sooner than if the accident had happened by means of a continued current. It is because in the former case the oxygen contained in the water is soon exhausted, while in the latter it is not exhausted at all. Hence also we may account for the phenomenon exhibited by plants vegetating in distilled water under a receiver filled with atmospheric air, which, having no proper soil to supply the root with nourishment, effect the developement of their parts only at the expense of their own proper substance; the interior of the stem, or a portion of the root, or the lower leaves, decaying and giving up their extractive juices to the other parts. — Thus it appears that oxygen gas, or that constituent part of the atmospheric air which has been found to be indispensable to the life of animals, is also indispensable to the life of vegetables. But, although the presence and action of oxygen are absolutely necessary to the process of vegetation, plants do not thrive so well in an atmosphere of pure oxygen, as in an atmosphere of pure or common air. This was proved by an experiment of Saussure's, who, having introduced some plants of *Pisum sativum*, that were but just issuing from the seed, into a receiver containing pure oxygen gas, found that in the space of six days they had acquired only half the weight of such as were introduced at the same time into a receiver containing common air. Whence it follows that oxygen, though the principal agent in the process of vegetation, is not yet the only agent necessary to the health and growth of the plant, and that the proportion of the constituent parts of the atmospheric air is well adapted for the purposes both of vegetable and animal life.

1560. *Decomposition of water.* Although the opinion was proved to be groundless, by which water had been supposed to be convertible into all the different ingredients entering into the composition of the vegetable substance, by means of the action of the vital energy of the plant; yet when water was ultimately proved to be a chemical compound, it was by no means absurd to suppose that plants may possess the power of decomposing part, at least, of what they absorb by the root, and thus acquire the hydrogen as well as a portion of the oxygen which, by analysis, they are found to contain. This opinion was, accordingly, pretty generally adopted, but was not yet proved by any direct experiment. Senebier pointed out several phenomena from which he thought it was to be inferred, but particularly that of the germination of some seeds moistened merely with water, and so situated as to have no apparent contact with oxygen. The decomposition of water was inferred also by Ingenhouz, from the amelioration of an atmosphere of common air into which he had introduced some succulent plants vegetating in pure water. Saussure having gathered a number of plants, of the same species, as nearly alike as possible in all circumstances likely to be affected by the experiment, dried part of them to the temperature of the atmosphere, and ascertained their weight; the rest he made to vegetate in pure water, and in an atmosphere of pure oxygen for a given period of time, at the end of which he dried them as before, and ascertained their weight also, which it was thus only necessary to compare with the weight of the former, in order to know whether the plants had increased in solid vegetable substance or not. But after many experiments on a variety of plants, the result always was, that plants when made to vegetate in pure water only, and in an atmosphere of pure oxygen, or of common air deprived of its carbonic acid, scarcely added any thing at all to their weight in a dried state; or if they did, the quantity was too small to be appreciated. But from a similar experiment, in which carbonic acid gas was mixed with common air, the decomposition and fixation of water by the vegetating plant are legitimately inferred. It does not appear, however, that plants do in any case decompose water directly; that is, by appropriating its hydrogen and at the same time disengaging its oxygen in the form of gas, which is extricated only by the decomposition of carbonic acid.

1561. *Descent of the proper juice.* When the sap has been duly elaborated in the leaf by means of the several processes that have just been described, it assumes the appellation of the *cambium*, or proper juice of the plant. In this ultimate state of elaboration it is found chiefly in the bark, or rather between the bark and wood, and may very often be distinguished by a peculiar colour, being sometimes white, as in the several species of spurge, and sometimes yellow, as in celandine. It is said to be the principal seat of the medical virtues of plants; and was regarded by Malpighi as being to the plant what the blood is to the animal body, the immediate principle of nourishment and grand support of life; which opinions he endeavours to establish by the following analogies: if the blood escapes from the vessels of the animal body, it forms neither flesh nor bone, but tumours; if the proper juices of the plant are extravasated, they form neither bark nor wood, but a lump of gum, resin, or inspissated juice. The disruption of the blood-vessels, and consequent loss of blood, injure and often prove fatal to the animal; the extravasation of the proper juice injures and often proves fatal to vegetables, unless the evil is prevented by the skill and management of the gardener. Whatever may be the value of these remarks as tending to establish the analogy in question, it cannot be doubted that the *cambium*, or proper juice, constitutes at least the grand principle of vegetable organisation; generating and developing in succession the several organs of the plant, or furnishing the vital principle with the immediate materials of assimilation.

1562. *The proper juice is conveyed to the several parts of the plant by an appropriate set of vessels.* One of the earliest and most satisfactory experiments on this subject, at least as far as regards the return of the proper juice through the leaf and leaf-stalk, is that of Dr. Darwin, which was conducted as follows: a stalk of the *Euphórbia* helioscòpia, furnished with its leaves and seed-vessels, was placed in a decoction of madder-root, so as that the lower portion of the stem and two of the inferior leaves were immersed in it. After remaining so for several days the colour of the decoction was distinctly discerned passing along the midrib of each leaf. On the upper side of the leaf many of the ramifications, going from the midrib towards the circumference, were observed to be tinged with red; but on the under side there was observed a system of branching vessels, originating in the extremities of the leaf, and carrying not a red but a pale milky fluid, which, after uniting in two sets, one on each side the midrib, descended along with it into the leaf-stalk. These were the vessels returning the elaborated sap. The vessels observable on the upper surface Darwin calls arteries, and those on the under surface he calls veins. To this may be added the more recent discoveries of Knight, who, in his experiments instituted with a view to ascertain the course of the sap, detected in the leaf-stalk, not only the vessels which he calls central tubes, through which the coloured infusion ascended, together with their appendages, the spiral tubes; but also another set of vessels surrounding the central tubes, which he distinguishes by the appellation of external tubes, and which appeared to be conveying in one direction or other a fluid which was not coloured, but which proved, upon further investigation, to be the descending proper juice. In tracing them upwards they were found to extend to the summit of the leaf, and in tracing them downwards they were found to extend to the base of the leaf-stalk, and to penetrate even into the inner bark. According to Knight, then, there are three sets of vessels in leaves, the central tubes, the spiral tubes, and the external tubes. But by what means is the proper juice conducted from the base of the leaf-stalk to the extremity of the root? This was the chief object of the enquiry of the earlier phytologists who had not yet begun to trace its progress in the leaf and leaf-stalk; but who were acquainted with facts indicating at least the descent of a fluid in the trunk. Du Hamel stript sixty trees of their bark in the course of the spring, laying them bare from the upper extremity of the trunk and branches to the root; the experiment proved indeed fatal to them, as they all died in the course of three or four years. But many of them had made new productions both of wood and bark from the buds downwards, extending in some cases to the length of a foot; though very few of them had made any new productions from the root upwards. Hence it is that the proper juice not only descends from the extremity of the leaf to the extremity of the root, but generates also in its descent new and additional parts. The experiments of Knight on this subject are, if possible, more convincing than even those of Du Hamel. From the trunks of a number of young crab trees he detached a ring of bark of half an inch in breadth. The sap rose in them, and the portion of the trunk above the ring augmented as in the other subjects that were not so treated, while the portion below the ring scarcely augmented at all. The upper lips of the wounds made considerable advances downwards, while the lower lips made scarcely any advances upwards; but if a bud were protruded under the ring, and the shoot arising from it allowed to remain, then the portion of the trunk below that bud began immediately to augment in size, while the portion between the bud and incision remained nearly as before. When two circular incisions were made in the trunk so as to leave a ring of bark between them with a leaf growing from it, the portion above the leaf died, while the portion below the leaf lived; and when the upper part of a branch was stripped of its leaves the bark withered as far as it was stript. Whence it is evident that the sap which has been elaborated in the leaves and converted into proper juice, descends through the channel of the bark, or rather between the bark and alburnum to the extremity of the root, effecting the developement of new and additional parts. But not only is the bark thus ascertained to be the channel of the descent of the proper juice after entering the trunk; the peculiar vessels through which it immediately passes have been ascertained also. In the language of Knight they are merely a continuation of the external tubes already noticed, which after quitting the base of the foot-stalk he describes as not only penetrating the inner bark, but descending along with it and conducting the proper juice to the very extremity of the root. In the language of Mirbel they are the large or rather simple tubes so abundant in the bark of woody plants, though not altogether confined to it; and so well adapted by the width of their diameter to afford a passage to the proper juice.

1563. *Causes of descent.* The proper juice then, or sap elaborated in the leaf, descends by the returning vessels of the leaf stalk, and by the longitudinal vessels of the inner bark, the large tubes of Mirbel and external tubes of Knight, down to the extremity of the root.

1564. *The descent of the proper juice* was regarded by the earlier phytologists as resulting from the agency of gravitation, owing perhaps more to the readiness with which the conjecture suggests itself than to the satisfaction which it gives. But the insufficiency of this cause was clearly pointed out by Du Hamel, who observed in his experiments with ligatures that the tumour was always formed on the side next to the leaves, even when the branch was bent down, whether by nature or art, so as to point to the earth, in which case the power propelling the proper juice is acting not only in opposition to that of gravitation, but with such force as to overcome it. This is an unanswerable argument; and yet it seems to have been altogether overlooked, or at least undervalued in its importance, by Knight, who endeavours to account for the effect by ascribing it to the joint operation of gravitation, capillary attraction, the waving motion of the tree, and the structure of the conducting vessels; but the greatest of these causes is gravitation. Certain it is that gravitation has considerable influence in preventing the descent of the sap in young shoots of trees which have grown upright; these, when bent down after being fully grown, form larger buds, and often blossom instead of leaf buds. This practice, with a view to the production of blossom-buds, is frequently adopted by gardeners (*Hort. Trans.* i. 237.) in training fruit trees. — These causes are each, perhaps, of some efficacy; and yet even when taken altogether they are not adequate to the production of the effect. The greatest stress is laid upon gravitation; but its agency is obviously over-rated, as is evident from the case of the pendent shoots of the weeping willow; and if gravitation is so very efficacious in facilitating the descent of the proper juice, how comes its influence to be suspended in the case of the ascending sap? The action of the silver grain will scarcely be sufficient to overcome it; and if it should be said that the sap ascends through the tubes of the alburnum by means of the agency of the vital principle, why may not the same vital principle conduct also the proper juice through the returning vessels of the bark? In short, if, with Saussure, we admit the existence of a contracting power in the former case sufficient to propel the sap from ring to ring, it will be absolutely necessary to admit it also in the latter. Thus we assign a cause adequate to the production of the effect, and avoid at the same time the transgression of that most fundamental principle of all sound philosophy which forbids us to multiply causes without necessity. M. Dutrochet's hypothesis (1550.) for the ascent of the sap accounts equally for its descent.

Sect. IV. *Process of Vegetable Developement.*

1565. *The production of the different parts and organs of plants* is effected by the assimilation of the proper juice. The next object of our enquiry, therefore, will be that of tracing out the order of the developement of the several parts, together with the peculiar mode of operation adopted by the vital principle. But this mode of operation is not exactly the same in herbaceous and annual plants as in woody and perennial plants. In the former, the process of developement comprises as it were but one act of the vital principle, the parts being all unfolded in immediate succession, and without any perceptible interruption till the plant is complete. In the latter, the process is carried on by gradual and definite stages easily cognisable to the senses, commencing with the approach of spring, and terminating with the approach of winter; during which, the functions of the vital principle seem to be altogether suspended, till it is aroused again into action by the warmth of the succeeding spring. The illustration of the latter, however, involves also that of the former; because the growth of the first year exemplifies at the same time the growth of annuals, while the growth of succeeding years exemplifies whatever is peculiar to perennials.

1566. *Elementary organs.* If the embryo, on its escape from the seed and conversion into a plant, is taken and minutely inspected, it will be found to consist of a root, plumelet, and incipient stem, which have been developed in consecutive order; and if the plant is taken and dissected at this period of its growth, it will be found to be composed merely of an epidermis enveloping a soft and pulpy substance, that forms the mass of the individual; or it may be furnished also with a central and longitudinal fibre; or with bundles of longitudinal fibres giving tenacity to the whole. These parts have been developed, no doubt, by means of the agency of the vital principle operating on the proper juice; but what have been the several steps of operation?

1567. *No satisfactory explication of this phenomenon has yet been offered.* It is likely, however, that the rudiments of all the parts of the plant do already exist in the embryo in such specific order of arrangement as shall best fit them for future developement, by the introsusception of new and additional particles. The pellicle constituting the vegetable epidermis has generally been regarded as a membrane essentially distinct from the parts which it covers, and as generated with a view to the discharge of some particular function. Some phytologists, however, have viewed it in a light altogether different, and have regarded it as being merely the effect of accident, and nothing more than a scurf formed on the exterior and pulpy surface of the parenchyma indurated by the action of the air. It is more probably, however, formed by the agency of the vital principle, even while the plant is yet in embryo, for the very purpose of protecting it from injury when it shall have been exposed to the air in the process of vegetation. There are several respects in which an analogy between the animal and vegetable epidermis is sufficiently striking: they are both capable of great expansion in the growth of the subject; they are both easily regenerated when injured (except in the case of induration), and seemingly in the same manner; they are both subject, in certain cases, to a constant decay and repair; and they both protect from injury the parts enclosed.

1568. *Composite organs.* The elucidation of the developement of the composite organs involves the discussion of the two following topics: — the formation of the annual plant, and of the original shoot of the perennial; and the formation of the subsequent layers that are annually added to the perennial.

1569. *Annuals and annual shoots.* If a perennial of a year's growth is taken up in the beginning of winter, when the leaves, which are only temporary organs, have fallen, it will be found to consist of a root and trunk, surmounted by one bud or more. The root is the radicle expanded into the form peculiar to the species, but the trunk and buds have been generated in the process of vegetation.

1570. *The root or trunk*, if taken and cut into two by means of a transverse section, will be found to consist already of bark, wood, and pith. Here, then, is the termination of the growth of the annual, and of the first stage of the growth of the perennial: how have their several parts or organs been formed?

1571. *The pith* seems only a modification of the original pulp, and the same hypothesis that accounts for the formation of the one will account also for the formation of the other; but the pith and pulp, or parenchyma, are ultimately converted into organs essentially distinct from one another, though phytologists have been much puzzled to assign to each its respective functions. In the ages in which phytological opinions were formed without enquiry, one of the vulgar errors of the time seems to have been that the function of the pith was that of generating the stone of fruit, and that a tree deprived of its pith would produce fruit without a stone (*Phys. des Arb.*, liv. i. chap. 3.); but this opinion is by much too absurd to merit a serious refutation. Another early opinion, exhibiting, however, indications of legitimate enquiry, was, that the pith was analogous to the heart and brain of animals, as related by Malpighi; who did not himself adopt it, but believed the pith to be, like the cellular tissue, the viscera in which the sap was elaborated for the nourishment of the plant, and for the protrusion of future buds. Magnol thought that it produced the flower and fruit, but not the wood. Du Hamel regarded it as being merely an extension of the pulp or cellular tissue, without being destined to perform any important function in the process of vegetation. But Linnæus was of opinion that it produces even the wood; regarding it not only as the source of vegetable nourishment, but as being also to the vegetable what the brain and spinal marrow are to animals—the source and seat of life. In these opinions there may be something of truth, but they have all the common fault of ascribing to the pith either too little or too much. Mr. Lindsay of Jamaica suggested a new opinion on the subject, regarding it as being the seat of the irritability of the leaves of the Mimòsa; and Sir J. E Smith says, he can see nothing to invalidate the arguments on which this opinion is founded. Plenck and Knight regard it as destined by Nature to be a reservoir of moisture to supply the leaves when exhausted by excess of perspiration. Hence it appears that the peculiar function of the pith has not yet been altogether satisfactorily ascertained; and the difficulty of ascertaining it has been thought to be increased from the circumstance of its seeming to be only of a temporary use in the process of vegetation, by its disappearing in the aged trunk. But although it is thus only temporary as relative to the body of the trunk, yet it is by no means temporary as relative to the process of vegetation, the central part of the aged trunk being now no longer in a vegetating state, and the pith being always present in one shape or other in the annual plant, or in the new additions that are annually made to perennials. The pith, then, is essential to vegetation in all its stages: and from the analogy of its structure to that of the pulp, or parenchyma, which is known, as in the leaf, to be an organ of elaboration, the function of the pith is most probably that of giving some peculiar elaboration to the sap.

1572. *The generation of the layer of wood in woody plants*, or of the parts analogous to wood in the case of herbaceous plants, has been hitherto but little attended to. If we suppose the rudiments of the different parts to exist already in the embryo, then we have only to account for their developement by means of the introsusception and assimilation of sap and proper juice: but if we suppose them to be generated in the course of vegetation, then the difficulty of the case is augmented; and, at the best, we can only state the result of operations that have been so long continued as to present an effect cognisable to the sense of sight, though the detail of the process is often so very minute as to escape even the nicest observation. All, then, that can be said on the subject is merely, that the tubes, however formed, do, by virtue of the agency of the vital principle operating on the proper juice, always make their appearance at last in a uniform and determinate manner, according to the tribe or species to which the plant belongs, uniting and coalescing so as to form either a circular layer investing the pith, as in woody plants; a number of divergent layers intersecting the pith, as in some herbaceous plants; or bundles of longitudinal and woody fibre interspersed throughout the pith, as in others. In the same manner we may account for the formation of the layer of bark.

1573. *Perennials and their annual layer* If a perennial is taken at the end of the second year and dissected, as in the example of the first year, it will be found to have increased in height by the addition of a perpendicular shoot, consisting of bark, wood, and pith, as in the shoot of the former year; and in diameter by the addition of a new layer of wood and of bark, generated between the wood and bark of the former year, and covering the original cone of wood, like the paper that covers a sugar-loaf: this is the fact of the mode of augmentation about which phytologists have not differed, though they have differed widely with regard to the origin of the additional layer by which the trunk is increased in diameter. Malpighi was of opinion that the new layer of wood is formed from the liber of the former year.

1574. *The new layer of wood* Linnæus considered as formed from the pith, which is absurd, because the opinion goes to the inversion of the very order in which the layer is formed, the new layer being always exterior to the old one. But, according to the most general opinion, the layer was thought to be formed from a substance oozing out of the wood or bark—first a limpid fluid, then a viscid pulp, and then a thin layer attaching itself to the former; the substance thus exuding from the wood or bark was generally regarded as being merely an extravasated mucilage, which was somehow or other converted into wood and bark: but Du Hamel regarded it as being already an organised substance, consisting of both cellular and tubular tissue, which he designated by the appellation of the *cambium*, or proper juice.

1575. *Knight has thrown the highest degree of elucidation on this, one of the most obscure and intricate processes of the vegetable economy*, in having shown that the sap is elaborated, so as to render it fit for the formation of new parts, in the leaf only. If a leaf or branch of the vine is grafted even on the fruit-stalk or tendril, the graft will still succeed; but if the upper part of a branch is stripped of its leaves, the bark will wither as far as it is stripped; and if a portion of bark furnished with a leaf is insulated by means of detaching a ring of bark above and below it, the wood of the insulated portion that is above the leaf is not augmented: this shows evidently that the leaf gives the elaboration necessary to the formation of new parts, and that without the agency of the leaf no new part is generated: — Such then is the mode of the augmentation of the plant in the second year of its growth. It extends in width by a new layer of wood and of bark insinuated between the wood and bark of the former year; and in height by the addition of a perpendicular shoot or of branches, generated as in the shoot of the first year. But if the plant is taken and dissected at the end of the third year, it will be found to have augmented in the same manner; and so also at the end of the succeeding year, as long as it shall continue to live; so that the outermost layer of bark, and innermost layer of wood, must have been originally tangent in the first year of the plant's growth; the second layer of bark, and second layer of wood, in the second year; and so on in the order of succession till you come to the layer of the present year, which will in like manner divide into two portions, the outer forming one layer or more of bark, and the inner forming one layer or more of wood. And hence the origin of the concentric layers of wood and of bark in the trunk. But how are we to account for the formation of the divergent layers, which Du Hamel erroneously supposed to proceed from the pith? The true solution of the difficulty has been furnished by Knight, who, in tracing the result of the operation of budding, observed, that the wood formed under the bark of the inserted bud unites indeed confusedly with the stock, though still possessing the character and properties of the wood from which it was taken, and exhibiting divergent layers of new formation which originate evidently in the bark, and terminate at the line of union between the graft and stock.

1576. But how is *the formation of the wood that now occupies the place of the pith* to be accounted for? It appears that the tubes of which the medullary sheath is composed do, in the process of vegetation, deposit a *cambium*, which forms an interior layer that is afterwards converted into wood for the purpose of filling up the medullary canal.

1577. *Opinion of Darwin and Du Petit Thouars.* According to these philosophers, (and the hypothesis, we believe, was originally proposed by Dr. Darwin,) " the phenomena which took place at the period of germination are renewed by every leaf which successively unfolds itself. The cotyledons were the source of the fibres which were sent down into the earth through the root; in like manner every leaf is enabled to maintain a communication between itself and the soil, by the means of fibres. Hence arises another kind of increase, of which no notice has yet been taken — the increase in thickness. A stem, which at the hour of its birth was no thicker than a pin, in a few months acquires the diameter of an inch, or more. This arises from the successive superposition of the bundles of fibres which are created upon the developement of each leaf, and of every leaf-bud. The latter makes its first appearance under the form of a green point, which originates from the inner layers of the ligneous body, which it traverses, and penetrates into the bark. A short time after its first appearance, it may be perceived that the bud is surrounded by a portion of woody fibre, which passes downwards, covers over the wood previously formed, and thus forms a new layer. The existence of this it is easy to demonstrate; for the fibres of the leaves separate easily from the wood, but the leaf-buds, when broken off, evidently arise from the interior of the wood. All the new parts formed by the leaf-bud soon become so completely identified with the old wood, that, after a short period, no marks of separation remain." (*London Encyclopædia*, art. *Botany*.)

1578. *Conversion of the alburnum into perfect wood.* In consequence of the increase of the trunk by means of the regular and gradual addition of an annual layer, the layers, whether of wood or of bark, are necessarily of different degrees of solidity in proportion to their age, the inner layer of bark and the outer layer of wood being the softest; and the other layers increasing in their degree of solidity till you reach the centre on the one hand, and the circumference on the other, where they are respectively the hardest, forming perfect wood or highly indurated bark, which bark sloughs or splits into chinks, and falls off in thick crusts, as in the plane tree, fir, and birch. What length of time, then, is requisite to convert the alburnum into perfect wood, or the liber into indurated bark; and by what means are they so converted? There is no fixed and definite period of time that can be positively assigned as necessary to the complete induration of the wood or bark, though it seems to require a period of a good many years before any particular layer is converted from the state of alburnum to that of perfect wood; and perhaps no layer has received its final degree of induration till such time as the tree has arrived at its full growth. The induration of the alburnum, and its consequent durability, are attributed by many to the loss of sap which the layer sustains after the period of its complete developement, when the supply from the root diminishes, and the waste by evaporation or otherwise is still kept up, inducing a contraction or condensation of its elementary principles which augments the solidity of the layer, in the first degree, and begins the process that future years finish. But Knight believes the induration of the alburnum, as distinguishable in the winter, to be owing rather to some substance deposited in it in the course of the preceding summer, which he regards as being the proper juice in a concrete or inspissated state, but which is carried off again by the sap as it ascends in the spring.

1579. *Circulation of vegetable juices.* After the discovery of the circulation of the blood of animals, phytologists, who were fond of tracing analogies between the animal and vegetable kingdoms, began to think that there perhaps existed in plants also a circulation of fluids. The sap was supposed to be elaborated in the root. The vessels in which it was propelled to the summit of the plant were denominated arteries; and the vessels in which it was again returned to the root were denominated veins. Du Hamel, while he admits the ascent of the sap, and descent of the proper juice, each in peculiar and appropriate vessels, does not, however, admit the doctrine of a circulation, which seems, about the middle of the last century, to have fallen into disrepute. For Hales, who contended for an alternate ascent and descent of fluids in the day and night, and in the same vessels, or for a sort of vibratory motion, as he also describes it, gave no countenance whatever to the doctrine of a circulation of juices. But the doctrine, as it appears, has been again revived, and has met with the support of some of the most distinguished of modern phytologists. Hedwig is said to have declared himself to be of opinion, that plants have a circulation of fluids similar to that of animals. Corti is said to have discovered a species of circulation in the stem of the *Chàra*, but confined, it is believed, within the limits of the internodia. Willdenow has also introduced the subject, and defended the doctrine (*Principles of Botany*, p. 85.); but only by saying he believes a circulation to exist, and that it is impossible for the leafless tree to resist the cold if there is not a circulation of fluids. Knight has given his reasons somewhat in detail; and though his doctrine of a circulation should be false, yet the account which he gives of the progress and agency of the sap and proper juice, short of circulation, may be true. The sum of the account is as follows: — When the seed is deposited in the ground under proper conditions, moisture is absorbed and modified by the cotyledons, and conducted directly to the radicle, which is by consequence first developed. But the fluid which has been thus conducted to the radicle, mingling no doubt with the fluid which is now also absorbed from the soil, ascends afterwards to the plumelet through the medium of the tubes of the alburnum. The plumelet now expands and gives the due preparation to th ascending sap, returning it in its elaborated state to the tubes of the bark, through which it again descends to the extremity of the root, forming in its progress new bark and new alburnum; but mixing also, as he thinks, with the alburnum of the former year, where such alburnum exists, and so completing the circulation.

1580. *Decomposite organs.* To the above brief sketch of the agency of the vital principle in the generation or growth of the elementary and composite organs, there now remains to be added that of the progress and mode of the growth of the decomposite organs, or organs immediately constituting the plant, as finishing the process of the vegetable developement. This will include the phenomena of the ultimate developement of the root, stem, branch, bud, leaf, flower, and fruit.

1581. *The root.* From the foregoing observations and experiments, it appears that the roots of plants or at least of woody plants, are augmented in their width by the addition of an annual layer, and in their length by the addition of an annual shoot, bursting from the terminating fibre. But how is the developement of the shoot effected? Is it by the introsusception of additional particles throughout the whole of its extent; or only by additions deposited at the extremity? In order to ascertain the fact, with regard to the elongation of the root, Du Hamel instituted the following experiment: — Having passed several threads of silver transversely through the root of a plant, and noted the distances, he then immersed the root in water. The upper threads retained always their relative and original situation, and the lowest thread, which was placed within a few lines of the end, was the only one that was carried down. Hence he concluded that the root is elongated merely by the extremity. Knight, who from a similar experiment obtained the same result, deduced from it also the same conclusion. We may regard it, then, as certain, that the mode of the elongation of the root is such as is here represented, though in the progress of its developement, it may affect a variety of directions. The original direction of the root is generally perpendicular, in which it descends to a considerable depth if not interrupted by some obstacle. In taking up some young oak trees that had been planted in a poor soil, Du Hamel found that the root had descended almost four feet, while the height of the trunk was not more than six inches. If the root meets with an obstacle, it then takes a horizontal direction, not by the bending of the original shoot, but by the sending out of lateral shoots. The same effect also follows if the extremity of the root is cut off, but not always; for it is a common thing in nursery gardens to cut off the tap-roots of drills of seedling oaks, without removing them, by a sharp spade, and these generally push out new tap-roots, though not so strong as the former. When a root ceases of its own accord to elongate, it sends out lateral fibres which become branches, and are always the more vigorous the nearer they are to the trunk; but the lateral branches of horizontal roots are the less vigorous the nearer they are to the end next the trunk. In the former case, the increased luxuriance is perhaps owing to the easy access of oxygen in the upper divisions; but, in the latter case, the increased luxuriance of the more distant divisions is not so easily accounted for, if it is not to be attributed to the more ample supply of nutriment which the fibres meet with as they recede from the trunk, particularly if you suppose a number of them lying horizontally, and diverging like the radii of a circle. But the direction of roots is so liable to be affected by accidental causes, that there is often but little uniformity even in roots of the same species. If plants were to be sown in a soil of the same density throughout, perhaps there might be at least as much uniformity in the figure and direction of their roots, as in those of their branches; but this will seldom happen. For if the root is injured by the attacks of insects, or interrupted by stones, or earth of too dense a quality, it then sends out lateral branches, as in the above cases; sometimes extending in length, by following the direction of the obstacle, and sometimes ceasing to elongate, and forming a knot at the extremity. But where the soil has been loosened by digging or otherwise, the root generally extends itself to an unusual length; and where it is both loosened and enriched, it divides into a multiplicity of fibres. This is also the case with the roots of plants vegetating in pots, or near a river, but especially in water. Where roots have some considerable obstacle to overcome, they will often acquire a strength proportioned to the difficulty: sometimes they will penetrate through the hardest soil to get at a soil more nutritive; and sometimes they will insinuate their fibres into the crevices even of walls and rocks, which they will burst or overturn. This of course requires much time, and does much injury to the plant. Roots consequently thrive best in a soil that is neither too loose nor too dense; but as the nourishment which the root absorbs is chiefly taken up by the extremity, so the soil is often more exhausted at some distance from the trunk than immediately around it. Du Hamel regards the small fibres of the root, which absorb the moisture of the soil, as being analogous to the lacteals of the animal system, which absorb the food digested by the stomach: but the root is rather to be regarded as the mouth of the plant, selecting what is useful to nourishment, and rejecting what is yet in a crude and indigestible state; the larger portions of it serving also to fix the plant in the soil, and to convey to the trunk the nourishment absorbed by the smaller fibres, which, ascending by the tubes of the alburnum, is thus conveyed to the leaves, the digestive organs of plants. Du Hamel thinks that the roots of plants are furnished with pre-organised germs, by which they are enabled to send out lateral branches when cut, though the existence of such germs is not proved; and affirms, that the extremities of the fibres of the root die annually, like the leaves of the trunk and branches, and are again annually renewed; which last peculiarity Professor Willdenow affirms also to be the fact, but without adducing any evidence by which it appears to be satisfactorily substantiated. On the contrary, Knight, who has also made some observations on this subject, says, it does not appear that the terminating fibres of the roots of woody plants die annually, though those of bulbous roots are found to do so: but the fibres of creeping plants, as the common crowfoot and strawberry, certainly die annually, as do those of the vine.

1582. *The stem.* The stem, like the root, or at least the stem of woody plants, is also augmented in width by the addition of an annual layer, and in length, by the addition of an annual shoot bursting from the terminating bud. Is the developement of the shoot issuing from the stem effected in the same manner also? The developement of the shoot from the stem is not effected in the same manner as the developement of that from the root, by additions to the extremity only, but by the introsusception of additional particles throughout its whole extent, at least in its soft and succulent state: the longitudinal extension diminishing in proportion as the shoot acquires solidity, and ceasing entirely when the wood is perfectly formed, though often continuing at the summit after it has ceased at the base. The extension of the shoot is inversely as its induration, rapid while it remains herbaceous, but slow in proportion as it is converted into wood. Hence moisture and shade are the most favourable to its elongation, because they prevent or retard its induration; and hence the small cone of wood which is formed during the first year of the plant's growth increases no more after the approach of winter, either in height or thickness. Such is the mode of the growth and developement of the trunk of perennial and woody plants, to which there exists a striking exception in the growth of the trunk of palms. Their internal structure has been already taken notice of as possessing no concentric or divergent layers, and no medullary canal, but merely an assemblage of large and woody fibres, interspersed without order in a pulp or parenchyma, softer at the centre, and gradually becoming harder as it approaches the circumference. When the seed of the palm tree germinates, it protrudes a circular row of leaves, or of fronds, which crowns the radicle, and is succeeded in the following year by a similar row issuing from the centre or bosom of the former leaves, which ultimately die down to the base. This process is continued for four or five years successively, without exhibiting as yet any appearance of a stem, the remaining bases of the leaves or frond forming by their union merely a sort of knob or bulb. At last, however, they constitute by their union an incipient stem, as thick the first year as it ever is after; which in the following year is augmented in heighth as before, and so in succession as long as the plant lives, the leaves always issuing from the summit and crowning the stem, which is a regular column, but decaying at the end of the year, and leaving circular marks at the points of insertion, which furrow the surface of the plant, and indicate the years of its growth.

1583. *The branches*, in their mode of growth and developement, exhibit nearly the same appearances as the trunk from which they issue. They originate in a bud, and form also a cone which consists of pith, wood, and bark; or rather they form a double cone: for the insertion of the branch into the trunk resembles also a cone whose base is at the circumference, and whose apex is at the centre, at least if it is formed in the first year of the plant's growth, or on the shoot of the present year; but falling short of the centre in proportion to the lateness of its formation, and number of intervening layers. Branches in their developement assume almost all varieties of position, from the reflected to the horizontal and upright; but the lower branches of trees are found to be generally parallel to the surface of the soil on which they grow, even though that surface should be the sloping side of a hill, owing, as some have thought, to the evolution of a greater number of buds on the side that forms the obtuse angle with the soil, in consequence of its being exposed to the action of a greater mass of air.

1584. *The bud*, which in the beginning of spring is so very conspicuous on the trees of this country as to be obvious to the most careless observer, is by no means common to all plants, nor to plants of all climates; shrubs in general, and annuals universally, as well as all plants whatever growing within the tropics, are destitute of buds, the leaf being in them immediately protruded from the bark. It is only in the woody plants of cold climates, therefore, that we are to look for buds; and in them no new part is added, whether proper to the leaf or flower, without the intervention of a bud. For when the young shoot is produced, it is at the same time furnished with new buds, which are again extended into new shoots in the following spring; and thus the bud is to be regarded as forming, not only the cradle, but also the winter quarters of the shoot, for which its coat of tiled and glutinous scales seems admirably adapted. It is found chiefly in the extremity, or on the surface of the young shoot or branch, and but rarely on the stem, except it be at the collar where it produces suckers. It is also generated for the most part in the axils of the leaves, as may be seen by inspecting the annual shoot of almost any tree at random: but it is not universally so; for to this rule there exists a curious and singular exception in the bud of the *Plátanus*, which is generated in the very centre of the base of the foot-stalk, and is not discoverable till after the fall of the leaf. But how are the buds formed which are thus developed? Malpighi thought they were formed from the pith or cellular tissue, which Grew regarded as viscera destined for the elaboration of the sap and protrusion of future buds. Du Hamel thinks the exterior scales of the bud originate in the interior part of the bark, and Knight relates an experiment from which he thinks it follows that the buds are formed from the descending proper juice. But whatever may be the actual origin of the bud, it is evident that its developement does not take place except through the medium of the proper juice, which has been elaborated in the leaves of preceding buds, and originally in those of the plumelet, as the young bud does not make its appearance till the leaves of the preceding buds have expanded, and will not ultimately succeed if deprived of them too soon.

1585. *The bark*, it is probable, performs the same functions as the leaves in the early state of the buds, and occasionally in all states. Otherwise it would not be easy to account for the growth of cactuses, euphorbias, some apocyneous plants, &c., which are all destitute of leaves. In fine, the bark may be compared to a universal leaf, with one surface only. (*London Ency.* art. *Bot.*)

1586. *Bulbs* are so very similar to buds both in their origin and developement, as to require no specific investigation.

1587. *The leaf.* When the leaves burst from the expanding bud, and even long before that period, as may be seen by the dissection of the bud in the winter, they are complete in all their parts. Hence it is obvious that the leaf, like the young shoot, effects its final developement by means of the introsusception of new particles throughout the whole of its dimensions; and yet this law of developement is not common to all leaves whatever, for the leaves of liliaceous plants extend chiefly at the point of their junction with the bulb. The effect, perhaps, of their peculiarity of structure, in being formed of parallel tubes which extend throughout their whole length, without those transverse and branching fibres that constitute what are called the nerves of the leaves of woody plants.

1588. *The flower and fruit.* When the flower bursts from the expanding bud, and even long before that period, it is already complete in all its parts, as may be seen also by the dissection of the bud in winter. Linnæus represents the pistil as originating in the pith, the stamens in the wood, and the corolla and calyx in the inner and outer bark respectively: but this account of their origin, though extremely plausible at first sight, will not bear the test of minute examination, being contradicted by the anatomy of the parts themselves; particularly in the case of compound flowers. Knight, in investigating the organisation of the apple and pear, endeavoured to ascertain the origin of the several parts by tracing the organs of the fruit-stalk to their termination. In the fruit-stalk he thought he could discover the pith, the central tubes, spiral tubes, and tubes of the bark, together with its epidermis: and in tracing them to their termination, he thought the pith seemed to end in the pistils; the central vessels in the stamens, after diverging round the core and approaching again in the eye of the fruit; and the bark and epidermis in the two external skins. Hence he infers that the flower is a prolongation of the pith, wood, and bark. A question of some considerable importance has arisen out of this subject: does the flower or fruit elaborate sap for its own developement, or is it supplied with nourishment from the leaf? By placing small branches of the apple, pear, and vine, with blossoms not expanded, in a decoction of logwood, Knight found that the central vessels were coloured by the decoction. By means of a similar experiment on the same subjects after the fruit was formed, the colouring matter was traced through the mass of the fruit to the base of the stamina. And hence it appears that the flower and fruit do possess the power of elaborating sap for their own developement. Knight infers from the foregoing data, that the blossom is nourished from the alburnum, by means of the mingling of the proper juice, which the alburnum may be supposed to contain, with the sap in its ascent.

Sect. V. *Anomalies of Vegetable Developement.*

1589. *A deviation from the general laws of developement is* occasioned by the intervention of some accidental cause; or of some cause operating permanently in certain subjects. Hence the anomaly may regard the developement either of an individual or a species, and may occur either in the root, stem, branch, leaf, bud, flower, or fruit, according to the circumstances in which it is placed; or it may affect the habit, duration, or physical virtues of the plant.

1590. *The root.* According to the general laws of vegetable developement, plants of the same species are furnished with the same species of root, not producing at one time a woody or fibrous root, and at another time a bulbous root: and yet it is found that there are cases in which changes of this kind do occur. If part of the root of a tree, planted by a pond or river, protrudes beyond the bank so as to be partially immersed, it divides at the extremity into innumerable ramifications, or sends out innumerable fibres from the surface, which become again subdivided into fibres still more minute, and give to the whole an appearance something resembling that of the tail of a fox; and it has accordingly been denominated by Du Hamel the fox-tail root. (*fig.* 189.)

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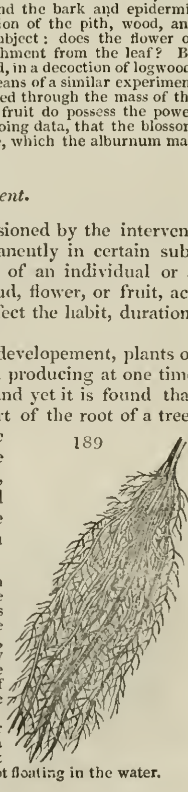

1591. *The root of the Phlèum praténse*, when growing in a moist soil, which it naturally affects, is uniformly fibrous; but when growing in a dry soil, where it is also often to be found, it is furnished with a bulbous root. The same is the case with the *Alopecùrus geniculàtus*; which, when growing in its native marshes, protrudes a fibrous root, though, when growing in a very dry situation, as on the top of a dry wall, it is found to be furnished with an ovate and juicy bulb. This anomaly also seems to be merely the result of a provision of nature by which the plant is endowed with the capacity of collecting a supply of moisture suited to existing circumstances, and hence of adapting itself to the soil in which it grows.

1592. *The roots of Utriculària mìnor*, which consist of a number of slender and hair-like filaments, exhibit the singular anomaly of being furnished with a multitude of small and membranous bladders, each containing a transparent and watery fluid, and a small bubble of air, by means of which the plant is kept floating in the water.

1593. *The descending root*, an anomaly which attends some perennials, is at first spindle-shaped and perpendicular, sending out some lateral fibres, but dies at the lower extremity in the course of the succeeding winter, and protrudes new fibres from the remaining portion, and even from the lower portion of the stem, in the course of the following spring, which, by descending into the soil, draw down the plant with them, so that part of what was formerly stem is now converted into root. This process is repeated every year, and by consequence a portion of the stem is made to descend every year into the earth. The anomaly may be exemplified in the roots of *Valeriàna* dioíca, Tanacètum vulgàre, and *O'*xalis Acetosélla; and will also account for the bitten and truncated appearance of Scabiòsa succìsa, or devil's bit.

1594. *Migratory roots* depend on a principle similar to the foregoing. If the stem of a descending root happens to be creeping or procumbent instead of being erect, then the lateral shoots from above are carried forward in the direction of that procumbency, so that in the course of a few years the plant has actually changed its place by so much as the stem has been converted into a root. This is well exemplified in the genus *I'*ris, a plant of which, as it enlarges in circumference, dies in the centre, and presents a ring of plants instead of a solitary one. In the case of some aquatics, which float about on the surface of the water as they happen to be driven by the winds, the whole plant may be said to be migratory, as in the genus *Lé*mna, and some marine plants.

1595. *The beet-root*, if dissected when about a year old, presents the singular anomaly of being already furnished with from five to eight distinct and concentric circles of longitudinal tubes or sap-vessels, imbedded at regular intervals in its pulp; whereas other biennial roots form only an individual circle each year, and are, consequently, at no time furnished with more than two.

1596. *Roots changed to branches and branches to roots.* If the stem of a young plum or cherry tree, but particularly of a willow, is taken in the autumn, and bent so as that one half of the top may be laid in the earth, one half of the root being at the same time taken carefully out, but sheltered at first from the cold and then gradually exposed to it, and the remaining part of the top and root subjected to the same process in the following year, the branches of the top will become roots, and the ramifications of the root will become branches, protruding leaves, flowers, and fruit in due season.

1597. *The stem.* If the stem of a tree planted by a pond or river is so bent in its growth as to come near to the surface of the water and to be occasionally immersed in it, it will sometimes send out from the under surface a multitude of shoots that will descend into the water, and develope themselves in the manner of the fox-tail root. Sometimes it happens that a stem, instead of assuming the cylindrical form common to the species, assumes a compressed and flattened form similar to the herbage of the *Cá*ctus, as in the fir tribe, ash, &c.

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1598. *The anomaly of the flattened stem* (*fig.* 190.) is accounted for by Du Hamel, by supposing that an unnatural junction must have taken place in the leaf-bud; and so united shoots that would otherwise have been distinct. Sometimes the stem is disfigured by accidental tumours or bunches projecting from the surface, and forming ultimately what are called knots in the wood. They are very common in the oak and elm, and are produced, perhaps, by means of some obstruction in the channel of the sap's motion, by which the vessels become convoluted and swell up into a bunch.

1599. But *bunches* are also to be met with on the stems of herbaceous plants, as on that of the *Cá*rduus praténsis; of which you will often find a portion near the top swollen out into an egg-shaped or egg-oblong bunch, extending from an inch to two inches in length, and about an inch across. If this bunch is cut open in the month of August, it will be found to contain several large and white maggots. It has consequently been occasioned by the puncture of the parent insect depositing its eggs. It does not seem to affect the general health of a vigorous plant, though it might prove seriously injurious to a weak one.

1600. *Bundled stem.* Sometimes two or more contiguous stems, extending in the process of their growth till they meet and press against one another, become incorporated at length into one, and form a sort of bundle. This is what may be termed a natural graft, in opposition to an artificial graft, of which it is the model and prototype. The natural graft is always effected by means of the union of the liber of the respective stems composing it; so that the perfection of the art of grafting consists in applying the liber of the graft and stock together, in such a manner as shall most facilitate their incorporation.

1601. *The branch.* If the branch of a tree is situated, as in the foregoing case of the stem, so as to be partially or periodically immersed in water, it will send out also the same sort of brush-like shoots.

1602. *Bunches or knots, exhibiting a plexus of young shoots* (*fig.* 191. *a*) issuing from nearly the same point,

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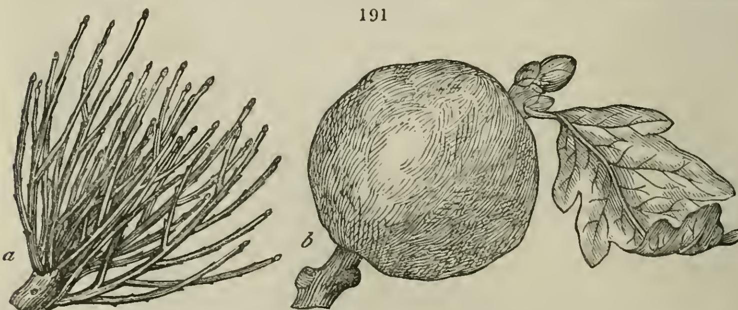
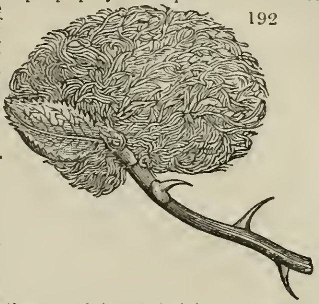


crossing in all directions, and finally incorporating together by means of a sort of natural graft, frequently disfigure the branch. These bunches are frequently to be met with on the branches of the birch tree, and are known among the peasantry of Scotland by the name of witches' knots. They are occasioned, like the bunches of the stem, by some obstruction in the channel of the sap or proper juice. A peculiar sort of knot or bunch is also formed on the branches of the dog-rose. The nucleus, which is generally from an inch to an inch and a half in diameter, is covered with a long and winged shag, first of a green and then of a purple colour, presenting the appearance of a small bunch of moss. (*fig.* 192.) It has been occasioned, like that of the stem of the thistle, by the puncture of an insect depositing its eggs in the tender shoot; for if it is cut open about the month of August, it contains maggots. These anomalies remind us always of that singular disease in the human species, the Plica polónica.



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1603. *The bud.* The regular developement of the bud is also often prevented by means of the puncture of insects, and converted into a large globular tumour.

1604. The *gall* tumour is very often effected by a species of Cy̆nips, which drives its piercer into the heart of the bud while yet tender, and penetrates with its saw into the very pith; injecting at the same time a drop of the corroding liquor contained in its bag, and then laying its eggs. The bud being thus wounded, and the juices corrupted by the injected poison, the circulation is not only impeded, but a fermentation is induced which burns the contiguous parts and changes their colour. The extravasated juice flows round the egg, and is there accumulated and converted into a sort of spongy lump, which vegetates and augments till it forms what is called a gall. The gall thus formed affords both shelter and nourishment to the young maggot, which, after being converted into a fly, pierces its enclosure and launches into the open air. The most remarkable of such galls are those produced on the oak tree, and known in this country by the vulgar name of oak-apples. (*fig.* 191. *b*) The bud of the willow, particularly *S*àlix *H*èlix, is apt to be punctured by insects and converted into a gall: but the conversion is not always complete; and in this case the shoot remains dwarfish, and the leaves, which are now protruded from nearly the same point, assume something of the figure of a rose. Hence it has obtained the common name of the rose-willow. The galls of the *S*álvia pomífera, formed in the above manner, are said to be of a very pleasant flavour, and are esteemed a great delicacy in Eastern countries.

1605. *The leaves.* These, like the buds, are also frequently chosen for the nidus of insects, and disfigured with galls or excrescences. But the most remarkable gall produced on the leaf, and indeed the most remarkable and important of all galls, is that which is so extremely useful in the arts of dyeing and making ink, the nut-gall of the shops.

1606. *The nut-gall* is generated on the leaf of a species of oak that grows plentifully in the Levant, and is so well known in commerce as to require no particular description. It is occasioned by the puncture of the Cy̆nips quercifòlii, which deposits its egg in the substance of the leaf by making a small perforation on the under surface. Galls and tumours are to be found on the leaves of many plants; and indeed almost all leaves are liable to deformities, giving them a blistered, wrinkled, or curled appearance, and often producing disease.

1607. *The excess or deficiency of leaves* protruded in a group sometimes constitutes the anomaly, as in the case of the trefoils.

1608. Sometimes it is found in the *natural figure* of the leaf itself, as in *A*spáragus officinàlis, where they are bristle-shaped; Salsòla *Kàli*, awl-shaped; and *A*'llium Cèpa, in which they are tubular, tapering to a point. But one of the most remarkable anomalies of figure is that which occurs in the genus Sarracèn*ia*, the lower portion of the leaves of which is tubular, ascending, and approaching to funnel-shaped, or rather pitcher-shaped reversed, with a flattened and concave limb attached by the one side to the orifice of the tube, and constituting the upper portion of the leaf. Linnæus, who was acquainted with this singularity of structure, accounted for it by supposing that it was an institution of Nature, meant for the purpose of furnishing the plant with a supply of water, which it could thus catch and retain in the leaf: but as some species of the genus do not readily admit water, notwithstanding their capacity to retain it, this hypothesis is regarded by Sir J. E. Smith as being extremely doubtful, who accordingly offers a different solution, founded upon the following facts. An insect, of the Sphéx or *I*chneùmon kind, had been observed by one of the gardeners of the botanic garden at Liverpool to drag several large flies to a leaf of Sarracèn*ia* adúnca, and to force them into the tubular part of it. On examination the leaf was found to be about half filled with water, in which the flies were now struggling; the other leaves were also examined, and were found crammed with dead or drowning flies. The leaves of Sarracèn*ia* purpùrea are said to exhibit also the same phenomena, and seem peculiarly well adapted to entrap and confine flies, by having the margin beset with inverted hairs, which render the escape of such insects as may have accidentally fallen into the watery tube, or are intentionally forced into it, impracticable; so that the putrid exhalation from the dead insects contained in the leaf often offends the nostrils, even in passing near the plant. Hence Sir J. E. Smith infers, that the growth of the plant is perhaps benefited by means of the air evolved by the dead flies, which the water has been intended to tempt, and the leaves to entrap and retain. This ingenious conjecture is, no doubt, sufficiently plausible as far as the plant may be affected; but cannot be regarded as quite satisfactory till such time as it shall have been shown that the health of the plant is injured when insects are prevented from approaching it.

1609. *The Nepénthes distillatòria* exhibits also an anomaly similar to that of Sarracèn*ia*, in holding an ounce or two of a fluid which appears to be secreted from the leaf, and to be intended as a lure to insects, which gain admission either by the spontaneous opening of the lid, or by forcibly raising it themselves. The consequence is that they fall into the fluid and are drowned, no insect being capable of living in it except a certain small squilla or shrimp, with a protuberant back, which, according to Rumphius, sometimes crawls into it and can live there. To this phenomenon Sir J. E. Smith applies the same explication as above, which is of course liable to the same objection.

1610. *The figure of the leaf, however singular, is generally the same throughout the same individual,* except in the case of accidental deformity, and yet there are exceptions even to this rule; for sometimes the lower leaves of a plant are entire while the upper leaves are divided, as occurs in a variety of mountainous plants, such as burnet, saxifrage, anise, coriander; and sometimes the lower leaves are divided while the upper leaves are entire, as in the case of a variety of aquatics, particularly *R*anúnculus aquáticus, in which the lower leaves are capillary and immersed, and the upper leaves flat and circular, floating on the surface of the water. But sometimes the dissimilitude of the leaves is still more remarkable: the Chinese mulberry, a Botany Bay tree, has not two leaves alike in form on the whole plant. And, lastly, there are some plants, as in the case of the *F*úngi, that are wholly destitute of leaves, and hence called aphyllous; while there are others, as in the case of the *F*ùci, that seem to be wholly leaf.

1611. *The flower.* The principal anomaly of the flower is that by which one of its parts is unduly augmented, to the exclusion or diminution of some of the rest. The flower is then said to be luxuriant; and comprises the three following varieties: the multiplicate, the full, and the proliferous flower.

1612. *The multiplicate flower* is sometimes, though rarely, occasioned by an unusual multiplication of the divisions of the calyx, as in Diánthus Caryophýllus, and some of the alpine grasses. But the anomaly most generally consists in the undue multiplication of the divisions of the corolla, by the conversion of part of the stamens into petals, which is occasionally to be met w th both in monopetalous and polypetalous flowers. It occurs but seldom, however, in flowers growing in their natural state and habit, though now and then a double flower is met with even in such circumstances.

1613. *The full flower* is generally described to be that in which the divisions of the corrolla are so multiplied as to exclude the stamens and pistils wholly by means of their conversion into petals; which conversion is most readily effected in polypetalous flowers, such as the tulip, poppy, pink, and ranunculus; monopetalous flowers seldom being found full. This complete metamorphosis is always either the effect of cultivation, or of some concurrence of natural circumstances analogous to it, and is indeed one of the principal objects of the art of the florist; the beauty of the flower, according to general estimation, being thus much augmented. In the full flower the stamens are almost always converted into petals, whence we should perhaps infer their identity of origin. But the pistil is often converted into a leaf, as may be seen by inspecting the flower of the double-blossomed cherry, which generally protrudes from the centre a leaf in miniature. But a flower may become full also by the multiplication of the parts of the nectary, as is sometimes the case in the genus Aquilègia, which produces full flowers in three different ways: by the multiplication of the petals to the exclusion of the nectaries; by the multiplication of the nectaries to the exclusion of the petals; and by the multiplication of the nectaries while the proper petals remain. There are also some peculiarities in the manner in which compound flowers become full. Radiated flowers become full sometimes by the multiplication of the floscules of the ray to the exclusion of the floscules of the disk, as in Heliánthus, *A*'nthemis, and *C*entaurèa; and sometimes by the multiplication of the floscules of the disk to the exclusion of those of the ray, as in Matricària and *B*éllis.

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1614. *The proliferous flower* (*fig.* 193.) is that out of which another flower or another shoot is produced. It is seldom found but in flowers already full; from the centre of which, that is, from the ovary or pistil, it sometimes happens that a new flower and foot-stalk is produced, if the flower is simple, as in the ranunculus, anemone, and pink; or several flowers and foot-stalks issuing from the common calyx, if the flower is compound, as in the daisy, hawkweed, and marigold; or a new umbel issuing from the centre of the original umbel, if the flower is umbellate, as in *C*órnus.

1615. *Various anomalies.* Sometimes the proliferous issue of the full flower is not itself a flower, but a shoot furnished with leaves, as has been sometimes, though rarely, observed in the case of the anemone and rose. Such are the several varieties of luxuriant flowers, constituting anomalies of excess: but it sometimes happens that there is also in the flower an anomaly of defect in the absence of one of its parts. Examples of this sort are occasionally to be met with in the flowers of Cheiránthus *Chéiri*, Campánula pentagònia, and Tussilàgo anándria, in which the corolla is altogether wanting, though proper to the species; and in this case the flower is said to be mutilated. Sometimes the anomaly consists in the situation of the flower, which is generally protruded from the extremity or sides of the branches; but the flower of the *R*úscus is protruded from the surface of the leaf. Or it may consist in the relative situation of the several parts of the flower. In simple flowers, the pistil is invariably central with regard to the stamens; but in compound flowers the pistils are often situated in the circumference and the stamens in the centre. This seems to be the case, also, with some monœcious plants, having their flowers on the same peduncle, as in the example of the *C*árex and *A*'rum, in which the stamens are more central than the pistils. Sometimes the anomaly consists in the color of the corolla, which will often deviate even in the same species. The general colour of the common cowslip (Prímula vèris) is a bright yellow; but an individual is occasionally to be met with, though very rarely, in which the limb or expansion of the corolla is purple with a line of yellow around the border. Sometimes the anomaly consists in the time of flowering. The season proper for the flowering of the apple and pear tree is the month of May; but trees of that sort have been known to protrude both buds and blossoms even in the month of November. Some plants, however, blow only in the winter, as in the case of the laurustinus and *A*'rbutus *U*nèdo; while others blow only in the night, and refuse to expand their petals to the light of the sun. Such is the case of the Cáctus grandiflòra, that produces one of the most magnificent of flowers, but blows only in the night; and is hence known also by the appellation of the night-blowing cereus. Some plants, such as the *A*'lgæ, and *F*úngi, are altogether destitute of conspicuous flowers; and are hence called *Cryptogamous*. The flower of the fig is perhaps one of the most singular in respect of concealment. The flowers of perfect plants, which, in other cases, uniformly precede the fruit, are in this case concealed within what is generally denominated the fruit; as may be proved by cutting open a green fig (*fig.* 194.) by means of a longitudinal section passing through its axis. Great numbers of flowers are then discovered lining a sort of cavity in the axis of the fruit; and hence what is called the fruit or fig, in common language, is rather the receptacle of the flower than any thing else. Most plants have their flowers furnished both with stamens and pistils, and are hence hermaphrodites. But there are also many genera that have the stamens in one flower and the pistils in another, both on the same individual: these are denominated *Monœcious* plants, and are exemplified in the oak and hazel. Other genera have the flowers with stamens on one plant, and the flowers with pistils on another: these are denominated *Diœcious*, and are exemplified in the hop and willow. Others have unisexual flowers of each kind on one and the same plant, as in Monœcia; on separate plants, as in Diœcia; and on others mixed with those which are hermaphrodite: these are denominated *Polygamous*, and are exemplified in the genus *A*'triplex. In a species of Eutérpe, found on the island of Bourbon, the flowers are visible eight years before they are expanded. The summit is formed of twelve leaves, each supplied with a bunch of flowers in its axilla. Three leaves only expand each year, so that four years will have elapsed between the expansion of the first flowers and of the last, although even the former were discoverable four, and the latter eight, years previously. (*London Encyc.*, art. *Botany*.)

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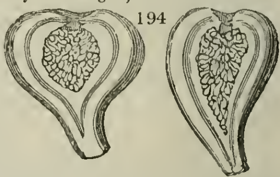

1616. *The fruit.* The anomalies of the fruit may affect either its number, figure, colour, or appendages.

1617. The common hazel-nut produces in general but one kernel in one shell; but in the course of opening a considerable number, you will now and then meet with one containing two or three kernels in a shell. This is, perhaps, best accounted for by supposing, with Du Hamel, that it is the result of an unnatural graft effected in the bud; though some think that the shell does always contain the rudiments of two or more kernels, although it rarely happens that more than one is developed. But if two apples or pears are developed in an incorporated state, which is a case that now and then occurs, it is no doubt best accounted for by the graft of Du Hamel. Sometimes the anomally consist in the figure of the fruit, which is deformed by tumours or excrescences, in consequence of the bite of insects, or injuries of weather producing warts, moles, or specks. Sometimes it consists in the colour, producing green melons and white cucumbers. Sometimes it consists in an appendage of leaves. (*fig.* 195.)

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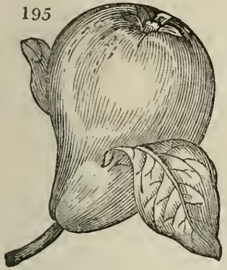

1618. *Habit.* The anomalies of habit are principally occasioned by soil and cultivation.

1619. *Some plants,* which, when placed in a rich soil, grow to a great height, and affect the habit of a tree, are, when placed in a poor soil, converted into dwarfish shrubs. This may be exemplified in the case of the box-tree ; it also occurs in the case of herbaceous plants ; as in that of *Myosòtis*, which in dry situations is but short and dwarfish, while in moist situations it grows to such a size as to seem to be altogether a different plant. The habit of the plant is sometimes totally altered by means of cultivation : the *Pỳrus* satìva, when growing in a wild and uncultivated state, is furnished with strong thorns ; but when transferred to a rich and cultivated soil the thorns disappear. This phenomenon, which was observed by Linnæus, was regarded as being equivalent to the taming of animals : but this explication is, like some others of the same great botanist, much more plausible than profound, in place of which Professor Willdenow substitutes the following ; the thorns protruded in the uncultivated state of the plant, are buds rendered abortive from want of nourishment, which when supplied with a sufficiency of nourishment are converted into leaves and branches.

1620. *Physical virtues.* When plants are removed from their native soil and taken into a state of culture, it alters not only their habit but their physical virtues. Thus the sour grape is rendered sweet ; the bitter pear, pleasant ; the dry apricot, pulpy ; the prickly lettuce, smooth ; and the acrid celery, wholesome. Potherbs also are rendered more tender, by means of cultivation, and better fitted for the use of man ; and so are all our fine fruits.

1621. *Duration.* Plants are either annuals, biennials, or perennials, and the species is generally of the same duration in every climate. But it has been found that some plants, which are annuals in a cold climate, such as that of Sweden, will become perennials in a hot climate, such as that of the West Indies ; this anomaly has been exemplified in Tropæ`olum, beet root and *Málva* arbòrea : and, on the contrary, some plants, which are perennials in hot climates, are reduced to annuals when transplanted into a cold climate ; this has been exemplified in the climbing kidneybeans.

Sect. VI. *Of the Sexuality of Vegetables.*

1622. The doctrine that *plants are of different sexes,* and which constitutes the foundation of the Linnean system, though but lately established upon the basis of logical induction, is by no means a novel doctrine. It appears to have been entertained even among the original Greeks, from the antiquity of their mode of cultivating figs and palms. Aristotle and Theophrastus maintained the doctrine of the sexuality of vegetables ; and Pliny, Dioscorides, and Galen adopted the division by which plants were then distributed into male and female ; but chiefly upon the erroneous principle of habit or aspect, and without any reference to a distinction absolutely sexual. Pliny seems to admit the distinction of sex in all plants whatever, and quotes the case of a palm tree as exhibiting the most striking example.

1623. *Linnæus,* reviewing with his usual sagacity the evidence on which the doctrine rested, and perceiving that it was supported by a multiplicity of the most incontrovertible facts, resolved to devote his labours peculiarly to the investigation of the subject, and to prosecute his enquiries throughout the whole extent of the vegetable kingdom ; which great and arduous enterprise he not only undertook, but accomplished with a success equal to the unexampled industry with which he pursued it. So that by collecting into one body all the evidence of former discovery or experiment, and by adding much that was original of his own, he found himself at length authorised to draw the important conclusion, that no seed is perfected without the previous agency of the pollen, and that the doctrine of the sexes of plants is consequently founded in fact.

1624. *Proofs from the economy of the aquatics.* Many plants of this class which vegetate for the most part wholly immersed in water, and often at a considerable depth, gradually begin to elevate their stems as the season of flowering advances, when they at last rear their heads above the surface of the water, and present their opening blossoms to the sun, till the petals have begun to fade, after which they again gradually sink down to the bottom to ripen and to sow their seeds. This very peculiar economy may be exemplified in the case of *Rúppia* marítima, and several species of *Potamogèton* common in our ponds and ditches. From this we may fairly infer, that the flowers rise thus to the surface merely to give the pollen an opportunity of reaching the stigma uninjured. But the most remarkable example of this kind is the Vallisnèri*a* spiràlis (*fig* 196.), a plant which grows in the ditches of Italy. The plant is of the class Diœ`cia, producing its fertile flowers on the extremity of a long and slender stalk (*a*) twisted spirally like a corkscrew, which uncoiling of its own accord, about the time of the opening of the blossom, elevates the flowers to the surface of the water, and leaves them to expand in the open air. The barren flowers (*b*) are produced in great numbers upon short upright stalks issuing from a different root, from which they detach themselves about the time of the

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expansion of the female blossom, mounting up like little air bubbles, and suddenly expanding when they reach the surface (*c*), where they float about in great numbers among the female blossoms, and often cling to them in clusters, so as to cover them entirely; thus bringing the stamens and pistils into immediate contact, and giving the anthers an opportunity of discharging their pollen immediately over the stigma. When this operation has been performed, the now uncoiled stalk of the female plant begins again to resume its original and spiral form, and gradually sinks down, as it gradually rose, to ripen its fruit at the bottom of the water. In 1819, we gathered these stalks, in the canals near Padua, upwards of ten feet long.

Sect. VII. *Impregnation of the Seed.*

1625. *The stamens and pistils are the male and female organs of vegetable generation, and the pollen is the substance by which the impregnation of the seed is effected;* but how is the pollen conveyed to the ovary, and what is the amount of its action?

1626. *Access of the pollen.* When the stamens and pistils are situated near each other, the elastic spring with which the anther flies open, will generally be sufficient to disperse the pollen, so as that part of it must infallibly reach the stigma, in such flowers as do not perfect their stamens and pistils at the same time. The pollen is very generally conveyed from the anther to the stigma, through the instrumentality of bees, and other insects peculiar to a species. The object of the insect is the discovery of honey, in quest of which, whilst it roves from flower to flower, and rummages the recesses of the corolla, it unintentionally covers its body with pollen, which it conveys to the next flower it visits, and brushes off as it acquired it by rummaging for honey; so that part of it is almost unavoidably deposited on the stigma, and impregnation thus effected. Nor is this altogether so much a work of random as it at first appears: for it has been observed that even insects, which do not upon the whole confine themselves to one species of flower, will yet very often remain during the whole day upon the species they happen first to alight on in the morning. Hence the impregnation of the females of Diœcious plants where no male is near; hence also a sort of natural crossing of the breed of plants, which might probably otherwise degenerate.

1627. *Fecundation of the ovary.* Admitting that the pollen is conducted to the ovary through the tubes of the style, how after all is the ovary fecundated, or the seed rendered fertile? On this subject naturalists have been much divided; and, according to their several opinions, have been classed under the respective appellations of ovarists, animalculists, and epigenesists.

1628. *Ovarist.* According to the opinion of the *Ovarist*, the embryo preexists in the ovary, and is fecundated by the agency of the pollen, as transmitted to it through the style.

1629. *Animalculist.* But the theory of the ovarists is not without its difficulties; for, as the embryo is never found to make its appearance till after fecundation, it has been thought that it must necessarily preexist in the pollen of the anther; from which it is conveyed to the ovary through the medium of the style, and afterwards matured. This theory was founded upon that of Leuwenhoeck, with regard to animal generation, which supposes the preexistence of animalcula in the seminal principle of the male; the animalcula being conveyed *in coïtu* to the ovary of the female, where alone they are capable of developement.

1630. *Epigenesist.* The difficulties inseparable from both theories, together with the phenomenon of hybrid productions, have given rise also to a third; this is the *Theory of the Epigenesists*, who maintain that the embryo preexists neither in the ovary nor pollen, but is generated by the union of the fecundating principles of the male and female organs; the former being the fluid issuing from the pollen when it explodes, and the latter the fluid that exudes from the surface of the stigma when mature.

1631. *Hybrids.* Although the arguments of the epigenesists are by no means satisfactory, yet it cannot be denied, that hybrid productions partake of the properties both of the male and female from which they spring. This was long ago proved to be the fact by Bradley, and more recently confirmed by the experiments of Knight; as well as happily converted to the advantage of the cultivator.

1632. *Vegetable crossing.* Observing that farmers who rear cattle improve the progeny by means of *crossing* the breed, Knight argued from analogy, that the same improvement might be introduced into vegetables. His principal object was that of procuring new and improved varieties of the apple and pear, to supply the place of such as had become diseased and unproductive. But as the necessary slowness of all experiments of the kind, with regard to the fruit in question, did not keep pace with the ardour of his desire to obtain information on the subject, he was induced to institute some tentative experiments upon the common pea; a plant well suited to his purpose, both from its quickness of growth, and from the many varieties in form, size, and colour which it afforded. In 1787, a degenerate sort of pea was growing in his garden, which had not recovered its former vigour even when removed to a better soil. Being thus a good subject of experiment, the male organs of a dozen of its immature blossoms were destroyed, and the female organs left entire. When the blossoms had attained their mature state, the pollen of a very large and luxuriant grey pea was introduced into the one half of them, but not into the other. The pods of both grew equally; but the seeds of the half that were unimpregnated withered away without having augmented beyond the size to which they had attained before the blossoms expanded. The seeds of the other half were augmented and matured, as in the ordinary process of impregnation; and exhibited no perceptible difference from those of other plants of the same variety; perhaps because the external covering of the seed was furnished entirely by the female. But when they were made to vegetate in the succeeding spring, the effect of the experiment was obvious. The plants rose with great luxurance, indicating in their stem, leaves, and fruit, the influence of this artificial impregnation; the seeds produced were of a dark grey. By impregnating the flowers of this variety with the pollen of others, the colour was again changed, and new varieties obtained, superior in every respect to the original on which the experiment was first made, and attaining, in some cases, to a height of more than twelve feet. (*Phil. Trans.*, 1789.) Knight thinks his experiments on this subject afford examples of superfœtation, a phenomenon, the existence of which appears doubtful amongst animals, and of which the proof amongst vegetables is not yet quite satisfactory. Of one species of superfœtation he has certainly produced examples; that is, when, by impregnating a white pea-blossom with the pollen both of a white and grey pea, white and grey seeds were obtained. But of the other species of superfœtation, in which one seed is supposed to be the joint issue of two males, the example is not quite satisfactory. Such a production is perhaps possible, and further experiments may probably ascertain the fact; but it seems to be a matter of mere curiosity, and not apparently connected with any views of utility.

1633. *The practicability of improving the species* is rendered strikingly obvious by these experiments; and the ameliorating effect is the same, whether by the male or female; as was ascertained by impregnating the largest and most luxuriant plants with the pollen of the most diminutive and dwarfish, or the contrary. By such means any number of varieties may be obtained, according to the will of the experimenter, amongst which some will no doubt be suited to all soils and situations. Knight's experiments of this kind were extended also to wheat; but not with equal success: for though some very good varieties were obtained, yet they were found not to be permanent. But the success of his experiments on the apple tree were equal to his hopes. This was, indeed, his principal object, and no means of obtaining a successful issue were left untried. The plants which were obtained in this case were found to possess the good qualities of both of the varieties employed, uniting the greatest health and luxuriance with the finest and best-flavoured fruit.

1634. *Improved varieties of every fruit and esculent plant may be obtained by means of artificial impregnation, or crossing*, as they were obtained in the cases already stated. Whence Knight thinks, that this promiscuous impregnation of species has been intended by nature to take place, and that it does in fact often take place, for the purpose of correcting such accidental varieties as arise from seed, and of confining them within narrower limits. All which is thought to be countenanced from the consideration of the variety of methods which nature employs to disperse the pollen, either by the elastic spring of the anthers, the aid of the winds, or the instrumentality of insects. But although he admits the existence of vegetable hybrids, that is, of varieties obtained from the intermixture of different species of the same genus, yet he does not admit the existence of vegetable mules, that is, of varieties obtained from the intermixture of the species of different genera; in attempting to obtain which he could never succeed, in spite of all his efforts. Hence he suspects that where such varieties have been supposed to take place, the former must have been mistaken for the latter. It may be said, indeed, that if the case exists in the animal kingdom, why not in the vegetable kingdom? to which it is, perhaps, difficult to give a satisfactory reply: but from the narrow limits within which this intercourse is in all cases circumscribed, it scarcely seems to have been the intention of nature that it should succeed even among animals. Salisbury is of a different opinion, and considers (*Hort. Trans.*, i. 364.) that new species may be created both by bees and by the agency of man; and the recent experiments of Herbert, Sweet, and others, seem to confirm this opinion. Sweet's experience leads him to conclude that the plants of all orders strictly natural may be reciprocally impregnated with success, and he has already, in the nursery-gardens of Messrs. Colville, produced many new Gerània and *R*hodoràceæ.

1635. *A singular or anomalous effect of crossing*, or extraneous impregnation, is the change sometimes undergone by the seed or fruit which is produced by the blossom impregnated. These results are not uniform, but they are of frequent occurrence, and have attracted notice from a very early period. John Turner observes (*Hort. Trans.*, v. 63.) that Theophrastus and Pliny (*Theophrast. Hist. Plant.*, l. ii. c. 4.; *Plinii Hist. Nat.*, l. xvii. c. 25.) seem to allude to it, and that the notion was entertained by Bradley, who, in his *New Improvements in Planting and Gardening*, after giving directions for fertilising the female flowers of the hazel with the pollen of the male, says, "By this knowledge we may alter the property and taste of any fruit, by impregnating the one with the farina of another of the same class, as, for example, a codlin with a pearmain, which will occasion the codlin so impregnated to last a longer time than usual, and be of a sharper taste; or, if the winter fruit should be fecundated with the dust of the summer kinds, th will decay before their usual time; and it is from this accidental coupling of the farina of one kind with the other, that in an orchard, where there is a variety of apples, even the fruit gathered from the same tree differs in its flavour and times of ripening; and, moreover, the seeds of those apples so generated, being changed by that means from their natural qualities, will produce different kinds of fruit, if they are sown." Turner, after quoting several instances, and, among others, one from the *Philosophical Transactions* "concerning the effect which the farina of the blossoms of different sorts of apples had on the fruit of a neighbouring tree," states upwards of six cases of hybridised apples, that had come within his own observation; and concludes with the remark, that, if there does exist in fruits such a liability to change, it will at once be evident to the intelligent cultivator how much care is requisite in growing melons, cucumbers, &c., to secure their true characters, even without reference to saving seed for a future crop. In the same volume of the *Horticultural Transactions* (p. 234.) an account is given of different-coloured peas being produced in the same pod, by crossing the parent blossom. All these facts seem to contradict the generally received opinion, that crossing only affects the next generation; here it appears to affect the embryo offspring; and a gardener, who had no keeping apples in his orchard, might communicate that quality in part to his summer fruit by borrowing the use of a neighbour's blossoms from a late variety. It is probable, however, that such counter-impregnations do not take place readily; otherwise the produce of a common orchard would be an ever-varying round of monstrosities.

Sect. VIII. *Changes consequent upon Impregnation.*

1636. *The peculiar changes consequent upon impregnation*, whether in the flowers or fruit, may be considered as external and internal.

1637. *External changes.* At the period of the impregnation of the ovary the flower has attained to its ultimate state of perfection, and displayed its utmost beauty of colouring and richness of perfume. But as it is now no longer wanted, so it is no longer provided for in the economy of vegetation. Its period of decline has commenced; as is indicated, first by the decay of the stamens, then of the petals, and then of the calyx, which wither and shrink up, and finally detach themselves from the fruit altogether, except in some particular cases in which one or other of them becomes permanent and falls only with the fruit. The stigma exhibits also similar symptoms of decay, and the style itself often perishes. The parts contiguous to the flower, such as the bractes and floral leaves, are sometimes also affected; and finally the whole plant, at least in the case of annuals, begins to exhibit indications of decay. But while the flower withers and falls, the ovary is advancing to perfection, swelling and augmenting in size, and receiving now all the nutriment by which the decayed parts were formerly supported. Its colour begins to assume a deeper and richer tinge; its figure is also often altered, and new parts are even occasionally added, wings, crests, prickles, hooks, bloom, down. The common receptacle of the fruit undergoes also similar changes, becoming sometimes large and succulent, as in the fig and strawberry; and sometimes juiceless and indurated, as in compound flowers.

1638. *Internal changes.* If the ovary is cut open as soon as it is first discoverable in the flower, it will be found to be divisible into several distinct parts, exhibiting an apparatus of cells, valves, and membranes, constituting the pericarp, and sometimes the external coats of the seed. Impregnation has no sooner taken place than its influence begins to be visible; the umbilical cord, which was formerly short and distended, is in some cases converted into a long and slender thread Sometimes the position of the seed is altered. Before impregnation the seeds of Caryophýllus aromáticus and Metrosidèros gummífera are horizontal; after impregnation they become vertical. Before impregnation the Magnòl*ia* seeds are erect; after impregnation they become inverted and pendulous. The figure of the seed is often also altered in passing from its young to its mature state; changing from smooth to angular, from tapering to oval, from oval to round, and from round to kidney-shaped. But all the seeds are not brought to maturity, of which the rudiments may exist in the ovary. Lagœ'cia and Hasselquíst*ia* produce uniformly the rudiments of two seeds, of which they mature but one. But the principal changes resulting from impregnation are operated in the seed itself, which, though previously a homogeneous and gelatinous mass, is now converted into an organised body, or embryo. Such are the phenomena, according to the description of Gærtner, accompanying or following the impregnation of all flowers producing seeds; exceptions occur where the fecundation is spurious and incomplete; where the ovary swells, but exhibits no traces of perfect seed within, as often happens in the vine and *T*àmus; or where barren and fertile seeds are intermingled together in the same ovary. This proceeds from some defect either in the quantity or quality of the pollen; but rather in the quality, as it is not always plants having the most pollen that produce the most seeds. The two stamens of the Orchídeæ fecundate 8000 seeds, and the five stamens of tobacco fecundate 900: while the 50 stamens of Barringtŏn*ia*, the 230 of *Thèa*, and the 80 of the Caryophýllus fecundate only two or three ovules.

Sect. IX. *The Propagation of the Species.*

1639. *As the life of the vegetable, like that of the animal, is limited to a definite period*, and as a continued supply of vegetables is always wanted for the support of animals, what we call art, or nature operating by means of the animal man, has taken care to institute such means as shall secure the multiplying and perpetuating of the species in all possible cases.

1640. *Equivocal generation.* It was long a vulgar error, countenanced even by the philosophy of the times, that vegetables do often spring up from the accidental mixture of earth and putrid water, or other putrid substances, in the manner of what was called the equivocal generation of animals; or, at the very least, that the earth contains the principle of vegetable life in itself, which, in order to develope, it is only necessary to expose to the action of the air. The former alternative of the error has been long ago refuted; the latter has lost its hold, having been refuted by Malpighi, who proved that the earth produces no plant without the intervention of a seed, or of some other species of vegetable germ deposited in it by nature or by art.

1641. *Propagation by seeds.* When the seed has reached maturity in the due and regular course of the developement of its several parts, it detaches itself sooner or later from the parent plant, either singly or along with its pericarp, and drops into the soil, where it again germinates and takes root, and springs up into a new individual. Such is the grand means instituted by nature for the replenishing and perpetuating of the vegetable kingdom.

1642. *Dispersion of seed.* If seeds were to fall into the soil merely by dropping down from the plant, then the great mass of them, instead of germinating and springing up into distinct plants, would grow up only to putrefy and decay; to prevent which consequence nature has adopted a variety of the most efficacious contrivances, all tending to the dispersion of the seed. The first means to be mentioned is that of the elasticity of the pericarp of many fruits, by which it opens when ripe, with a sort of sudden spring, ejecting the seed with violence, and throwing it some considerable distance from the plant. This may be exemplified in a variety of cases; the seeds of oats when ripe are projected from the calyx with such violence, that in a fine and dry day you may even hear them thrown out with a slight and sudden snap, in passing through a field that is ripe. The pericarp of the dorsiferous ferns (*fig.* 197.) is furnished with a sort of peculiar elastic ring, intended, as it would appear, for the very purpose of projecting the seeds. The capsules of the squirting cucumber, geranium, and Fraxinélla, discharge their seeds also when ripe with an elastic jerk. But the pericarp of Impàtiens, which consists of five cells with five valves, exhibits perhaps one of the best examples of this mode of dispersion. If it be accidentally touched when ripe it will immediately burst open, while the valves, coiling themselves up in a spiral form, and springing from the stem, discharge the contained seeds, and scatter them all around. The bursting of the pericarp of some species of pines is also worthy of notice. The pericarp, which is a cone, remains on the tree till the summer succeeding that on which it was produced, the scales being still closed: but when the hot weather has commenced and continued for some time, so as to dry the cone thoroughly, the scales open of their own accord with a sudden jerk, ejecting the contained seeds: and if a number of them happen to burst together, which is often the case, the noise is such as to be heard at some considerable distance. The twisted awn of *Avèna fátua* (*fig.* 198.) or wild oat, as well as that of Erŏdium cicutàrium, and some others, seems to have been intended particularly for the purpose of aiding the further dispersion of the seed, after being discharged from the plant or pericarp. This spiral awn or spring, which is beset with a multitude of fine and minute hairs, possesses the property of contracting by means of drought, and of expanding by means of moisture. Hence it remains of necessity in a perpetual state of contraction or dilatation, dependent upon change of weather; from which, as well as from the additional aid of the fine hairs, which act as so many fulcra, and cling to whatever object they meet, the seed to which it is attached is kept in continual motion till it either germinates or is destroyed. The awn of barley, which is beset with a multitude of little teeth all pointing to its upper extremity, presents also similar phenomena. For when the seed with its awn falls from the ear and lies flat upon the ground, it is necessarily extended in its dimensions by the moisture of the night, and contracted by the drought of the day: but as the teeth prevent it from receding in the direction of the point, it is consequently made to advance in the direction of the base of the seed, which is thus often carried to the distance of many feet from the stalk on which it grew. If any one is yet sceptical with regard to the travelling capacity of the awn, let him only introduce an awn of barley with the seed uppermost between his coat and shirt sleeve at the wrist, when he walks out in the morning, and by the time he returns to breakfast, if he has walked to any great distance, he will find it up at his armpit. This journey has been effected by means of the continued motion of the arm, and consequently of the teeth of the awn acting as feet to carry it forward.

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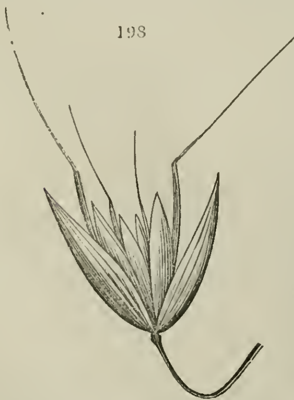

1643. *Where distance of dispersion* is required, nature is also furnished with a resource. One of the most common modes by which seeds are conveyed to a distance from their place of growth is that of the instrumentality of animals. Many seeds are thus carried to a distance from their place of growth, merely by their attaching themselves to the bodies of such animals as may happen accidentally to come in contact with the plant, in their search after food; the hooks or hairs with which one part or other of the fructification is often furnished, serving as the medium of attachment, and the seed being thus carried about with the animal till it is again detached by some accidental cause, and at last committed to the soil. This may be exemplified in the case of the Bìdens and *M*yosòtis, in which the hooks or prickles are attached to the seed itself; or in the case of Gàlium *A*parine and others, in which they are attached to the pericarp; or in the case of the thistle and the burdock, in which they are attached to the general calyx. Many seeds are dispersed by animals in consequence of their pericarps being used as food. This is often the case with the seeds of the drupe, as cherries and sloes, and with the berries of the hawthorn, which birds often carry away till they meet with some convenient place for devouring the pulpy pericarp, and then drop the stone into the soil. And so also fruit is dispersed that has been hoarded for the winter, though even with the view of feeding on the seed itself, as in the case of nuts hoarded up by squirrels, which are often dispossessed by some other animal, which, not caring for the hoard, scatters and disperses it. Sometimes the hoard is deposited in the ground itself, in which case part of it is generally found to take root and to spring up into plants; though it has been observed that the ground squirrel often deprives the kernel of its germ before it deposits the fruit it collects. Rooks have been also observed to lay up acorns and other seeds in the holes of fence-posts, which being either forgot or accidentally thrust out, fall ultimately into the earth and germinate. But sometimes the seed is even taken into the stomach of the animal, and afterwards deposited in the soil, having passed through it unhurt. This is often the case with the seed of many species of berry, such as the mistletoe, which the thrush swallows and afterwards deposits upon the boughs of such trees as it may happen to alight upon. The seeds of the Lorànthus americànus, another parasitical plant, are said to be deposited in like manner on the branches of the Coccóloba grandiflòra and other lofty trees; as also the seeds of Phytolácca decándra, the berries of which are eaten by the robin, thrush, and wild pigeon. And so also the seeds of currants or roans are sometimes deposited, after having been swallowed by blackbirds or other birds, as may be seen by observing a currant bush or young roan tree growing out of the cleft of another tree, where the seed has been left, and where there may happen to have been a little dust collected by way of soil; or where a natural graft may have been effected by the insinuation of the radicle into some chink or cleft. It seems indeed surprising that any seeds should able to resist the heat and digestive action of the stomach of animals; but it is undoubtedly the fact. Some seeds seem even to require it. The seeds of Magnòl*ia* glaúca, which have been brought to this country, are said generally to have refused to vegetate till after undergoing this process, and it is known that some seeds will bear a still greater degree of heat without any injury. Spallanzani mentions some seeds that germinated after having been boiled in water: and Du Hamel gives an account of some others that germinated even after having been exposed to a degree of heat measuring 235° of Fahrenheit. In addition to the instrumentality of brute animals in the dispersion of the seed might be added also that of man, who, for purposes of utility or of ornament, not only transfers to his native soil seeds indigenous to the most distant regions, but sows and cultivates them with care. "A farmer in the west of Scotland has been in the practice, for some years, of feeding his cows upon potato-apples, and using their dung, and raising seedling plants from it the seeds; having passed through the stomach of the cow, without having undergone such a change as to prevent them from vegetating." (*Note of Mr. Cleghorn, Ed. of the Edinburgh Farm. Mag.*)

1644. *The agency of winds* is one of the most effective modes of dispersion instituted by nature. Some seeds are fitted for this mode of dispersion from their extreme minuteness, such as those of the mosses, lichens and *F*úngi, which float invisibly on the air, and vegetate wherever they happen to meet with a suitable soil. Others are fitted for it by means of an attached wing, as in the case of the fir tree and Liriodéndron tulipífera, so that the seed, in falling from the cone or capsule, is immediately caught by the wind, and carried to a distance. Others are peculiarly fitted for it by means of their being furnished with an aigrette or down, as in the case of the dandelion, goat's-beard, and thistle, as well as most plants of the class Syngenèsia; the down of which is so large and light in proportion to the seed it supports, that it is wafted on the most gentle breeze, and often seen floating through the atmosphere in great abundance at the time the seed is ripe. Some have a tail, as in Clématis Vitálba. Others are fitted for this mode of dispersion by means of the structure of the pericarp, which is also wafted along with them, as in the case of Staphylèa trifòlia, the inflated capsule of which seems as if obviously intended thus to aid the dispersion of the contained seed, by its exposing to the wind a large and distended surface with but little weight; and so also in the case of the maple, elm, and ash, the capsules of which are furnished, like some seeds, with a membranous wing, which when they separate from the plant the wind immediately lays hold of and drives before it.

1645. *The instrumentality of streams, rivers, and currents of the ocean*, is a further means adopted by nature for the dispersion of the seeds of vegetables. The mountain-stream or torrent washes down to the valley the seeds which may accidentally fall into it, or which it may happen to sweep from its banks when it suddenly overflows them. The broad and majestic river, winding along the extensive plain, and traversing the continents of the world, conveys to the distance of many hundreds of miles the seeds that may have vegetated at its source. Thus the southern shores of the Baltic are visited by seeds which grew in the interior of Germany, and the western shores of the Atlantic by seeds that have been generated in the interior of America. But fruits indigenous to America and the West Indies have sometimes been found to be swept along by the currents of the ocean to the western shores of Europe, and even on the coasts of Orkney and Shetland. Fruits of Mimòsa scándens, Stizolòbium prùriens, Guilandìn*a Bónduc*, and Anacárdium occidentàle, or cashew-nut, have been thus known to be driven across the Atlantic to a distance of upwards of 2000 miles; and although the fruits now adduced as examples are not such as could vegetate on the coast on which they were thrown, owing to soil or climate, yet it is to be believed that fruits may have been often thus transported to climates or countries favourable to their vegetation.

1646. *Propagation by gems.* Though plants are for the most part propagated by means of seeds, yet many of them are propagated also by means of gems; that is, bulbs and buds.

1647. *The caulinary bulb* is often the means of the propagation of the species: it generally appears in the axils of the leaves, as in Dentària bulbífera and *L*ilium bulbíferum; or between the spokes of their umbels, as in *A*'llium canadénse; or in the midst of the spike of flowers, as in *P*olýgonum vivíparum and *P*òa alpìna. As plants of this last kind are mostly alpine, it has been thought to be an institution or resource of nature, to secure the propagation of the species in situations where the seed may fail to ripen.

1648. *The bud*, though it does not spontaneously detach itself from the plant and form a new individual, will yet sometimes strike root and develope its parts if carefully separated by art and planted in the earth: but this is to be understood of the leaf-bud only, for the flower-bud, according to Mirbel, if so treated, always perishes.

1649. *Propagation by the leaves.* The species may sometimes be propagated even by means of the leaves, as in the aloe, Xylophýlla, sea-onion, and some species of *A*'rum; which if carefully deposited in the soil will grow up into new plants, by virtue, no doubt, of some latent gem contained in them. The *F*úngi and lichens, according to Gærtner, are all gemmiferous, having no sexual organs, and no pollen impregnating a germ. In the genus Lycopérdon, the gelatinous substance that pervades the cellular tissue is converted into a proliferous powder; in Clavària, the fluid contained in the cavities of the plant is converted into a proliferous powder also; and in the agarics, *H*ýpnum, and *B*olètus, vesicles containing soboliferous granules are found within the lamellæ, pores, or tubes. Hedwig, on the contrary, ascribes to the *F*úngi a sexual apparatus, and maintains that the pollen is lodged in the volva: but here it is to be recollected, as in the cases of the scutellæ of the litchens, that all *F*úngi are not furnished with a volva, and consequently not furnished with pollen. The *C*onférvæ and *U*'lvæ, together with the genera Blàsi*a* and Riccì*a* are also, according to Gærtner, propagated only by gems; while Marchántia, Anthóceros, Jungermánnia, and Lycopérdon, are said to be propagated both by gems and seeds.

1650. *Runners* are young shoots issuing from the collar or summit of the root, and creeping along the surface of the soil; but producing a new root and leaves at the extremity, and forming a new individual, by the decay of the connecting link, as in the strawberry.

1651. *Slips.* The process of raising perennials by slips is well known to gardeners, and should, perhaps, be regarded as an extension of the old plant, rather than as the generation of a new one; though it serves the purpose of the cultivator equally well as a plant raised from seed, with the additional advantage of bearing fruit much sooner. But how is the root generated which the slip thus produces? If the trunk of a tree is lopped, and all its existing buds destroyed, then there will be protruded from between the wood and bark a sort of protuberant lip or ring formed from the proper juice, and from which there will spring a number of young shoots. The formation of the root, in the case of the slip, is effected in the same manner, the moisture of the soil encouraging the protrusion of buds at and near the section; and the bud that would have been converted into a branch above ground is converted into a root below.

1652. *Layers.* The mode of propagation by layers is practised upon trees that are delicate, and which cannot readily be propagated by means of slips; in which case the root is generated nearly as in the former case, the soil stimulating the protrusion of buds which are converted into roots. In many plants, such as the currant and laurel, this is altogether a natural process, effected by the spontaneous bending down of a branch to the surface of the soil.

1653. *Suckers or offsets.* Many plants protrude annually from the collar a number of young shoots, encircling the principal stem and depriving it of a portion of its nourishment, as in the case of most fruit trees. Others send out a horizontal root from which there at last issues a bud that ascends above the soil, and is converted into a little stem, as in the case of the elm tree and *Syringa.* Others send out a horizontal shoot from the collar or its neighbourhood; or a shoot that ultimately bends down by its own weight till it reaches the ground, in which it strikes root, and again sends up a stem as in the currant bush and laurel. The two former are called *suckers* or *offsets*, though the term offset should, perhaps, be restricted to the young bulbs that issue and detach themselves annually from bulbous roots. The latter is not designated by any particular name, but may be regarded as a sort of natural layer, resembling also, in some respects, the runner; from which, however, it is distinguished in that it never detaches itself spontaneously from the parent plant, as is the case also with the two former: but if either of them is artificially detached, together with a portion of root or a slice of the collar adhering to it, the detached part will now bear transplanting, and will constitute a distinct plant.

1654. *Grafting and budding.* The species is also often propagated, or at least the variety is multiplied, by means of *grafting;* which is an artificial application of a portion of the shoot or root of one tree or plant to the stem, shoot, branch, or root of another, so that the two shall coalesce together and form but one plant. The shoot which is to form the summit of the new individual is called the scion; the stem to which it is affixed is called the stock; and the operation, when effected, the graft. As the graft is merely an extension of the parent plant from which the scion came, and not properly speaking a new individual, so it is found to be the best method of propagating approved varieties of fruit trees without any danger of altering the quality of the fruit, which is always apt to be incurred in propagation from seed, but never in propagating from the scion. The scion will also bear fruit much sooner than the tree that is raised from seed; and, if effected on a proper stock, will be much more hardy and vigorous than if left on the parent plant. Hence the great utility of grafting in the practice of gardening. Till lately, grafting was confined to the ligneous plants, but it is now successfully practised on the roots and shoots of herbaceous vegetables; and the dahlia is grafted by the root; the melon on the gourd; the love-apple on the potato; the cauliflower on the cabbage, &c., by the shoot. A very ingenious tract has been published on this subject, entitled, *Essai sur la Greffe de l'Herbe des Plantes et des Arbres, par Monsr. le Baron de Tschoudy, Bourgeois de Glaris.* Paris, 1819.

Sect. X. *Causes limiting the Propagation of the Species.*

1655. *Though plants are controlled chiefly by animals,* yet they also control one another. From the various sources of vegetable reproduction, but particularly from the fertility and dispersion of the seed, the earth would soon be overrun with plants of the most prolific species, and converted again into a desert, if it were not that nature has set bounds to their propagation by subjecting them to the control of man, and to the depredations of the great mass of animals; as well as by confining the germination of their seeds to certain and peculiar habitations arising from soil, climate, altitude, and other circumstances. In order to form an idea of the manner in which the latter act upon vegetation, imagine that every year an enormous quantity of seeds, produced by the existing vegetables, are spread over the surface of the globe, by the winds and other causes already mentioned; all of these seeds which fall in places suitable for their vegetation, and are not destroyed by animals, germinate and produce plants; and then among these plants, the strongest, and largest, and those to which the soil is best suited, develope themselves in number and magnitude so as to choke the others. Such is the general progress of nature, and among plants, as among animals, the strong flourish at the expense of the weak. These causes have operated for such a length of time, that the greater number of species are now fixed in, and considered as belonging to, certain soils, situations, and climates, beyond which they seldom propagate, otherwise than by the hands of man.

Sect. XI. *Evidence and Character of Vegetable Vitality.*

1656. *The power of counteracting the laws of chemical affinity* is reckoned the best and most satisfactory evidence of the presence and agency of a vital principle, as inherent in any subject. This principle, which seems first to have been instituted by Humboldt, is obviously applicable to the case of animals, as is proved by the process of the digestion of the food, and its conversion into chyle and blood; as well as from the various secretions and excretions effected by the several organs, and causing the growth and developement of the individual, in direct opposition to the acknowledged laws of chemical affinity, which, as soon as the vital principle is extinct, begin immediately to give evidence of their action, in the incipient symptoms of the putrefaction of the dead body. But the rule is also applicable to the case of vegetables, as is proved by the introsusception, digestion, and assimilation of the food necessary to their developement; all indicating the agency of a principle capable of counteracting the laws of chemical affinity, which, at the period of what is usually called the death of the plant, begin also immediately to act, and to give evidence of their action in the incipient symptoms of the putrefaction of the vegetable. Vegetables are therefore obviously endowed with a species of vitality. But, admitting the presence and agency of a vital principle inherent in the vegetable subject, what are the peculiar properties by which this principle is characterised?

1657. *Excitability.* One of the most distinguishable properties of the vital principle of vegetables is that of its excitability, or capacity of being acted upon by the application of natural stimuli, impelling it to the exertion of its vegetative powers; the natural stimuli thus impelling it being light and heat.

1658. *The stimulating influence of light* upon the vital principle of the plant is discoverable, whether in the stem, leaf, or flower. The direction of the stem is influenced by the action of light, as well as the colour of the leaves. Distance from direct rays of light or weak light produces etiolation, and its absence blanching. The luxuriance of branches depends on the presence and action of light, as is particularly observable in the case of hot-house plants, the branches of which are not so conspicuously directed, either to the flue in quest of heat, or to the door or open sash in quest of air, as to the sun in quest of light. Hence also the branches of plants are often more luxuriant on the south, than on the north, side; or at least on the side that is best exposed to light. The position of the leaf is also strongly affected by the action of light, to which it uniformly turns its upper surface. This may be readily perceived in the case of trees trained to a wall, from which the upper surface of the leaf is by consequence always turned; being on a south wall turned to the south, and on a north wall turned to the north: and if the upper surface of the leaf is forcibly turned towards the wall, and confined in that position for a length of time, it will soon resume its primitive position upon regaining its liberty, but particularly if the atmosphere be clear. The leaves of the mallow are said to exhibit but slight indications of this susceptibility, as also sword-shaped leaves; and those of the mistletoe are equally susceptible on both sides. It had been conjectured that these effects are partly attributable to the agency of heat; and to try the value of the conjecture, Bonnet placed some plants of the *A*'triplex in a stove heated to 25° of Reaumur. Yet the stems were not inclined to the side from which the greatest degree of heat came; but to a small opening in the stoves. Heat, then, does not seem to exert any perceptible influence in the production of the above effects. Does moisture? Bonnet found that the leaves of the vine exhibited the same phenomenon when immersed in water, as when left in the open air. Whence it seems probable that light is the sole agent in the production of the effects in question. But as light produces such effects upon the leaves, so darkness or the absence of light produces an effect quite the contrary; for it is known that the leaves of many plants assume a very different position in the night from what they have in the day. This is particularly the case with winged leaves, which, though fully expanded during the day, begin to droop and bend down about sunset and during the fall of the evening dew, till they meet together on the inferiorside of the leaf-stalk; the terminal lobe, if the leaf is furnished with one, folding itself back till it reaches the first pair; or the two side lobes, if the leaf is trifoliate, as in the case of common clover. So, also, the leaflets of the false acacia and liquorice hang down during the night, and those of Mimòsa pudìca fold themselves up along the common foot-stalk so as to overlap one another. Linnæus has designated the above phenomenon by the appellation of *The Sleep of Plants.* The expansion of the flower is also effected by the action of light. Many plants do not fully expand their petals except when the sun shines: and hence alternately open them during the day and shut them up during the night. This may be exemplified in the case of papilionaceous flowers in general, which spread out their wings in fine weather to admit the rays of the sun, and again fold them up as the night approaches. It may be exemplified also in the case of compound flowers, as the dandelion and hawkweed. But the most singular case of this kind is perhaps that of the lotus of the Euphrates, which is described by Theophrastus as rearing and expanding its blossoms by day, closing and sinking down beneath the surface of the water by night so as to be beyond the grasp of the hand, and again rising up in the morning to present its expanded blossom to the sun. The same phenomenon is related also by Pliny. But although many plants open their flowers in the morning and shut them again in the evening, yet all flowers do not open and shut at the same time. Plants of the same species are tolerably regular as to time, other circumstances being the same; and hence the daily opening and shutting of the flower botanists have denominated *The Horològium Flòræ.* Flowers requiring but a slight application of stimulus open early in the morning, while others, requiring more, open somewhat later. Some do not open till noon, and some, whose extreme delicacy cannot bear the action of light at all, open only at night; such as the Càctus grandiflòra, or night-blowing cereus. But it seems somewhat doubtful whether or not light is the sole agent in the present case; for it has been observed that equatorial flowers open always at the same hour, and that tropical flowers change their hour of opening according to the length of the day. It has been observed, also, that the flowers of plants which are removed from a warmer to a colder climate expand at a later hour in the latter. A flower that opens at six o'clock in the morning in Senegal, will not open in France or England till eight or nine, nor in Sweden till ten; a flower that opens at ten o'clock in Senegal, will not open in France or England till noon or later, and in Sweden it will not open at all; and a flower that does not open till noon or later in Senegal, will not open at all in France or England. This seems as if heat or its absence were also an agent in the opening or shutting of flowers; though the opening of such as blow only in the night cannot be attributed either to light or heat. But the opening or shutting of some flowers depends not so much on the action of the stimulus of light as on the existing state of the atmosphere, and hence their opening or shutting betokens change. If the Siberian sow-thistle shuts at night, the ensuing day will be fine; and if it opens, it will be cloudy and rainy. If the African marigold continues shut after seven o'clock in the morning, rain is near at hand; and if the Convólvulus arvénsis, Caléndula pluviàlis, or *A*nagállis arvénsis, is even already open, it will shut upon the approach of rain, the last of which, from its peculiar susceptibility, has obtained the name of the poor man's weatherglass. But some flowers, besides expanding during the light of day, incline also towards the sun, and follow his course, looking towards the east in the morning, towards the south at noon, and towards the west in the evening; and again returning in the night to their former position in the morning. Such flowers are designated by the appellation of *Heliotropes*, on account of their following the course of the sun; and the movement they thus exhibit is denominated their *nutation.* This phenomenon had been observed by the ancients long before they made any considerable progress in botany, and had even been interwoven into their mythology, having originated, according to the records of fabulous history, in one of the metamorphoses of early times. Clytie, inconsolable for the loss of the affections of Sol, by whom she had been formerly beloved, and of whom she was still enamoured, is represented as brooding over her griefs in silence and solitude; where, refusing all sustenance, and seated upon the cold ground, with her eyes invariably fixed on the sun during the day, and watching for his return during the night, she is at length transformed into a flower, retaining, as much as a flower can retain it, the same unaltered attachment to the sun. This is the flower which is denominated *H*eliotròpium by the ancients, and described by Ovid as *Flos qui ad solem vertitur.* But it is to be observed, that the flower alluded to by Ovid cannot be the *H*eliotròpium of the moderns, because Ovid describes it as resembling the violet: much less can it be the sun-flower, which is a native of America, and could not consequently have been known to Ovid; so that the true *H*eliotròplum of the ancients is perhaps not yet ascertained. Bonnet has further remarked that the ripe ears of corn, which bend with the weight of grain, scarcely ever incline to the north, but always less or more to the south; of the accuracy of which remark any one may easily satisfy himself by looking at a field of wheat ready for the sickle; he will find the whole mass of ears nodding, as if with one consent, to the south. The cause of the phenomenon has been supposed to be a contraction of the fibres of the stem or flower-stalk on the side exposed to the sun; and this contraction has been thought by De la Hire and Dr. Hales to be occasioned by an excess of transpiration on the sunny side; which is probably the fact, though there seems upon the principle to be some difficulty in accounting for its returning at night; because if you say that the contracted side expands and relaxes by moisture, what is it that contracts the side that was relaxed in the day? The moisture, of which it is no doubt still full, would counteract the contraction of its fibres, and prevent it from resuming its former position in the morning.

1659. *Heat* as well as light acts also as a powerful stimulus to the exertions of the vital principle. This has been already shown in treating of the process of germination; but the same thing is observable with regard to the developement and maturation of the leaves, flower, and fruit; for although all plants produce their leaves, flower, and fruit annually, yet they do not all produce them at the same period or season. This forms the foundation of what Linnæus has called the *Calendàrium Flòræ*, including a view of the several periods of the frondescence and efflorescence of plants, together with those of the maturation of the fruit.

1660. *Frondescence.* It must be plain to every observer, that all plants do not protrude their leaves at the same season, and that even of such as do protrude them in the same season, some are earlier and some later. The honeysuckle protrudes them in the month of January; the gooseberry, currant, and elder, in the end of February, or the beginning of March; the willow, elm, and lime tree, in April; and the *Plátanus*, oak, and ash, which are always the latest among trees, in the beginning or towards the middle of May. Many annuals do not come up till after the summer solstice; and many mosses not till after the commencement of winter. This gradual and successive unfolding of the leaves of different plants seems to arise from the peculiar susceptibility of the species to the action of heat, as requiring a greater or less degree of it to give the proper stimulus to the vital principle. But a great many circumstances will always concur to render the time of the unfolding of the leaves somewhat irregular; because the mildness of the season is by no means uniform at the same period of advancement; and because the leafing of the plant depends upon the peculiar degree of temperature, and not upon the return of a particular day of the year. Hence it has been thought that no rule could be so good for directing the husbandman in the sowing of his several sorts of grain, as the leafing of such species of trees as might be found by observation to correspond best to each sort of grain respectively, in the degree of temperature required. Linnæus (Stillingfleet informs us) instituted some observations on the subject about the year 1750, with a view chiefly to ascertain the time proper for the sowing of barley in Sweden; he regarded the leafing of the birch tree as being the best indication for that grain, and recommended the institution of similar observations with regard to other sorts of grain, upon the grounds of its great importance to the husbandman, who may be said to attend to it in a manner instinctively; but as all the trees of the same species do not come into leaf precisely at the same time, and as the weather may alter even after the most promising indications, no guide, natural or artificial, can be absolutely depended on with a view to future results.

1661. *Efflorescence.* The flowering of the plant, like the leafing, seems to depend upon the degree of temperature induced by the returning spring, as the flowers are also protruded pretty regularly at the same successive periods of the season. The mezereon and snowdrop protrude their flowers in February; the primrose in the month of March; the cowslip in April; the great mass of plants in May and June; many in July, August, and September; some not till the month of October, as the meadow saffron; and some not till the approach or middle of winter, as the laurustinus and arbutus. Such at least is the period of their flowering in this country; but in warmer climates they are earlier, and in colder climates they are later. Between the tropics, where the degree of heat is always high, it often happens that plants will flower more than once in the year; because they do not there require to wait till the temperature is raised to a certain height, but merely till the developement of their parts can be effected in the regular operation of nature, under a temperature already sufficient. For the greater part, however, they flower during our summer, though plants in opposite hemispheres flower in opposite seasons. But in all climates the time of flowering depends also much on the altitude of place, as well as on other causes affecting the degree of heat. Hence plants occupying the polar regions, and plants occupying the tops of the high mountains of southern latitudes, are in flower at the same season; and hence the same flowers are later in opening in North America than in the same latitudes in Europe, because the surface of the earth is higher, or the winters more severe.

1662. *Maturation of the fruit.* Plants exhibit as much diversity in the warmth and length of time necessary to mature their fruit, as in their frondescence and flowering; but the plant that flowers the soonest does not always ripen its fruit the soonest. The hazel tree, which blows in February, does not ripen its fruit till autumn; while the cherry, which does not blow till May, ripens its fruit in June. It may be regarded, however, as the general rule, that if a plant blows in spring, it ripens its fruit in summer, as in the case of the currant and gooseberry; if it blows in summer, it ripens its fruit in autumn, as in the case of the vine; and if it blows in autumn, it ripens its fruit in winter: but the meadow-saffron, which blows in the autumn, does not ripen its fruit till the succeeding spring.

1663. Such are the primary facts on which a *Calendàrium Flòræ* should be founded. They have not hitherto been minutely attended to by botanists; and perhaps their importance is not quite so great as has been generally supposed; but they are at any rate sufficiently striking to have attracted the notice even of savages. Some tribes of American Indians act upon the very principle suggested by Linnæus, and plant their corn when the wild plum blooms, or when the leaves of the oak are about as large as a squirrel's ears. The names of some of their months are also designated from the state of vegetation. One is called the budding month, and another the flowering month; one the strawberry month, and another the mulberry month; and the autumn is designated by a term signifying the fall of the leaf. Thus the proposed nomenclature of the French for the months and seasons was founded in nature as well as in reason.

1664. *Cold.* As the elevation of temperature induced by the heat of summer is essential to the full exertion of the energies of the vital principle, so the depression of temperature consequent upon the colds of winter has been thought to suspend the exertion of the vital energies altogether. But this opinion is evidently founded on a mistake, as is proved by the example of those plants which protrude their leaves and flowers in the winter season only, such as many of the mosses; as well as by the dissection of the yet unfolded buds at different periods of the winter, even in the case of such plants as protrude their leaves and blossoms in the spring and summer, in which, it has been already shown, there is a regular, gradual, and incipient developement of parts, from the time of the bud's first appearance till its ultimate opening in the spring. The sap, it is true, flows much less freely, but is not wholly stopped. Du Hamel planted some young trees in the autumn, cutting off all the smaller fibres of the root, with a view to watch the progress of the formation of new ones. At the end of every fortnight he had the plants taken up and examined with all possible care to prevent injuring them, and found that, when it did not actually freeze, new roots were uniformly developed.

1665. *Energies of life in plants like the process of respiration in animals.* Hence it follows, that even during the period of winter, when vegetation seems totally at a stand, the tree being stripped of its foliage, and the herb apparently withering in the frozen blast, still the energies of vital life are exerted; and still the vital principle is at work, carrying on in the interior of the plant, concealed from human view, and sheltered from the piercing frosts, operations necessary to the preservation of vegetable life, or protrusion of future parts; though it requires the returning warmth of spring to give that degree of velocity to the juices which shall render their motion cognizable to man, as well as that expression to the whole plant which is the most evident token of life: in the same manner as the processes of respiration, digestion, and the circulation of the blood are carried on in the animal subject even while asleep; though the most obvious indications of animal life are the motions of the animal when awake. Heat then acts as a powerful stimulus to the operations of the vital principle, accelerating the motion of the sap, and consequent developement of parts; as is evident from the sap's beginning to flow much more copiously as the warmth of spring advances, as well as from the possibility of anticipating the natural period of their developement by forcing them in a hot-house. But it is known that excessive heat impedes the progress of vegetation as well as excessive cold; both extremes being equally prejudicial. Hence the sap flows more copiously in the spring and autumn than in either the summer or winter; as may readily be seen by watching the progress of the growth of the annual shoot, which, after having been rapidly protruded in the spring, remains for a while stationary during the great heat of the summer, but is again elongated during the more moderate temperature of autumn.

1666. *Artificial stimulants.* There are also several substances which have been found to operate as stimulants to the agency of the vital principle, when artificially dissolved in water, and applied to the root or branch. Oxygenated muriatic acid has been already mentioned: and the vegetation of the bulbs of the hyacinth and narcissus is accelerated by means of the application of a solution of nitre. Dr. Barton of Philadelphia found that a decaying branch of Liriodéndron tulipífera, and a faded flower of the yellow iris, recovered and continued long fresh when put into water impregnated with camphor; though flowers and branches, in all respects similar, did not recover when put into common water.

1667. *Irritability.* Plants are not only susceptible of the action of the natural stimuli of light and heat, exciting them gradually to the exercise of the functions of their different organs in the regular progress of vegetation; they are susceptible also of the action of a variety of accidental or artificial stimuli, from the application of which they are found to give indications of being endowed also with a property similar to what we call irritability in the animal system. This property is well exemplified in the genus *Mimòsa;* particularly in that species known by the name of the *Sensitive Plant;* in the Dionæ̀a *m*uscípula, and in the Drósera. But sometimes the irritability resides in the flower, and has its seat either in the stamens or style. The former case is exemplified in the flower of the berberry and Cáctus *Tùna*, and the latter in Stylídium glandulòsum.

1668. *Sensation.* From the facts adduced in the preceding sections, it is evident that plants are endowed with a capacity of being acted upon by the application of stimuli, whether natural or artificial, indicating the existence of a vital principle, and forming one of the most prominent features of its character. But besides this obvious and acknowledged property, it has been thought by some phytologists that plants are endowed also with a species of *sensation.* Sir J. E. Smith seems rather to hope that the doctrine may be true, than to think it so.

1669. *Instinct.* There are also various phenomena exhibited throughout the extent of the vegetable kingdom, some of which are common to plants in general, and some peculiar to certain species, which have been thought by several botanical writers to exhibit indications, not merely of sensation, but of *instinct.* The tendency of plants to incline their stem and to turn the upper surface of their leaves to the light, the direction which the extreme fibres of the root will often take to reach the best nourishment, the folding up of the flower on the approach of rain, the rising and falling of the water lily, and the peculiar and invariable direction assumed by the twining stem in ascending its prop, are among the phenomena which have been attributed to instinct. Keith has endeavoured (*Lin. Trans.* xi. p. 11.) to establish the doctrine of the existence and agency of an instinctive principle in the plant, upon the ground of the direction invariably assumed by the radicle and plumelet respectively, in the germination of the seed.

1670. *Definition of the plant.* But if vegetables are living beings endowed with sensation and instinct, or any thing approaching to it, so as to give them a resemblance to animals, how are we certainly to distinguish the plant from the animal? At the extremes of the two kingdoms the distinction is easy; the more perfect animals can never be mistaken for plants, nor the more perfect plants for animals; but at the mean, where the two kingdoms may be supposed to unite, the shades of discrimination are so very faint or evanescent that of some individual productions it is almost impossible to say to which of the kingdoms they belong. Hence it is that substances which have at one time been classed among plants, have at another time been classed among animals; and there are substances to be met with whose place has not yet been satisfactorily determined. Of these may be mentioned the genus *Corallìna* (*fig.* 199.), which Linnæus placed among

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animals, but which Gærtner places among plants. Linnæus, Bonnet, Hedwig, Mirbel, and Link, have each given particular definitions. According to Link, a plant is a compound organic body, deriving nourishment from the soil in which it grows. According to Keith, a vegetable is an organised and living substance springing from a seed or gem, which it again produces; and effecting the developement of its parts by means of the intro-susception and assimilation of unorganised substances which it derives from the atmosphere or the soil in which it grows. The definition of the animal is the counterpart: an animal is an organised and living being proceeding from an egg or embryo, which it again produces, and effecting the developement of its parts by means of the intro-susception of organised substances or their products. For all practical purposes, perhaps plants may be distinguished from animals with sufficient accuracy by means of the trial of burning; as animal substances in a state of ignition exhale a strong and phosphoric odour, which vegetable substances do not.

Chap. V.

Vegetable Pathology, or the Diseases and Casualties of Vegetable Life.

1671. As plants are, like animals, organised and living beings, they are, like animals, also liable to such *accidental injuries and disorders* as may affect the health and vigour, or occasion the death, of the individual. These are wounds, accidents, diseases, and natural decay.

Sect. I. *Wounds and Accidents.*

1672. *A wound* is a forcible separation of the solid parts of the plant effected by means of some external cause, intentional or accidental.

1673. *Incisions* are sometimes necessary to the health of the tree, in the same manner, perhaps, as bleeding is necessary to the health of the animal. The trunks of the plum and cherry tree seldom expand freely till a longitudinal incision has been made in the bark; and hence this operation is often practised by gardeners. If the incision affects the epidermis only, it heals up without leaving any scar; if it penetrates into the interior of the bark, it heals up only by means of leaving a scar; if it penetrates into the wood, the wound in the wood itself never heals up completely, but new wood and bark are formed above it as before.

1674. *Boring* is an operation by which trees are often wounded for the purpose of making them part with their sap in the season of their bleeding, particularly the birch tree and American maple. A horizontal, or rather slanting, hole is bored in them with a wimble, so as penetrate an inch or two into the wood; from this the sap flows copiously; and though a number of holes are often bored in the same trunk, the health of the tree is not very materially affected. For trees will continue to thrive, though subjected to this operation for many successive years; and the hole, if not very large, will close up again like the deep incision, not by the union of the broken fibres of the wood, but by the formation of new bark and wood projecting beyond the edge of the orifice, and finally shutting it up altogether.

1675. *Girdling* is an operation to which trees in North America are often subjected, when the farmer wishes to clear his land of timber. It consists in making parallel and horizontal incisions with an axe into the trunk of a tree, and carrying them quite round the stem, so as to penetrate through the *alburnum*, and then to scoop out the intervening portion. If this operation is performed early in the spring, and before the commencement of the bleeding season, the tree rarely survives it; though some trees that are peculiarly tenacious of life, such as A'cer saccharinum and Nýssa integrifòlia, have been known to survive it a considerable length of time.

1676. *Fracture.* If a tree is bent so as to fracture part only of the cortical and woody fibres, and the stem or branch but small, the parts will again unite by being put back into their natural position, and well propped up. Especially cure may be expected to succeed if the fracture happens in the spring; but it will not succeed if the fracture is accompanied with contusion, or if the stem or branch is large; and even where it succeeds the woody fibres do not contribute to the union, but the granular and herbaceous substance only, which exudes from between the wood and liber, insinuating itself into all interstices, and finally becoming indurated into wood.

1677. *Pruning.* Wounds are necessarily inflicted by the gardener or forester in pruning or lopping off the superfluous branches; but this is seldom attended with any bad effects to the health of the tree, if done by a skilful practitioner: indeed, no further art is required, merely for the protection of the tree, beyond that of cutting the branch through in a sloping direction, so as to prevent the rain from lodging. In this case the wound soon closes up by the induration of the exposed surface of the section, and by the protrusion of a granular substance, forming a sort of circular lip between the wood and bark; and hence the branch is never elongated by the growth of the same vessels that have been cut, but by the protrusion of new huds near the point of section.

1678. *Grafting.* In the operation of grafting there is a wound both of the stock and graft, which are united, not by the immediate adhesion of the surfaces of the two sections, but by means of a granular and herbaceous substance exuding from between the wood and bark, and insinuating itself as a sort of cement into all open spaces: new wood is finally formed within it, and the union is complete.

1679. *Felling* is the operation of cutting down trees close to the ground, which certain species will survive, if the stump be protected from the injuries of animals, and the root fresh and vigorous. In this case the fibres of the wood are never again regenerated, but a lip is formed as in the case of pruning; and buds, which spring up into new shoots, are protruded near the section; so that from the old shoot, ten, twelve, or even twenty, new stems may issue, according to its size and vigour. The stools of the oak and ash tree will furnish good examples; but there are some trees, such as the pine and fir tribe, which never send out any shoots after the operation of felling. The frankincense pine is said to be an exception; but any specimens we have seen do not incline us to the belief of such an anomaly.

1680. *If buds are destroyed* in the course of the winter, or in the early part of the spring, many plants will again generate new buds, which will develope their parts as the others would have done, except that they never contain blossom or fruit. Du Hamel thought these buds sprang from preorganised germs, which he conceived to be dispersed throughout the whole of the plant; but Knight thinks he has discovered the true source of the regeneration of buds, in the proper juice that is lodged in the alburnum. Buds thus regenerated never contain or produce either flower or fruit; perhaps because the fruit-bud requires more time to develope its parts, or a peculiar and higher degree of elaboration; and that this hasty production is only the effect of a great effort of the vital principle for the preservation of the individual, and one of those wonderful resources to which nature always knows how to resort when the vital principle is in danger. But though such buds do not produce flowers directly, as in the case of plants which bear their blossoms on last year's wood; yet they often produce young shoots which produce blossoms and fruit the same season, as in the case of cutting down an old vine or pruning the rose.

1681. Sometimes the *leaves of a tree are destroyed* partially or totally as soon as they are protruded from the bud, whether by the depredations of caterpillars or other insects, or by the browsing of cattle. But if the injury is done early in the spring, new leaves will be again protruded without subsequent shoots. Some trees will bear to be stripped even more than once in a season, as is the case with the mulberry tree, which is cultivated in the south of France and Italy for the purpose of feeding the silkworm; but if it be stripped more than once in the season, it requires now and then a year's rest.

1682. *The decortication* of a tree, or the stripping it of its bark, may be either intentional or accidental, partial or total. If it is partial, and affects the epidermis only, then it is again regenerated, as in the case of slight incision, without leaving any scar. But if the epidermis of the petal, leaf, or fruit is destroyed, it is not again regenerated, nor is the wound healed up, except by means of a scar. Such is the case also with all decortications that penetrate deeper than the epidermis, particularly if the wound is not protected from the action of the air. If the decortication reaches to the wood, then new bark issues from between the bark and wood, and spreads till it covers the wound. But the result is not the same when the wound is covered from the air. In the season of the flowing of the sap Du Hamel detached a ring of bark of three or four inches in breadth, from the trunks of several young elm trees, taking care to defend the decorticated part from the action of the air, by surrounding it with a tube of glass cemented above and below to the trunk. After a few days the tubes became cloudy within, particularly when it was hot; but when the air became cool, the cloud condensed and fell in drops to the bottom. At last there began to appear, as if exuding from between the bark and wood of the upper part of the wound, a sort of rough scurfy substance; and on the surface of the wood, as if exuding from between the longitudinal fibres of the alburnum, a number of gelatinous drops. They were not connected with the scurfy substance at the top, but seemed to arise from small slips of the liber that had not been completely detached. Their first appearance was that of small reddish spots changing by degrees into white, and finally into a sort of grey, and extending in size till they at last united and formed longitudinal ridges, which constituted a new bark.

1683. *Abortion or failure in the produce* of flowers, fruits, or of perfect seeds, is generally the effect of accidental injuries, either directly to the flower or fruit, by which they are rubbed off or devoured by insects; or to the leaves by insects; or to the roots by exposure to the air or cutting off so much of them as essentially to lessen their power of drawing up nourishment. Other causes will readily suggest themselves; and one of the commonest, as to seeds and fruits, is want of sufficient impregnation.

1684. *Premature flowering or fruiting* is sometimes brought on by insects, but more generally by checks produced by cold, or injuries from excessive heat, or long-continued drought. Fruit is often ripened prematurely by the puncture of insects; and a pine-apple plant of almost any age may be thrown into fruit by an hour or two's exposure to a frosty atmosphere in winter, or by scorching the roots in an overhot tan-bed at any season.

Sect. II. *Diseases.*

1685. *Diseases* are corrupt affections of the vegetable body, arising from a vitiated state of its juices, and tending to injure the habitual health either of the whole or part of the plant. The diseases which occur the most frequently among vegetables are the following: — Blight, smut, mildew, honey-dew, dropsy, flux of juices, gangrene, etiolation, suffocation, contortion, consumption.

1686. *Blight.* Much has been written on the nature of blight; and in proportion as words have been multiplied on the subject, the difficulties attending its elucidation have increased.

1687. *The blight, or blast,* was well known to the ancient Greeks, who were, however, totally ignorant of its cause, regarding it merely as a blast from heaven, indicating the wrath of their offended deities, and utterly incapable of prevention or cure. It was known also to the Romans under the denomination of *rubìgo,* who regarded it in the same light as the Greeks, and even believed it to be under the direction of a particular deity, Rubìgus, whom they solemnly invoked that blight might be kept from corn and trees. It is still well known from its effects to every one having the least knowledge of husbandry or gardening; but it has been very differently accounted for: and, perhaps, there is no one cause that will account for all the different cases of blight, or disease going by the name of blight; though they have been supposed to have all the same origin. If we take the term in its most general acceptation, it will include at least four distinct species, — blight originating in cold and frosty winds; blight originating in a sort of sultry and pestilential vapour; blight originating from want of nourishment; and blight originating in the immoderate propagation of a sort of small and parasitical fungus.

1688. *Blight originating in cold and frosty winds,* is often occasioned by the cold and easterly winds of spring, which nip and destroy the tender shoots of the plant, by stopping the current of the juices. The leaves which are thus deprived of their due nourishment wither and fall, and the juices which are now stopped in their passage swell and burst the vessels, and become the food of innumerable little insects which soon after make their appearance. Hence they are often mistaken for the cause of the disease itself; the farmer supposing they are wafted to him on the east wind, while they are only generated in the extravasated juices as forming a proper nidus for their eggs. Their multiplication will no doubt contribute to the spread of the disorder, as they always breed fast where they find plenty of food. But a similar disease is often occasioned by the early frost of spring. If the weather is prematurely mild, the blossom is prematurely protruded, which, though it is viewed by the unexperienced with delight, yet it is viewed by the judicious with fear. For it very often happens that this premature blossom is totally destroyed by subsequent frosts, as well as both the leaves and shoots, which consequently wither and fall, and injure if they do not actually kill the plant. This evil is also often augmented by the unskilful gardener, even in attempting to prevent it; that is, by matting up his trees too closely, or by keeping them covered in the course of the day, and thus rendering the shoots so tender that they can scarcely fail to be destroyed by the next frost.

1689. *Blight, originating in sultry and pestilential vapour,* generally happens in the summer, when the grain has attained to its full growth, and when there are no cold winds or frosts to occasion it. Such was the blight that used to damage the vineyards of ancient Italy, and which is yet found to damage our hop-plantations and wheat-crops. The Romans observed that it generally happened after short but heavy showers occurring about noon, and followed by clear sunshine, about the season of the ripening of the grapes, and that the middle of the vineyard suffered the most. This corresponds pretty nearly to what is in this country called the fire-blast among hops, which has been observed to take place most commonly about the end of July, when there has been rain with a hot gleam of sunshine immediately after; the middle of the hop-ground is also the most affected, whether the blight is general or partial, and is almost always the point in which it originates. In a particular case which was minutely observed, the damage happened a little before noon, and the blight ran in a line forming a right angle with the sunbeams at that time of the day. There was but little wind, which was, however, in the line of the blight. (*Hale's Body of Husbandry.*) Wheat is also affected with a similar sort of blight, and about the same season of the year, which totally destroys the crop. In the summer of 1809, a field of wheat, on rather a light and sandy soil, came up with every appearance of health, and also into ear with a fair prospect of ripening well. About the beginning of July it was considered as exceeding any thing expected from such a soil. A week afterwards a portion of the crop on the east side of the field, to the extent of several acres, was totally destroyed; being shrunk and shrivelled up to less than one half the size of what it had formerly been, and so withered and blasted as not to appear to belong to the same field. The rest of the field produced a fair crop.

1690. *Blight from want of nourishment* may happen to all plants, wild or cultivated; but it is most commonly met with in corn fields, in very dry seasons, in those thin gravelly surfaces which do not sufficiently retain the moisture. In such spots the plants are thrown prematurely into blossom, and the ear or seed-pod ripens before it is filled. In England the farmers call this the white blight.

1691. *Blight, originating in Fúngi,* attacks the leaves or stems both of herbaceous and woody plants, such as *Euphórbia Cyparíssias, Bérberis vulgàris,* and *Rhámnus cathárticus*; but more generally grasses, and particularly our most useful grains, wheat, barley, and oats. It always appears in the least ventilated parts of a field, and has generally been preceded by cold, moist weather, which, happening in the warm month of July, suddenly chills and checks vegetation. It generally assumes the appearance of a rusty-looking powder, that soils the finger when touched. In March, 1807, some blades of wheat attacked with this species of blight were examined by Keith; the appearance was that of a number of rusty-looking spots or patches dispersed over the surface of the leaf, exactly like that of the seeds of dorsiferous ferns bursting their indusium. Upon more minute inspection, these patches were found to consist of thousands of small globules collected into groups beneath the epidermis, which they raised up in a sort of blister, and at last burst. Some of the globules seemed as if embedded even in the longitudinal vessels of the blade. They were of a yellowish or rusty brown, and somewhat transparent. But these groups of globules have been ascertained by Sir J. Banks to be patches of a minute fungus, the seeds of which, as they float in the air, enter the pores of the epidermis of the leaf, particularly if the plant is sickly; or they exist in the manure or soil, and enter by the pores of the root. (*Sir J. Banks on Blight,* 1805.) This fungus has been figured by Sowerby, and by F. Bauer and Grew. It is known among farmers by the name of red rust, and chiefly affects the stalks and leaves. But there is another species of fungus known to the farmer by the name of red gum, which attacks the ear only, and is extremely prejudicial. In the aggregate it consists of groups of minute globules interspersed with transparent fibres. The globules are filled with a fine powder, which explodes when they are put into water. It is very generally accompanied with a maggot of a yellow colour, which preys also upon the grain, and increases the amount of injury.

1692. The only means of preventing or lessening the effect of any of the different varieties of blight mentioned is proper culture. Palliatives are to be found in topical applications, such as flower of sulphur, and where the disease proceeds from, or consists of, innumerable minute insects, it may occasionally be removed. Grisenthwaite conjectures that in many cases in which the blight and mildew attack corn-crops, it may be for want of the peculiar food requisite for perfecting the grain; it being known that the fruit or seeds of many plants contain primitive principles not found in the rest of the plant. Thus the grain of wheat contains gluten and phosphate of lime, and where these are wanting in the soil, that is, in the manured earths in which the plant grows, it will be unable to perfect its fruit, which of consequence becomes more liable to disease. (*New Theory of Agr.*)

1693. *Smut* is a disease incidental to cultivated corn, by which the farina of the grain, together with its proper integuments and even part of the husk, is converted into a black soot-like powder. If the injured ear be struck with the finger, the powder will be dispersed like a cloud of black smoke; and if a portion of the powder be wetted by a drop of water and put under the microscope, it will be found to consist of millions of minute and transparent globules, which seem to be composed of a clear and glairy fluid encompassed by a thin and skinny membrane. This disease does not affect the whole body of the crop, but the smutted ears are sometimes very numerously dispersed throughout it. Some have attributed it to the soil in which the grain is sown, and others have attributed it to the seed itself, alleging that smutted seed will produce a smutted crop: but in all this there seems to be a great deal of doubt. Willdenow regards it as originating in a small fungus, which multiplies and extends till it occupies the whole ear (*Princip. of Bot.* p. 356.): but F. Bauer of Kew seems to have ascertained it to be merely a morbid swelling of the ear, and not at all connected with the growth of a fungus. (*Smith's Introd.* p. 282.) It is said to be prevented by steeping the grain, before sowing, in a weak solution of arsenic. But, besides the disease called smut, there is also a disease analogous to it, or a different stage of the same disease, known to the farmer by the name of bags or smut balls, in which the nucleus of the seed only is converted into a black powder, whilst the ovary, as well as the husk, remains sound. The ear is not much altered in its external appearance, and the diseased grain contained in it will even bear the operation of threshing, and consequently mingle with the bulk: but it is always readily detected by the experienced buyer, and fatal to the character of the sample. It is said to be prevented as in the case of smut.

1694. *Mildew* is a thin and whitish coating with which the leaves of vegetables are sometimes covered, occasioning their decay and death, and injuring the health of the plant. It is frequently found on the leaves of *T*ussilàgo *F*árfara, Hùmulus Lùpulus, *C*órylus avellàna, and the white and yellow dead-nettle. It is found also on wheat in the shape of a glutinous exudation, particularly when the days are hot and the nights without dew. J. Robertson (*Hort. Trans.* v. 178.) considers it as a minute fungus of which different species attack different plants. Sulphur he has found to be a specific cure. In cultivated crops mildew is said to be prevented by manuring with soot; though by some this is denied, and soot, by rendering the crop more luxuriant, is said to be an encourager of mildew, the richest parts of a field being always most infected by it. As it is least common in airy situations, thinning and ventilation may be considered as preventives.

1695. *Honey-dew* is a sweet and clammy substance which coagulates on the surface of the leaves during hot weather, particularly on the leaves of the oak tree and beech, and is regarded by Curtis as being merely the dung of some species of aphides. This seems to be the opinion of Willdenow also, and it is no doubt possible that it may be the case in some instances or species of the disease: but Sir J. E. Smith contends that it is not always so, or that there are more species of honey-dew than one, regarding it particularly as being an exudation, at least in the case of the beech, whose leaves are, in consequence of an unfavourable wind, apt to become covered with a sweet sort of glutinous coating, similar in flavour to the fluid obtained from the trunk.

1696. It is certain, however, that *saccharine exudations are found on the leaves of many plants*, though not always distinguished by the name of honey-dew; which should not perhaps be applied except when the exudation occasions disease. But if it is to be applied to all saccharine exudations whatever, then we must include under the appellation of honey-dew, the saccharine exudations observed on the orange tree by De la Hire, together with that of the lime tree which is more glutinous, and of the poplar which is more resinous; as also that of the Cistus créticus, and of the manna which exudes from the ash tree of Italy and larch of France. It is also possible that the exudation or excrement constituting honey-dew may occasionally occur without producing disease; for if it should happen to be washed off soon after by rains or heavy dews, then the leaves will not suffer. Washing is therefore the palliative; judicious culture the preventive.

1697. *Dropsy.* Plants are also liable to a disease which affects them in a manner similar to that of the dropsy in animals, arising from long-continued rain or too abundant watering. Willdenow describes it as occasioning a preternatural swelling of particular parts, and inducing putrefaction. It is said to take place chiefly in bulbous and tuberous roots, which are often found much swelled after rain. It affects fruit also, which it renders watery and insipid. It prevents the ripening of seeds, and occasions an immoderate production of roots from the stem.

1698. *In succulent plants* this disease generally appears in consequence of excessive waterings, and is for the most part incurable. The leaves drop, even though plump and green; and the fruit rots before reaching maturity. In this case the absorption seems to be too great in proportion to the transpiration; but the soil when too much manured produces similar effects. Du Hamel planted some elms in a soil that was particularly well manured, and accordingly they pushed with great vigour for some time; but at the end of five or six years they all died suddenly. The bark was found to be detached from the wood, and the cavity filled up with a reddish-coloured water. The symptoms of this disease suggest the palliatives; and the preventive is ever the same — judicious culture.

1699. *Flux of juices.* Some trees, but particularly the oak and birch, are liable to a great loss of sap, which bursts out spontaneously, owing to its superabundance, or issues from accidental wounds: sometimes it is injurious to the health of the plant, and sometimes not.

1700. There is a *spontaneous extravasation* of the sap of the vine, known by the name of the tears of the vine, which is not always injurious. As it often happens that the root imbibes sap, which the leaves are not yet prepared to throw off, because not yet sufficiently expanded, owing to an inclement season, the sap which is first carried up, being propelled by that which follows, ultimately forces its way through all obstructions, and exudes from the bud. But this is observed only in cold climates; for in hot climates, where the developement of the leaves is not obstructed by cold, they are ready to elaborate the sap as soon as it reaches them. There is also a spontaneous extravasation of proper juice in some trees, which does not seem in general to be injurious to the individual. Thus the gum which exudes from cherry, plum, peach, and almond trees is seldom detrimental to their health, except when it insinuates itself into the other vessels of the plant and occasions obstructions.

1701. But *the exudation of gum* is sometimes a disease, and one for which there is seldom any remedy. It is generally the consequence of an unsuitable soil, situation, or climate. Cold raw summers will produce it in the peach, apricot, and more tender sorts of plum and cherry; or grafting these fruits on diseased stocks. Cutting out the part and applying a covering of loam, or tar and charcoal, to exclude the air, are palliatives; but the only effectual method, where it can be practised, is to take up the tree and place it in a suitable soil and situation.

1702. *The extravasation and corruption* of the ascending or descending juices, have been known to occasion a fissure of the solid parts. Sometimes the fissure is occasioned by means of frost, and forms what is called a double alburnum; that is, first a layer that has been injured by the frost, and then a layer that passes into wood. Sometimes a layer is partially affected, and that is generally owing to a sudden and partial thaw on the south side of the trunk, which may be followed again by a sudden frost. In this case the alburnum is split into clefts or chinks, by means of the expansion of the frozen sap.

1703. *Chilblains.* But clefts thus occasioned often degenerate into chilblains which discharge a blackish and acrid fluid, to the great detriment of the plant, particularly if the sores are so situated that rain or snow will readily lodge in them and become putrid. The same injury may be occasioned by the bite or puncture of insects while the shoot is yet tender; and as no vegetable ulcer heals up of its own accord, the sooner a cure is attempted the better, as it will, if left to itself, ultimately corrode and destroy the whole plant, bark, wood, and pith. The only palliative is the excision of the part affected, and the application of a coat of grafting wax. (*Willdenow*, p. 354.)

1704. *Gangrene.* Of this disorder there are two varieties, the dry and the wet. The former is occasioned by means of excessive heat or excessive cold. If by means of cold, it attacks the leaves of young shoots, and causes them to shrink up, converting them from green to black; as also the inner bark, which it blackens in the same manner, so that it is impossible to save the plant except by cutting it to the ground. If by means of heat, the effects are nearly similar, as may oftentimes be seen in gardens, or even in forests, where the foresters are allowed to clear away the moss and withered leaves from the roots. Sometimes the disease is occasioned by the too rapid growth of a particular branch, depriving the one that is next it of its due nourishment, and hence inducing its decay. Sometimes it is occasioned by means of parasitical plants, as in the case of the bulbs of the saffron, which a species of Lycopérdon often attaches itself to and totally corrupts.

1705. *Dry gangrene.* The harmattan winds of the coast of Africa kill many plants, by means of inducing a sort of gangrene which withers and blackens the leaves, and finally destroys the whole plant. The nopal of Mexico is also subject to a sort of gangrene which begins with a black spot, and extends till the whole leaf or branch rots off, or the plant dies. But plants are sometimes affected with a gangrene by which a part becomes first soft and moist, and then dissolves into foul ichor. This is confined chiefly to the leaves, flowers, and fruit. Sometimes it attacks the roots also, but rarely the stem. It seems to be owing, in many cases, to too wet or too rich a soil; but it may originate in contusion, and may be caught by infection. But the nopal is subject also to a disease called by Thierry *la dissolution*, considered by Sir J. E. Smith, as distinct from gangrene, and which appears to be Willdenow's dry gangrene. A joint of the nopal, or a whole branch, and sometimes an entire plant, changes in the space of a single hour from a state of apparent health to a state of putrefaction or dissolution. Now its surface is verdant and shining, and in an instant it changes to a yellow, and its brilliancy is gone. If the substance is cut into, the parts are found to have lost all cohesion, and are quite rotten. The attempt at a cure is by speedy amputation below the diseased part. Sometimes the vital principle, collecting and exerting all its energies, makes a stand as it were against the encroaching disease, and throws off the infected part. (*Smith's Introduction*, p. 276., edit. 6.)

1706. *Etiolation.* Plants are sometimes affected by a disease which entirely destroys their verdure, and renders them pale and sickly. This is called *etiolation*, and may arise merely from want of the agency of light, by which the extrication of oxygen is effected, and the leaf rendered green. Hence it is that plants placed in dark rooms, or between great masses of stone, or in the clefts of rocks, or under the shade of other trees, look always peculiarly pale. But if they are removed from such situations, and exposed to the action of light, they will again recover their green colour. Etiolation may also ensue from the depredations of insects nestling in the radicle, and consuming the food of the plant, thus debilitating the vessels of the leaf so as to render them insusceptible of the action of light. This is said to be often the case with the radicles of *S*ecàle cereàle; and the same result may also arise from poverty of soil.

1707. *Suffocation.* Sometimes it happens that the pores of the epidermis are closed up, and transpiration consequently obstructed, by means of some extraneous substance which attaches itself to, and covers, the bark. This obstruction induces disease, and the disease is called *suffocation.*

1708. Sometimes it is occasioned *by the immoderate growth of lichens* upon the bark, covering the whole of the plant, as may be often seen in fruit trees, which it is necessary to keep clean by means of scraping off the lichens, at least from the smaller branches. For if the young branches are thus coated, so as that the bark cannot perform its proper functions, the tree will soon begin to languish, and will finally become covered with fungi, inducing or resulting from decay, till it is at last wholly choked up.

1709. But a similar effect is also occasionally produced *by insects*, in feeding upon the sap or shoot. This may be exemplified in the case of the aphides, which sometimes breed or settle upon the tender shoot in such multitudes as to cover it from the action of the external air altogether. It may be exemplified also in the case of Cóccus *h*espéridum and *A*'carus telàrius, insects which infest hot-house plants, the latter by spinning a fine and delicate web over the leaf, and thus preventing the access of atmospheric air. Insects are to be removed either by the hand or other mechanical means, or destroyed by excess of some of the elements of their nutrition, as heat, cold, or moisture, where such excess does not prove injurious to the plant; or by a composition, either fluid or otherwise, which shall have the same effects. Prevention is to be attempted by general culture, and particular attention to hinder the propagation of the insects or vermin, whether oviparous or otherwise, by destroying their embryo progeny.

1710. Sometimes the disease is occasioned *by an extravasation of juices* which coagulate on the surface of the stalk, so as to form a sort of crust, investing it as a sheath, and preventing its farther expansion.

1711. Sometimes the disease arises *from want of an adequate supply of nourishment* as derived from the soil, in which case the lower part of the plant is the best supplied, while the upper part of it is starved. Hence the top shoots decrease in size every succeeding year, because a sufficient supply of sap cannot be obtained to give them their proper developement. This is analogous to the phenomena of animal life, when the action of the heart is too feeble to propel the blood through the whole of the system: for then the extremities are always the first to suffer. And perhaps it may account also for the fact, that in bad soils, and unfavourable seasons, when the ear of barley is not wholly perfected, yet a few of the lower grains are always completely developed. (*Smith's Introduction*, p. 279.)

1712. *Contortion.* The leaves of plants are often injured by means of the puncture of insects, so as to induce a sort of disease which discovers itself in the contortion or convolution of the margin, or wrinkled appearance of the surface. The leaves of the apricot, peach, and nectarine, are extremely liable to be thus affected in the months of June and July. The leaves of the apple are affected by the A`phis lanígera; those of the larch by another woolly aphis (A. larício); those of the hawthorn by a species of *T*enthrêdo, &c. (*See Major's Treatise on the Insects prevalent in Fruit Trees and Garden Produce.*)

1713. *The leaf* which has been punctured soon begins to assume a rough and wrinkled figure, and a reddish and scrofulous appearance, particularly on the upper surface. The margins roll inwards on the under side, and enclose the eggs which are scattered irregularly on the surface, giving it a blackish and granular appearance, but without materially injuring its health. In the vine, the substance deposited on the leaf is whitish, giving the under surface a sort of a frosted appearance, but not occasioning the red and scrofulous aspect of the upper surface of the leaf of the nectarine. In the poplar, the eggs when first deposited resemble a number of small and hoary vesicles containing a sort of clear and colourless fluid. The leaf then becomes reflected and conduplicated, enclosing the eggs, and exhibiting a few reddish protuberances on the upper surface. The embryo is nourished by this fluid; and the hoariness is converted into a fine cottony down, which for some time envelopes the young fly. The leaf of the lime tree in particular, when fully expanded, is liable to attacks from insects; and hence the gnawed appearance it so often displays. The injury seems to be occasioned by some species of puceron depositing its eggs in the parenchyma, generally about the angles that branch off from the midrib. A sort of down is produced, at first green, and afterwards hoary; sometimes in patches, and sometimes pervading the whole leaf; as in the case of the vine. Under this covering the egg is hatched; and then the young insect gnaws and injures the leaf, leaving a hole or scar of a burnt or singed appearance. Sometimes the upper surface of the leaf is covered with clusters of wart-like substances somewhat subulate and acute. They seem to be occasioned by means of punctures made in the under surface, on which a number of openings are discoverable, penetrating into the warts, which are hollow and villous within. The disease admits of palliation by watering frequently over the leaves; and by removing such as are the most contorted and covered by larvæ.

1714. *Consumption.* From barren or improper soil, unfavourable climes, careless planting, or exhaustion from too frequent flowering, it often happens that disease is induced which terminates in a gradual decline and wasting away of the plant, till at length it is wholly dried up. Sometimes it is also occasioned by excessive drought, or by dust lodging on the leaves, or by fumes issuing from neighbouring manufactories, or by the attacks of insects.

1715. There is *a consumptive affection* frequently attacking the pine tree (*Willdenow, Princ. Bot.* p. 351.), which affects the alburnum and inner bark chiefly, and seems to proceed from long-continued drought, or from frost suddenly succeeding mild or warm weather, or from heavy winds. The leaves assume a tinge of yellow, bordering upon red. A great number of small drops of resin, of a putrid odour, exude from the middle of the boughs. The bark exfoliates, and the alburnum presents a livid appearance: the tree swarms with insects (Dypterýgia pinástri *Steph.*), and the disease is incurable, inducing inevitably the total decay and death of the individual. The preventive is obviously good culture, so as to maintain vigorous health: palliatives may be employed, according to the apparent cause of the disease.

Sect. III. *Natural Decay.*

1716. Although a plant should not suffer from the influence of accidental injury, or from disease, still there will come a time when its several organs will begin to experience the approaches of *a natural decline* insensibly stealing upon it, and at last inducing death. The duration of vegetable existence is very different in different species. Yet in the vegetable, as well as in the animal kingdom, there is a term or limit set, beyond which the individual cannot pass. Some plants are annuals, and last for one season only, springing up suddenly from seed, attaining rapidly to maturity, producing and sowing their seeds, and afterwards immediately perishing. Such is the character of the various species of corn, as exemplified in oats, wheat, and barley. Some plants continue to live for a period of two years, and are therefore called biennials, springing up the first year from seed, and producing roots and leaves, but no fruit; and in the second year producing both flower and fruit, as exemplified in the carrot, parsnep, and caraway. Other plants are perennials, that is, lasting for many years; of which some are called undershrubs, and die down to the root every year; others are called shrubs, and are permanent both by the root and stem, but do not attain to a great height or great age; others are called trees, and are not only permanent by both root and stem, but attain to a great size, and live to a great age. But even of plants that are woody and perennial, there are parts which perish annually, or which are at least annually separated from the individual; namely, the leaves, flowers, and fruit, leaving nothing behind but the bare caudex, which submits in its turn to the ravages of time, and ultimately to death.

1717. *The decay of the temporary organs,* which takes place annually, is a phenomenon familiar to every body, and comprehends the fall of the leaf, the fall of the flower, and the fall of the fruit.

1718. *The fall of the leaf*, or annual defoliation of the plant, commences for the most part with the colds of autumn, and is accelerated by the frosts of winter, which strip the forest of its foliage, and the landscape of its verdure. But there are some trees which retain their leaves throughout the whole of the winter, though changed to a dull and dusky brown, and may be called *ever-clothed* trees, as the beech: and there are others which retain their verdure throughout the year, and are denominated evergreens, as the holly. The leaves of both sorts ultimately fall in the spring. Sir J. E. Smith considers that leaves are thrown off by a process similar to that of the sloughing of diseased parts in the animal economy; and Keith observes, that if it is necessary to illustrate the fall of the leaf by any analogous process in the animal economy, it may be compared to the shedding of the antlers of the stag, or of the hair of beasts or feathers of birds, which being, like the leaves of plants, distinct and peculiar organs, fall off, and are regenerated annually, but do not slough. According to Professor Vaucher every leaf consists of a distinct system of fibres, having only a temporary continuity with the shoot, kept up by an adhesive substance, probably formed by a portion of the parenchyma interposed between the two systems of fibres. While this parenchyma is under the influence of vegetable action the adhesion is maintained; when this action ceases the union is dissolved and the leaf falls.

1719. *The flowers*, which, like the leaves, are only temporary organs, are for the most part very short-lived; for as the object of their production is merely to effect the impregnation of the germs, that object is no sooner attained than they begin to give indications of decay, and speedily fall from the plant; so that the most beautiful part of the vegetable is also the most transient.

1720. *The fruit*, which begins to appear conspicuous when the flower falls, expands and increases in volume, and, assuming a peculiar hue as it ripens, ultimately detaches itself from the parent plant, and drops into the soil. But it does not in all cases detach itself in the same manner: thus, in the bean and pea the seed-vessel opens and lets the seeds fall out, while in the apple, pear, and cherry, the fruit falls entire, enclosing the seed, which escapes when the pericarp decays. Most fruits fall soon after ripening, as the cherry and apricot; but some remain long attached to the parent plant after being fully ripe, as in the case of the fruit of *Euónymus* and *Méspilus*. But these, as well as all others, though tenacious of their hold, detach themselves at last, and bury themselves in the soil, to give birth to a new individual in the germination of the seed. The fall of the flower and fruit is accounted for in the same manner as that of the leaf.

1721. *Decay of the permanent organs*. Such, then, is the process and presumptive rationale of the decay and detachment of the temporary organs of the plant. But there is also a period beyond which even the permanent organs themselves can no longer carry on the process of vegetation. Plants are affected by the infirmities of old age as well as animals, and are found to exhibit also similar symptoms of approaching dissolution. The root refuses to imbibe the nourishment afforded by the soil, or if it does imbibe a portion, it is but feebly propelled, and partially distributed, through the tubes of the alburnum; the elaboration of the sap is now effected with difficulty as well as the assimilation of the proper juice, the descent of which is almost totally obstructed; the bark becomes thick and woody, and covered with moss or lichens; the shoot becomes stunted and diminutive; and the fruits palpably degenerate, both in quantity and quality. The smaller or terminal branches fade and decay the first, and then the larger branches also, together with the trunk and root; the vital principle gradually declines without any chance of recovery, and is at last totally extinguished. "When life is extinguished, nature hastens the decomposition; the surface of the tree is overrun with lichens and mosses, which attract and retain the moisture; the empty pores imbibe it; and putrefaction speedily follows. Then come the tribes of fungi, which flourish on decaying wood, and accelerate its corruption; beetles and caterpillars take up their abode under the bark, and bore innumerable holes in the timber; and woodpeckers in search of insects pierce it more deeply, and excavate large hollows, in which they place their nests. Frost, rain, and heat assist, and the whole mass crumbles away, and dissolves into a rich mould." (*Dial. on Bot.* p. 365.)

Chap. VI.

Vegetable Geography and History, or the Distribution of Vegetables relatively to the Earth and to Man.

1722. *The science of the distribution of plants*, Humboldt observes (*Essai sur la Géographie des Plantes*, 1807), considers vegetables in relation to their local associations in different climates. It points out the grand features of the immense extent which plants occupy, from the regions of perpetual snow to the bottom of the ocean, and to the interior of the globe, where, in obscúre grottoes, cryptogamous plants vegetate, as unknown as the insects which they nourish. The superior limits of vegetation are known, but not the inferior; for every where in the bowels of the earth are germs which develope themselves when they find a space and nourishment suitable for vegetation. On taking a general view of the disposition of vegetables on the surface of the globe, independently of the influence of man, that disposition appears to be determined by two sorts of causes, *geographical* and *physical*. The influence of man, or of cultivation, has introduced a third cause, which may be called *civil*. The different aspects of plants, in different regions, have given rise to what may be called their *characteristic* or *picturesque distribution*; and the subject of distribution may be also considered relatively to the *systematic* divisions of vegetables, their *arithmetical* proportions, and *economical* applications.

Sect. I. *Geographical Distribution of Vegetables.*

1723. *The territorial limits to vegetation* are determined in general by three causes: — 1. By sandy deserts, which seeds cannot pass over either by means of winds or birds, as that of Sahara, in Africa; 2. By seas too vast for the seeds of plants to be drifted from one shore to the other, as in the ocean; while the Mediterranean sea, on the contrary, exhibits the same vegetation on both shores; and, 3. By long and lofty chains of mountains. To these causes are to be attributed the fact that similar climates and soils do not always produce similar plants. Thus in certain parts of North America, which altogether resemble Europe in respect to soil, climate, and elevation, not a single European plant is to be found. The same remark will apply to New Holland, the Cape of Good Hope, Senegal, and other countries, as compared with countries in similar physical circumstances, but geographically different. The separation of Africa and South America, Humboldt considers, must have taken place before the developement of organised beings, since scarcely a single plant of the one country is to be found in a wild state in the other.

Sect. II. *Physical Distribution of Vegetables.*

1724. *The natural circumstances* affecting the distribution of plants may be considered in respect to temperature, elevation, moisture, soil, and light.

1725. *Temperature* has the most obvious influence on vegetation. Every one knows that the plants of hot countries cannot in general live in such as are cold, and the contrary. The wheat and barley of Europe will not grow within the tropics. The same remark applies to plants of still higher latitudes, such as those within the polar circles, which cannot be made to vegetate in more southern latitudes; nor can the plants of more southern latitudes be made to vegetate there. In this respect, not only the medium temperature of a country ought to be studied, but the temperature of different seasons, and especially of winter. Countries where it never freezes, those where it never freezes so strongly as to stagnate the sap in the stems of plants, and those where it freezes with strength sufficient to penetrate into the cellular tissue, form three classes of regions in which vegetation ought to differ. But this difference is somewhat modified by the effect of vegetable structure, which resists, in different degrees, the action of frost. Thus, in general, trees which lose their leaves during winter resist the cold better than such as retain them; resinous trees, more easily than such as are not so; herbs of which the shoots are annual and the root perennial, better than those where the stems and leaves are persisting; annuals which flower early, and whose seeds drop and germinate before winter, resist cold less easily than such as flower late, and whose seeds lie dormant in the soil till spring. Monocotyledonous trees, which have generally persisting leaves and a trunk without bark, as in palms, are less adapted to resist cold than dicotyledonous trees, which are more favourably organised for this purpose, not only by the nature of their proper juice, but by the disposition of the cortical and alburnous layers, and the habitual carbonisation of the outer bark. Plants of a dry nature resist cold better than such as are watery; all plants resist cold better in dry winters than in moist winters; and an attack of frost always does most injury in a moist country, in a humid season, or when the plant is too copiously supplied with water.

1726. Some plants of firm texture, but *natives of warm climates, will endure a frost of a few hours' continuance*, as the orange at Genoa, (*Humboldt, De Distributione Plantarum*); and the same thing is said of the palm and pine-apple, facts most important for the gardener. Plants of delicate texture, and natives of warm climates, are destroyed by the slightest attack of frost, as the *Phaseolus*, *Nastúrtium*, &c.

1727. *The temperature of spring* has a material influence on the life of vegetables; the injurious effects of late frosts are known to every cultivator. In general, vegetation is favoured in cold countries by exposing plants to the direct influence of the sun; but this excitement is injurious in a country subject to frosts late in the season; in such cases, it is better to retard than to accelerate vegetation.

1728. *The temperature of summer*, as it varies only by the intensity of heat, is not productive of so many injurious accidents as that of spring. Very hot dry summers, however, destroy many delicate plants, and especially those of cold climates. A very early summer is injurious to the germination and progress of seeds; a short summer, to their ripening, and the contrary.

1729. *Autumn* is an important season for vegetation, as it respects the ripening of seeds; hence where that season is cold and humid, annual plants, which naturally flower late, are never abundant, as in the polar regions; the effect is less injurious to perennial plants, which generally flower earlier. Frosts early in autumn are as injurious as those which happen late in spring. The conclusion, from these considerations, obviously is, that temperate climates are more favourable to vegetation than such as are either extremely cold or extremely hot: but the warmer climates, as Keith observes, are more favourable, upon the whole, to vegetation than the colder, and that nearly in proportion to their distance from the equator. The same plants, however, will grow in the same degree of latitude, throughout all degrees of longitude, and also in correspondent latitudes on different sides of the equator; the same species of plants, as some of the palms and others, being found in Japan, India, Arabia, the West Indies, and part of South America, which are all in nearly the same latitudes; and the same species being also found in Kamschatka, Germany, Great Britain, and the coast of Labrador, which are all also in nearly the same latitudes. (*Willdenow, p.* 374.)

1730. *Rules for determining the temperature of a country.* " The fact that a degree of latitude is equal to a degree of Fahrenheit, and that 400 feet of elevation is equal also to a degree of Fahrenheit, is original and curious, and will go far to assist us in determining the clime of any country." (*Amer. Quart. Rev. March,* 1829. p. 174.)

1731. *The most remarkable circumstances respecting the temperature in the three zones* are exhibited in the following Table by Humboldt. The temperature is taken according to the centigrade thermometer. The fathom is 6 French feet, or 6·39453 English feet.

	Torrid zone.		Temperate zone.			Frigid zone.
	Andes of Quito, Lat. 0°.	Mountains of Mexico, Lat. 20°	Caucasus, Lat. 42°½.	Pyrenees, Lat. 42½°.	Alps, Lat. 45¼° to 46°	Lapland, Lat. 67° to 70°.
Inferior limit of perpetual snow	2460 fa.	2350 fa.	1650 fa.	1400 fa.	1370 fa.	550 fa.
Mean annual heat at that height	1½°.	—	—	3½°.	4°.	6°.
Mean heat of winter, do.	1⅓°.	—	—	—	10°.	20½°.
Mean heat of Aug. do.	1¾°.	—	—	—	6°.	9½°.
Distance between trees and snow	600 fa.	350 fa.	650 fa.	230 fa.	450 fa.	300 fa.
Upper limit of trees	1800 fa.	2000 fa.	1000 fa.	1170 fa.	920 fa.	250 fa.
Last species of trees towards the snow	Escalòn*ia* Alstòn*ia*.	*P*ìnus occident.	*B*étula álba	*A*bies rùbra	*A*bies commùnis	*B*étula álba.
Upper limit of the *E*ricíneæ	Bejàr*iæ*, 1600 fa.	—	*R*hodod. caucás. 1380 fa.	—	*R*hodod. ferrug. 1170 fa.	*R*hodod. lapónic. 480 fa.
Distance between the snow and corn	800 fa.	—	630 fa.	—	700 fa.	450 fa.

1732. *Elevation,* or the height of the soil above the level of the sea, determines, in a very marked manner, the habitation of plants. The temperature lessens in regular gradation, in the same manner as it does in receding from the equator, and 600 feet of elevation, Humboldt states, are deemed equal to one degree of latitude, and occasion a diminution of temperature equal to 23° of Fahrenheit; 300 feet being nearly equal to half a degree. Mountains 1000 fathoms in height, at 46° of latitude, have the mean temperature of Lapland; mountains of the same height between the tropics enjoy the temperature of Sicily; and the summits of the lofty mountains of the Andes, even where situated almost directly under the equator, are covered with snow as eternal as that of the north pole. The highest land in Scotland where corn has been found to attain maturity in favourable seasons is said to be at the mining ground on Lead Hills. (*See General Reports of Scotland,* chap. *Climate.*)

1733. Hence it is that *plants of high latitudes live on the mountains of such as are much lower,* and thus the plants of Greenland and Lapland are found on the Alps and Pyrenees. At the foot of Mount Ararat, Tournefort met with plants peculiar to Armenia; above these he met with plants which are found also in France; at a still greater height he found himself surrounded with such as grow in Sweden; and at the summit with such as vegetate in the polar regions. This accounts for the great variety of plants which are often found in a Flora of no great extent; and it may be laid down as a botanical axiom, that the more diversified the surface of the country, the richer will its Flora be, at least in the same latitudes. It accounts, also, in some cases, for the want of correspondence between plants of different countries, though placed in the same latitudes; because the mountains or ridges of mountains, which may be found in the one and not in the other, will produce the greatest possible difference in the character of their Floras. To this cause may generally be ascribed the diversity which often actually exists between plants growing in the same latitudes, as between those of the north-west and north-east coasts of North America, and also between those of the south-west and south-east coasts; the former being more mountainous, the latter more flat. Sometimes the same sort of difference takes place between the plants of an island and those of the neighbouring continent; that is, if the one is mountainous and the other flat; but if they are alike in their geographical delineation, then they are generally alike in their vegetable productions.

1734. *Cold and lofty situations are the favourite habitations of most cryptogamic plants* of the terrestrial class, especially the fungi, algæ, and mosses; as also of plants of the class Tetradynàmia, and of the Umbelliferous and Syngenesious tribes; whereas trees and shrubs, ferns, parasitic plants, lilies, and aromatic plants, are most abundant in warm climates: but this is not to be understood merely of geographical climates, because, as we have seen, the physical climate depends upon altitude; in consequence of which, combined with the ridges and directions of the mountains, America and Asia are much colder in the same degrees of northern latitude than Europe. American plants, vegetating at forty-two degrees of northern latitude, will vegetate very well at fifty-two degrees in Europe; the same, or nearly so, may be said of Asia; which, in the former case, is perhaps owing to the immense tracts of woods and marshes covering the surface, and in the latter, to the more elevated and mountainous situation of the country affecting the degree of temperature. So, also, Africa is much hotter under the tropics than America; because in the latter, the temperature is lowered by immense chains of mountains traversing the equatorial regions, while in the former it is increased by means of the hot and burning sands which cover the greater part of its surface.

1735. *Elevation influences the habits of plants in various ways:* by exposing them to the wind; by causing them to be watered by a very fresh and pure water from the melting of adjoining snow; and to be covered in winter by a thick layer of snow, which protects them from severe frosts. Hence many alpine plants become frozen during winter in the plains, and in gardens which are naturally warmer than their proper stations. In great elevations, the diminution of the density of the air may also have some influence on vegetation. The rarity of the atmosphere admits a more free passage for the rays of light, which, being in consequence more active, ought to produce a more active vegetation. Experience seems to prove this on high mountains; and the same effect is produced in high latitudes by the length of the day. On the other hand, vegetables require to absorb a certain quantity of oxygen gas from the air during the night; and as they find less of that in the rarefied air of the mountains, they ought to be proportionably feeble and languishing. According to experiments made by Theodore de Saussure, plants which grow best in the high Alps are those which require to absorb least oxygen during the night; and, in this point of view, the shortness of the nights near the poles corresponds. These causes, however, are obviously very weak, compared to the powerful action of temperature.

1736. *Great anomalies* are found in the comparative height at which the same plant will grow in different circumstances. In countries situated under the equator, the two sides of the mountain are of the same temperature, which is solely determined by elevation; but in countries distant from it, the warmest side is that towards the south, and the zones of plants, instead of forming lines parallel to the horizon, incline towards the north. The reason, in both cases, is sufficiently obvious. In the temperate zone we find the same plants frequently on low and elevated situations, but this is never the case between the tropics.

1737. *Altitude influences the habits of aquatics:* thus some aquatics float always on the surface of the water, as *Lémna*, while others are either partially or wholly immersed. Such aquatics as grow in the depths of the sea are not influenced by climate; but such as are near the surface are influenced by climate, and have their habitations affected by it.

1738. *The moisture, or mode of watering,* natural to vegetables, is a circumstance which has a powerful influence on the facility with which plants grow in any given soil. The quantity of water absolutely necessary for the nourishment of plants, varies according to their tissue: some are immersed, others float on its surface; some grow on the margin of waters, with their roots always moistened or soaked in it; others, again, live in soil slightly humid or almost dry. Vegetables which resist extreme drought most easily are, 1. Trees and herbs with deep roots; because they penetrate to, and derive sufficient moisture from, some distance below the surface; 2. Plants, which, being furnished with few pores on the epidermis, evaporate but little moisture from their surface, as the succulent tribe.

1739. *The qualities of water*, or the nature of the substances dissolved in it, must necessarily influence powerfully the possibility of certain plants growing in certain places. But the difference in this respect is much less than would be imagined, because the food of one species of plant differs very little from that of another. The most remarkable case is that of salt marshes, in which a great many vegetables will not live, whilst a number of others thrive there better than any where else. Plants which grow in marine marshes, and those which grow in similar grounds situated in the interior of a country, are the same. Other substances naturally dissolved in water appear to have much less influence on vegetation, though the causes of the habitations of some plants, such as those which grow best on walls, as Peltària, and in lime-rubbish, as *Th*láspi, and other Crucíferæ, may doubtless be traced to some salt (nitrate of lime, &c.) or other substance peculiar to such situations.

1740. *The nature of the earth's surface* affects the habitations of vegetables in different points of view: 1. As consisting of primitive earths, or the *débris* of rocks or mineral bodies; and, 2. As consisting of a mixture of mineral, animal, and vegetable matter.

1741. *Primitive surfaces* affect vegetables mechanically according to their different degrees of movability or tenacity. On coarse sandy surfaces plants spring up easily; but many of them, which have large leaves or tall stems, are as easily blown about and destroyed. On fine, dry, sandy surfaces, plants with very delicate roots, as Pròte*a* and *E*rìca, prosper; a similar earth, but moist in the growing season, is suited to bulbs. On clayey surfaces plants are more difficult to establish, but when established are more permanent: they are generally coarse, vigorous, and perennial in their duration.

1742. With respect to *the relative proportions of the primitive earths* in these surfaces, it does not appear that their influence on the distribution of plants is so great as might at first sight be imagined. Doubtless different earths are endowed with different degrees of absorbing, retaining, and parting with moisture and heat; and these circumstances have a material effect in a state of culture, where they are comminuted and exposed to the air; but not much in a wild or natural state, where they remain hard, firm and covered with vegetation. The difference, with a few exceptions, is never so great but that the seeds of a plant which has been found to prosper well in one description of earth, will germinate and thrive as well in another composed of totally different earths, provided they are in a nearly similar state of mechanical division and moisture. Thus, Decandolle observes, though the box is very common on calcareous surfaces, it is found in as great quantities in such as are schistous or granitic. The chestnut grows equally well in calcareous and clayey earths, in volcanic ashes, and in sand. The plants of Jura, a mountain entirely calcareous, grow equally well on the Vosges or the granitic Alps. But though the kind or mixture of earths seems of no great consequence, yet the presence of metallic oxides and salts, as sulphates of iron or copper, or sulphur alone, or alum, or other similar substances in a state to be soluble in water, are found to be injurious to all vegetation, of which some parts of Derbyshire and the maremmes of Tuscany (*Chateauvieux*, let. 8.) are striking proofs. But except in these rare cases, plants grow with nearly equal indifference on all primitive surfaces, in the sense in which we here take these terms; the result of which is, that earths, strictly or chemically so termed, have much less influence on the distribution of plants than temperature, elevation, and moisture. Another result is, as Decandolle has well remarked, that it is often a very bad method of culture, to imitate too exactly the nature of the earth in which a plant grows in its wild state.

1743. *Mixed or secondary soils* include not only primitive earths, or the *débris* of rocks, but vegetable matters; not only the medium through which perfect plants obtain their food, but that food itself. In this view of the subject the term soil is used in a very extensive acceptation, as signifying, not only the various sorts of earths which constitute the surface of the globe, but every substance whatever on which plants are found to vegetate, or from which they derive their nourishment. The obvious division of soils, in this acceptation of the term, is that of aquatic, terrestrial, and vegetable soils; corresponding to the division of aquatic, terrestrial, and parasitical plants.

1744. *Aquatic* soils are such as are either wholly or partially inundated with water, and are fitted to produce such plants only as are denominated aquatics. Of aquatics there are several subdivisions according to the particular situations they affect, or the degree of immersion they require.

1745. One of the principal subdivisions of aquatics is that of *marine plants*, such as the *F*ùci and many of the *A*'lgæ, which are very plentiful in the seas that wash the coasts of Great Britain, and are generally attached to the stones and rocks near the shore. Some of them are always immersed; and others, which are situated above low-water mark, are immersed and exposed to the action of the atmosphere alternately. But none of them can be made to vegetate except in the waters of the sea. Another subdivision of aquatics is that of *river plants*, such as *C*hàra, *P*otamogèton, and *N*ymphæ'a, which occupy the beds of fresh-water rivers, and vegetate in the midst of the running stream; being for the most part wholly immersed, as well as found only in such situations.

1746. A third subdivision of aquatics is that of *paludal or fen plants*, being such as are peculiar to lakes, marshes, and stagnant or nearly stagnant waters, but of which the bottom is often tolerably clear. In such situations you find the Isoëtes lacústris, flowering rush, water ranunculus, water violet, and a variety of others, which uniformly affect such situations; some of them being wholly immersed, and others immersed only in part.

1747. *Earthy soils* are such as emerge above the water, and constitute the surface of the habitable globe, which is every where covered with vegetable productions. Plants affecting such soils, which comprise by far the greater part of the vegetable kingdom, are denominated terrestrial, being such as vegetate upon the surface of the earth, without having any portion immersed in water, or requiring any further moisture for their support beyond that which they derive from the earth and atmosphere. This division is, like the aquatics, distributed into several subdivisions according to the peculiar situations which different tribes affect.

1748. Some of them are *maritime*, that is, growing only on the sea-coast, or at no great distance from it, such as *S*tátice, *G*laúx, *S*amòlus, samphire, sea-pea.

1749. Some are *fluviatic*, that is, affecting the banks of rivers, such as *L*ŷthrum, Lycòpus, *E*upatòr*ium*.

1750. Some are *champaign*, that is, affecting chiefly the plains, meadows, and cultivated fields, such as *C*ardámine, *T*ragopògon, Agrostémma.

1751. Some are *dumose*, that is, growing in hedges and thickets, such as the bramble.

1752. Some are *ruderate*, that is, growing on rubbish, such as *S*enècio viscòsus.

1753. Some are *sylvatic*, that is, growing in woods or forests, such as *S*tàchys sylvática, Angélica sylvéstris.

1754. And, finally, some are *alpine*, that is, growing on the summits of mountains, such as *P*òa alpìna, Epilòbium alpìnum, and many of the mosses and lichens.

1755. *Vegetable soils* are such as are formed of vegetating or decayed plants themselves, to some of which the seeds of certain other plants are found to adhere, as being the only soil fitted to their germination and developement. The plants springing from them are denominated *Parasitical*, as being plants that will vegetate neither in the water nor earth, but on certain other plants, to which they attach themselves by means of roots, that penetrate the bark, and from the juices of which they do often, though not always, derive their support. This last circumstance constitutes the ground of a subdivision of parasitical plants, into such as adhere to the dead or inert parts of other plants, and such as adhere to living plants, and feed on their juices.

1756. In the first subdivision we may place *parasitical mosses, lichens*, and *fungi*, which are found as often, and in as great perfection, on the stumps of rotten trees, and on rotten pales and stakes, as on trees which are yet vegetating; whence it is also plain that they do not derive their nourishment from the juices of the plants on which they grow, but from their decayed parts, and the atmosphere by which they are surrounded; the plant to which they cling serving as a basis of support.

1757. In the second subdivision we may place all *plants strictly parasitical*, that is, all such as do actually abstract from the juices of the plant to which they cling the nourishment necessary to the developement of their parts; and of which the most common, at least as being indigenous to Britain, are the mistletoe, dodder, broom-rape, and a sort of tuber which grows on the root of saffron, and destroys it if allowed to spread.

1758. *The mistletoe* (*V*iscum *álbum*) is found for the most part on the apple tree; but sometimes also on the oak. If its berry is made to adhere to the trunk or branch of either of the foregoing trees, which from its glutinous nature it may readily be made to do, it germinates by sending out a small globular body attached to a pedicle, which after it acquires a certain length bends towards the bark, whether above it or below it, into which it insinuates itself by means of a number of small fibres which it now protrudes, and by which it abstracts from the plant the nourishment necessary to its future developement. When the root has thus fixed itself in the bark of the supporting tree, the stem of the parasite begins to ascend, at first smooth and tapering, and of a pale green colour, but finally protruding a multiplicity of branches and leaves. It seems to have been thought by some botanists that the roots of the mistletoe penetrate even into the wood, as well as through the bark. But the observations of Du Hamel show that this opinion is not well founded. The roots are, indeed, often found within the wood, which they thus seem to have penetrated by their own vegetating power: but the fact is, that they are merely covered by the additional layers of wood which have been formed since the fibres first insinuated themselves into the bark.

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1759. *The* Cúscuta *europæ̀a*, or dodder (*fig.* 200.), though it is to be accounted a truly parasitical plant in the issue, is yet not originally so. For the seed of this plant, when it has fallen to the ground, takes root originally by sending down its radicle into the soil and elevating its stem into the air. It is not yet, therefore, a parasitical plant. But the stem which is now elevated above the surface lays hold of the first plant it meets with, though it is particularly partial to hops and nettles, and twines itself around it, attaching itself by means of little parasitical roots, at the points of contact, and finally detaching itself from the soil altogether by the decay of the original root, and becoming a truly parasitical plant. Withering describes the plant in his *Arrangement* as being originally parasitical; but this is certainly not the fact.

1760. *The Orubánche*, or broom-rape, which attaches itself by the root to the roots of other plants, is also to be regarded as being truly parasitical, though it sometimes sends out fibres which seem to draw nourishment from the earth. It is found most frequently on the roots of clover and common broom, but also in various other places.

1761. *The Epidéndrum flòs àeris* is regarded also by botanists as a parasitical plant, because it is generally found growing on other trees. But as it is found to grow in old tan, it probably derives only support from the bark of trees, and not nourishment.

1762. *Light* is a body which has very considerable influence on the structure of vegetables, and some, also, on their habitation. The *Fúngi* do not require the usual intervention of day, in order to decompose carbonic acid gas, and can live and thrive with little or no light. In green plants, which require the action of light, the intensity requisite is very different in different species; some require shady places, and hence the vegetable inhabitants of caves, and the plants which grow in the shades of forests; others, and the greater number, require the direct action of the sun, and grow in exposed, elevated sites. Decandolle considers that the great difficulty of cultivating alpine plants in the gardens of plains, arises from the impossibility of giving them at once the fresh temperature and intense light which they find on high mountains.

Sect. III. *Civil Causes affecting the Distribution of Plants.*

1763. *By the art of man plants may be inured to circumstances foreign from their usual habits.* Though plants in general are limited to certain habitations destined for them by nature, yet some are, and probably the greater number may be, inured to climates, soils, and situations, of which they are not indigenous. The means used are acclimation and culture.

1764. *Acclimation* seems to be most easily effected in going from a hot to a cold climate, particularly with herbaceous plants; because it often happens that the frosts of winter are accompanied with snow, which shelters the plant from the inclemency of the atmosphere till the return of spring. Trees and shrubs, on the contrary, are acclimated with more difficulty, because they cannot be so easily sheltered from the colds, owing to the greater length of their stems and branches. The acclimation, or naturalisation of vegetables has been attempted by two modes: by sowing the seeds of successive generations, and by the difference of temperature produced by different aspects. But though the habits of individuals may be altered by what is called acclimation, that is, by diminishing or increasing the supplies of nourishment and of heat, yet no art or device of man will alter the nature of the species. The potato, the kidneybean, the nasturtium, georgina, and many other plants which have been long in culture in Europe, and propagated from seeds ripened there through innumerable generations, there is no reason to suppose are in the least degree more hardy than when first imported from Asia or South America. The same slight degree of autumnal frost blackens their leaves, and of spring cold destroys their germinating seeds. But as summer is nearly the same thing in all lands, the summer or annual plants of the tropics are made to grow in the summers of the temperate zones, and, indeed, in general, the summer plants of any one country will grow in the summer climate of any other. The cucumber is grown in the fields in Egypt, and near Petersburg.

1765. *Domesticated plants.* "Some plants," Humboldt observes, "which constitute the object of gardening and of agriculture, have time out of mind accompanied man from one end of the globe to the other. In Europe the vine followed the Greeks; the wheat, the Romans; and the cotton, the Arabs. In America, the Tultiques carried with them the maize; and the potato and quinoa (Chenopòdium *Quinòa,* of which the seeds are used) are found wherever have migrated the ancient Condinamarea. The migration of these plants is evident; but their first country is as little known as that of the different races of men, which have been found in all parts of the globe from the earliest traditions." (*Géographie des Plantes*, p. 25.)

1766. *The general effect of culture on plants* is that of enlarging all their parts; but it often also alters the qualities, forms, and colours: it never, however, alters their primitive structure. "The potato," as Humboldt observes, "cultivated in Chile, at nearly twelve thousand feet above the level of the sea, carries the same flower as in Siberia."

1767. *The culinary vegetables of our gardens,* compared with the same species in their wild state, afford striking proofs of the influence of culture on both the magnitude and qualities of plants. Nothing in regard to magnitude is more remarkable than in the case of the *Brássica* tribe; and nothing, in respect to quality, exceeds the change effected on the celery, the carrot, and the lettuce.

1768. *The influence of culture on fruits* is not less remarkable. The peach, in its wild state in Media, is poisonous; but cultivated in the plains of Ispahan and Egypt, it becomes one of the most delicious of fruits. The effect of culture on the apple, pear, cherry, plum, and other fruits, is nearly as remarkable; for not only the fruit and leaves, but the general habits of the tree, are altered in these and other species. The history of the migration of fruit trees has been commenced by Sickler, in a work (*Geschichte,* &c.) which Humboldt has praised as equally curious and philosophical.

1769. *The influence of culture on plants of ornament* is great in most species. The parts of all plants are enlarged; some are numerically increased, as in the case of double flowers; and, what is most remarkable, even the colours are frequently changed, in the leaf, flower, and fruit.

1770. *The influence of civilisation and culture, in increasing the number of plants in a country,* is very considerable, and operates directly, by introducing new species for culture in gardens, fields, or timber-plantations; and indirectly by acclimation and final naturalisation of many species, by the influence of winds and birds in scattering their seeds. The vine and the fig are not indigenous to France, but are now naturalised there by birds. In like manner the orange is naturalised in the south of Italy. Many plants of the Levant are naturalised both in France and Britain; some, as the cabbage, cherry, and apple, were probably naturalised in England during its subjection to the Romans. The narrow-leaved elm was brought from the Holy Land during the crusades. *P*ha-sèolus vulgàris and Impàtiens *B*alsamìna were brought originally from India; and, *Datùra* Stramònium, which is now naturalised in Europe, was brought originally from India or Abyssinia. Buckwheat and most species of corn and peas came also from the East, and along with them several plants found among corn only, such as *C*entaurèa *C*ȳanus, Agrostémma *G*ithàgo, *R*áphanus Raphanistrum, and *M*ȳagrum satìvum. The country whence the most valuable grasses migrated is not known. Bruce says he found the oat wild in Abyssinia, and wheat and millet have been found in a wild state in hilly situations in the East Indies. Rye and the potato were not known to the Romans. The country of the former Humboldt declares to be totally unknown.

1771. *The greatest refinement in culture consists in the successful formation of artificial climates,* for the culture of tropical plants, in cold regions. Many vegetables, natives of the torrid zone, as the pine apple, the palm, &c., cannot be acclimated in temperate countries: but by means of hot-houses of different kinds, they are grown, even on the borders of the frozen zone, to the highest degree of perfection; and, in Britain, some of the tropical fruits, as the pine and melon, are brought to a greater size and better flavour than in their native habitations. Casting our eyes on man, and the effects of his industry, we see him spread on the plains and sides of mountains, from the Frozen Ocean to the equator, and every where wishing to assemble around him whatever is useful and agreeable of his own country or those of others. The more difficulties to surmount, the more rapidly are developed the moral faculties; and thus the civilisation of a people is almost always in an inverse ratio with the fertility of the soil which they inhabit. What is the reason of this? Humboldt asks. Habit and the love of native land.

Sect. IV. *Characteristic or Picturesque Distribution of Vegetables.*

1772. *The social and antisocial habits of plants* are their most remarkable characteristics. Like animals, they live in two classes: the one class grows alone and scattered, as Solà-num Dulcamàra, *L*ȳchnis dioíca, *P*olȳgonum Bistórta, Anthéricum Liliàgo, &c.; the other class unites in society, like ants or bees, covers immense surfaces, and excludes other species, such as Fragària vésca, *V*accínium Myrtíllus, *P*olȳgonum aviculàre, *A*íra canéscens, *P*ìnus sylvéstris, &c. Barton states that the Mitchéll*a* rèpens is the plant most extensively spread in North America, occupying all the ground between the 28° and 69° of north latitude; that the *A*'rbutus ùva úrsi extends from New Jersey to the 72° of north latitude; while, on the contrary, Gordòn*ia*, Franklín*ia*, and Dionæ'*a* muscípula are found isolated in small spots. Associated plants are more common in the temperate zones than in the tropics, where vegetation is less uniform and more picturesque. In the temperate zones, the frequency of social plants, and the culture of man, have rendered the aspect of the country comparatively monotonous. Under the tropics, on the contrary, all sorts of forms are united; thus cypresses and pines are found in the forests of the Andes of Quindiu and of Mexico; and bananas, palms, and bamboos in the valleys (*fig.* 201.):

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but green meadows and the season of spring are wanting, for nature has reserved gifts for every region. "The valleys of the Andes," Humboldt observes, "are ornamented with bananas and palms; on the mountains are found oaks, firs, barberries, alders, brambles, and a crowd of genera believed to belong only to countries of the north. Thus the inhabitant of the equinoctial regions views all the vegetable forms which nature has bestowed around him on the globe. Earth developes to his eyes a spectacle as varied as the azure vault of heaven, which conceals none of her constellations." The people of Europe do not enjoy the same advantage. The languishing plants, which the love of science or luxury cultivates in our hot-houses, present only the shadow of the majesty of equinoctial vegetation; but, by the richness of our language, we paint these countries to the imagination, and cultivated man feels a happiness peculiar to civilisation.

1773. *The features* of many plants are so obvious and characteristic, as to strike every general observer. The Scitamíneæ, tree-heaths, firs and pines, Mimòsæ, climbers, *C*ácti, grasses, lichens, mosses, palms, *E*quisetàceæ, *M*alvàceæ, *A*roideæ, *O*rchídeæ, *L*iliàceæ, &c., form remarkable groups distinguishable at first sight. Of these groups, the most beautiful are the palms, Scitamineæ, and *L*iliàceæ, which include the bamboos and plantains, the most splendid of umbrageous plants.

1774. *The native countries of plants may often be discovered by their features*, in the same manner as the national distinctions which are observable in the looks and colour of mankind, and which are effected chiefly by climate. Asiatic plants are remarkable for their superior beauty; African plants for their thick and succulent leaves, as in the case of the *C*ácti; and American plants for the length and smoothness of their leaves, and for a sort of singularity in the shape of the flower and fruit. The flowers of European plants are but rarely beautiful, a great portion of them being amentaceous. Plants indigenous to polar and mountainous regions are generally low, with small compressed leaves; but with flowers large in proportion. Plants indigenous to New Holland are distinguishable by small and dry leaves, which have often a shrivelled appearance. In Arabia they are low and dwarfish; in the Archipelago they are generally shrubby and furnished with prickles; while, in the Canary Islands, many plants, which, in other countries, are merely herbs, assume the port of shrubs and trees. The shrubby plants of the Cape of Good Hope and New Holland exhibit a striking similarity. The shrubs and trees of the northern parts of Asia and America also are very much alike; which may be exemplified in the *P*látanus orientàlis of the former, and in the *P*látanus occidentàlis of the latter, as well as in *F*àgus sylvática and *F*àgus latifòlia, or *A*'cer cappadòcium and *A*'cer saccharìnum; and yet the herbs and undershrubs of the two countries do not in the least correspond. "A tissue of fibres," Humboldt observes, "more or less loose, vegetable colours more or less vivid, according to the chemical mixture of their elements, and the force of the solar rays, are some of the causes which impress on the vegetables of each zone their characteristic features."

1775. *The influence of the general aspect of vegetation on the taste and imagination of a people;* the difference in this respect between the monotonous oak and pine forests of the temperate zones, and the picturesque assemblages of palms, mimosas, plantains, and bamboos of the tropics; the influence of the nourishment, more or less stimulant, peculiar to different zones, on the character and energy of the passions; these, Humboldt observes, unite the history of plants with the moral and political history of man.

Sect. V. *Systematic Distribution of Vegetables.*

1776. *The distribution of plants, considered in respect to their systematic classifications*, is worthy of notice. The three grand systematic divisions of plants are Acotyledòneæ, Dicotyledòneæ, and Monocotyledòneæ. A simplification of this division considers plants as *agamous* or *phanerogamous*, that is, without or with visible sexes.

1777. *Plants of visible sexes.* Taking the globe in zones, the temperate contain the greater part of all the phanerogamous or visible sexual species of plants. The equinoctial countries contain nearly $\frac{1}{20}$, and Lapland only $\frac{1}{30}$ part.

1778. *Plants with the sexual parts invisible* or indistinct. Taking the whole surface of the globe, the agamous plants, that is, *M*úsci, *F*úngi, *F*ùci, &c., are to the phanerogamous or perfect plants, nearly as 1 to 7; in the equinoctial countries as 1 to 5; in the temperate zones, as 2 to 5; in New Holland, as 2 to 11; in France, as 1 to 2; in Lapland, Greenland, Iceland, and Scotland, they are as 1 to 1, or even more numerous than the phanerogamous plants. Within the tropics, agamous plants grow only on the summits of the highest mountains. In several of the islands of the Gulf of Carpentaria, having a Flora of phanerogamous plants exceeding 200 species, R. Brown did not observe a single moss.

1779. In the whole globe, the *Monocotyledòneæ*, including the *G*ramíneæ, *L*iliàceæ, Scitamíneæ, &c., are to the whole of the perfect plants as 1 to 6; in the temperate zones (between 36° and 52°,) as one to 4; and in the polar regions as 1 to 20. In Germany, the Monocotyledòneæ are to the total number of species as 1 to $4\frac{1}{2}$; in France as 1 to $4\frac{2}{3}$; in New Holland the three grand divisions of plants, beginning with the Acotyledòneæ, are nearly as 1, $2\frac{1}{7}$, and $7\frac{1}{4}$.

1780. *Dicotyledòneæ.* In the whole globe, the Monocotyledòneæ are estimated by

R. Brown (*Gen. Rem on the Bot. of Terr. Aust.*, 1814.), from Persoon's *Synopsis*, to be to the Dicotyledòneæ as 2 to 11; or, with the addition of undescribed plants, as 2 to 9. From the equator to 30° of north latitude, they are as 1 to 5. In the higher latitudes a gradual diminution of Dicotyledòneæ takes place, until in about 60° north latitude and 50° south latitude they scarcely equal half their intertropical proportions. The ferns in the temperate regions are to the whole number of species as 1, 2, and 5; that is, in the polar regions as 1, in the temperate countries as 2, and in the intertropical regions as 5. In France, ferns form $\frac{1}{72}$ part of the phanerogamous plants; in Germany, $\frac{1}{48}$; in Lapland $\frac{1}{25}$.

1781. *The natural orders* of perfect, or phanerogamous, plants are variously distributed in different countries. The following Table gives a general view of the relative proportions of several natural orders of perfect plants in France, Germany, and Lapland.

Names of Natural Orders.	Number of Species in different Countries.			Ratio of each Family to the whole of the Phanerogamous plants in these Countries.		
	Fran.	Germ.	Lapl.	Fran.	Germ.	Lapl.
Cyperöídeæ	134	102	55	1/27	1/18	1/9
Gramíneæ	284	143	49	1/13	1/15	1/10
Júnceæ	42	20	20	1/86	1/94	1/25
These three Families together	460	265	124	1/8	1/7	1/4
Orchídeæ	54	44	11	1/67	1/43	1/45
Labiàtæ	149	72	7	1/24	1/26	1/71
Rhinántheæ et Scrophularíneæ	147	76	17	1/24	1/94	1/29
Boragíneæ	49	26	6	1/74	1/72	1/83
Ericeæ et *Rhedodéndreæ*	29	21	20	1/125	1/90	1/25
Compósitæ	490	238	38	1/7	1/8	1/13
Umbellíferæ	170	86	9	1/34	1/22	1/33
Crucíferæ	190	106	22	1/19	1/18	1/23
Malvàceæ	25	8	—	1/145	1/235	—
Caryophýlleæ	165	71	29	1/22	1/27	1/17
Leguminòsæ	230	96	14	1/15	1/18	1/35
Euphórbiaceæ	51	18	1	1/71	1/101	1/497
Amentàceæ	69	48	23	1/52	1/39	3/11
Coníferæ	19	7	3	1/192	1/269	1/165
	3645	1884	497			

1782. *The most universal plants* are the agamous families. Their germs are the only ones which nature developes spontaneously in all climates. The *Polýtrichum commùne* (*fig.* 202.) grows in all latitudes; in Europe and under the equator; on high mountains and on a level with the sea; in short, wherever there is shade and humidity. No phanerogamous plants have organs sufficiently flexible to accomodate themselves in this manner to every zone. The *Alsìne mèdia*, *Fragària vésca*, and *Solànum nìgrum* have been supposed to enjoy this advantage; but all that can be said is, that these plants are very much spread, like the people of the race of Caucasus, in the northern part of the ancient continent. (*Humboldt.*)


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Sect. VI. *Economical Distribution of Vegetables.*

1783. *The plants chiefly employed in human economy differ in different climates and countries*; but some, as the cereal grasses, are in universal use; and others, as the banana and plantain, only in the countries which produce them.

1784. *The bread-corn* of the temperate climates is chiefly wheat and maize; of the hot climates, rice, and of the coldest climates, barley.

1785. *The edible roots* of the old world are chiefly the yam, sweet potato, onion, carrot, and turnip; of the new, the potato.

1786. *The oleraceous herbs* of temperate climates are chiefly the *Brássica* family, and other Cruciferæ. In hot climates potherbs are little used. Legumes, as the pea, bean, and kidneybean, are in general use in most parts of the old world.

1787. *The fruits of the northern hemisphere* belong chiefly to the orders of *Pomàceæ*, *Amygdalíneæ*, Grossulàriæ, *Rosàceæ*, *Vitíceæ*, and Amentàceæ.

1788. *The fruits of the East Indies* belong chiefly to *Myrtàceæ*, Guttíferæ, Aurantiàceæ, Musà*ceæ*, *Pálmæ*, *Cucurbitàceæ*, Myristíceæ, &c.

1789. *The fruits of China* are chiefly of the orders of Aurantiàceæ, *Myrtàceæ*, *Rhámneæ*, *Pomàceæ*, *Amygdalíneæ*, *Pálmæ*, &c.

1790. *The fruits of Africa* belong to *Sapòteæ*, *Pálmæ*, Chrysobalàneæ, Guttíferæ, *Apocýneæ*, Papilionàceæ, Musà*ceæ*, and Cucurbitàceæ.

1791. *The fruits of South America* belong to *Anonàceæ*, *Myrtàceæ*, *Terebintàceæ*, Myristíceæ, *Pálmæ*, Bromel*iàceæ*, *Sapòteæ*, *Lauríneæ*, Chrysobalàneæ, Musà*ceæ*, Papilionàceæ, and Passiflòreæ.

1792. *The most showy herbaceous flowers* of the temperate zone belong to *Rosàceæ*, *Liliàceæ*, *Irídeæ*, *Ericíneæ*, *Ranunculàceæ*, Primulàceæ, Caryophýlleæ, *Gentià*ne*æ*, &c. Those of the torrid zone belong to the Scitamíneæ, Amaryllid*eæ*, Bignon*iàceæ*, Melastomàceæ, Magnol*iàceæ*, Papilionàceæ, *Apocýneæ*, &c.

1793. The most useful *timber trees* of temperate climates are of the pine or fir kind; of warm climates, the palm and bamboo. *The universal agricultural order is the Gramineæ.*

Sect. VII. *Arithmetical Distribution of Vegetables.*

1794. *The total number of species* of plants known, amounted in 1820 to about 44,000, of which 38,000 have been described. According to Humboldt and R. Brown, they are thus distributed: — in Europe 7000; in temperate Asia 1500; in equinoctial Asia and the adjacent islands 4500; in Africa 3000; in temperate America, in both hemispheres, 4000; in equinoctial America 13,000; in New Holland and the islands of the Pacific Ocean 5000; — in all 38,000. In Spitsbergen there are 30 species of perfect plants; in Lapland 534; in Iceland 533; in Sweden 1299; in Scotland 900; in Britain upwards of 1400; in Brandenburg 2000; in Piedmont 2800; in Jamaica, Madagascar, and the coast of Coromandel, from 4000 to 5000. It is now (anno 1829) believed that there may be from 100,000 to 200,000 species of plants. Such is the progress of discovery and of ideas.

Sect. VIII. *Distribution of the British Flora, indigenous and exotic.*

1795. *Nearly thirty thousand species* are enumerated in Loudon's *Hórtus Británnicus*, including all the indigenous species of *Músci*, *Fúngi*, *Fùci*, *A'lgæ*, and *Lichènes*.

1796. *The natives of Britain*, flowering plants, which enter into this *Hórtus* are upwards of 1400 species; but the native British Flora contains in all above 3300 species. Of these there are about 1437 cotyledonous plants, and nearly 1893 imperfect, or what are termed, in the Jussieuean system, Acotyledòneæ.

1797. Of *the cotyledonous or perfect plants*, 182 are trees or shrubs; 855 are perennials; 60 are biennials; and 340 annuals. Of the trees and shrubs, 47 are trees; 25 above 30 feet high, and the remainder under 30, but above 10 feet high. Of the perennials 83 are grasses; the next greatest number belong to the first two orders of the class Pentándria; the next to the Syngenèsia; and the third to Monœ'cia Triándria, or the *C*yperàceæ of Jussieu, comprehending chiefly the genus *C*àrex. Most of the biennials belong to the first order of the 19th class, and the first two orders of Pentándria. There are 41 annual grasses; 52 annuals belong to the first two orders of Pentándria; and the next greatest number of annuals to Diadélphia Decándria, which includes the trefoils and vetches.

1798. Of *the acotyledonous, or imperfect plants*, 800 are *Fúngi*; 18 *A'lgæ*; 373 *Lichènes*; 85 Hepáticæ; 460 *Músci*; and 130 *Fílices*; according to a rude estimate formed in 1820.

1799. In regard to *the distribution of the perfect plants* as to elevation, little or nothing has been yet generalised on the subject. In regard to soils, 276 are found in bogs, and marshy or moist places; 140 on the sea shores; 128 in cultivated grounds; 121 in meadows and pastures; 78 in sandy grounds; 76 in hedges and on hedge banks; 70 on chalky and other calcareous soils; 64 on heaths; 60 in woods; 30 on walls; 29 on rocks; and 19 on salt marshes; reckoning from Galpine's *British Flora*, 1820.

1800. In *the distribution of the imperfect plants*, the *Fílices* prevail in rocky places and wastes; most of the *Músci*, *Hepáticæ*, and *Lichènes*, on rocks and trees; most of the *Fùci* and *A'lgæ* in the sea; and of the *Fúngi*, on decaying vegetable bodies, especially trunks of trees, manures, &c.

1801. In respect to *geographical distribution*, the mountainous and hilly districts of England and South Wales are most prolific; the greatest number, according to extent of surface, are found in England and Wales, and the smallest number in Ireland.

1802. *The genera of the native British Flora* enter into 23 classes and 71 orders of the former, and 8 classes and 121 orders of the latter system.

1803. With respect to *the uses or application of the native Flora*, there are about 18 sorts of wild fruits which *may* be eaten, exclusive of the wild apple and pear; but only the pear, apple, plum, currant, raspberry, strawberry, and cranberry, are gathered wild, or cultivated in gardens. There are about 20 boiling culinary plants natives, including the cabbage, sea-kale, asparagus, turnip, carrot, and parsnep. There are about the same number of spinaceous plants, salading, and pot and sweet herbs, which may be used, but of which a few only enter into the dietetics of modern cooks. There are 3 fungi, in general use, the mushroom, truffle, and morel; and various others, as well as about 8 species of sea-weeds, are occasionally eaten. There are about 6 native plants cultivated as florist's flowers, including the Prímula elàtior, *Cròcus*, *Narcíssus*, Diánthus, &c. Nearly 100 grasses, clovers, and leguminous plants are used in agriculture, or serve in their native places of growth as pasturage for cattle. Two native plants, the oat and the big or wild barley, are cultivated as farinaceous grains. Most of the trees are used in the mechanical arts, for fuel, or for tanning: one plant, the flax, not aboriginal, but now naturalised, affords fibre for the manufacture of linen cloth. Various plants yield coloured juices which may be, and in part are, used in dyeing; and some hundred species have been, and a few are still, used in medicine. About 20 cotyledonous plants, and above 50 acotyledonous, chiefly fungi, are, or are reputed to be, poisonous, both to men and cattle.

1804. By *the artificial Flora of Britain*, we understand such of the native plants as admit of preservation or culture in gardens; and such exotics as are grown there, whether in the open ground, or in different descriptions of plant habitations. The total number of species which compose this Flora, or *Hórtus Británnicus*, as taken from Sweet's catalogue of 1819, is about 13,000, including botanists' varieties, and excluding agamous plants. This Flora may be considered in regard to the countries whence the plants were introduced; the periods of their introduction; their obvious divisions; their systematic classification; their garden habitations; their application; and their native habitations.

1805. With respect to *the native countries of the artificial flora*, or *Hórtus Británnicus*, of 970 species, they are unknown; the remaining 12,000 species were first introduced from the following: —

Europe.		Asia.		Africa.		America.			
Continent.		*Continent.*		*Continent.*		*S. Continent.*		*N. Continent.*	
S. of Europe -	659	East Indies -	826	Cape of Good Hope -	2280	Mexico - -	102	United States	1222
Spain - -	266	Siberia - -	364	Barbary - -	77	Peru - - -	77	Carolina - -	129
Italy - - -	202	Levant - -	213	Egypt - -	69	Brazil - - -	74	Virginia - -	49
Hungary - -	173	China - -	205	Morocco - -	13	Guinea - -	33	Canada - -	28
Austria - -	171	Caucasus - -	67	Sierra Leone -	12	Vera Cruz ..	22	Missouri - -	24
Germany - -	134	Persia - -	37	Guinea - -	11	Caraccas - -	21	Louisiana -	18
Switzerland -	117	Japan - -	36	Abyssinia -	8	Chile - -	29	Georgia - -	16
France - -	103	Syria - - -	19	Algiers - -	8	Buenos Ayres	8	Florida - -	9
Various other Parts -	446	Various other Parts -	82	Various other Parts -	51	Various other Places -	275	Other parts of British America and the United States -	111
Islands.		*Islands.*		*Islands.*		*S. Islands.*		*N. Islands.*	
Madeira - -	75	New So. Wales	239	Canaries - -	82	Cayenne - -	9	West Indies -	435
Candia - -	66	New Holland	152	Teneriffe -	21	Falkland Islands -	3	Jamaica - -	248
Other Islands -	352	Ceylon - -	31	St. Helena -	6	Terra del Fuego -	1	Bahamas - -	9
Britain - -	1400	Van Dieman's Land -	21	Cape Verde Islands	1			Other Islands	55
		Other Islands	73						

European plants in the artificial Flora of Britain - - - - - -	4169
Asiatic - - - - - - - - - -	2365
African - - - - - - - - - -	2639
South America - - - - - - - - -	644
North America - - - - - - - - -	2353
Native countries unknown - - - - - - -	970
	13,140

1806. With respect to *the dates of the introduction of the exotics* from those countries, not any are known before the time of Gerard, in Henry VIII.'s reign. From this author and Trew, it appears that 47 species were introduced in or before 1548, including the apricot, fig, pomegranate, &c. Those previously introduced, of which the dates are unknown, may be considered as left here by the Romans, or afterwards brought over from France, Italy, and Spain, by the ecclesiastics, and preserved in the gardens of the religious houses. Henry died in 1547; but the plants introduced in the year after his death may be considered as properly belonging to his reign.

Edw. VI. 1547 to 1553. During this troublous reign, only seven exotic species were added to the British garden, chiefly by Dr. Turner, director of the Duke of Somerset's (then Lord Protector) garden at Syon House.

Mary. 1553 to 1558. No plants introduced.

Elizabeth. 1558 to 1603. 533 species were introduced during this reign. Of these, 288 are enumerated in the first edition of Gerard's *Herbal*, published 1557. Drake's voyage round the world, Raleigh's discoveries in North America, and the consequent introduction of the tobacco and potato, took place during this reign.

James I. 1603 to 1625. Only 20 plants introduced during this period.

Charles I. 1625 to 1649. 331 plants introduced, which are chiefly mentioned by Parkinson, the first edition of whose work was published in 1629. Parkinson was the king's herbalist, and Tradescant his kitchen-gardener. A taste for plants began to appear among the higher classes during this reign; various private gentlemen had botanic gardens; and several London merchants procured seeds and plants for Lobel, Johnston, and Parkinson, through their foreign correspondents.

O. and R. Cromwell. 1649 to 1658. 95 plants introduced by the same means as before. Cromwell encouraged agriculture; but the part he acted left no leisure for any description of elegant or refined enjoyment.

Charles II. 1660 to 1685. 152 plants introduced chiefly mentioned by Ray, Morrison, and different writers in the *Transactions of the Royal Society*, founded in 1663. The Oxford and Chelsea gardens were founded, or enlarged, during this reign. Sir Hans Sloane and Evelyn flourished. Many native plants were now brought into notice by Ray and Willoughby.

James II. 1685 to 1688. 44 plants introduced.

William and Mary. 1688 to 1702. 298 species introduced, chiefly from the West Indies, and through Sir Hans Sloane and the Chelsea garden. Plukenet succeeded Parkinson as royal herbalist during this reign; and botanists were sent from England, for the first time, to explore foreign countries. As in the two former reigns great additions were now made to the indigenous Flora, by Ray, Sibbald, Johnson, and others. Many of the 50 species annually presented to the Royal Society were natives.

Anne. 1702 to 1714. 230 plants, in great part from the East and West Indies, and through the Chelsea garden.

George I. 1714 to 1727. 182 plants, chiefly through the Chelsea garden.

George II. 1727 to 1760. 1770 plants, almost entirely through the Chelsea garden, now in its zenith of fame under Miller. 375 of these plants are stated as introduced in 1730 and 1731, the latter being the year in which the first folio edition of the *Gardeners' and Botanists' Dictionary* appeared. 239 in 1739, in which year the 4th edition of the same work appeared. 196 in 1752, and above 400 in 1758 and 1759, when subsequent editions were published. In the last, in 1763, the number of plants cultivated in England is stated to be more than double the number contained in the edition of 1731.

George III. 1760 to 1817. 6756 plants introduced, or considerably above half the number of exotics now in the gardens of this country. This is to be accounted for from the general progress of civilisation, and the great extension of British power and influence in every quarter of the world; especially in the East Indies, at the Cape of Good Hope, and New South Wales. The increasing liberality of intercourse which now obtained among the learned of all countries, must also be taken into account, by which, notwithstanding the existence of political differences, peace reigned and commerce flourished in the world of science. George III. may also be said to have encouraged botany, aided by the advice, assistance, and unwearied efforts of that distinguished patron of science, Sir Joseph Banks; and the garden of Kew, and its late curator, Aiton, became the Chelsea garden and the Miller of this reign. Most of the new plants were sent there, and first described in the *Hórtus Kewénsis*. The next greatest numbers were procured by the activity of the London nurserymen, especially Lee, and Loddiges, and described in the *Botanical Magazine*; Andrew's *Heathery*; the *Botanical Register*; Loddiges' *Cabinet*, and other works. The greatest number of plants introduced in any one year, during this period, is 336 in 1800, chiefly heaths and proteas from the Cape of Good Hope, taken from the Dutch in 1795. The following are the numbers annually introduced since that period:—

1801.	116	1805.	169	1809.	48	1813.	42
1802.	169	1806.	224	1810.	68	1814.	44
1803.	267	1807.	61	1811.	149	1815.	192
1804.	299	1808.	52	1812.	316	1816.	301

Annual Average of 17 years, ending 1816, 156 species.

1807. With respect to *the obvious character of the artificial Flora*, 350 species are hardy trees or shrubs; of these 270 are trees above 10, and 100 trees above 30 feet, high. Of these, the larch, spruce fir, silver fir, and Lombardy poplar sometimes attain the height of 100 feet. Above 400 species are hardy grasses. Of the tender exotics, the majority are trees or shrubs, and the next in number annuals and bulbs. The colours of the blossoms are generally rich and vivid in proportion to the warmth of the climate of which the plants are natives.

1808. *Purchasable British Flora.* The whole of the plants enumerated as forming the British Flora, are probably not at any one time all in existence in Britain. Many of them, especially the exotic species which were introduced at Kew, have been lost there through accidents or diseases, and are wanting for a time till new seeds or plants are obtained from abroad. Had they been distributed among the nurserymen, they would have been abundantly multiplied and spread over the country. Casualties happen even to hardy plants, and a species which at one time is to be found in moderate quantities in the nurseries is at another period comparatively scarce. Thus, if we reduce the actual number of species to be found in cultivation at one time to from 9000 to 10,000, it will be found nearer the truth. In the public nurseries, varieties are very much cultivated, in order, as it were, to place the beauties of esteemed species in different points of view; or to produce in vegetables something analogous to what are called variations in musical compositions. The following may be considered as a popular or horticultural distribution of the species and varieties obtainable from British nurseries. It is taken from a catalogue entitled *Pródromus,* &c.; or Forerunner of the collection in Page's Southampton nursery-garden, said to be drawn up by L. Kennedy (late of the Hammersmith nursery), and published in 1818.

1809. *Hardy Plants.*

	Sp. & Var.		Sp. & Var.		Sp. & Var
Trees above 30 feet high	100	Hardy climbing shrubs	130	Marsh plants	70
Trees under 30 and above 10 feet high	200	Herbaceous plants	2800	Biennials	300
Deciduous shrubs	500	Grasses introduced in botanic collections	150		Total 4580
Roses, double and single	330	Bulbous-rooted plants	250		
Evergreen shrubs	400	Aquatics	50		

1810. *Green-house and Dry-stove plants.*

	Sp. & Var.		Sp. & Var.		Sp. & Var.
Trees and Shrubs	1150	Climbers	90	Herbaceous and stemless plants	340
Heaths	400	Succulents	170		
Geraniums	150	Mesymbryanthemums	160		Total 3180
Proteas	120	Bulbous-rooted plants	300		

1811. *Hot-house Plants.*

	Sp. & Var.		Sp. & Var.
Trees and shrubs	850	Aquatics	25
Climbers	150	Reedy or scitamineous	55
Succulent plants	130		
Bulbous-rooted plants	80		Total 1463
Herbaceous	170		

1812. *Annuals, native and exotic.*

	Sp. & Var.		Sp. & Var.
Hardy	300	Used in agriculture exclusive of grasses	80
Half hardy	140		
Tender	100		Total 820
Esculent	200		

Total. Hardy, 4580; green-house and dry-stove, 3180; hot-house, 1463; annuals, 820; total, 10,043; of these, above 3000 may be considered as varieties, so that the actual Hortus procurable in British nurseries may be estimated, as to the British Hortus of books, as 7 to 12, or including the cryptogamous plants, as 8 to 12.

1813. With respect to *the application of the purchasable Flora of Britain*, including species and varieties, we submit the following as only a rude outline, the subject not admitting of perfect accuracy from the ever-changing number of varieties.

1814. *Varieties of Fruit-trees, and Fruit-bearing Plants*, for Sale in British Nurseries.

	Sp. & Var.		Sp. & Var.		Sp. & Var.
Apples	500	Apricots	30	Cranberry	
Pears	400	Plums	150	Mulberries	2
Medlars	2	Cherries	100	Filberts	6
Quinces	2	Grapes	150	Walnuts	
Services	4	Figs	30	Chestnuts	3
Oranges and Lemons	60	Gooseberries	200	Melons	15
Peaches	100	Currants	4	Pine-apples	20
Nectarines	50	Raspberries	10		
Almonds	6	Strawberries	40	Total in ordinary nursery catalogues	1906

1815. *Esculent Herbaceous Plants*, annuals and perennials, used in Horticulture.

	Sp.	Var.		Sp.	Var.		Sp.	Var.
Cabbage tribe	1	35	Pot herbs and garnishings	11	16	Edible wild plants which may be used	31	31
Leguminous plants	3	59	Sweet herbs	12	20	Edible fungi	3	3
Esculent roots	10	45	Plants used in confectionary and domestic medicine	14	18	Edible fuci	8	8
Spinaceous plants	6	10	Plants used as preserves and pickles	12	26			
Alliaceous plants	7	18				Total	154	337
Asparaginous plants	11	18						
Acetaceous plants	25	40						

1816. *Florists' Flowers*, used in Floriculture.

	Sp. & Var.		Sp. & Var.		Sp. & Var.
Bulbous-rooted Plants.		Colchicums	10	*Tuberous-rooted Plants.*	
Hyacinths	200	Other sorts	100	Dahlias	400
Tulips	300	*Fibrous-rooted Plants.*		Pæonies	20
Crocuses	100	Auriculas	200	Ranunculuses	300
Narcissus	200	Polyanthuses	100	Anemones	200
Irises	60	Primroses	20		
Fritillaries	20	Cowslips	10	Total	2666
Crown-imperials	20	Pinks	200		
Dens canis	6	Carnations	300		

1817. *Hardy Timber-trees and Shrubs*, used in Arboriculture, Floriculture, and Landscape-gardening.

	Sp. & Var.		Sp. & Var.
Trees planted for timber	100	Shrubs planted for various uses, as fuel, charcoal, bark, firewood, &c.	20
Trees planted for other useful purposes	20		
Trees planted for ornament	180		
Hedge-plants	10		Total 330

1818. *Agricultural Herbaceous Plants*, grown for Food for Men and Cattle, and for use in various Arts.

	Sp.	Var.		Sp.	Var.
Grains for human food	4	20	Plants used for dyeing	2	2
Leguminous seeds	4	10	Plants used for the clothing arts	2	2
Roots	6	20	Sea plants used	6	6
Herbage plants, not grasses	9	15	Mosses used in dyeing	1	1
Herbage grasses, and grasses for grains for the inferior animals	20	25	Mosses used for various purposes in the arts	6	6
Plants used for furnishing oils and essences	5	5	Total	65	112

1819. *Miscellaneous applications* of Hardy Perennials, native and exotic.

	Sp. & Var.		Sp. & Var.
Border-flowers, or such as are used in flower-gardens and shrubberies, in ordinary cases about	300	Used for distillation and perfumery	20
Used in the modern pharmacopœias	50		Total 870
Sold by herbalists, and used by quacks and irregular practitioners	20		

1820. *Application of curious hot-house exotics, or such plants of ornament as require the protection of glass.* Of these there are in ordinary green-houses seldom more than 100 species and varieties, and not more than half that number in most of our plant-stoves. The remainder of this class are confined to the public and private botanic gardens, and to eminent public nurseries. Many of this division are of great importance in their native countries, as the indigo, sugar-cane, tea-tree, cinnamon, &c.; the mango, durion, and other excellent fruits; the palms, bamboos, &c. Even some, here treated as entirely ornamental, afford useful products in their own countries; as the camellia, sun-flower, &c., from the seeds of which oils are expressed in China and America. The cultivation or preservation of living specimens of these plants, therefore, in our green-houses and stoves, is an entertainment at once rational and useful; as many species at length become acclimated, and some even naturalised; and uses may in time be discovered for such as are now merely looked on as objects of curiosity. But that they contribute to elegant enjoyment, it is quite enough to justify much more than all the care that is taken to obtain and preserve them; for what is life when it does not exceed mere obedience to the animal instincts?

1821. With respect to *the native habitations of the exotic part of the British Hortus*, little can be advanced with certainty. In general it would appear that moist and moderately warm climates, and irregular surfaces, are most prolific in species; and, judging of the whole world from Europe, we should venture to consider half the species of plants in existence as growing in soft and rather moist grounds, whether low or elevated. The soil of surfaces constantly moist, or inclining to be moist, whether watered from the atmosphere or from subterraneous sources, is generally found to be minutely divided, and of a black vegetable or peaty nature. Immense tracts in Russia and America are of this description, and, even when dry, resist evaporation better than any other. In such soils, the roots of plants are generally small and finely divided, as those of the heaths, most bog plants, and nearly all the American shrubs. The next sort of habitation most prolific in species, appears to us to be arenaceous soils in temperate climates, and in proportion to their moisture. Here the roots of plants are also small, but less so than in soils of the former description. On rocky and calcareous soils the roots of plants are generally strong and woody, or at least long and penetrating. In clayey habitations, exclusive of the alluvial deposits of rivers, few plants are found, and these generally grasses, strong fibrous-rooted herbaceous plants, or tap-rooted trees. Such at least is the amount of our generalisations; but as our observation has been limited to Europe, and does not even extend to the whole of it, those who have visited Africa and Asia are much more capable of illustrating the subject. One conclusion, we think, the cultivator is fully entitled to draw, that the greater number of plants, native or foreign, will thrive best in light soil, such as a mixture of soft, black, vegetable mould or peat and fine sand kept moderately moist; and that on receiving unknown plants or seeds, of the native sites of which he is ignorant, he will err on the safe side by placing them in such soils rather than in any other; avoiding, most of all, clayey and highly manured soils, as only fit for certain kinds of plants constitutionally robust, or suited to become monstrous by culture.

1822. *The Hórtus Británnicus of* 1829 contains nearly 30,000 species and varieties, and the *Purchasable Flora of Britain* of the same year, contains at least 1000 species and varieties, more than it did in the year 1818 when the above estimate was formed; but the relative proportions of the distribution cannot be materially different now from what they were then, for which reason we have not deemed it requisite to go a second time through the labour of enumeration, for the sake of a result which is by no means essential to a work like the present.

Chap. VII.

Origin and Principles of Culture, as derived from the Study of Vegetables.

1823. The final object of all the sciences is their *application to purposes subservient to the wants and desires of men.* The study of the vegetable kingdom is one of the most important in this point of view, as directly subservient to the arts which supply food, clothing, and medicine; and indirectly to those which supply houses, machines for conveying us by land or by water, and in short almost every comfort and luxury. Without the aid of the vegetable kingdom, few mineral bodies would be employed in the arts, and the great majority of animals, whether used by man as labourers, or as food, could not live.

1824. *Agriculture and gardening* are the two arts which embrace the whole business of cultivating vegetables, to whatever purpose they are applied by civilised man. Their fundamental principles, as arts of culture, are the same; they are for the most part suggested by nature, and explained by vegetable chemistry and physiology (Chap. III. and IV.); and most of them have been put in practice by man for an unknown length of time, without much reference to principles. All that is necessary, therefore, for effecting this branch of culture, is to imitate the habitation, and to propagate. This is, or ought to be, the case, wherever plants are grown for medical or botanical purposes, as in herb and botanic gardens. Nature is here imitated as exactly as possible, and the results are productions resembling, as nearly as possible, those of nature.

1825. *To increase the number and improve the nutritive qualities of plants*, it is necessary to facilitate their mode of nutrition, by removing all obstacles to the progress of the plant. These obstacles may either exist under or above the surface; and hence the origin of draining, clearing from surface incumbrances, and the various operations, as digging, ploughing, &c., for pulverising the soil. Nature suggests this in accidental ruptures of the surface, broken banks, the alluvial deposits from overflowing rivers, and the earth thrown up by underground animals. Many of the vegetables within the influence of such accidents are destroyed, but such as remain are ameliorated in quality, and the reason is, their food is increased, because their roots being enabled to take a more extensive range, more is brought within their reach.

1826. *It is necessary, or at least advantageous, to supply food artificially*; and hence the origin of manuring. All organised matters are capable of being converted into the food of plants; but the best manure for ameliorating the quality, and yet retaining the peculiar chemical properties of plants, must necessarily be decayed plants of their own species. It is true that plants do not differ greatly in their primary principles, and that a supply of any description of putrescent manure will cause all plants to thrive; but some plants, as wheat, contain peculiar substances (as gluten and phosphate of lime), and some manures, as those of animals, or decayed wheat, containing the same substances, must necessarily be a better food or manure for such plants. Manuring is an obvious imitation of nature, every where observable in the decaying herbage of herbaceous plants, or the fallen leaves of trees, rotting into dust or vegetable mould about their roots; and in the effect of the dung left by pasturing or other animals.

1827. *Amelioration of climate* by increasing or diminishing its temperature, according to the nature of the plant, is farther advantageous in improving the qualities of vegetables; unless, indeed, the plant is situated in a climate which experience and observation show to be exactly suited to its nature. Hence the origin of shelter and shade, by means of walls, hedges, or strips of plantation; of sloping surfaces or banks, to receive more directly or indirectly the rays of the sun; of rows, drills, and ridges, placed north and south in preference to east and west, in order that the sun may shine on both sides of the row, drill, or ridge, or on the soil between rows and drills every day in the year; of soils better calculated to absorb and retain heat; of walls fully exposed to the south, or to the north; of training or spreading out the branches of trees on these walls; of hot-walls; of hot-beds; and, finally, of all the varieties of hot-houses. Nature suggests this part of culture, by presenting, in every country, different degrees of shelter, shade, and surface, and in every zone different climates.

1828. *The regulation of moisture* is the next point demanding attention. When the soil is pulverised, it is more easily penetrated both by air and water; when an increase of food is supplied, the medium through which that food is taken up by the plant should be increased; and when the temperature is increased, evaporation becomes greater. Hence the origin of watering by surface or subterraneous irrigation, manual supplies to the root, showering over the leaves, steaming the surrounding atmosphere, &c. This is only to imitate the dews and showers, streams and floods of nature; and it is to be regretted that the imitation is in most countries attended with so much labour, and requires so much nicety in the arrangement of the means, and judgment in the application of the water, that it is but very partially applied by man in every part of the world, except perhaps in a small district of Italy. But moisture may be excessive; and on certain soils at certains seasons, and on certain productions at particular periods of their progress, it may be necessary to carry off a great part of the natural moisture, rather than let it sink into the earth, or to draw it off where it has sunk in and injuriously accumulated, or to prevent its falling on the crop at all. Hence the origin of surface-drainage by ridges, and of under-draining by covered conduits or gutters; and of awnings and other coverings to keep off the rain or dews from ripe fruits, seeds, or rare flowers.

1829. *The regulation of light* is the remaining point. Light sometimes requires to be increased and sometimes to be excluded, in order to improve the qualities of vegetables; and hence the origin of thinning the leaves which overshadow fruits and flowers, the practice of shading cuttings, seeds, &c., and the practice of blanching. The latter practice is derived from accidents observable among vegetables in a wild state, and its influence on their quality is physiologically accounted for by the obstruction of perspiration, and the prevention of the chemical changes effected by light on the epidermis.

1830. *Increase in the magnitude of vegetables*, without reference to their quality, is to be obtained by an increased supply of all the ingredients of food, distributed in such a body of well pulverised soil as the roots can reach to; by additional heat and moisture; and by a partial exclusion of the direct rays of the sun, so as to moderate perspiration, and of wind, so as to prevent sudden desiccation. But experience alone can determine what plants are best suited for this, and to what extent the practice can be carried. Nature gives the hint in the occasional luxuriance of plants accidentally placed in favourable circumstances; man adopts it, and, improving on it, produces cabbages and turnips of half a cwt., apples of one pound and a half, and cabbage-roses of four inches in diameter; productions which may in some respects be considered as diseased.

1831. *To increase the number, improve the quality, and increase the magnitude of particular parts of vegetables.* It is necessary, in this case, to remove such parts of the vegetable as are not wanted, as the blooms of bulbous or tuberous-rooted plants, when the bulbs are to be increased, and the contrary; the water-shoots and leaf-buds of fruit-trees; the flower-stems of tobacco; the male flowers and barren runners of the Cùcumis tribe, &c. Hence the important operations of pruning, ringing, cutting off large roots, and other practices for improving fruits and throwing trees into a bearing state. At first sight these practices do not appear to be copied from nature; but, independently of accidents by fire, already mentioned, which both prune and manure, and of fruit-bearing trees, say thorns or oaks, which, when partially blown out by the roots, or washed out of the soil by torrents, always bear better afterwards, why may not the necessity that man was under, in a primitive state of society, of cutting or breaking off branches of trees, to form huts, fences, or fires, and the consequently vigorous shoots produced from the parts where the amputation took place, or the larger fruit on that part of the tree which remained, have given the first idea of pruning, cutting off roots, &c.? It may be said that this is not nature but art; but man, though an improving animal, is still in a state of nature, and all his practices, in every stage of civilisation, are as natural to him as those of the other animals are to them. Cottages and palaces are as much natural objects as the nests of birds, or the burrows of quadrupeds; and the laws and institutions by which social man is guided in his morals and politics, are not more artificial than the instinct which congregates sheep and cattle in flocks and herds, and guides them in their choice of pasturage and shelter. It is true that the usual acceptation of the words nature and art scarcely justifies this application of them; but we are viewing the subject in its most extensive light.

1832. *To form new varieties of vegetables,* as well as of flowers and useful plants of every description, it is necessary to take advantage of their sexual differences, and to operate in a manner analogous to crossing the breed in animals. Hence the origin of new sorts of fruits, grains, legumes, and roots. Even this practice is but an imitation of what takes place in nature by the agency of bees and other insects, and of the wind; all the difference is, that man operates with a particular end in view, and selects individuals possessing the particular properties which he wishes to perpetuate or improve. New varieties, or rather subvarieties, are formed by altering the habits of plants; by dwarfing through want of nourishment; variegating by arenaceous soils; giving or rather continuing peculiar habits when formed by nature, as in propagating from monstrosities, for instance, fasciculi of shoots, weeping shoots, shoots with peculiar leaves, flowers, fruit, &c.

1833. *To propagate and preserve from degeneracy* approved varieties of vegetables, it is in general necessary to have recourse to the different modes of propagating by extension. Thus choice apples and other tree fruits could not be perpetuated by sowing their seeds, which experience has shown would produce progeny more or less different from the parent, but they are preserved and multiplied by grafting; pine-apples are propagated by cuttings or suckers, choice carnations by layers, potatoes by cuttings of the tubers, &c. But approved varieties of annuals are in general multiplied and preserved by selecting seeds from the finest specimens and paying particular attention to supply suitable culture. Approved varieties of corns and legumes, no less than of other annual plants, such as garden flowers, can only be with certainty preserved by propagating by cuttings or layers, which is an absolute prolongation of the individual; but as this would be too tedious and laborious for the general purposes both of agriculture and gardening, all that can be done is to select seeds from the best specimens. This part of culture is the farthest removed from nature; yet there are, notwithstanding, examples of the fortuitous graft; of accidental layers; and of natural cuttings, as when leaves, or detached portions, of plants (as of the Cardámine hirsùta) drop and take root.

1834. *The preservation of vegetables for future use* is effected by destroying or rendering dormant the principle of life, and by warding off, as far as practicable, the progress of chemical decomposition. When vegetables or fruits are gathered for use or preservation, the air of the atmosphere which surrounds them is continually depriving them of carbon, and forming the carbonic acid gas. The water they contain, by its softening qualities, weakens the affinity of their elements; and heat produces the same effect by dilating their parts, and promoting the decomposing effect both of air and water. Hence, drying in the sun or in ovens, is one of the most obvious modes of preserving vegetables for food, or for other economic purposes; but not for growth, if the drying processes are carried so far as to destroy the principle of life in seeds, roots, or sections of the shoots of ligneous plants. Potatoes, turnips, and other esculent roots, may be preserved from autumn till the following summer, by drying them in the sun, and burying them in perfectly dry soil, which shall be at the same time at a temperature but a few degrees above the freezing point. Corn may be preserved for many years, by first drying it thoroughly in the sun, and then burying it in dry cool pits, and closing these so as effectually to exclude the atmospheric air. In a short time the air within is changed to carbonic acid gas, in which no animal will live, and in which, without an addition of oxygen or atmospheric air, no plant or seed will vegetate. The corn is thus preserved from decomposition, from insects, from vermin, and from vegetation, in a far more effectual manner than it could be in a granary. In this way the Romans preserved their corn in chambers hewn out of dry rock; the Moors, in the sides of hills; the Chinese, at the present time, in deep pits, in dry soil; and the aboriginal nations of Africa, as we have seen (1136.), in earthen vessels hermetically sealed. (*Lasteyrie des Fosses propres à la Conservation des Graines. Chaptal Chimie appliqué à l'Agriculture,* tom. ii. ch. 10.) These practices are all obvious imitations of what accidentally takes place in nature, from the withered grassy tressock to the hedgehog's winter store; and hence the origin of herb, seed, fruit, and root rooms and cellars, and of packing plants and seeds for sending to a distance.

1835. *The whole art of vegetable culture* is but a varied developement of the above fundamental practices, all founded in nature, and for the most part rationally and satisfactorily explained on chemical and physiological principles. Hence the great necessity of the study of botany to the cultivator, not in the limited sense in which the term is often taken, as including mere nomenclature and classification, but in that extended signification in which we have here endeavoured, proportionately to our limited space, to present the study of the vegetable kingdom. Those who would enter more minutely into the subject will have recourse to the excellent work of Keith, from whom we have quoted at such length; to Sir J. E. Smith's *Introduction;* and to the familiar introductions to the Linnean and Jussieuean systems of botany in the Magazine of Natural History, vols. i. and ii.

BOOK II.

OF THE STUDY OF THE ANIMAL KINGDOM WITH REFERENCE TO AGRICULTURE.

1836. *Organised matter is of two kinds, animal and vegetable.* Yet however obvious the difference between them may appear, it is, in point of fact, extremely difficult to state in what this difference consists. The power of locomotion, enjoyed by the more perfect animals, would seem at first an admirable distinction; but there are multitudes of others as completely destitute of this power as plants. If we descend in the scale of animal life, we find beings formed like vegetables, and externally distinguished from them only by their voluntary motion. Yet even this, as an exclusive distinction, will not avail us; because there are very many plants (as the Dionæ'a muscípula, several species of Mimòsa, and some few of Cássia) which are well known to be highly irritable. Macleay, who has discussed this question with great ability, concludes by remarking "that animals are to be distinguished from vegetables by the existence of an absorbent intestinal cavity, and of a nervous system; but that both these marks become indistinct in those animals, which, from the simplicity of their structure, approach nearest to the vegetable nature." (*Hor. Ent.*)

1837. *A partial knowledge of animals is essential to the agriculturist;* as they have frequently a much greater influence over his operations than the most consummate skill, or the most prudent management. This knowledge should be both scientific and practical. Without the first, he cannot communicate to others the established name of any known animal, or an accurate account of any that may be unknown. While, without the second, he will be ignorant of those habits and properties which render animals either hurtful or beneficial to man. In proof of the importance of this knowledge, the following anecdote deserves attention: — In 1788, great alarm was excited in this country by the probability of importing in wheat from North America the insect called the Hessian fly, whose dreadful ravages had spread desolation and almost famine over that country during the two preceding years. The privy council sat day after day anxiously debating what measures should be adopted to ward off a danger, more to be dreaded, as they well knew, than the plague or pestilence. Expresses were sent off in all directions to the officers of the customs at the different out-ports respecting the examination of cargoes. Despatches were sent to the ambassadors in France, Austria, Prussia, and America, to gain that information which only a scientific knowledge of the insect could supply: and so important was the business deemed, that, according to Young, the minutes of council, and the documents collected, fill upwards of two hundred octavo pages. Fortunately, England contained one illustrious naturalist, whose attention had long been directed to all subjects which connects natural history with agriculture, and to whom the privy council had the wisdom to apply. It was by Sir Joseph Banks's entomological knowledge, and through his suggestions, that they were at length enabled to form some kind of judgment on the subject. This judgment was after all, however, very imperfect. Sir Joseph Banks had never seen the Hessian fly, nor was it described in any entomological system. He called for facts respecting its nature, propagation, and economy, which could be had only in America. These were obtained as speedily as possible, and consisted of numerous letters from individuals ; essays from magazines ; the reports of the British minister there, &c. One would have supposed that from these statements, many of them drawn up by farmers who had lost entire crops by the insect, which they professed to have examined in every stage, the requisite information might have been obtained. So far, however, was this from being the case, that many of the writers seem ignorant whether the insect be a moth, a fly, or what they term a bug ! And though, from the concurrent testimony of several, its being a two-winged fly seemed pretty accurately ascertained, no intelligent description is given from which any naturalist can infer to what genus it belongs, or whether it is a known species. With regard to the history of its propagation and economy, the statements are so various and contradictory, that, though he had such a mass of materials before him, Sir Joseph Banks was unable to form any satisfactory conclusion. (*Young's Ann. of Agriculture*, xi. 406. *Kirby and Spence*, i. 51.)

1838. *An acquaintance with the domesticated and indigenous animals alone of Britain is essential to the agriculturist*, and even of the latter the terrestrial proportion only will come under his notice. A knowledge of the names by which the wild species are universally known is all that he need study in the classification of quadrupeds and birds, and these may be acquired from the *British Zoology* of Pennant ; the *quadrupeds and birds* of Bewick, or the *British Fauna* of Dr. Turton. A *British Fauna* has been published by Dr. Fleming, which supplies, in a great measure, the deficiencies of the before-mentioned works. A more perfect acquaintance, however, with insects is essentially necessary, because their influence, in one shape or other, is constantly apparent in the avocations of the husbandman. The cheapest and most comprehensive work on British insects is Samouelle's *Entomologist's useful Compendium*, in which the elements of the science are explained, and a large proportion of our native insects enumerated. But no work on zoology, as it affects agriculture or gardening, has yet appeared. Those who wish to enter deeper into this science, and understand the present state of the " Philosophy of Zoology," will find the discoveries of the celebrated Cuvier, and other modern naturalists, concentrated and digested with much ability by Dr. Fleming, in a work bearing the above title. From these sources we have extracted the principal part of the following chapters, which relate to Animal Anatomy, Chemistry, Physiology, Pathology, Uses, and Artificial Improvement.

Chap. I.

Systematic Zoology, &c.

1839. *The technical terms in zoology* are much more numerous than those in botany, because there are an infinitely greater variety of forms in animals than in plants. Those made use of in the veterinary art are most important to the agriculturist, and these terms are usually prefixed to treatises on that subject.

1840. *In describing animals*, naturalists select those characters for distinguishing the species which are external : but the sexes of the vertebrated animals can only be ascertained by an internal examination of the reproductive organs. The higher divisions, or those which constitute classes, orders, families, and (in some cases) genera, depend more or less on internal structure.

1841. *The best descriptions are often insufficient :* accurate drawings or preserved specimens should therefore be kept to verify the first examination, or to perpetuate peculiarities that may have escaped previous notice. When the agriculturist requires information from others on any particular insect detrimental to his crops, a simple description of the object is not sufficient. This indeed may lead to a knowledge of the species, but not to the means by which the evil is to be checked. He should carefully note down the time, the manner, and the situation in which the insect first makes its appearance, the period which it remains in the larva or grub state, in what way it changes to the perfect insect, whether above or beneath the ground, and, lastly, in what situations the female deposits her eggs ; two or three specimens of the insect, in its various stages, should likewise be preserved in spirits; and this, from the small size of these beings, can be done with facility, and will supersede the necessity of any laboured description of the objects themselves. With such materials, he will find a most important advantage in submitting his doubts and queries to some one of the societies in London, whose object is more particularly the investigation of such matters. The Zoological Club of the Linnæan Society is composed of the most eminent naturalists in the kingdom; and their labours promise to effect much in this department of rural economy. Specimens, &c. may be sent to the secretary, N. A. Vigors, Esq., Soho Square, London; or they may be sent to the same gentleman, as secretary of the Zoological Society, Bruton Street, London.

1842. *The classification of animals*, until the discoveries of the French philosophers, was long regulated by their external characters alone; from this resulted all the artificial systems of the last century. A more intimate acquaintance with nature has convinced naturalists of the present day, that it is only by considering the structure of animals, both internal and external, with reference to their modes of life, that the natural system can ever hope to be discovered. The brilliant anatomical and physiological discoveries of Cuvier, Lamark, Latreille, and others, in France, have laid the foundation of this system; but it was reserved for our own countryman, Macleay, to generalise their details, and combine these valuable materials into a whole. By a new and most extraordinary mode of investigation, this gifted writer has proved the existence of five primary divisions in the animal world, corresponding to the same number in the vegetable: while, through the doctrine of affinity and analogy, the apparently contradictory opinions of Linnæus, with those of others who succeeded him, are in many instances reconciled and explained. (*Hor. Ent. Trans. of Linn. Society*, 14, p. 46.)

Chap. II.

Animal Anatomy.

1843. *The leading organs of animal structure* may be conveniently arranged as external and internal.

Sect. I. *External Anatomy of Animals.*

1844. *All animals agree in possessing an exterior covering, or skin,* to modify their surface, regulate their form, and protect them from the action of surrounding elements. In the more perfect animals, this organ consists of the following parts: the cuticle, the córpus mucòsum, the còrium, the pannículus, and the cellular web.

1845. *The cuticle* is destitute of blood-vessels, nerves, and fibres, and usually consists of a thin transparent membrane possessing little tenacity. In those animals which live on the land, it is more rigid in its texture, and more scaly and dry on its surface, than in those which reside in the water. In aquatic animals, it is in general smooth, often pliable; and, in many cases, its texture is so soft and delicate, that it appears like mucus. It assumes, likewise, other appearances, such as scales, nails, shells and plates, which deserve the attentive consideration of the naturalist, as furnishing him with important characters for the arrangement of animals.

1846. *The mucous web* occurs immediately underneath the cuticle, from which, in general, it may be easily disjoined; but it is often so closely attached to the true skin below, as not to be separated even by maceration in water.

1847. *The corium* (*cùtis vèra*), or true skin, lies immediately underneath the cuticle or mucous web. It is usually destitute of colour. It consists in some animals, as quadrupeds, of solid fibres, which cross one another in every possible direction, and form a substance capable of considerable extensibility and elasticity. It is more obviously organised than the two membranes by which it is covered. Blood-vessels and nerves penetrate its substance, and may be observed forming a very delicate network on its surface.

1848. *The muscular web* varies greatly in its appearance according to the motions which the skin and its appendices are destined to perform. It consists of a layer of muscles, the extremities of whose fibres are inserted into the corium externally, and adhere to the body internally in various directions. This layer is very obvious in the hedgehog and the porcupine, to assist in rolling up the body and moving the spines; and, in birds, to effect the erection of their feathers. In man it can scarcely be said to exist, except in the upper parts, where cutaneous muscles may be observed, destined for moving the skin of the face, cheeks, and head. In the skin of the frog, the only cutaneous muscles which can be observed are seated under the throat; the skin on the other parts of the body being loose and unconnected with the parts beneath. The use of this layer of the integument is to corrugate the skin, and elevate the hairs, feathers or spines with which it is furnished.

1849. *The cellular web* forms the innermost layer of the common integuments, and rests immediately on the flesh of the body. It consists of plates crossing one another in different directions, and forming a cellular membrane, varying in its thickness, tenacity, and contents, according to the species. In frogs it does not exist. The cells of this membrane are filled with various substances, according to the nature of the animal. In general they contain fat, as in quadrupeds and birds. In some of these the layer is interrupted, as in the ruminating animals, while it is continuous in others, as the boar and the whale. In birds, while a part of this web is destined for the reception of fat, other portions are receptacles for air. In the moon-fish the contained matter resembles albumen in its chemical characters.

1850. *The appendices of the skin* are hairs, feathers, horns, scales, shells, and crusts.

1851. *Hairs* differ remarkably not only in their structure, but likewise in their situation. In some cases they appear to be merely filamentous prolongations of the cuticle, and subject to all its changes. This is obviously the case with the hair which covers the bodies of many caterpillars, and which separates along with the cuticle, when the animal is said to cast its skin. In true hair the root is in the form of a bulb, taking its rise in a cellular web. Each bulb consists of two parts, an external, which is vascular, and from which the hair probably derives its nourishment; and an internal, which is membranous, and forms a tube or sheath to the hair during its passage through the other layers of the skin. From this bulb, and enveloped by this membrane, the hair passes through the corium, mucous web, and cuticle. It usually raises up small scales of this last layer, which soon become dry and fall off, but do not form the external covering of the hair, as some have supposed. The hair itself consists of an external horny covering, and a central vascular part, termed *medulla* or *pith*. This horny covering consists of numerous filaments placed laterally, to which different kinds of hair owe their striated appearance. These filaments appear of unequal lengths, those nearest the centre being longest; and, consequently, the hair assumes the form of an elongated cone, with its base seated in the skin. This form gives to the hair that peculiar property on which the operation of *felting* depends. In consequence of this structure of the surface, if a hair is seized at the middle between two fingers, and rubbed by them, the root will gradually recede, while the point of the hair will approach the fingers; in other words, the hair will exhibit a progressive motion in the direction of the root, the imbricated surface preventing all motion in the opposite direction. It is owing to this state of the surface of hairs, that woollen cloth, however soft and pliable, excites a disagreeable sensation of the skin in those not accustomed to wear it. It likewise irritates sores by these asperities, and excites inflammation. The surface of linen cloth, on the other hand, feels smooth, because the fibres of which it consists possess none of those inequalities of surface by which hairs are characterised.

1852. *If a quantity of wool* be spread upon a table, covered with a woollen cloth, and pressed down in different directions, it is obvious that each hair will begin to move in the direction of its root, as if it had been rubbed between the fingers. The different hairs thus moving in every direction become interwoven with each other, and unite in a continuous mass. This is the felt with which hats are made. Curled hairs entwine themselves with one another more closely than those which are straight, though flexible, as they do not, like these, recede from the point of pressure in a straight line; and hence hatters employ various methods to produce curl in the short fur of rabbits, hares, and moles, which they employ. This is accomplished chiefly by applying the solution of certain metallic salts to the fur by a brush; so that, when the hairs are dry, the surface which was moistened contracts more than the other, and produces the requisite curve.

1853. *It is owing to the asperities of the surface of hair* that the spinning of wool is so difficult. This is in a great measure removed, by besmearing it with oil, by which the inequalities are filled up, or, at least, the asperities become less sensible. When the wool is made into cloth, it is necessary to remove the oil, which is done by the process of fulling. The cloth is placed in a trough, with water and clay, and agitated for some time. The oil is removed by the clay and water, while the agitation, acting like pressure, brings the hairs into closer union, and the cloth is taken out, not only cleansed, but felted. The hairs of every thread entwine themselves with those which are contiguous; so that the cloth may be cut without being subject to ravel. It is from this tendency to felt that woollen cloth and stockings increase in density, and contract in dimensions, on being washed. In many places woollen stuffs are felted, on a small scale, by placing them in running water, or under cascades; and the Zetlanders expose them to the motions of the tides, in narrow inlets of the sea.

1854. *In general, there is a close connection between the colour of the hair* and that of the mucous web. This is displayed in those animals which are spotted, in which the colour of the skin is generally variegated like that of the hair.

1855. *Hairs differ remarkably in form.* In general they are round. Frequently on the body they are thickest in the middle. Sometimes they are flat, or two-edged; and, in the whiskers of seals, they are waved on the margins. In many animals they are long and straight; while, in others, they are crisped, and are then termed *wool*. When stiff, they are termed *bristles*; and, when inflexible, *spines*.

1856. *Hair grows by the roots.* In some species it is renewed annually; and in all it is readily reproduced.

1857. *Hair is the most permanent* of all the substances consisting of animal matter, resisting putrefaction for a great length of time.

1858. *Feathers* are nearly related to hairs; they consist of the quill, shaft, and web. The quill, like the hair, takes its rise in the cellular membrane: the central portion of the shaft has a texture like cork, and the web which usually occupies both sides of it is composed of what are called barbes, and the sides of these with barbules. The colour of feathers exhibits great difference: in some birds it varies with the seasons, in others with food, and in others with the extinction of life. Like hairs, feathers are not only renewed periodically, but they are readily reproduced if accidentally destroyed.

1859. *Horns* take their rise from the same situation as hairs or feathers. They may be regarded as hairs agglutinated, and forming a hollow cone. The fibrous structure of horn may be perceived in many animals at the base, where it unites with the skin. At this part it receives the additions to its growth, the apex of the cone being pushed out in proportion as the increase takes place at the root, and on the inner surface. But horns differ remarkably from hair, in having their central cavity filled by a projection of bone or other solid substance from the body beneath.

1860. *The different markings of the horns*, particularly the transverse ridges, are indications of the different layers of growth; and in many cases the number of these ridges corresponds with the years of life.

1861. *The colour of the horn* is, in general, distributed through the mass; sometimes, however, it is collected into bands or threads. It seldom experiences much change during the life of the animal. It is permanent, or does not experience those periodical renovations which we have stated to take place with hair and feathers. The deciduous horns of the stag are different in their nature from true horns, and will be afterwards taken notice of. The term horn is usually restricted to the coverings of the projections of the frontal bones of oxen, sheep, and similar quadrupeds; but various appendices of the skin, composed of the same materials, and equally permanent, although seated on other parts of the body, may with propriety be included under the same appellation; among these may be enumerated beaks, hoofs, claws, nails, and spurs.

1862. *Beaks.* The substance of these covers the external surface of the maxillary bones of birds, and is composed of horn.

1863. *Hoofs* resemble horns in their manner of growth, and in containing a central support, formed by the termination of the extreme bones of the feet. They grow from the inner surface and base, and are thus fitted to supply the place of those parts which are worn away by being exposed to friction against hard bodies. Hoofs are peculiar to certain herbivorous quadrupeds.

1864. *Claws* resemble hoofs in structure and situation, deriving their origin from the skin, having a bony centre, and occurring at the extremities of the fingers and toes.

1865. *Nails* differ from horns and claws, in the circumstance of not being tubular, but consisting of a plate generally convex on the outer surface, and concave beneath.

1866. *Spurs* occur chiefly on what is termed the leg (*tarsus*) of gallinaceous birds. They are found, likewise, on the ornithorynchus. Like horns, they are supported in the centre by bone.

1867. *Horns, hoofs, and similar parts*, bear a close resemblance to one another in chemical composition. When heated they soften, and may be easily bent or squeezed into particular shapes. They consist of coagulated albumen, with a little gelatine; and, when incinerated, yield a little phosphate of lime.

1868. *Their use*, in animal economy, is to protect the soft parts from being injured by pressure against hard bodies. They are in general wanting, where the parts are in no danger of suffering from the influence of such agents. When torn off from the base, they are seldom completely renewed, although very remarkable exertions are frequently made by the system to repair the loss.

1869. *Scales* vary remarkably in their form, structure, mode of adhesion, and situation in different animals. In general they are flat plates, variously marked. In some cases each scale consists of several decreasing plates, the lowest of which is largest; so that the upper surface becomes somewhat imbricated. Some scales adhere by the whole of their central surface; while others resemble the human nail, in having the outer extremity free.

1870. *Shells* consist of layers of an earthy salt, with interposed membranes of animal matter, resembling coagulated albumen. They grow by the addition of layers of new matter to the edges and internal surface. When broken, the animal can cement the edges and fill up the crack, or supply the deficiency when a portion is abstracted.

1871. *The earthy matter of shells* is lime, in union with carbonic acid. Phosphate of lime has likewise been detected, but in small quantity. The colour is secreted from the animal, along with the matter of the shell.

1872. *Crusts* are, in general, more brittle in their texture than shells. They exhibit remarkable differences as to thickness and composition. They differ from shells chiefly in containing a considerable portion of phosphate of lime, and in a greater subdivision of parts. In some cases, however, as the crusts of the bodies of insects, the earthy matter is almost absent, and they may be regarded as formed of cuticle alone. When they contain much earthy matter, as in the crusts of lobsters, the epidermis may be detected as a cover, and the corium beneath may be perceived as a very thin film. In many cases, these crusts are renewed periodically; and, in all, they are readily repaired. Crusts occur in insects, the Crustàcea, and the Echinodérmata, or sea-urchins, and star-fish.

1873. *These different appendices of the skin* pass, by insensible degrees, into one another, as hair into spines, horns into nails, scales into shells, and crusts into membranes. They have all one common origin, namely, the skin; and independently of secondary purposes, they all serve for protection.

1874. *The secretions of the skin* are of three kinds; one class performing the office of lubricating the skin, another of regulating the temperature of the body, and a third that of carrying off the superfluous carbon.

1875. *Unctuous secretions* are confined to animals which have warm blood, and the cells of the cellular web filled with fat, Mammàlia and birds.

1876. *Viscous secretions.* In the animals with cold blood, secretions are produced, by the skin, of substances differing in quality from those of warm-blooded animals; but destined to serve the same purposes, namely, to protect the skin from the action of the surrounding element.

1877. *Sweat*, in ordinary cases, exudes from the skin in a state of vapour; and when condensed consists of water with a small portion of acetic acid and common salt. This secretion is considered as intended to regulate the degree of animal heat, and prevent its accumulation beyond certain limits.

1878. *Carbon* is also emitted by the skin, and appears to be in effect a secondary kind of respiration, but the discovery is but recent. (See *Ellis on the Germination of Seeds and Respiration of Animals*, 1807 and 1811.)

1879. *Absorption.* There are several circumstances which prove that the skin of the human body, in particular states, is capable of exerting an absorbing power. Whether the absorption takes place by peculiar vessels, or by the exhaling vessels having their motions reversed, or whether absorption ever takes place in the state of health, are questions to which no satisfactory answer has been given.

Sect. II. *Internal Anatomy of Animals.*

1880. *Animal anatomy* admits of three divisions, the osseous, the muscular, and the nervous structure of animals.

Subsect. 1. *Osseous Structure of Animals.*

1881. *The organs of external anatomy* are generally considered as destined for protection; while those of the interior of the animal, or the bones, give stability to the power, support the muscles, and afford levers for the performance of locomotion. Bones may be considered with regard to their composition, articulations, and arrangement. All bones are composed of the periosteum, cartilaginous basis, earthy matter, and fat.

1882. *The periosteum* bears the same relation to the bone as the skin to the body, serving as a covering for its surface, and a sheath for the different cavities which enter it. It varies in thickness according to the nature of the bone. Its texture is obviously fibrous; and it possesses blood-vessels. Its sensibility indicates the existence of nerves.

1883. *The cartilaginous basis* consists of gelatine and coagulated albumen, the *earthy matter* is chiefly phosphate of lime, and the *fat* resembles that of the fixed oils.

1884. *Bones increase in size,* not as in shells, scales, or horns, by the addition of layers to the internal surface, but by the expansion of the cartilaginous basis; which, when it becomes saturated with earthy matter, is incapable of farther enlargement. This is the reason why the bones of young animals are soft and flexible, while those of old animals are hard and brittle.

1885. *The proportion* between the cartilaginous basis and the earthy matter differs, not only in every animal according to age, the earthy matter being smallest in youth, but, likewise, according to the nature of the bone itself, and the purposes which it is destined to serve. The teeth contain the largest portion of earthy matter. Remarkable differences are likewise observable, according to the class or species.

1886. *Bone is readily reproduced,* in small quantities, especially in youth. In the case of fracture, the periosteum inflames and swells, the crevice is filled up by a cartilaginous basis, abounding in vessels, and the earthy matter is at length deposited, giving to the fractured part, in many cases, a greater degree of strength than it originally possessed. In animals of the deer kind, the horns, which are true bone, are annually cast off; a natural joint forming at their base, between them and the bones of the cranium, with which they are connected. They are afterwards reproduced under a skin or periosteum, which the animal rubs off when the new horns have attained their proper size. In some cases of disease, the earthy matter is again absorbed into the system, the cartilaginous basis predominates, and the bones become soft and tender. This takes place in the disease of youth termed *rickets,* and in a similar complaint of advanced life, known under the name of *mollities óssium.* In other instances, bone is formed as a monstrous production, in organs which do not produce it in a state of health, as the brain, the heart, and the placenta. (*Monro's Outlines of Anatomy,* p. 63.)

1887. *Cartilage* can scarcely be said to differ in its nature, from the cartilaginous basis of the bone. It is of a fine fibrous structure, smooth on the surface, and remarkably elastic. It covers those parts of bones which are exposed to friction, as the joints, and is thickest at the point of greatest pressure. By its smoothness, it facilitates the motion of the joints, and its elasticity prevents the bad effects of any violent concussion. It is intimately united with the bone, and can scarcely be regarded as different from an elongation of the cartilaginous basis. Where it occurs at a joint with considerable motion, it is termed *articular* or *obducent* cartilage. In other cases, it occurs as a connecting medium between bones which have no articular surfaces, but where a variable degree of motion is requisite. The ribs are united to the breast-bone in this manner. Between the different vertebræ, there are interposed layers of cartilage, by which the motions of the spine are greatly facilitated. As these connecting cartilages are compressible and elastic, the spine is shortened when the body remains long in a vertical position, owing to the superincumbent pressure. Hence it is that the height of man is always less in the evening than in the morning. All these cartilages are more or less prone to ossification, in consequence of the deposition of earthy matter in the interstices. To this circumstance may be referred, in a great measure, the stiffness of age, the elasticity of the cartilages decreasing with the progress of ossification.

1888. *The articulations of bones* exhibit such remarkable differences, in respect to surface, connection, and motion, that anatomists have found it difficult to give to each manner of union an appropriate name and character. We shall only notice the most obvious kinds and motions, and these admit of two divisions, the *true joints* and the *motionless junctions.*

1889. *In the motionless junctions,* the connecting surfaces come into close and permanent contact, as in the serrated edges of the bones of the human skull, or the even edges of the bones of the heads of quadrupeds and birds. Sometimes a pit in one bone receives the extremity of another like a wedge, as in the case of the human teeth; in other cases, the one bone has a cavity with a protuberance at its centre, which receives another bone, as in the claws of cats, seals, &c. The human ribs are united with the breast-bone by the intervention of cartilage, as are the two sides of the lower jaw with each other in vertebral animals.

1890. *In true joints* the articular surfaces are enveloped with cartilage, remarkable for the smoothness of its free surface, and its intimate union with the bone, of which it forms a protecting covering. The periosteum is not continued over the surface of the cartilage, but is prolonged like a sheath over the joint, until it joins that of the opposite bone. It thus forms a close bag at the joint, in which nothing from without can enter, and from which nothing can escape. Into this bag the lubricating liquor termed synòvia is conveyed. It is secreted by a mucous membrane on the interior; on which account, as it in some cases appears like little bags, the term búrsa mucòsa has been bestowed upon it.

1891. *Ligaments.* Besides the sheath formed by the continuation of the periosteum, which is too slender to retain the bones in their proper place, the joints are furnished with *ligaments.* These are membranes of a dense fibrous texture, flexible, elastic, and possessed of great tenacity. They have their insertion in the periosteum and bone, with which they are intimately united. The motions which joints of this kind are capable of performing, may be reduced to three kinds, flexion, twisting, and sliding. In *flexion*, the free extremity of the bone which is moved, approaches the bone which is fixed, describing the segment of a circle, whose centre is in the joint. In *twisting*, the bone which is moved turns round its own axis, passing through the articulation. In *sliding*, the free extremity of the bone moved, approaches the bone which is fixed, in a straight line.

Subsect. 2. *Muscular Structure of Animals.*

1892. *The muscles are the organs by which motion is executed:* they unfold the most singular mechanism of parts, and an infinite variety of movements. The muscles appear in the form of large bundles, consisting of cords. These, again, are formed of smaller threads, which are capable of division into the primary filaments. Each muscle, and all its component cords and filaments, are enveloped by a covering of cellular membrane, liberally supplied with blood-vessels and nerves. — At the extremities of the muscular fibres, where they are attached to the more solid parts, there are usually threads of a substance, differing in its appearance from the muscle, and denominated *tendon* or *sinew.* The tendons are, in general, of a silvery white colour, a close, firm, fibrous texture, and possessed of great tenacity. The thread of which they consist, are attached on the one extremity to the surface of a bone, or other hard part; and, on the other, they are variously interspersed among the fibres or bundles of the muscle. — They are considered as destitute of sensibility and irritability, and form a passive link between the muscle and the bone, or other point of support.

1893. *Muscles are the most active members of the animal frame.* They alone possess the power of irritability, and execute all the motions of the body. The causes which excite them to action may be reduced to two kinds. In the first the will, through the medium of the nerves, excites the irritability of the fibres; and, in the second, the action is produced by the application of external objects, either directly or by the medium of the nerves. The changes which take place in the tenacity of muscles after death are very remarkable. The same force which they could resist with ease in a living state is sufficient to tear them to pieces after the vital principle has departed.

1894. *The functions of the muscles* are either those of rest or motion. Many animals protect themselves against the disturbing movements of the air and water, by placing their bodies in a *prone position.* To give still greater efficacy to this protecting attitude, they retire to valleys, woods, or dens, on the earth, or to the deepest places in the waters; and are thus able, by the weight of their own bodies, and the advantage of their position, to outlive the elemental war. — But there are other animals, which, while they are equally cautious to make choice of proper situations for their safety, employ in addition, peculiar organs with which they are provided, to connect themselves more securely with the basis on which they rest.

1895. *Grasping.* The most simple of these expedients, grasping, is displayed by bats, birds, and insects, in the employment of their toes and claws in seizing the objects of their support. In birds, the assumption and continuance of this attitude is accomplished by a mechanical process; so that there is no expenditure of muscular energy. In every case of this kind, the claws are so admirably adapted to the station of the animal, that the detention of the body in the same spot, during this state of rest, is accompanied with little exertion.

1896. *Suction.* The sucker by which animals fix themselves varies greatly in its form, and even structure. In the limpet, and other gasteropodous Mollúsca, its surface is smooth and uniform; and the adhesion appears to depend on its close application to every part of the opposing surface. In other animals, as the leech and the sea-urchin, the sucker is formed at the extremity of a tube; the muscular motions of which may serve to pump out any air which may remain, after the organ has been applied to the surface of the body.

1897. *Cementation.* The *cementation* which is employed by animals to preserve themselves stationary, consists in a part of their own bodies being cemented to the substance on which they rest. This takes place in the common muscle, by means of strong cartilaginous filaments, termed the *byssus*, united in the body to a secreting gland, furnished with powerful muscles, and, at the other extremity, glued to the rock or other body to which it connects itself. In other cases, as in the oyster, the shell itself is cemented to the rock.

1898. *The muscular motions* of animals are standing, walking, leaping, flying, and swimming.

1899. *In standing* it is necessary that the parts of the body be so disposed, as that the centre of gravity of the whole body fall within the space which they occupy, and that the muscles have sufficient power to counteract those movements which might displace the body from that position. It is obvious that the more numerous the limbs, and the more equally they are distributed on the inferior side of the body, the more securely will the centre of gravity be retained within the space which these feet include.

1900. *Walking* is defined by Cuvier to be a motion on a fixed surface, in which the centre of gravity is alternately moved by one part of the extremities, and sustained by the other, the body never being at any time completely suspended over the ground. It is produced by the alternate flexion and extension of the limbs, aided by the motions of the trunk, advancing the position of the centre of gravity in the intended direction.

1901. *In animals with many feet,* as the Myriópoda, walking is performed by so uniform a motion, that the body may be said to glide along the surface.

1902. *In animals with four feet,* " each step is executed by two legs only; one belonging to the fore pair, and the other to the hind pair; but sometimes they are those of the same side, and sometimes those of opposite sides." (*Cuvier's Comparative Anatomy*, lect. vii, a, 1.) The latter is that kind of motion in horses, which grooms term a *pace*. The right fore-leg is advanced so as to sustain the body, which is thrown upon it by the left hind-foot, and at the same time, the latter bends in order to its being moved forward. While they are off the ground, the right hind-foot begins to extend itself, and the moment they touch the ground, the left fore-foot moves forward to support the impulse of the right foot, which likewise moves forward. The body is thus supported alternately by two legs placed in a diagonal manner. When the right fore-foot moves, in order to sustain the body, pushed forward by the right hind-foot, the motion is then called an *amble*. The body, being alternately supported by two legs on the same side, is obliged to balance itself to the right and left, in order to avoid falling; and it is this balancing movement which renders the gait so soft and agreeable to women and persons in a weak state of body. (*Cuvier's Comp. Anat.*, lect. vii.)

1903. *The serpentine motion* consists in bringing up the tail towards the head by bending the body into one or more curves, then resting upon the tail, and extending the body, thus moving forward, at each step, nearly the whole length of the body, or one or more of the curves into which it was formed. Among the Mollúsca, and many of the annulose animals, the same kind of motion is performed by alternate contractions and expansions, laterally and longitudinally of the whole body, or of those parts which are appropriated to progressive motion.

1904. *A mode of moving analagous to walking,* is performed by animals who have suckers, and is exemplified in the leech, which at every step advances nearly the whole length of its body.

1905. *In the action of leaping,* the whole body rises from the ground, and for a short period is suspended in the air. It is produced by the sudden extension of the limbs, after they have undergone an unusual degree of flexion. The extent of the leap depends on the form and size of the body, and the length and strength of the limbs. The Myriópoda are not observed to leap. Many of the spiders and insects leap with ease forwards, backwards, and laterally. In those which are remarkable for this faculty, the thighs of the hind-legs are in general of uncommon size and strength. Among reptiles the leaping frog is well known, in opposition to the crawling toad. Among quadrupeds, those are observed to leap best, which have the hind legs longer and thicker than the fore-legs, as the kangaroo and the hare. These walk with difficulty, but leap with ease.

1906. *Serpents* are said to leap, by folding their bodies into several undulations, which they unbend all at once, according to the velocity they wish to give to their motion. The jumping maggot, found in cheese, erects itself upon its anus, then forms its body into a circle, bringing its head to the tail; and, having contracted every part as much as possible, unbends with a sudden jerk, and darts forward to a surprising distance. Many crabs and Podùræ bend their tail, or hairs which supply its place, under their belly, and then, suddenly unbending, give to the body a considerable degree of progressive motion.

1907. *Flying.* Flying is the continued suspension and progress of the whole body in the air, by the action of the wings. In leaping, the body is equally suspended in the air, but the suspension is only momentary; in flying, on the contrary, the body remains in the air, and acquires a progressive motion by repeated strokes of the wings on the surrounding fluid. The centre of gravity is always below the insertion of the wings in the bodies of flying animals to prevent them from falling on their backs, but near that point on which the body is, during flight, as it were suspended. The action of flying is performed by animals belonging to different classes. Among the Mammàlia, bats display this faculty, by means of wings, formed of a thin membrane extending between the toes, which are long and spreading, between the fore and hind legs, and between the hind legs and the tail. In birds, the wings, which occupy the place of the anterior extremities in the Mammàlia, and are the organs of flight, consist of feathers, which are stronger than those on the body, and of greater length. Among reptiles, the flying lizard may be mentioned, whose membranaceous wings, projecting from each side of the body, without being connected with the legs, enable it to fly from one tree to another in search of food. A few fishes are likewise capable of sustaining themselves for a short time by means of their fins; these are termed flying fish. Spiders are able to move in the air by means of their threads.

1908. *Swimming* is the same kind of action in water, as flying is in air. The organs which are employed for this purpose resemble the oars of a boat in their mode of action, and in general possess a considerable extent of surface and freedom of motion. Swimming, however, is not confined to those animals which are furnished with oars or swimmers. Many animals move with ease in the water by means of repeated undulations of the body, as serpents, eels, and leeches; or by varying the form of the body by alternate contractile and expansive movements, as the Medùsæ.

1909. In these *different displays of voluntary motion,* the muscles are only able to continue in exercise for a limited period, during which the irritability diminishes, and the further exertion of their powers becomes painful. When thus fatigued, animals endeavour to place themselves in a condition for resting, and fall into that state of temporary lethargy, denominated *sleep*.

1910. *The positions assumed by animals during sleep* are extremely various. In the horse, they even differ according to circumstances. In the field he lies down, in the stable he stands. Dogs and cats form their bodies into a circle, while birds place their heads under their wings.

1911. *The ordinary mode of sleep* is likewise exceedingly various in different animals, and in the same animal is greatly influenced by habit. It in general depends on circumstances connected with food. It is probable, that all animals, however low in the scale, have their stated intervals of repose, although we are as yet unacquainted either with the position which many of them assume, or the periods during which they repose.

Subsect. 3. *Structure of the Nervous System.*

1912. *The nervous system*, by containing the organs of sensation and volition, is that which distinguishes animal from vegetable beings. It consists, in the vertebrated animals, of the brain, the spinal marrow, and the nerves.

1913. *The brain*, exclusive of its integuments, appears in the form of a soft, compressible, slightly viscous mass. The spinal marrow originates with the brain, and consists of four cords united in one body. The nerves, also, originate in the brain or spinal marrow. Some of them appear to have a simple origin; but, in general, several filaments, from different parts of the brain or spinal marrow, unite to form the trunk of a nerve. This trunk again subdivides in various ways; but the ramifications do not always exhibit a proportional decrease of size. It frequently happens that the branches of the same nerve, or of different ones, unite and separate repeatedly within a small space, forming a kind of network, to which the name *plexus* has been applied. Sometimes filaments pass from one nerve to another; and, at the junction, there is usually an enlargement of medullary matter termed a *ganglion*. Numerous filaments, from different nerves, often unite to form a ganglion, from which proceed trunks frequently of greater magnitude than the filaments which entered. Thus nerves, very different in their origin, form communications with one another; so that the whole nervous system may be considered as a kind of network, between the different parts of which an intimate connection subsists. In consequence of this arrangement, it is often matter of very great difficulty to ascertain the *origin* of those filaments, which unite to constitute the trunk of a nerve. In some instances, they appear to arise from the surface of the brain or spinal marrow; in other cases, from the more central parts.

1914. *The brain, in the animals without vertebræ*, is destitute of the protecting bony covering, which forms the head and back bone in the vertebral animals. The brain itself is much more simple in its structure. Independently of very remarkable differences in the structure of the nervous system in the different genera of invertebral animals, there may still be perceived two models, according to which, the organs belonging to it are arranged. In the first, the brain is situated upon the œsophagus, and presents different forms according to the species, appearing more like a ganglion than like the brain of the vertebral animals. It sends off several nerves to the mouth, eyes, and feelers. Two, one on each side, pass round the œsophagus, and, uniting below, form a ganglion in some cases larger than what is considered the true brain. From this ganglion, nerves are likewise sent off to different parts of the body. The animals in which this nervous system prevails belong to the great division termed Mollúsca. In the second, the brain is situated as in the Mollúsca, sending out nerves to the surrounding parts, and likewise one nerve on each side, which, by their union, form a ganglion, from which other nerves issue. This ganglion produces likewise a nervous cord, which proceeds towards the extremity of the body, forming throughout its length ganglia, from which small nerves proceed; this cord, at its commencement, is, in some cases, double for a short distance. It has been compared to the medulla oblongata, and spinal marrow of the vertebral animals. This kind of nervous system is peculiar to the annulose animals. There are usually ganglia on the nervous cord, corresponding with the number of rings of which the body consists.

1915. *The functions of the brain and nervous system;* the organs of perception, as of touch, of heat, of light, of hearing, of smell, and of taste; and also the faculties of the mind, we pass over as belonging chiefly to the anatomy and physiology of the human frame, and therefore less immediately connected with the animals used in agriculture. The reader will find these subjects ably treated by Dr. Fleming.

Chap. III.

Animal Chemistry; or the Substances which enter into the Composition of the Bodies of Animals.

1916. *The elementary principles of the animal kingdom* have been ascertained with considerable precision; but the binary, ternary, or other compounds which they form, have not been investigated with so much success. As these various ingredients are brought into union in the animal system by the agency of the vital principle, their state of combination may be expected to differ widely from the ordinary results of electric attraction. When such compounds of organisation are submitted to analysis, the influence of the vital principle having ceased, the products obtained may be regarded, in many cases, as modifications of the elements of the substance, occasioned by the processes employed, rather than the display of the number or nature of the ingredients, as they existed previously to the analytical operations. Hence the great caution requisite in drawing conclusions regarding the composition of animal bodies.

1917. *The elementary substances which are considered as entering into the parts of animals* are, carbon, hydrogen, oxygen, azote, phosphorus, sulphur, fluoric acid, muriatic acid, iodine, potash, soda, ammonia, lime, magnesia, silica, iron, and manganese.

1918. *Carbon* exists in various states of combination in the fluids, as well as in the solids, of every animal; and has been detected in the form of charcoal in the lungs. When animal substances are exposed to a high temperature in closed vessels, the charcoal which is produced differs considerably from that which is obtained by the same means from vegetables. It is more glossy in appearance, and is incinerated with much greater difficulty.

1919. *Hydrogen* is universally distributed in the animal kingdom; it occurs as a constituent ingredient of all the fluids, and of many of the solids. It is invariably in a state of combination with charcoal; for, as far as we know, it has never been detected in an uncombined or separate state. It has been found in the human intestines, in the form of carburetted hydrogen.

1920. *Oxygen* is as widely distributed as the preceding, in the fluids and solids of all animals. A constant supply of it from the atmosphere is indispensably necessary to the continuation of animal life. It occurs, not only in combination with other bodies, but probably, likewise in a separate state, in the air-bag of fishes, in which it is found, varying in quantity, according to the species, and the depth at which the fishes have been caught. It is common, in union with charcoal, forming *carbonic acid.*

1921. *Azotic* gas is very widely distributed as a component part of animal substances. It occurs in almost all the fluids, and in those solid parts which have carbon as a base. The almost universal prevalence of this principle in animal substances constitutes one of the most certain marks by which they may be distinguished from vegetables. Azote likewise occurs, in an uncombined state, in the air-bag of some fishes.

1922. *Phosphorus.* This inflammable body exists, in union with oxygen, in the state of phosphoric acid, in many of the solids and fluids of animals. Its existence, however, in an uncombined state, has not been satisfactorily determined, although there appears a tendency to refer the luminousness of several animals to the slow combustion of this substance. Even phosphoric acid can scarcely be said to exist in a separate state, being found in combination with potash, soda, ammonia, lime, or magnesia.

1923. *Sulphur*, in combination, exists in considerable abundance in animal substances. It can scarcely be said to occur in a separate state in animals; at least, the experiments which may be quoted as encouraging such a supposition are by no means decisive. United with oxygen, in the form of sulphuric acid, it exists in combination with potash, soda, and lime.

1924. *Fluoric acid* has been detected in bones and urine, in a state of combination with lime.

1925. *Muriatic acid* exists in a great number of the animal fluids, in combination with an alkali, as in the ammonia and soda of urine.

1926. *Iodine* has been detected in sponge.

1927. *Potash* exists in combination with the sulphuric, muriatic, or phosphoric acids; but it is far from abundant in animal fluids.

1928. *Soda* is present in all the fluids in various states of combination, and is more abundant than the preceding. It gives to many of the secretions the alkaline property of changing vegetable blues into green. It is found in union with the carbonic, phosphoric, sulphuric, and muriatic acids.

1929. *Ammonia* exists in its elements in all the fluids, and many of the solids, of animals, and is frequently produced during putrefaction. These elements are likewise found united in the system, and the alkali then appears in union with the various acids, as the phosphoric, muriatic, and lactic.

1930. *Lime*, of which the hard parts of animals, such as bones and shells, are principally composed, is of universal occurrence. It is always in a state of combination, and chiefly with the carbonic or phosphoric acids.

1931. *Magnesia* occurs sparingly. It has been detected in the bones, blood, and some other substances, but always in small quantity, and chiefly in union with phosphoric acid.

1932. *Silica* occurs more sparingly than the preceding. It is found in the hair, urine, and urinary calculi.

1933. *Iron* has hitherto only been detected in the colouring matter of the blood, in bile, and in milk. Its peculiar state of combination in the blood has given rise to various conjectures; but a satisfactory solution of the question has not yet been obtained. In milk, it appears to be in the state of phosphate.

1934. *Manganese*, in oxide, has been observed, along with iron, in the ashes of hair.

1935. Such are *the simple substances* which have been detected by chemists in the solids and fluids of animals; but seldom in a free state, and often in such various proportions of combination to render it extremely difficult to determine their true condition.

1936. *The compounds of organisation* are gelatine, albumen, fibrin, mucus, urea, sugar, oils, and acids.

1937. *Gelatine* occurs in nearly a pure state in the air-bags of different kinds of fishes, as, for example, isinglass, which, if dissolved in hot water and allowed to cool, forms jelly. When a solution of tannin is dropped into a solution of gelatine, a union takes place, and an insoluble precipitate of a whitish colour falls to the bottom. It is on the union of the tannin of the oak bark with the gelatine of the hides, that the process of tanning leather depends. Gelatine exists in abundance in different parts of animals, as bones, muscles, skin, ligaments, membranes, and blood. It is obtained from these substances by boiling them in warm water; removing the impurities, by skimming, as they rise to the surface, or by subsequent straining and clarifying. It is then boiled to a proper consistence. It is the characteristic ingredient of the softest and most flexible parts of animals.

1938. *Gelatine is extensively used in the arts*, under the names of glue and size, on account of its adhesive quality, and to give the requisite stiffness to certain articles of manufacture. In domestic economy, it is likewise employed in the form of jelly, and in the formation of various kinds of soup. What is termed *Portable Soup* is merely jelly which has been dried, having been previously seasoned, according to the taste, with different spices.

1939. *Albumen*, the white of an egg, exists in great abundance, both in a coagulated and liquid state, in the different parts of animals. Hair, nails, and horn are composed of it. It appears likewise as a constituent of bone and shell; and there are few of the fluid or soft parts of animals in which it does not exist in abundance. What has hitherto been termed the *Resin of Bile* is, according to Berzelius, analogous to albumen.

1940. *Albumen is extensively used in the arts.* When spread thin on any substance, it soon dries, and forms a coating of varnish. Its adhesive power is likewise considerable. When rubbed on leather, it increases its suppleness. But its chief use is in clarifying liquors. For this purpose, any substance abounding in albumen, as the white of eggs, or the serum of blood, is mixed with the liquid, and the whole heated to near the boiling point. The albumen coagulates, and falls to the bottom, carrying along with it the impurities which were suspended in the fluid, and which rendered it muddy. If the liquor contains alcohol, the application of heat is unnecessary.

1941. *Fibrin* exists in the blood, and was formerly called the fibrous part of the blood. It likewise exists in all muscles, forming the essential part, or basis, of these organs. It exhibits many remarkable varieties, as it appears in the flesh of quadrupeds, birds, and fishes; but has not hitherto been turned to any particular use.

1942. *Extractive* exists in the muscles of animals, in the blood, and in the brain. It communicates the peculiar flavour of meat to soups. In the opinion of Fourcroy, the brown crust of roasted meat consists of it.

1943. *The soft parts of animals are constituted of these four substances,* which also enter into the composition of the hard parts and of the fluids. They are readily distinguishable from one another. Extractive alone is soluble in alcohol; gelatine is insoluble in cold, but soluble in hot, water; albumen is soluble in cold, and insoluble in hot, water; the fibrin is equally insoluble in hot and cold water. They are variously mixed or united; and as they consist of some elementary principles, chiefly carbon, hydrogen, oxygen, and azote, it is probable that they are in many cases changed, the one into the other, by the living principle; a transmutation which the chemist has succeeded in accomplishing, and which may soon be of advantage in the arts. The proportion of carbon appears to be least in gelatine and greatest in fibrin.

1944. *Mucus* occurs in a liquid state in the animal economy, as a protecting covering to different organs. It necessarily differs in its qualities, according to the purposes it is destined to serve. In the nose, it defends the organ of smell from the drying influence of the air; in the bladder, it protects the interior from the contact of the acid of the urine; while it preserves the gall-bladder from the action of alkaline bile. It does not contain any suspended particles like the blood, but is homogeneous. (*Dr. Young, Annals of Phil.*, vol. ii. p. 117.) When inspissated, it constitutes, in the opinion of some, the basis of the epidermis, horns, nails, and feathers. But the difficulty of obtaining it in a pure state, and the discordant characters assigned to it by different chemists, prevent us from reposing confidence in the accuracy of the analysis of those substances, of which it is considered as forming an essential ingredient.

1945. *Urea* is a substance obtained by evaporation and trituration from the urine of the Mammàlia when in a state of health. In the human subject it is less abundant after a meal, and nearly disappears in the disease called diabetes, and in affections of the liver.

1946. *Sugar* exists in considerable abundance in milk, and in the urine of persons labouring under diabetes. In the latter fluid, it is to be considered as a morbid secretion of the kidneys, occupying the natural situation of the urea. In milk, however, it exists as a constituent principle, and may readily be obtained by the following process: evaporate fresh whey to the consistence of honey, dissolve it in water, clarify with the whites of eggs, and again evaporate to the consistence of syrup. On cooling, white cubical crystals will be obtained, but less sweet than vegetable sugar.

1947. *Oils* vary greatly as to colour, consistence, smell, and other characters. They possess, however, in common, the properties of the fixed oils, in being liquid, either naturally or when exposed to a gentle heat, insoluble in water and alcohol, leaving a greasy stain upon paper, and being highly combustible. They are distinguished as spermaceti, ambergris, fat, and common oils.

1948. *Spermaceti* constitutes the principal part of the brain of the whale, and is freed from the oil which accompanies it by draining and squeezing, and afterwards by the employment of an alkaline lie, which saponifies the remainder. It is then washed in water, cut into thin pieces with a wooden knife, and exposed to the air to dry. It is used in medicine and candlemaking.

1949. *Ambergris* is found in the intestines of the spermaceti whale, and in those only which are in a sickly state. It appears to be the excrement, altered by a long retention in the intestines, and therefore scarcely merits a place among the natural ingredients of the animal system. Upon being voided by the animal, it floats on the surface of the sea, and has been found in various quarters of the globe. It usually has the beaks of cuttle-fish adhering to it. It is employed in small quantities by druggists and perfumers.

1950. *Fat* consists of two substances, suet and oil. It is usually purified by separating the vessels and membranes which adhere to it, by repeatedly washing with cold water, and afterwards melting it, along with boiling water.

1951. *Tallow* is the fat of ruminating animals, and is hard and brittle; while the fat of the hog, called *lard*, is soft and semifluid. Its uses, as an article of food, in the making of candles, hard soap, and ointments, and to diminish friction, are well known.

1952. *The properties of oils* depend in a great degree on the mode of preparation, with the exception of the odour, which arises from the kind of animal from which the oil has been derived. *Spermaceti oil* is considered as the thinnest of the animal oils, and the fittest for burning in lamps. It is obtained from the spermaceti, by draining and pressure. *Train oil* is procured by melting the blubber, or external layer of fat, found underneath the skin of different kinds of whales and seals. From the process employed, it contains, besides the oil, gelatine, albumen, and other animal matters, which render it thick, dark-coloured, and disposed to become rancid. *Fish oil* is sometimes extracted from the entire fish (as the sprat, pilchard, and herring, when they occur in too great quantities to be salted), by boiling in water, and skimming off the oil, as it appears on the surface. In general, however, the oil is obtained from the livers of fish, in which it is lodged in cells.

1953. The *acids* found in animals consist of various proportions of carbon, hydrogen, oxygen, and azote. Some of them are peculiar to the animal kingdom, and others exist in equal abundance in plants.

1954. *The uric or lithic acid* abounds in urine, and appears to be a production of the kidneys. The *lactic acid* is common in the animal fluids. The *amniotic acid* has been found in the uterus of a cow. The *formic acid* is procured by distilling ants. The *benzoic, oxalic, acetic,* and *malic* acids are common both to plants and animals, but seldom occur in the latter.

1955. These *elements,* by combining in different proportions, exhibit a great variety of separate substances. The earthy salts are likewise abundant; and when they occur in a separate state, they strengthen the albuminous framework, and form the skeleton, giving stability to the body, and acting as levers to the muscles. The alkaline salts occur in the greatest abundance in the secreted fluids.

1956. The *fluids* consist of those juices which are obtained from our food and drink, such as the chyle, and are termed *crude* of the *blood,* or prepared from the crude fluids, and destined to communicate to every part of the body the nourishment which it requires; and of those fluids which are separated from the blood, in the course of circulation, such as the bile, and termed secreted fluids. These are all contained in appropriate vessels, and are subject to motion and change.

1957. The *solids* are derived from the fluids, and are usually divided into the soft and hard. The soft solids consist chiefly of what is termed animal matter, of combinations of carbon, hydrogen, oxygen, and azote. They consist of fibres, which are usually grouped into faggots; of plates, which, crossing one another in various directions, give rise to cellular structure, or of a uniform pulpy mass.

1958. *The fibrous texture* may be observed in all the muscles, tendons, and ligaments, and in the bones of many animals, especially before birth. These fibres, however minutely divided, do not appear to be hollow, like those of the vegetable kingdom.

1959. *The cellular texture* is universally distributed in the form of membranes, which invest every organ, the bundles of fibres in every muscle, and, by forming tubes with the addition of the fibrous texture, constitute the containing vessels. The substance gives form to all the different parts, and is that particular portion which is first formed, and which constitutes the frame on and within which the other materials of the system are deposited. It readily expands by the increase of its contents; and, with equal ease, contracts, when the distending cause is removed.

1960. *The pulpy texture* is confined to the brain and nerves, the liver, kidneys, and other secreting organs of the system. Its composition appears to the eye homogenous, and its form is regulated by its cellular envelope.

1961. *These soft solids* alone are capable of possessing the faculty of sensation. By their aid, the nervous energy is exerted on the different parts of the body; and, through them, the impressions of external objects are received.

1962. *The hard solids* consist either of cartilage, which resembles, in its qualities, coagulated albumen; or of bone, formed by various combinations of earthy salts. They are destitute of sensation, and are chiefly employed in defending the system from injury, giving it the requisite stability, and assisting the muscles in the execution of their movements.

1963. *The proportion between the solids and fluids* is not only remarkably different in different species, but in the same species, in the various stages of growth.

CHAP. IV.

Animal Physiology; the Digestive, Circulating, and Reproductive Functions of Animals.

SECT. I. *Of the Digestive System.*

1964. *The instinct of animals for food* presides over the organs of the stomach. Hunger is felt when the stomach is empty; it is promoted by exercise, cold air applied to the skin, and cold, acid, or astringent fluids introduced into the stomach. Inactivity, warm covering, the attention diverted, and warm fluids, have a tendency to allay the sensation.

1965. *Thirst* is accompanied with a sensation of dryness in the mouth. This dryness may be occasioned by excessive expenditure of the fluids, in consequence of the dryness or saltness of the food which has been swallowed; or to their deficiency, from the state of the organs.

1966. *Both hunger and thirst,* besides being greatly influenced by habit, exhibit very remarkable peculiarities, according to the species and tribes of animals.

1967. Those which live on the spoils of the animal kingdom are said to be carnivorous, when they feed on flesh; piscivorous, when they subsist on fishes; and insectivorous, when they prey on insects. Again, those animals which are phytivorous, or subsist on the products of the vegetable kingdom, are either granivorous and feed on seeds; graminivorous, pasturing on grass; or herbivorous, browsing on twigs and shrubs.

1968. *Besides those substances which animals make use of as food, water is likewise employed as drink*, and as the vehicle of nutritious matter. Salt is necessarily mixed with the drink of the inhabitants of the ocean, and is relished by man and many other animals. Other inorganic substances are likewise employed for a variety of purposes. Many savages make use of steatite and clay along with their food. The common earthworm swallows the soil, from which, in its passage through the intestines, it extracts its nourishment.

1969. *In some cases, substances are swallowed for other purposes than nourishment.* Stones are retained in the stomach of birds to assist in triturating the grain. The wolf is said to satisfy his hunger by filling his stomach with mud.

Sect. II. *Of the Circulating System.*

1970. *The food being reduced to a pultaceous mass*, and mixed with a variety of secreted fluids, by means of the digestive organs, is in this state denominated chyme. This mixture exhibits a chemical constitution nearly approaching that of blood, into which it is destined to be converted, by the separation of the useless from the useful part. This is effected by certain vessels called lacteals, which absorb the nutritious part of the chyme, and convey it to a particular receptacle. Another set of absorbents, the lymphatics, take up all the substances which have been ejected from the circulation, and which are no longer necessary in the particular organs, and communicate their contents to the store already provided by the lacteals. The veins receive the altered blood from the extremities of the arteries or the glands, in which they terminate, and proceed with it towards the lungs, to be again aerated. In their progress they obtain the collected fluid of the other absorbents, and, in the lungs, again prepare the whole for the use of the system. Thus, during the continuance of life, the arteries supply the materials by which the system is invigorated and enlarged, and oppose that tendency to decay, produced by the influence of external objects. The process continues during the whole of life, new matter is daily added, while part of the old and useless is abstracted. The addition is greatest in early life, the abstraction is greatest in old age.

1971. This *continued system of addition and subtraction* has led some to conclude, that a change in the corporeal identity of the body takes place repeatedly during the continuance of life; that none of the particles of which it consisted in youth remain in its composition in old age. Some have considered the change effected every three, others every seven, years. This opinion, however, is rendered doubtful by many well known facts. Letters marked on the skin by a variety of substances frequently last for life. There are some diseases, such as small-pox and measles, of which the constitution is only *once* susceptible; but it is observed to be liable to the attack of these diseases at every period of human life.

Sect. III. *Of the Reproductive System of Animals.*

1972. *Animals are reproduced in consequence of the functions of certain organs*, with the exception of some of the very lowest in the scale. In those animals which possess peculiar organs for the preparation of the germ or ovum, some are androgynous (man-woman), and either have the sexual organs incorporated, and capable of generating without assistance, or the sexual organs are distinct, and the union of two individuals is necessary for impregnation: others have the sexual organs separate, and on different individuals. The young of such animals are either nourished at first by the store of food in the egg, or by the circulating juices of the mother. Those species in which the former arrangement prevails are termed oviparous, while the term viviparous is restricted to the latter.

1973. *In all animals it is the business of the female to prepare the ovum or germ*, and bring it to maturity. For this purpose, the germ is produced in the ovarium, farther perfected in the uterus or matrix, and finally expelled from the system through the vagina. The office of the male is to impregnate the germ by means of the spermatic fluid. This fluid is secreted in the testicles, transmitted by the spermatic ducts, and finally conveyed by the external organ to its ultimate destination.

1974. Among *the viviparous animals*, the reproductive organs present many points of resemblance, and appear to be constructed according to a common model. It is otherwise with the sexual organs of the oviparous tribes. These exhibit such remarkable differences in form and structure that it is impossible to collect them into natural groups, or assign to them characters which they have in common.

1975. *The manner in which the eggs of birds are impregnated* by the male has not been satisfactorily determined. With the exception of the cicatricula, a female bird, in the absence of the male, can produce an egg. The conjunction of the sexes, however, is necessary for the impregnation of the egg, and the effect is produced previous to the exclusion.

1976. In *many kinds of fishes and reptiles*, the yolks, after being furnished with their glair, are ejected from the body of the female, and the impregnating fluid from the male is afterwards poured over them. Impregnation can be effected readily in such cases, by the artificial application of the spermatic fluid.

1977. *Impregnation in insects* appears to take place while the eggs pass a reservoir containing the sperm, situated near the termination of the oviduct in the volva.

1978. *The most simple mode of hatching* is effected by the situation in which the eggs are placed by the mother, after or during their exclusion. In this mode a place is usually selected where the eggs will be exposed to a suitable and uniform temperature, and where a convenient supply of food may be easily obtained for the young animals. Such arrangements prevail in the insect tribe.

1979. In *the second mode*, the mother, aided in some cases by the sire, forms a nest, in which she deposits her eggs, and, sitting upon them, aids their hatching by the heat of her body. Birds in general hatch their young in this manner.

1980. In *the third mode*, the eggs are retained in the uterus, without any connection, however, by circulating vessels, until the period when they are ready to be hatched, when egg and young are expelled at the same time. This takes place in some sharks and Mollúsca. The animals which exercise this last kind of incubation are termed ovoviviparous. In the *R*àna pìpa, the eggs are deposited in a bag on the back, where they are hatched, and where the young animals reside for some time after birth. Some animals, as the aphis, are oviparous at one season, and ovoviparous at another.

1981. *The young, after being hatched*, are, in many cases, independent of their parent, and do not stand in need of any assistance: they are born in the midst of plenty, and have organs adapted to the supply of their wants. Thus, many insects are hatched on, or within the very leaves which they are afterwards to devour. In other cases, the young are able to follow their parents, and receive from them a supply of appropriate food; or, if unable to follow, their parents bring their food to the nests.

1982. *The changes which the young of oviparous animals undergo in passing from infancy to maturity* have long attracted the notice of the inquisitive observer. The egg of the frog is hatched in the water, and the young animal spends in that element a part of its youth. While there it is furnished with a tail and external brónchiæ; both of which are absorbed, and disappear, when it becomes an inhabitant of the land. The infancy of the butterfly is spent in the caterpillar state, with organs of motion and mastication which are peculiar to that period. It is destined to endure a second hatching, by becoming enveloped in a covering, and suffering a transformation of parts previously to appearing in its state of maturity. These metamorphoses of oviparous animals present an almost infinite variety of degrees of change, differing in character according to the tribes or genera.

1983. In *birds*, it is well known that one sexual union suffices for the production of impregnated eggs during the period of laying. This is a case somewhat analogous to those quadrupeds which produce several young at a birth with one impregnation, differing however, in the circumstance that the eggs are not all produced at the same time, although they are afterwards hatched by the same incubation. In the *Aphides*, or plant-lice, as they are called, one impregnation not only renders fertile the eggs of the individual, but the animals produced from these, and the eggs of those again, unto the ninth generation.

1984. *Androgynous animals* are of two kinds; those where impregnation takes place by the mutual application of the sexual organs of two individuals; and those where the hermaphroditism is complete. The Mollúsca exhibit examples of both kinds.

1985. *Gemmiparous animals* are exemplified in the *H*ýdra or fresh-water polypus, and other zoophytes.

1986. *Hybridous animals*. In the accomplishment of the important purpose of generation, it is observed, that, in the season of desire, individuals of a particular species are drawn together by mutual sympathy, and excited to action by a common propensity. The produce of a conjunction between individuals of the same species partakes of the characters common to the species, and exhibits in due time the characteristic marks of puberty and fertility. In a natural state, the selective attribute of the procreative instinct unerringly guides the individuals of a species towards each other, and a preventive aversion turns them with disgust from those of another kind. In a domesticated state, where numerous instincts are suppressed, and where others are fostered to excess, individuals belonging to different species are sometimes known to lay aside their natural aversion, and to unite in the business of propagation. Instances of this kind occur among quadrupeds, birds, and fishes, among viviparous and oviparous animals, where impregnation takes place within, as well as when it is effected without, the body. The product of such an unnatural union is termed a hybridous animal. The following circumstances appear to be connected with hybridous productions: —

1987. *The parents must belong to the same natural genus or family*. There are no exceptions to this law. Where the species differ greatly in manners and structure, no constraints or habits of domestication will force the unnatural union. On the other hand, sexual union sometimes takes place among individuals of nearly related species. Thus, among quadrupeds, the mule is the produce of the union of the horse and the ass. The jackall and the wolf both breed with the dog. Among birds, the canary and goldfinch breed together, the Muscovy and common duck, and the pheasant and hen. Among fishes, the carp has been known to breed with the tench, the crusian, and even the trout. (*Phil. Trans.*, 1771, p. 318.)

1988. *The parents must be in a confined or domesticated state*. In all those hybridous productions which have yet been obtained, there is no example of individuals of one species giving a sexual preference to those of another. Among quadrupeds and birds, those individuals of different species which have united, have been confined and excluded from all intercourse with those of their own kind. In the case of hybridous fishes, the ponds in which they have been produced have been small and overstocked, and no natural proportion observed between the males and females of the different kinds. As the impregnating fluid, in such situations, is spread over the eggs after exclusion, a portion of it belonging to one species may have come in contact with the unimpregnated eggs of another species, by the accidental movements of the water, and not in consequence of any unnatural effort. In all cases of this unnatural union among birds or quadrupeds, a considerable degree of aversion is always exhibited, a circumstance which never occurs among individuals of the same species.

1989. *The hybridous products are barren*. The peculiar circumstances which are required to bring about a sexual union between individuals of different species sufficiently account for the total absence of hybridous productions in a wild state; and, as if to prevent even in a domesticated state the introduction and extension of spurious breeds, such hybridous animals, though in many cases disposed to sexual union, are incapable of breeding. There are, indeed, some statements which render it probable that hybrid animals have procreated with perfect ones; at the same time there are few which are above suspicion.

Chap. V.

Animal Pathology; or the Duration, Diseases, and Casualties of Animal Life.

1990. *Each species of animal is destined, in the absence of disease and accidents, to enjoy existence during a particular period.* In no species, however, is this term absolutely limited, as we find some individuals outliving others, by a considerable fraction of their whole lifetime. In order to find the ordinary duration of life of any species, therefore, we must take the average of the lives of a number of individuals, and rest satisfied with the approximation to truth which can thus be obtained. There is little resemblance in respect of longevity between the different classes, or even species, of animals. There is no peculiar structure, by which long-lived species may be distinguished from those that are short-lived. Many species whose structure is complicated live but for a few years, as the rabbit; while some of the testaceous Mollúsca, with more simple organisation, have a more extended existence. If longevity is not influenced by structure, neither is it modified by the size of the species. While the horse, greatly larger than the dog, lives to twice its age, man enjoys an existence three times longer than the former.

1991. *The circumstances which regulate the term of existence* in different species exhibit so many peculiarities, corresponding to each, that it is difficult to offer any general observations on the subject. Health is precarious, and the origin of diseases generally involved in obscurity. The condition of the organs of respiration and digestion, however, appears so intimately connected with the comfortable continuance of life, and the attainment of old age, that existence may be said to depend on the due exercise of the functions which they perform. Whether animals have their blood aerated by means of lungs or gills, they require a regular supply of oxygen gas: but as this gas is extensively consumed in the process of combustion, putrefaction, vegetation, and respiration, there is occasionally a deficiency in particular places for the supply of animal life. In general, where there is a deficiency of oxygen, there is also a quantity of carbonic acid or carburetted hydrogen present. These gases not only injure the system by occupying the place of the oxygen which is required, but exercise on many species a deleterious influence. To these circumstances may be referred the difficulty of preserving many fishes and aquatic Mollúsca in glass jars or small ponds; as a great deal of the oxygen in the air contained in the water is necessarily consumed by the germination and growth of the aquatic Cryptogàmia, and the respiration of the infusory Animálcula. In all cases, when the air of the atmosphere, or that which the water contains, is impregnated with noxious particles, many individuals of a particular species, living in the same district, suffer at the same time. The disease which is thus at first endemic or local, may, by being contagious, extend its ravages to other districts.

1992. *The endemical and epidemical diseases* which attack horses, sheep, and cows, obtain in this country the name of *murrain*, sometimes also that of *the distemper*. The general term, however, for the pestilential diseases with which these and other animals are infected, is Epizdöty (*epi*, amongst, *zōon*, an animal).

1993. *The ravages which have been committed among the domesticated animals, at various times, in Europe, by epizoötics*, have been detailed by a variety of authors. Horses, sheep, cows, swine, poultry, fish, have all been subject to such attacks; and it has frequently happened, that the circumstances which have produced the disease in one species have likewise exercised a similar influence over others. That these diseases arise from the deranged functions of the respiratory organs, is rendered probable by the circumstance that numerous individuals, and even species, are affected at the same time; and this opinion is strengthened, when the rapidity with which they spread is taken into consideration.

1994. *Many diseases*, which greatly contribute to shorten life, take their rise from circumstances connected with the organs of digestion. Noxious food is frequently consumed by mistake, particularly by domesticated animals. When cows, which have been confined to the house during the winter season, and fed with straw, are turned out to the pastures in the spring, they eat indiscriminately every plant presented to them, and frequently fall victims to their imprudence. It is otherwise with animals in a wild state, whose instincts guard them from the common noxious substances of their ordinary situation. The shortening of life, in consequence of the derangement of the digestive organs, is chiefly produced by a scarcity of food. When the supply is not sufficient to nourish the body, it becomes lean, the fat being absorbed to supply the deficiency; feebleness is speedily exhibited, the cutaneous and intestinal animals rapidly multiply, and, in conjunction, accelerate the downfal of the system.

1995. *The power of fasting*, or of surviving without food, possessed by some animals, is astonishingly great. An eagle has been known to live five weeks without food; a badger a month; a dog thirty-six days; a toad fourteen months, and a beetle three years. This power of outliving scarcity for a time, is of signal use to many animals, whose food cannot be readily obtained; as is the case with beasts of prey and rapacious birds. But this faculty does not belong to such exclusively: wild pigeons have survived twelve days, an antelope twenty days, and a land tortoise eighteen months. Such fasting, however, is detrimental to the system, and can only be considered as one of those singular resources which may be employed in cases where, without it, life would speedily be extinguished. In situations where animals are deprived of their accustomed food, they frequently avoid the effects of starvation, by devouring substances to which their digestive organs are not adapted. Pigeons can be brought to feed on flesh, and hawks on bread. Sheep, when accidentally overwhelmed with snow, have been known to eat the wool off each other's backs.

1996. *The various diseases to which animals are subject* tend greatly to shorten the period of their existence. With the methods of cure employed by different species we are but little acquainted. Few accurate observations appear to have been made on the subject. Dogs frequently effect a cure of their sores by licking them. They eat grass to excite vomiting, and probably to cleanse their intestines from obstructions or worms, by its mechanical effects. Many land animals promote their health by bathing, others by rolling themselves in the dust. By the last operation, they probably get rid of the parasitical insects with which they are infested.

1997. *But independently of scarcity, or disease,* comparatively few animals live to the ordinary term of natural death. There is a wasteful war every where raging in the animal kingdom. Tribe is divided against tribe, and species against species, and neutrality is nowhere respected. Those which are preyed upon have certain means which they employ to avoid the foe; but the rapacious are likewise qualified for the pursuit. The exercise of the feelings of benevolence may induce us to confine our attention to the former, and adore that goodness which gives shelter to the defenceless, and protection to the weak, while we may be disposed to turn precipitately from viewing the latter, lest we discover marks of cruelty, where we wished to contemplate nothing but kindness. But we should recollect, that, to the lower animals, destitute as they are of the means of attending to the aged or diseased, sudden death is a merciful substitute for the lingering tortures of starvation.

Chap. VI.

On the Distribution of Animals.

1998. *On a superficial view, vegetables seem more abundant than animals:* so contrary, however, is this to fact, that the species of animals, when compared with those of plants, may be considered in the proportion of 10 to 1. Hence it follows that botany, when compared with zoology, is a very limited study: plants, when considered in relation to insects alone, bear no proportion in the number of the species. The phanerogamous plants of Britain have been estimated in round numbers at 1500, while the insects that have already been discovered in this country (and probably many hundreds still remain unknown) amount to 10,000, which is more than six insects to one plant. It is therefore obvious that the knowledge acquired on the geographical distribution of animals, in comparison with what is known of plants, is slight and unsatisfactory: it is likewise attended with difficulties inseparable from the nature of beings so numerous and diversified, and which will always render it comparatively imperfect. It rarely happens that a single specimen of a plant is found isolated; the botanist can therefore immediately arrive at certain conclusions: if he is in a mountainous country, he is enabled to trace, without much difficulty, the lowest and the highest elevation at which a particular species is found; and the nature of the soil, which may be considered the food of the plant, is at once known. But these advantages do not attend the zoologist: his business is with beings perpetually moving upon the earth, or hid in the depths of ocean, performing numerous functions in secret; while of the marine tribes he can never hope to be acquainted with more than a very insignificant portion. The following observations must therefore be considered as merely an outline of those general laws which seem to regulate the geography of animals.

1999. *The distribution of animals on the face of the globe* must be considered under two heads, general and particular. The first relates to families or groups inhabiting particular zones, and to others by which they are represented in another hemisphere. The second refers to the local distribution of the animals of any particular country, or to that of individual species. It is to the general distribution of groups, as a celebrated writer has well observed, that the philosophic zoologist should first direct his attention, rather than to the locality of species. By studying nature in her higher groups, we discover that certain functions are developed under different forms, and we begin to discern something of the great plan of providence in the creation of animals, and arrive at general results, which must be for ever hid from those who limit their views to the habitations of species, or to the local distribution of animals.

2000. *Animals, like plants, are generally found to be distributed in zones.* Fabricius, in speaking of insects, divides the globe into eight climates, which he denominates the Indian, Egyptian, southern, Mediterranean, northern, oriental, occidental, and alpine. In the first he includes the tropics; in the second, the northern region immediately adjacent; in the third, the southern; in the fourth, the countries bordering on the Mediterranean Sea, including also Armenia and Media; in the fifth, the northern part of Europe, interjacent between Lapland and Paris; in the sixth, the northern part of Asia, where the cold in winter is intense; in the seventh, North America, Japan, and China; and in the eighth, all those mountains whose summits are covered with eternal snow. It is, however, easy to perceive, that this, though a very ingenious, is a very artificial theory: the divisions are vague and arbitrary, and we know that animals of one country differ essentially from those of another, although both may enjoy the same degree of temperature. M. Latreille has therefore attempted a more definite theory. His two primary divisions are the arctic and antarctic climates, according to their situation above or below the equinoctial line; and taking twelve degrees of latitude for each climate, he subdivides the whole into twelve. Beginning at 84° N.L., he has seven arctic climates: viz. the polar, subpolar, superior, intermediate, supratropical, tropical, and equatorial: but his antarctic climates, as no land has been discovered below 60° S.L., amount only to five, beginning with the equatorial, and terminating with the superior. He proposes also a further division of subclimates, by means of certain meridian lines; separating thus the old world from the new, and subdividing the former into two great portions; an eastern, beginning with India; and a western, terminating with Persia. He proposes, further, that each climate should be considered as having 24° of longitude and 12° of latitude. This system certainly approximates more to what we see in nature than that proposed by Fabricius; yet Mr. Kirby observes with truth, that the division of the globe into climates by equivalent parallels and meridians wears the appearance of an artificial and arbitrary system, rather than of one according to nature.

2001. *Mr. Swainson considers that the geographic distribution of animals* is intimately connected with the limits of those grand and obvious sections into which the globe is divided; and that in proportion to the geographical proximity of one continent to another, so will be either the proportional identity or the analogy of their respective animals. He considers Europe, Asia, and Africa as agreeing more particularly in possessing certain animals in common, which seem excluded altogether from America and Australia; both of which are not only isolated in situation, but their animals have a decided difference of form and habit from those of the three continents of the old world. He considers that the animal geography of Asia is connected with that of Australia by the intervention of Borneo, New Guinea, and the neighbouring isles; while that of America unites with Europe towards the polar regions. These five great types or divisions will, of course, present certain affinities or analogies dependent upon other causes, arising from temperature, food, and locality. (*Swainson's MSS.*)

2002. *Vertebrated animals have a wider range* than invertebrated animals, thus resembling man, who is spread over the whole earth: the dog and the crow are found wild in almost every climate; the swallow traverses, in a few days, from the temperate to the torrid zone; and numerous other birds annually perform long migrations. Next to these, insects, above all the other Invertebràtæ, enjoy the widest range; the house fly of America and of Europe are precisely the same; and Mr. Swainson has observed in Brazil vast flocks of butterflies, which annually migrate from the interior towards the coast.

2003 *Marine animals have, in general, a wider range than those strictly terrestrial.* This may probably originate in their being more independent of the effects of temperature. It is remarkable, that, with the exception of the crow and two or three others, the land birds of America differ entirely from those of Europe, yet that nearly all our aquatic species are found both in the new world and in the southern coasts of Africa.

2004. *Subordinate to the five geographic groups already noticed, temperature may be considered the principal regulator of the station of animals;* it has likewise a remarkable influence on their clothing. Many quadrupeds, inhabiting the colder regions, appear in their natural colours during summer, but become white in winter. The same change takes place in the plumage of several land birds; but is not observable in insects, or the other invertebrate groups. Temperature has likewise a great influence on the size and colour of animals. The Sphínx convólvuli of Europe is found also in India, but of a much smaller size and more distinctly coloured: this is usually the effect of heat upon animals whose chief range is in temperate latitudes. On those which may be considered intertropical, a greater degree of heat not only increases the brilliancy of their colours, but adds to their size. There are many birds and insects common both to central Brazil and Cayenne; but from the greater heat of the latter country, the specimens are always larger and their plumage more beautiful. Temperature likewise affects the clothing of animals in respect both to quality and quantity. This is more particularly observed in such domesticated animals as have been transplanted from their natural climates. The covering of swine in warm countries consists of bristles of the same form and texture, thinly dispersed; while the same animals in colder climates have an additional coating of fine frizzled wool next the skin, over which the long bristly hairs project. This difference is very remarkable in the swine of northern Europe and those of tropical America, the latter appearing almost naked: it may be observed in a less degree in those of the south of England and the north of Scotland. Similar appearances present themselves among the sheep of warm and cold countries: the fleece of those of England consists entirely of wool, while the sheep of Shetland and Iceland possess a fleece, containing, besides the wool, a number of long hairs, which give it an appearance of being very coarse.

2005. *The particular or local distribution of animals* is affected by various causes which have little influence on their geographic distribution. Thus the purely insectivorous birds of the family Sylvìadæ feed on all kinds of small insects, without regard to any particular species; yet the Sylvìadæ of America and those of Europe are each characterised by a peculiarity of structure which invariably designates the continent to which they belong. The wryneck is represented in America by the Oxyrhýnchus cristàtus *Swains.* (*Zool. Ill.* i. p. 149.); yet neither of these birds are found to inhabit *all* parts of their respective continents: their range, on the contrary, is regulated by temperature, food, and other circumstances connected with *local* distribution. (*Swainson's MSS.*)

2006. *From temperature originate all the causes which affect local distribution*, namely, food, situation, and migration. Were the climate of this country as unchanging as that of Brazil, the insects which now have only a single brood in the year might then produce several, and the swallow would no longer be obliged to quit us as now, for food in other climates, as soon as our insect season was at an end. Migration and torpidity are equally the effect of temperature; the first depends upon the effect which the changes of the seasons produce in the abundance or scarcity of food, whether animal or vegetable; the latter is a state of inaction during which the necessity for daily nourishment is suspended.

2007. *The migration of birds and of fish* is more extensive than that of quadrupeds. The birds of the Polar regions migrate to Britain during severe winters; while those of Africa come to us, in that season when the southern heats are most intense; but the same species which is migratory in one country is in some cases stationary in another. It is stated that the linnet is migratory in Greenland, but that it is stationary in Britain.

2008. *The torpidity or hybernation of animals* is evidently designed to suspend the necessity of taking food during the winter; although in some cases a small stock of provisions is laid up, most probably to serve for nourishment previously to entire torpidity taking place. Several quadrupeds are subject to this partial suspension of life, as the dormouse, hedgehog, bat, marmot, &c. It is said that birds have sometimes been found in a similar state; but this is very questionable. Among insects, on the contrary, torpidity is very common, and a large proportion, when undergoing transformation, pass a considerable part of their lives in this state.

2009. *Situation has an extensive influence on the local distribution of animals*, although it has little on the geographical distribution of groups. Air, earth, and water have their distinct inhabitants, ich are again restricted to certain situations in their respective elements. The higher regions of the air are frequented by the eagle and falcon tribes; the middle by the air-feeding birds; and the lower by insects which merely jump, or just fly above the ground. The different situations on land, as mountains, plains, woods, marshes, and even sandy deserts, are each peopled by distinct races of beings, whose subsistence is sought for and furnished in peculiar spots. Thus the range of any particular species is seldom or never continuous, or uninterrupted to its confines; but is rather dependent upon local causes, quite unconnected with geographic division. Water is either the total or the partial residence of animals innumerable; but *here* situation has an equal influence; the deeps and the shallows of the ocean, its exposed or sheltered shores, its sandy, rocky, or muddy bottoms, are each the resort of different beings, widely distinct from those residing in the streams, lakes, rivers, and estuaries of fresh waters. It is principally among insects that we find the perfect animal inhabiting a situation different from that which was essential to its existence in an imperfect state. The larvæ of the May-fly, known to the vulgar by the name of case-worm (Trichópteræ *Kirby*), and of all the Libéllulæ live entirely in the water, preying upon other aquatic insects; but as soon as the period of transformation arrives, they crawl on the plants, just above the surface, and bursting the skin, become winged insects, which immediately commence an uninterrupted war upon others in their new element. The larva of the well known *E*phémera is likewise aquatic, and spends nearly all its life in water; but the perfect insect is without jaws, mounts into the air, and seems born but to flutter and die. Many of the Coleóptera pass the first period of their existence entirely underground, others in the trunks of trees; and others again in putrid substances; situations very different from those which they frequent when arrived at maturity. Lepidopterous insects, after emerging from the eggs, undergo three changes, all of which are in situations totally opposite. In the larva state they reach their full dimensions by feeding upon the leaves of vegetables; they next pass into pupæ, and become torpid either above or beneath the surface of the ground; from which they emerge, and again become inhabitants of earth and air as perfect winged insects.

2010. *The rapacity of carnivorous animals* has been considered by some writers to have had a considerable effect on the distribution and even on the extinction of others; but no instance has yet been brought forward in support of this argument, nor does history furnish us with any proof of such having been the case. The fossil remains of those stupendous carnivorous animals which have been discovered of late years, and which existed in the antediluvian world, might have suggested this idea as probable, and that the destruction among a host of smaller animals which would alone have satisfied the hunger of a brood of lizards (like the Plesiosaúrus) forty feet long and six feet high, would soon have extirpated whole tribes; but it must not be forgotten that these gigantic animals belonged to a different creation from that which now covers the earth; and that neither in Africa nor in India, where the present races of carnivorous animals are most abundant, has any change or sensible diminution taken place in the proportion of those upon which they principally feed.

2011. *Man alone has exercised, in various ways, a powerful influence on animals,* and on their distribution: these changes, however, are purely artificial; they have caused the total or partial extinction of some species, and the extension and domestication of others. Against many, hostile to his interests, man carries on a war of extermination, which, as population spreads, is at length effected in particular countries. The wolf, once so abundant in Britain that their heads were received as tribute by our Saxon kings, has for centuries been extirpated from our forests; and a progressive decrease is continually going on among the wild animals, not only of Europe, but of North America. Others, inoffensive in their habits, but valued as food, have been driven from our island. The eyret and crane, as British birds, are no longer known; while the great bustard, which may be called the ostrich of Europe, is now rarely seen; and in all probability (unless its name should be inserted in the game laws), will be totally lost to us in a few years. In like manner that extraordinary bird the dodo (which was the ostrich of Asia) has not been seen for more than a century, and may possibly be no longer in existence. The benefits that have resulted, on the other hand, from the extension and domestication of useful animals are sufficiently known. All the various breeds of our domestic cock have originated from the forests of India, which have likewise furnished Europe with the pheasant and the peacock; the pintado or guinea fowl is of African origin; the horse and domestic ox were unknown in the new world before its discovery by the Spaniards; and the vast island of Australia has been supplied with all its domestic animals from Europe. The turkey is of American origin; and, although nearly extinct in its native forests, is domesticated all over the world. There are doubtless many other animals that might be domesticated, either for use or pleasure; but in a country like this, so variable in its climate, and where land is so valuable, it is much to be feared the necessary experiments will not be made.

2012. *The local distribution of British animals,* however interesting, is too confined a subject to lead to any general or important conclusions regarding the geographic distribution of animals. It is, however, an enquiry that merits attention; and although no one has yet expressly written upon the subject, the observations of White, Montague, and several others will furnish a great deal of valuable information. In arranging the British fauna, all such birds as have been seen apparently as wanderers, and only at long intervals of time, should be excluded, or at least distinctly noticed as accidental visitors; but to introduce the peacock, the domestic cock, and the turkey, into a natural history of British birds, as some have done, is a manifest absurdity; for upon this principle we should include the canary, the gold and silver pheasant, and all other exotic birds which may have accidentally bred in our aviaries.

Chap. VII.

Of the Economical Uses of Animals.

2013. On *the importance of animals* in the arts, as labourers, and as furnishing food, clothing, medicine, and materials for various manufactures, it is needless to enlarge.

2014. *As labourers* the quadrupeds alone are employed; of these the most generally useful in this country are the horse, the ox, and the ass. The excellent carriage roads through most parts of Europe have superseded the necessity, in a great measure, of beasts of burden, although in the mountainous parts of Spain and Italy, and nearly throughout the whole of Sicily, mules alone are employed to convey goods and produce. Such likewise is the case throughout Mexico and Brazil. The camel in Northern Africa, and the elephant in Asia, are no less essential to internal commerce. In the south of Italy, and in the European settlements in Africa, the ox alone is used in drawing carts and waggons, and in all other agricultural operations.

2015. *As articles of food* man employs animals belonging to every class, from the quadruped to the zoophyte. In some cases he makes choice of a part only of an animal, in other cases he devours the whole. He kills and dresses some animals, while he swallows others in a live state. The taste of man exhibits still more remarkable differences of a rational kind. The animals which are eagerly sought after by one tribe, are neglected or despised by another. Even those which are prized by the same tribe in one age, are rejected by their descendants in another. Thus the seals and porpoises, which, a few centuries ago, were eaten in Britain, and were presented at the feasts of kings, are now rejected by the poorest of the people.

2016. *Those quadrupeds and birds which feed on grass or grain* are generally preferred by man to those which subsist on flesh or fish. Even in the same animal, the flesh is not always of the same colour and flavour, when compelled to subsist on different kinds of food. The feeding of black cattle with barley straw has always the effect of giving to their fat a yellow colour. Ducks fed on grain have flesh very different in flavour from those which feed on fish. The particular odour of the fat of some animals seems to pass into the system unchanged, and, by its presence, furnishes us with an indication of the food which has been used. No animals have yet been discovered whose flesh is poisonous, although some few among the fishes and the mollúsca are deleterious to the human constitution at particular seasons.

2017. *The use of skins, as articles of dress*, is nearly coeval with our race. With the progress of civilisation, the fur itself is used, or the feathers, after having been subjected to a variety of tedious and frequently complicated processes. Besides the hair of quadrupeds, and the feathers of birds, used as clothing, a variety of products of the animal kingdom, as bone, shells, pearls, and corals, are employed as ornaments of dress, in all countries, however different in their degree of civilisation.

2018. *Medicine*. The more efficient products of the mineral kingdom have in the progress of the medical art in a great measure superseded the milder remedies furnished by animals and vegetables. The blister-fly, however, still remains without a rival; and the leech is often resorted to, when the lancet can be of no avail.

2019. *The arts*. The increase of the wants of civilised life calls for fresh exertions to supply them, and the animal kingdom still continues to furnish a copious source of materials for the arts. Each class presents its own peculiar offering, and the stores which yet remain to be investigated appear inexhaustible.

Chap. VIII.

Principles of improving the Domestic Animals used in Agriculture.

2020. *The animals in use in British agriculture* are few, and chiefly the horse, ox, sheep, swine, goat, and domestic fowls. The first is used solely as a labouring animal, and the rest chiefly as furnishing food. In applying the general principles of physiology to these animals with a view to their improvement for the use of man, we shall consider in succession the principles of breeding, rearing, and feeding.

Sect. I. *Objects to be kept in View in the Improvement of Breeds.*

2021. *The great object of the husbandman*, in every case, is to obtain the most valuable returns from his raw produce; to prefer that kind of live stock, and that breed of any kind, which will pay him best for the food the animal consumes. The value to which the animal itself may be ultimately brought, is quite a distinct and inferior consideration. (*Gen. Rep. Scot.*, c. xiv.)

2022. *To improve the form rather than to enlarge the size*, in almost every case, ought to be the grand object of improvement. Size must ever be determined by the abundance or scarcity of food, and every attempt to enlarge it beyond that standard must prove unsuccessful, and, for a time, destructive to the thriving of the animals, and the interest of their owners. It is certain that animals, too large or too small, will alike approach to that profitable size which is best adapted to their pastures; but the large animal becomes unhealthy, and degenerates in form, and in all its valuable properties; whereas the small one, while it increases in size, improves in every respect. (*Gen. Rep. Scot.*, c. xiv.)

Sect. II. *Of the Means of improving the Breed of Animals.*

2023. By *improvement of a breed* is to be understood the producing such an alteration in shape or description, as shall render the animal better fitted for the labours he has to perform; better fitted for becoming fat; or for producing milk, wool, eggs, feathers, or particular qualities of these. The fundamental principle of this amelioration is the proper selection of parents. Three theories have obtained notice on this subject; the first in favour of breeding from individuals of the same parentage, called the *in-and-in* system: the second in favour of breeding from individuals of two different offsprings or varieties, called the system of *cross breeding;* and the third in favour of breeding from animals of the same variety, but of different parentage, which may be called *breeding in the line*, or in the same race. As is usual in such cases, none of these theories is exclusively correct, at least as far as respects agricultural improvement; for, as it will afterwards appear, the principles on which a selection for breeding so as to improve the carcass of the animal depends, will lead occasionally to either mode. *Breeding in the same line*, however, is the system at present adopted by what are considered the best breeders.

2024. *The size, form, and general properties* of the inferior animals in a state of nature may be always traced to the influence of soil and climate. Abundance of food, though of a coarse quality, will produce an enlargement of size in an animal which has been compelled to travel much for a scanty supply. Early maturity is also promoted by the same abundance; and if the food is of a better quality, and obtained without fatigue, a tendency to fatten at an early age will be gradually superinduced, and combined with a tameness and docility of temper, a general improvement of form, and a diminished proportion of offal; but at the same time such animals will not be capable of enduring the fatigue and privations to which the less fortunate natives of the mountains of Scotland and Wales are habituated from their earliest age.

2025. *Hardiness of constitution* is one of the most desirable properties of live stock, for districts producing only a very scanty supply of food for winter.

2026. *A barren and mountainous surface and rigorous climate* not only prohibit any considerable improvement in the quantity and quality of its produce, but at the same time prescribe to the husbandman the kind of stock which he must employ for consuming that produce. His cattle and sheep must be in a great measure the creatures of his own mountains and of his own climate. He cannot avail himself of the scientific principles which have so eminently improved the live stock of rich pastures. The most esteemed breeds of England, instead of returning a greater quantity of meat for their food, could not subsist at all upon the mountains of the north. The first object of the Highland farmer is to select animals that will live and thrive upon his pastures. Of two breeds nearly equally hardy, he will no doubt prefer the cattle that will give the most valuable carcass, and the sheep that will return the most money in wool and carcass. He has seldom any considerable extent of land which would fatten any breed; and, if he had, there is no market for it within his reach. With his live stock, as with his crops, he must be determined by his situation; and he would judge very ill, if he should lay aside his oats and big (native barley) for the more valuable but precarious crops of wheat and barley.

2027. *Early maturity* is a most valuable property in all sorts of live stock. With regard to those animals which are fed for their carcasses, it is of peculiar importance that they should become fat at an early age, because they not only sooner return the price of their food with the profits of the feeder, but in general also a greater value for their consumption than slow-feeding animals. A propensity to fatten at an early age is a sure proof that an animal will fatten speedily at any after period of its life.

2028. *Tameness and docility of temper* are desirable properties in most of the domesticated animals. These are also in some degree incompatible with the character of the live stock of mountainous districts, merely because they are necessarily subjected to a very slight degree of domestication, and must search for their food over a great extent of country. When they are reared in more favourable situations, plentifully supplied with food, and more frequently under the superintendence of man, their native wildness is in a great measure subdued. The same treatment which induces early maturity will gradually effect this change.

2029. *The quality of the flesh, the proportion which the fine and coarse parts bear to each other, and the weight of both to that of the offal*, constitute the comparative value of two animals of equal weight, destined to be the food of man. The first of these properties seems to be determined by the breed and food; the second by the form and proportions of the animal; and the third by all these and its degree of fatness. The flesh of well-formed small animals, both of cattle and sheep, is well known to be finer grained, of a better flavour, more intermixed with fat, and to afford a richer gravy than that of large animals, and it brings a higher price accordingly in all the principal markets of the island.

2030. *The desirable properties of animals* are different, according to the purposes to which they are applied. The principal productions of live stock are meat, milk, labour, and wool. A breed of cattle equally well adapted to the butcher, the dairy-maid, and the plough or cart, is nowhere to be found. So far as experience enables us to judge, these properties appear to be inconsistent with one another, and to belong to animals of different forms and proportions. It must be evident, that a description of a well formed animal for fattening will not apply to any of the different varieties of horses. And with regard to sheep, there is reason to suspect that very fine wool cannot be produced by such as have the greatest propensity to fatten, and will return the most meat for the food they consume.

2031. *The chief object of most breeders of cattle and sheep* is their carcass. If a demand for dairy produce, for the labour of oxen, or for fine wool, should hereafter make it his interest to give a preference to any of these commodities, the form and proportions which he studies to obtain, with a view to the greatest produce of animal food, may probably require to be somewhat varied. In the mean time, it is only necessary in this place to notice the shapes which indicate a propensity to fatten in the shortest time, and with the least consumption of food, and to lay the fat on the most valuable parts of the carcass.

2032. *The head* should be fine, clean, and small.

2033. *The collar* full at the breast and shoulders, and tapering gradually to where the neck and head join.

2034. *The breast* broad, and well advanced before the legs.

2035. *The shoulders* wide and full, joining to the collar forward, and the chine backward, so as to leave no hollow in either place.

2036. *The back*, from the shoulders to the tail, broad, flat, and nearly level.

2037. *The chest* full and deep; the ribs rising from the back in a circular form.

2038. *The breadth of the back, and circular form of a deep chest,* are always considered as essential requisites. A flat-ribbed chest, however deep, and large bones, are invariably marks of a slow-feeding animal.

2039. *By a slight touch of the fingers,* a good judge of cattle knows immediately whether an animal will readily make fat or not, and in which part it will be the fattest. The sensation is different from that of softness, being mellow and kindly. This skill, however, is only to be acquired by practice, and the feeling can scarcely be expressed in words. There are several other indications of a propensity to fatten, which, though perhaps not strictly essential, are yet very generally found to accompany it; such as thin ears, hides, and pelts, and small, fine, and straight bones in the legs. Horns are to be chiefly regarded as a criterion for distinguishing one breed from another. A variety of minor circumstances are attended to by skilful breeders, in selecting animals for propagating, to which an unexperienced spectator would attach no importance whatever.

2040. *A breed may be said to be improved,* when some desirable property, which it did not possess before, has been imparted to it, and also when its defects have been removed or diminished, and its valuable properties enhanced. Improvement, in its more extensive application to the live stock of a country, may also be said to be effected, when, by a total or partial change of live stock, the value of the natural produce of the soil is augmented, and a greater quantity of human food and other desirable commodities obtained from it. Whatever may be the merit of that skilful management which is necessary to the formation of a valuable breed, a considerable degree of the same kind of merit may be justly claimed by those, who have introduced and established it in situations where its advantages had never been contemplated, and in which, indeed, the obstacles to its success might have appeared almost insurmountable. The whole of the preceding part of this section is taken from the *General Report of Scotland,* and is understood to contain the sentiments of the best breeders of that country.

2041. That *the breed of animals is improved by the largest males* is a very general opinion; but this opinion, according to some, is the reverse of the truth, and has done considerable mischief. The great object of breeding, by whatever mode, is the improvement of form; and experience has proved that this has only been produced in an eminent degree in those instances in which the females were larger than in the usual proportion of females to males; and that it has generally failed where the males were disproportionably large. (*Culley's Introduction.*) The following epitome of the science of breeding is by the late eminent surgeon, Henry Cline, who practised it extensively on his own farm at Southgate. We present it chiefly because it is the work of an eminent and very scientific man, and because it is almost the only systematic view of the subject produced by a man of science. It is proper at the same time to state that though it is approved and defended by Dr. Coventry at Edinburgh (*Remarks on Live Stock.* Pamph. 8vo. 1806.), it has been, and we believe is now, disapproved of by some eminent practical breeders. (*Farm. Mag.* vol. viii. p. 5.) Mr. Cline's system, however, is translated into most of the continental languages, and has lately been illustrated by M. de Dombasle in France, and M. Hazzi in Bavaria, and others.

2042. *The external form* of domestic animals has been much studied, and the proportions are well ascertained. But the external form is an indication only of internal structure. The principles of improving it must, therefore, be founded on a knowledge of the structure and use of internal parts.

2043. *The lungs* are of the first importance. It is on their size and soundness that the strength and health of animals principally depend. The power of converting food into nourishment is in proportion to their size. An animal with large lungs is capable of converting a given quantity of food into more nourishment than one with smaller lungs; and therefore has a greater aptitude to fatten.

2044. *The chest,* according to its external form and size, indicates the size of the lungs. The form of the chest should approach to the figure of a cone, having its apex situated between the shoulders, and its base towards the loins. Its capacity depends on its form more than on the extent of its circumference; for where the girth is equal in two animals, one may have much larger lungs than the other. A circle contains more than an ellipsis of equal circumference; and in proportion as the ellipsis deviates from the circle, it contains less. A deep chest, therefore, is not capacious unless it is proportionably broad.

2045. *The pelvis* is the cavity formed by the junction of the haunch bones with the bone of the rump. It is essential that this cavity should be large in the female, that she may be enabled to bring forth her young with less difficulty. When this cavity is small, the life of the mother and her offspring is endangered. The size of the pelvis is chiefly indicated by the width of the hips, and the breadth of the waist, which is the space between the thighs. The breadth of the loins is always in proportion to that of the chest and pelvis.

2046. *The head* should be small, by which the birth is facilitated. Its smallness affords other advantages, and generally indicates that the animal is of a good breed. Horns are useless to domestic animals, and they are often a cause of accidents. It is not difficult to breed animals without them. The breeders of horned cattle and horned sheep sustain a loss more extensive than they may conceive; for it is not the horns alone, but also much bone in the skulls of such animals to support their horns, for which the butcher pays nothing; and besides this, there is an additional quantity of ligament and muscle in the neck, which is of small value. The skull of a ram, with its horns, weighed five times more than a skull which was hornless. Both these skulls were taken from sheep of the same age, each being four years old. The great difference in weight depended chiefly on the horns, for the lower jaws were nearly equal; one weighing seven ounces, and the other six ounces and three quarters, which proves that the natural size of the head was the same in both, independent of the horns and the thickness of bone which supports them. In horned animals the skull is extremely thick. In a hornless animal it is much thinner, especially in that part where the horns usually grow. To those who have reflected on the subject, it may appear of little consequence whether sheep and cattle have horns; but on a moderate calculation it will be found, that the loss in farming stock, and also in the diminution of animal food, is very considerable, from the productions of horns and their appendages. A mode of breeding which would prevent the production of these, would afford a considerable profit in an increase of meat, wool, and other valuable parts.

2047. *The length of the neck* should be proportioned to the height of the animal, that it may collect its food with ease.

2048. *The muscles*, and the tendons which are their appendages, should be large; by which an animal is enabled to travel with greater facility.

2049. *The bones*, when large, are commonly considered an indication of strength; but strength does not depend on the size of the bones, but on that of the muscles. Many animals with large bones are weak, their muscles being small. Animals which have been imperfectly nourished during growth have their bones disproportionately large. If such deficiency of nourishment originated from a constitutional defect, which is the most frequent cause, they remain weak during life. Large bones, therefore, generally indicate an imperfection in the organs of nutrition.

2050. *To obtain the most improved form*, continues Mr. Cline, the two modes of breeding described as the in-and-in and crossing modes have been practised. The first mode may be the better practice, when a particular variety approaches perfection in form; especially for those who may not be acquainted with the principles on which improvement depends. When the male is much larger than the female, the offspring is generally of an imperfect form. If the female be proportionately larger than the male, the offspring is of an improved form. For instance, if a well-formed large ram be put to ewes proportionately smaller, the lambs will not be so well shaped as their parents; but if a small ram be put to larger ewes, the lambs will be of an improved form. The proper method of improving the form of animals consists in selecting a well-formed female, proportionately larger than the male. The improvement depends on this principle, that the power of the female to supply her offspring with nourishment is in proportion to her size, and to the power of nourishing herself from the excellence of her constitution. The size of the fœtus is generally in proportion to that of the male parent; and, therefore, when the female parent is disproportionately small, the quantity of nourishment is deficient, and her offspring has all the disproportions of a starveling. But when the female, from her size and good constitution, is more than adequate to the nourishment of a fœtus of a smaller male than herself, the growth must be proportionately greater. The larger female has also a larger quantity of milk, and her offspring is more abundantly supplied with nourishment after birth.

2051. *Abundant nourishment* is necessary to produce the most perfect formed animal, from the earliest period of its existence until its growth is complete. As already observed, the power to prepare the greatest quantity of nourishment from a given quantity of food, depends principally on the magnitude of the lungs, to which the organs of digestion are subservient. To obtain animals with large lungs, crossing is the most expeditious method; because well-formed females may be selected from a variety of large size to be put to a well-formed male of a variety that is rather smaller. By such a mode of crossing, the lungs and heart become proportionately larger, in consequence of a peculiarity in the circulation of the fœtus, which causes a larger proportion of the blood, under such circumstances, to be distributed to the lungs, than to the other parts of the body; and as the shape and size of the chest depend upon that of the lungs, hence arises that remarkably large chest, which is produced by crossing with females that are larger than the males. The practice, according to this principle of improvement, however, ought to be limited; for it may be carried to such an extent, that the bulk of the body might be so disproportioned to the size of the limbs as to prevent the animal from moving with sufficient facility. In animals where activity is required, this practice should not be extended so far as in those which are intended for the food of man.

2052. *The characters of animals*, or the external appearances by which the varieties of the same species are distinguished, are observed in the offspring; but those of the male parent more frequently predominate. Thus in the breeding of horned animals there are many varieties of sheep and some of cattle which are hornless. If a hornless ram be put to horned ewes, almost all the lambs will be hornless; partaking of the character of the male more than of the female parent. In some counties, as Norfolk, Wiltshire, and Dorsetshire, most of the sheep have horns. In Norfolk the horns may be got rid of by crossing with Ryeland rams; which would also improve the form of the chest and the quality of the wool. In Wiltshire and Dorsetshire, the same improvements might be made by crossing the sheep with South Down rams. An offspring without horns, or rarely producing horns, might be obtained from the Devonshire cattle, by crossing with hornless bulls of the Galloway breed; which would also improve the form of the chest, in which the Devonshire cattle are often deficient.

2053. *Examples of the good effects of crossing* may be found in the improved breeds of horses and swine in England. The great improvement of the breed of horses arose from crossing with the diminutive stallions, Barbs and Arabians; and the introduction of Flanders mares into this country was the source of improvement in the br ed of cart-horses. The form of the swine has been greatly improved by crossing with the small Chinese boar.

2054. *Examples of the bad effects of crossing the breed are more numerous.* When it became the fashion in London to drive large bay horses, the farmers in Yorkshire put their mares to much larger stallions than usual, and thus did infinite mischief to their breed, by producing a race of small-chested, long-legged, large-boned, worthless animals. A similar project was adopted in Normandy, to enlarge the breed of horses there, by the use of stallions from Holstein; and, in consequence, the best breed of horses in France would have been spoiled had not the farmers discovered their mistake in time, by observing the offspring much inferior in form to that of the native stallions. Some graziers in the Isle of Sheppy conceived that they could improve their sheep by large Lincolnshire rams; the produce of which, however, was much inferior in the shape of the carcass, and the quality of the wool; and the flocks were greatly impaired by this attempt to improve them. Attempts to improve the animals of a country by any plan of crossing should be made with the greatest caution; for by a mistaken practice, extensively pursued, irreparable mischief may be done. In any country where a particular race of animals has continued for centuries, it may be presumed that their constitution is adapted to the food and climate.

2055. *The pliancy of the animal economy* is such, that an animal will gradually accommodate itself to great vicissitudes in climate, and alterations in food; and by degrees undergo great changes in constitution; but these changes can be effected only by degrees, and may often require a great number of successive generations for their accomplishment. It may be proper to improve the form of a native race, but at the same time it may be very injudicious to attempt to enlarge their size; for the size of animals is commonly adapted to the soil and climate which they inhabit. Where produce is nutritive and abundant, the animals are large, having grown proportionately to the quantity of food which, for generations, they have been accustomed to obtain. Where the produce is scanty, the animals are small, being proportioned to the quantity of food which they were able to procure. Of these contrasts the sheep of Lincolnshire and of Wales are examples. The sheep of Lincolnshire would starve on the mountains of Wales.

2056. *Crossing the breed of animals may be attended with bad effects* in various ways, and that even when adopted in the beginning on a good principle. For instance, suppose some larger ewes than those of the native breed were taken to the mountains of Wales, and put to the rams of that country, if these foreign ewes were fed in proportion to their size, their lambs would be of an improved form, and larger in size than the native animals; but the males produced by this cross, though of a good form, would be disproportionate in size to the native ewes; and, therefore, if permitted to mix with them, would be productive of a starveling, ill-formed progeny. Thus a cross, which at first was an improvement, would, by giving occasion to a contrary cross, ultimately prejudice the breed. The general mistake in crossing has arisen from an attempt to increase the size of a native race of animals; being a fruitless effort to counteract the laws of nature. No attempt to enlarge the size of animals by any mode of breeding will ever succeed without a corresponding change in the quantity and quality of their food, and their means of procuring it without much fatigue. The climate also requires attention. An improved short horn could never arrive at perfection on the scanty and coarse fare, and severe climate, of the Highlands of Scotland. Size, in fact, is a very subordinate consideration. The great object, as observed above (§ 2021.), is to obtain the greatest possible return for the food consumed; and it is only where both the quantity and quality are in great abundance, that large animals, if of a good description, may be preferred to small ones.

2057. *The Arabian horses* are, in general, the most perfect in the world; which probably has arisen from great care in selection, and also from being unmixed with any variety of the same species; the males, therefore, have never been disproportioned in size to the females.

2058. *The native horses of India* are small, but well proportioned, and good of their kind. With the intention of increasing their size, the India company have adopted a plan of sending large stallions to India. If these stallions should be extensively used, a disproportioned race must be the result, and a valuable breed of horses may be irretrievably spoiled.

2059. *From theory, from practice, and from extensive observation,* the last more to be depended on than either, " it is reasonable," Cline continues, " to form this *conclusion:* it is wrong to enlarge a native breed of animals, for in proportion to their increase of size, they become worse in form, less hardy, and more liable to disease." (*Communications to the B. of Ag.*, vol. iv. p. 446.)

2060. *The above opinions* may be considered as supported by the most eminent practical breeders, as Bakewell, Culley, Somerville, Parry, and others; and by most theorists, as Coventry, Darwin, Hunt, Young, &c. T. A. Knight writes in the *Communications to the Board of Agriculture* in favour of cross-breeding, as do Pitt and others in the *County Surveys*, but mostly from very limited experience. Sir J. S. Sebright, in a letter addressed to Sir Joseph Banks, *on improving the breed of domestic animals*, 1809, has taken the opposite side of the question; but the meaning he attaches to the term breeding *in-and-in* is so limited, as to render it a very different sort of breeding from that practised by Messrs. Bakewell and Culley, which has been generally so named and recommended by Cline and others, who favour, rather than otherwise, the in-and-in system.

He says, "Magnell's fox-hounds are quoted as an instance of the success of breeding in-and-in; but upon speaking to that gentleman upon the subject, I found that he did not attach the meaning that I do to the term *in-and-in*. He said that he frequently bred from the father and the daughter, and the mother and the son. This is not what I consider as breeding in-and-in; for the daughter is only half of the same blood as the father, and will probably partake, in a great degree, of the properties of the mother. Magnell sometimes bred from brother and sister; this is certainly what may be called a *little close:* but should they both be very good, and, particularly, should the same defects not predominate in both, but the perfections of the one promise to correct in the produce the imperfections of the other, I do not think it objectionable: much farther than this the system of breeding from the same family cannot, in my opinion, be pursued with safety." (p. 10.) John Hunt, surgeon at Loughborough, a friend of Bakewell and Darwin, in a reply to Sir J. S. Sebright's pamphlet, entitled *Agricultural Memoirs, &c.* 1812, justly observes, that as Sir John has given no definition of the term *in-and-in*, from what may be gathered from the above extract he seems to have been as near as possible of the same mind as Bakewell, whose practice, it is on all sides allowed, was "to put together those animals which were most perfect in shape, without regard to affinity in blood." This, in fact, is the general practice in all the best breeding districts, and especially in Leicestershire and Northumberland, and may properly be termed breeding in the line.

2061. *George Culley*, a Northumberland farmer of great practice in breeding and feeding, in his *Observations on Live Stock*, not only concurs in this principle as far as respects quadrupeds, but considers it to hold good in the feathered tribe, and, in short, in animals of every kind. His conclusion is, "That of all animals, of whatever kind, those which have the smallest, cleanest, finest bones, are in general the best proportioned, and covered with the best and finest grained meat."—"I believe," he adds, "they are also the hardiest, healthiest, and most inclinable to feed; able to bear the most fatigue while living, and worth the most per lb. when dead." (*Observations*, 222.)

2062. *Cross-breeding, under judicious management*, might probably be often employed to correct the faults of particular breeds, or to impart to them new qualities. "Were I," says Sir J. S. Sebright, "to define what is called the art of breeding, I should say, that it consisted in the selection of males and females, intended to breed together, in reference to each other's merits and defects. It is not always by putting the best male to the best female, that the best produce will be obtained; for should they both have a tendency to the same defect, although in ever so slight a degree, it will in general preponderate so much in the produce, as to render it of little value. A breed of animals may be said to be improved, when any desired quality has been increased by art, beyond what that quality was in the same breed in a state of nature. The swiftness of the race-horse, the propensity to fatten in cattle, and the fine wool in sheep, are improvements which have been made in particular varieties of the species to which those animals belong. What has been produced by art must be continued by the same means; for the most improved breeds will soon return to a state of nature, or perhaps defects will arise, which did not exist when the breed was in its natural state, unless the greatest attention be paid to the selection of the individuals who are to breed together.

2063. *We must observe the smallest tendency to imperfection* in our stock, the moment it appears, so as to be able to counteract it, before it becomes a defect; as a rope-dancer, to preserve his equilibrium, must correct the balance, before it is gone too far, and then not by such a motion as will incline it too much to the opposite side. The breeder's success will depend entirely upon the degree in which he may happen to possess this particular talent.

2064. *Regard should not only be paid to the qualities apparent in animals* selected for breeding, but to those which have prevailed in the race from which they are descended, as they will always show themselves, sooner or later, in the progeny: it is for this reason that we should not breed from an animal, however excellent, unless we can ascertain it to be what is called *well bred;* that is, descended from a race of ancestors, who have, through several generations, possessed in a high degree the properties which it is our object to obtain. The offspring of some animals is very unlike themselves; it is, therefore, a good precaution, to try the young males with a few females, the quality of whose produce has been already ascertained: by this means we shall know the sort of stock they get, and the description of females to which they are the best adapted. If a breed cannot be improved, or even continued in the degree of perfection at which it has already arrived, but by breeding from individuals so selected as to correct each other's defects, and by a judicious combination of their different properties (a position that will not be denied), it follows that animals must degenerate, by being long bred from the same family, without the intermixture of any other blood, or from being what is technically called bred in-and-in."

2065. *Bakewell and Culley* say, "like begets like," therefore breed from the best. Of this, says Sir J. S. Sebright, there can be no doubt; "but it is to be proved how long the same family, *bred in-and-in*, will continue to be the best." *Breeding in the line* appears more consonant to what takes place in nature than either breeding from very near relationship or crossing one race with another; but, arguing from analogy, the result of certain experiments, made by T. A. Knight on the vegetable kingdom, seems to justify us in concluding that occasional crossing may become not only advantageous, but even necessary for the purpose of correcting defects. Nevertheless, as the last mentioned writer and Cline observe, it can only be safely resorted to by skilful and experienced breeders. (See the Rev. H. Berry, in *Brit. Farm. Mag.* vols. ii. & iii.)

Sect. III. *Of the General Principles of rearing, managing, and feeding Domestic Animals.*

2066. *Immediately after the birth of every animal*, even of such as are domesticated, the rudiments of its education, as well as its bodily nourishment, are necessarily given by the mother. For this purpose the latter should, during her pregnancy, have been duly protected against all extremes of temperature, well provided with shade and shelter, and abundantly supplied with food and water. When the period of gestation arrives, she should, in general, also be separated from the rest of the flock or herd, and by whatever means the case may demand, kept comfortable and tranquil.

2067. *After the birth*, the first interference on the part of man should be, that of supplying the mother with food of a light and delicate quality, compared with that which she had been in the habit of using, and also of administering the same description of food to the offspring, as far as it may by its nature be able to use it. The gentlest treatment should accompany these operations; and the opportunity taken of familiarising both parent and offspring with man, by gently caressing them, or at least by familiar treatment on the part of the attendant.

2068. *As the animals increase in size and strength*, they should have abundance of air, exercise, and food, according to their natures; and whatever is attempted by man in the way of taming or teaching should be conducted on mild and conciliating principles, rather than on those of harshness and compulsion. Caresses, or familiar treatment, should generally be accompanied by small supplies of food, at least at first, as an inducement to render the animal submissive to them; afterwards habit will, even in the inferior creation, render the familiarities of man agreeable to them for their own sake; but even then, to keep up this feeling, small portions of select food should frequently be employed as a reward. By contrasting this method with that of taming or teaching animals by fear or compulsion, the advantages of the former mode will be evident.

2069. *Interest is the grand mover of the lower animals* as well as of man. In taming by fear all the interest which the animal has is the avoiding of an evil; in taming by caresses and food it is the attainment of enjoyment. The most extraordinary results are recorded as having been obtained by the mild mode, with almost every species of animal on which it has been tried: to this may be advantageously joined, in the more powerful animals, hunger and fatigue. "The breeder Bakewell, Surgeon Hunt informs us, at an advanced period of life, not only conquered a vicious restive horse, but, without the assistance of either grooms or jockeys, taught this horse to obey his verbal orders with as great attention as the most accomplished animal that was ever educated at Astley's school. Bakewell was accustomed to say, that his horse could do every thing but speak. The method which he took to conquer this vicious animal was never told, even to his own domestics. He ordered his own saddle and bridle to be put on this horse, which at that time was thought to be ungovernable, when he was prepared for a journey of two or three hundred miles; and, that no one might be witness to the contest, he led the horse till he was beyond the reach of observation. How far he walked, or in what manner this great business was accomplished, was never known; but, when he returned from his journey, the horse was as gentle as a lamb, and would obey his master's verbal orders on all occasions. When what are called irrational animals are taught such strict obedience to the command of a superior order, it is in general supposed to be the effect of fear; but Bakewell never made use of either whip or spur. When on horseback he had a strong walking-stick in his hand, which he made the most use of when on foot; he always rode with a slack rein, which he frequently let lie upon the horse's neck, and so great was his objection to spurs, that he never wore them. It was his opinion that all such animals might be conquered by gentle means; and, such was his knowledge of animal nature, that he seldom failed in his opinion, whether his attention was directed to the body or the mind." (*Agr. Mem.*, p. 127.)

2070. *The purposes for which animals are fed or nourished* are for promoting their enlargement or growth; for fitting them for labour; for the increase of certain animal products; or for fattening them for slaughter as human food. We shall confine our remarks to the last purpose as being the most important, and as necessarily including much of what belongs to the three others. In the fattening of cattle the following points require to be attended to: abundance of proper food, a proper degree of heat, protection against extremes of weather, good air and water, moderate exercise, tranquillity, cleanliness, comfort, and health.

2071. *Food*, though it must be supplied in abundance, ought not to be given to satiety. Intervals of resting and exercise must be allowed according to circumstances. Even animals grazing on a rich pasture have been found to feed faster when removed from it once a day, and either folded or put in an inferior pasture for two or three hours. Stall-fed cattle and swine will have their flesh improved in flavour by being turned out into a yard or field once a day; and many find that they feed better, and produce better-flavoured meat, when kept loose under warm sheds or hammels, one or two in a division, a practice now very general in Berwickshire. (See *Hammel.*) Coarser food may be first given to feeding animals; and, as they acquire flesh, that which is of more solid and substantial quality. In general it may be observed, that if the digestive powers of the animal are in a sound state, the more food he eats the sooner will the desired result be obtained; a very moderate quantity beyond sufficiency constitutes abundance; but, by withholding this additional quantity, an animal, especially if young, may go on eating for several years, without ever attaining to fatness. Properly treated, a well fed ox, of moderate size, will fatten on a rich pasture in from four to six months; and, in stalls or covered pens, with green or steamed food, in a shorter period.

2072. *In young, growing animals* the powers of digestion are so great that they require less rich food than such as are of mature age; for the same reason, also, they require more exercise. If rich food is supplied in liberal quantities, and exercise withheld, diseases are generated, the first of which may be excessive fatness; growth is impeded by very rich food, for experience shows that the coarsest-fed animals have uniformly the largest bones. Common sense will suggest the propriety of preferring a medium course between very rich and very poor nutriment.

2073. *Mastication and cooking.* Unless food be thoroughly deprived of its vegetative powers before it enters the stomach, the whole nourishment which it is capable of affording cannot be derived from it. In the case of the leaves and stalks of vegetables, this is in general effected by mastication; but it requires some care to accomplish it in the case of grains. Hence the advantage of mixing corn given to horses or cattle with chaff or chopped straw; and hence it is supposed by some, that the instinct which fowls have to swallow small stones is intended by nature for the same object. But the most effectual mode of destroying the living principle is by the application of heat; and if vegetable food of every kind could be steamed or boiled before it was given to animals (at least in winter, and for fattening for the shambles, or feeding for milk), it is rendered probable, by analogy and experiment, that much more nourishment would be derived from it.

2074. *Salt*, it appears, from various experiments, may be advantageously given to most animals in very small quantities; it acts as a whet to the appetite, promotes the secretion of bile, and, in general, is favourable to health and activity. In this way only can it be considered as preventing or curing diseases; unless perhaps in the case of worms, to which all saline and bitter substances are known to be injurious.

2075. *That degree of heat* which is natural to animals in their original country, or has become so by habit and the breeding for successive generations in a cold climate, is necessary to their wellbeing; and a somewhat increased degree in the cold months, or diminished degree in such as are oppressively warm, is advantageous in the fattening process. Where a sufficient degree of warmth to promote the ordinary circulation of the blood is not produced by the natural climate, or by exercise, it must be supplied by an artificial climate. Houses and sheds are the obvious resources both for this purpose, and for protection from *extremes of weather*. Cold rains and northerly winds are highly injurious, by depriving the external surface of the body of caloric, more rapidly than it can be supplied from within by respiration, and the action of the stomach; and also by contracting the pores of the skin, so as to impede circulation. When an animal happens to shed its covering, whether of hair, wool, or feathers, at such inclement seasons, the effects on its general health are highly injurious. The excessive heats of summer, by expanding all the parts of the animal frame, occasion a degree of lassitude, and want of energy, even in the stomach and intestines; and while the animal eats and digests less food than usual, a greater waste than usual takes place by perspiration. Nature has provided trees, rocks, caverns, hills, and waters, to moderate these extremes of heat and weather; and man imitates them by hovels, sheds, and other buildings, according to particular circumstances.

2076. *Good air and water* it may seem unnecessary to insist on; but cattle and horses, and even poultry, pent up in close buildings, where there are no facilities for a change of the atmosphere, often suffer on this account. A slight degree of fever is produced at first, and, after a time, when the habit of the animal becomes reconciled to such a state, a retarded circulation, and general decay or diminution of the vital energies, take place.

2077. *Water ought to be soft and pure*, as being a better solvent than such as is *hard* and charged with earthy particles. It ought to be of a moderate temperature, under that of the open air in hot weather, and exceeding it in winter. Deep wells afford this difference. In particular cases, as in those of animals in a suckling state or milked by man, warmed water has been found advantageous. Meals, or other light rich matters, are sometimes mixed with it; but it does not clearly appear, except in the last case, that liquid food is so generally advantageous for fattening animals, as that which being equally rich is solid. Some judgment is requisite as to the time most proper for giving water to animals. In general, it does not appear necessary to supply it immediately after eating, for animals in a natural state, or pasturing in a field, generally lie down after filling themselves, and after the process of digestion seems to have gone on for some time, they go in quest of water. Perhaps the immediate dilution of food, after being taken into the stomach, with water, may, at the same time, weaken the digestive powers, by diluting the gastric juice. At all events, the free use of water at any time, but especially during meals, is found to weaken digestion in the human species. As animals of every kind become reconciled to any habit, not ultimately injurious to health, perhaps for housed animals a stated quantity of water, given an hour, or an hour and a half after what may be called their meals, may be the best mode.

2078. *Moderate exercise* ought not to be dispensed with, where the flavour of animal produce is any object; it is known to promote circulation, perspiration, and digestion, and by consequence to invigorate the appetite. Care must be taken, however, not to carry exercise to that point where it becomes a labour instead of a recreation. In some cases, as in feeding swine and poultry, fatness is hastened by promoting sleep, and preventing motion rather than encouraging it: but such animals cannot be considered healthy-fed; in fact, their fatness is most commonly the result of disease.

2079. *Tranquillity* is an obvious requisite, for where the passions of brutes are called into action, by whatever means, their influence on their bodies is often as great as in the human species. Hence the use of castration, complete or partial separation, shading from too much light, protection from insects, dogs, and other annoying animals, and from the too frequent intrusion of man.

2080. *Cleanliness* is favourable to health, by promoting perspiration and circulation. Animals in a wild state attend to this part of their economy themselves; but, in proportion as they are cultivated, or brought under the control of man, this becomes out of their power; and to insure their subserviency to his wishes, this part of culture, as well as others, must be supplied by art. Combing and brushing stall-fed cattle and cows are known to contribute materially to health; though washing sheep with a view to cleaning the wool often has a contrary effect, from the length of time the wool requires to dry. This often brings on colds, and aggravates the liver complaint, so incident to these animals. Bathing or steeping the feet of stalled animals occasionally in warm water would no doubt contribute to their health. Bathing swine two or three times a week in hot water, as in that used for boiling or steaming food, has been found a real advantage.

2081. *Comfort.* An animal may be well fed, lodged, and cleaned, without being comfortable in every respect; and in brutes, as well as men, want of comfort operates on the digestive powers. If the surface of a stall, in which an ox or a horse stands, deviates much from a level, he will be continually uneasy; and he will be uneasy during night, if its surface is rough, or if a proper bed of litter is not prepared every evening for him to repose on. The form of racks and mangers is often less commodious than it might be. A hay rack which projects forward is bad; because the animal in drawing out the hay is teased with the hay seeds falling into its eyes or ears; and this form, it may be added, is apt to cause the breath of the animal to ascend through its food, which must after a time render it nauseous. For this reason hay should lie as short a time as possible in lofts, but when practicable be given direct from the rick. Poultry of different kinds are often crowded together, without any regard to the comfort of the particular kinds by attending to their peculiarities, such as a smooth or soft floor for the web feet of the duck tribe, or the proper size of roosting sticks for the grasping-toed feet of the other tribes. Even the crowing of the cock must cause some degree of irritation, and consequently impede health and fattening by disturbing the repose of quiet fowls, such as the turkey or goose. Various other instances will occur to a reflecting mind; and surely it must be a duty as agreeable as it is conducive to our own interest, to promote as much as possible the comfort of those animals whose lives are shortly to be sacrificed for ours.

2082. *Health.* A good state of health will, in general, be the result of the mode of feeding and treatment which we have described; but in proportion as our treatment, either of ourselves or other animals, is refined and artificial, in the same proportion are the functions of nature liable to derangement or interruption from atmospherical changes, and various accidental causes. When this takes place, recourse must be had to art for relief. This is an obvious, natural, and reasonable practice; though some contend that as every disease is only an effort of nature to relieve the being from some evil, it ought to be left to itself. To treat animals when in health artificially, and the moment when they become diseased to abandon them to nature, is a proposition so incongruous and absurd, that one would suppose it would be rejected by the common sense of mankind. There are, however, some solitary instances of medical men having adopted this opinion; but the melancholy result of their acting on it in the human species, as well as its utter rejection by all rational professors, and men in general, has reduced it to its intrinsic value. There may be much of quackery in medicine; and unquestionably there is a great deal in the art, as applied to the brute creation by common practitioners: but to reject the medical art altogether, becomes, on the other hand, a species of quackery just as despicable as the other, and not less dangerous; for it cannot be much better for a patient to be left to die through neglect than to be killed by overmuch care.

2083. *Farriery, as applied to cattle and sheep*, is a department of medicine in which perhaps greater ignorance prevails than in any other. The subject, as applied to horses, has, since the establishment of veterinary schools in this country, and in France, become better understood; but the pupils from these establishments are so thinly scattered, that as Laurence (veterinary surgeon, and author of a *Treatise on Horses*) observes, it were desirable that country surgeons should in their different localities give instructions to the empirical local practitioners in the country, and to intelligent bailiffs; and that gentlemen of property might have such a sense of their own interest as to call in a surgeon in all cases of the least difficulty. All that we can here do is to repeat our advice of studying the art of prevention rather than of cure; to suggest that, in general, an analogy subsists between the constitution and diseases of the human and brute creation; to avoid recipes and specific cures, rarely to bleed animals, unless by regular advice; and to confine as much as possible the operations of cow-doctors and smiths to giving warm drinks, gentle purges, and clysters, which can seldom do any harm. Proprietors who can afford to employ intelligent bailiffs, or rather who give such men considerable salaries, should ascertain previously to hiring them, by means of general questions, or by reference to a professor, whether they know any thing of the subject. By thus creating a demand for this species of knowledge, it would soon be produced in abundance.

Sect. IV. *Of Feeding for Extraordinary Purposes.*

2084. *The extraordinary purposes of feeding* may comprehend, promoting the growth, maturity, or obesity of particular parts of the body; promoting the produce of milk or eggs; or, fitting an animal for hard labour or long journeys, fasting, and other privations.

2085. *Feeding for extraordinary purposes,* such as promoting the growth of the liver in geese; the heart in turkeys; producing excessively fat poultry, &c., seems to us utterly unjustifiable on principles of humanity, and unworthy of enlightened men. The practice of pulling out the animal's eyes, nailing it to the spot, and cramming or forcing the food down its throat, is surely as repugnant to good taste and feeling, as the food so produced must be tasteless and unwholesome. Putting out the eyes of certain singing birds to improve their voice, and some practices in the rearing of game cocks, and fancy pigeons (at least the first two) seem equally reprehensible.

2086. *The fattening of fowls for the London market* is a considerable branch of rural economy in some convenient situations. "They are put up in a dark place, and *crammed* with a paste made of barley meal, mutton suet, and some treacle or coarse sugar, mixed with milk, and are found to be completely ripe in a fortnight. If kept longer, the fever that is induced by this continued state of repletion renders them red and unsaleable, and frequently kills them." (*Agricultural Report of Berkshire, by William Mavor, LL.D.* 8vo. London, 1813.) But fowls brought to this state of artificial obesity are never so well flavoured in the flesh, and probably not so salubrious as those of the same species fattened in a more natural way. The great secret of having fine pullets is cleanliness, and high keeping with the best corn.

2087. *The process followed in different parts of France to enlarge the liver* is described at length by Sonnini. (*Nouveau Dictionnaire d'Histoire Naturelle,* art. *Oie.*) The object is to cause the whole vital forces to be determined towards this part of the animal, by giving it a kind of hepatic cachexy. In Alsace, the individual buys a lean goose, which he shuts up in a small box, so tight that it cannot turn in it. The back part of the bottom is furnished with a wide grating of rods, for the passage of the dung. In the fore part there is a hole for the head, and below it a small trough is kept always full of water, in which some pieces of wood charcoal are left to steep. A bushel of maize is enough to feed it during a month, at the end of which time the goose is sufficiently fattened. A thirtieth part is soaked in water each night, and crammed down its throat next day, morning and evening. The rest of the time it drinks and guzzles in the water. Towards the 22d day, they mix with the maize some poppy oil, and, at the end of the month, it is known by a lump of fat under each wing, or rather by the difficulty of breathing, that it is time to kill it, otherwise it will die of fat. The liver is then found weighing one or two pounds, and, besides, the animal is excellent for the table, and furnishes, during its roasting, from three to five pounds of fat, which is used in the cooking of vegetables. Of six geese, there are commonly only four (and these are the youngest) which answer the expectation of the fattener. They are kept in a cellar, or cool place with little light. The temperature most favourable for fattening is between 30° and 40° Fahrenheit, so that it is only practised during the latter part of the autumn, the winter, and the early part of spring. The process was examined in detail by us at Strasbourg in October 1828, and will be found noticed in the account of the tour which we made in that year, in the 5th volume of the *Gardener's Magazine.*

2088. *The Roman epicures,* who prized the livers of geese, had already observed, that darkness was favourable to this practice; no doubt, because it prevents all distraction, and directs the whole powers towards the digestive organs. The want of motion, and the difficulty of respiration, may be also taken into consideration; the first from its diminishing the waste of the system, and both from their retarding the circulation in the vena portarum, of which the blood ought to become hydrogenated, in proportion as its carbon unites itself to the oxygen which that liquid absorbs. This favours the formation of the oily juice, which, after having filled the cellular system of the body, enters into the biliary system and substance of the liver, and gives it that fatness and size which is so delightful to the palates of true gourmands. The liver thus only becomes enlarged consecutively, and the difficulty of respiration does not appear till the end, when its size prevents the action of the lungs. Among a hundred fatteners, there are scarcely two who adopt the practice of putting out the eyes of the geese, and even these do not resort to this barbarous practice till a day or two before they are killed; and, therefore, the geese of Alsace, which are free from these cruel operations, acquire a prodigious fatness, which may be called an oleaginous dropsy, the effect of a general atony of the absorbents, caused by want of exercise, combined with succulent food crammed down their throats, and in an under-oxygenated atmosphere. (*Encyc. Brit. Sup.*, art. *Food.*)

2089. *Early lamb.* As an instance of both breeding and feeding for extraordinary purposes, we may mention the practice of those farmers who furnish the tables of the wealthy with lamb, at almost every season of the year, by selecting certain breeds of sheep, such as the Dorsetshire, which lamb very early, or by treating them in such a way as to cause the female to come in heat at an unnatural time. In this way, lamb is procured as an article of luxury, as early as November and December; and, on the contrary, by keeping the ewe on a cold and poor hilly pasture, the lambing season is retarded, and lamb furnished in September and October.

2090. *Feeding for promoting the produce of milk or eggs.* That which in plants or animals is produced for particular purposes in nature may, by certain modes of treatment, be rendered, for a time, a habit in the plant or animal, without reference to its natural end. Thus in many cases annual plants may be rendered perennial by continually pinching off their flowers as they appear; and animals which give milk or lay eggs may be made to produce both for a much longer time than is natural to them, by creating a demand in their constitutions for these articles, by frequent and regular milkings, and by taking away every egg as soon as produced; and then, by appropriate food, furnishing the constitution with the means of supplying this demand, by rich liquid food, in the case of milking animals, and by dry, stimulating, and nourishing food, in the case of poultry.

2091. *Feeding to fit animals for hard labour or long journeys.* It seems agreed on, that dry rich food is the best for this purpose; and that very much depends on rubbing, cleaning, and warmth, in the intervals between labour and rest, in order to maintain something of the increased circulation; and, in short, to lessen the influence of the transition from the one to the other. The quantity of water given should never be considerable; at least in cold countries and seasons. (See *Horse*, in *Contents* or *Index.*)

Sect. V. *Of the Modes of killing Animals.*

2092. *The mode of killing animals has considerable effect on the flesh of the animal.* Most of those slaughtered for food are either bled to death, or are bled profusely immediately after being deprived of life in some other way. The common mode of killing cattle in this kingdom is, by striking them on the forehead with a pole-axe, and then cutting their throats to bleed them. But this method is cruel, and not free from danger. The animal is not always brought down by the first blow, and the repetition is difficult and uncertain; and, if the animal be not very well secured, accidents may happen. Lord Somerville (*General Survey of the Agriculture of Shropshire, by Joseph Plymley, M. A.*, 8vo. London, 1803, p. 243.) therefore endeavoured to introduce the method of pithing or laying cattle, by dividing the spinal marrow above the origin of the phrenic nerves, as is commonly practised in Barbary, Spain, Portugal, Jamaica, and in some parts of England; and Jackson says, that the " best method of killing a bullock is by thrusting a sharp-pointed knife into the spinal marrow, when the bullock will immediately fall without any struggle, then cut the arteries about the heart." (*Reflections on the Commerce of the Mediterranean, by John Jackson, Esq. F. S. A.*, 8vo. London, 1804, p. 91.) Although the operation of pithing is not so difficult but that it may, with some practice, be performed with tolerable certainty; and although Lord Somerville took a man with him to Portugal to be instructed in the method, and made it a condition that the prize cattle at his exhibitions should be pithed instead of being knocked down, still pithing is not becoming general in Britain. This may be partly owing to prejudice; but we have been told that the flesh of the cattle killed in this way in Portugal is very dark, and becomes soon putrid, probably from the animal not bleeding well, in consequence of the action of the heart being interrupted before the vessels of the neck are divided. It therefore seems preferable to bleed the animal to death directly, as is practised by the Jew butchers.

2093. *Du Gard's observations on pithing* deserve attention. This gentleman, a surgeon of the Shrewsbury Infirmary, after mature consideration, is against the practice, as causing more pain than it is intended to avoid. He says, " Pain and action are so generally joined, that we measure the degree of pain by the loudness of the cries, and violence of the consequent exertion; and therefore conclude, on seeing two animals killed, that the one which makes scarcely a struggle, though it may continue to breathe, suffers less than that which is more violently convulsed, and struggles till life is exhausted. It appears, however, that there may be acute pain without exertion, perhaps as certainly as there is action without pain; even distortions that at the first glance would seem to proceed from pain, are not always really accompanied with sensation. To constitute pain there must be a communication between the injured organ and the brain."

2094. *In the old method of slaughtering*, a concussion of the brain takes place, and therefore the power of feeling is destroyed. The animal drops, and although convulsions take place generally longer and more violent than when the spinal marrow is divided, yet there is, I think, reason to believe that the animal suffers less pain. The immediate consequence of the blow is the dilatation of the pupil of the eye, without any expression of consciousness or fear on the approach of the hand.

2095. From all these circumstances, Du Gard concludes that *the new method of slaughtering cattle is more painful than the old.* The puncture of the medulla spinalis does not destroy feeling, though it renders the body quiescent, and in this state the animal both endures pain at the punctured part, and suffers, as it were, a second death, from the pain and faintness from loss of blood in cutting the throat, which is practised in both methods. Sir Everard Home, in a valuable paper (*Shrew. Rep.*, p. 250.) has suggested a mode of performing the operation, which would answer completely, could we be sure of having operators sufficiently skilful; but we may the less regret the difficulty of getting new modes established when we thus see the superiority of an old custom under very improbable circumstances; and if well meaning reformers wanted any additional motives to care and circumspection, a very forcible one is furnished in the instance of the time and trouble taken to introduce this operation, which, as it has been hitherto practised, is the very reverse of what was intended.

2096. *Jewish modes.* The Mosaic law so strictly prohibits the eating of blood, that the Talmud contains a body of regulations concerning the killing of animals; and the Jews, as a point of religion, will not eat the flesh of any animal not killed by a butcher of their own persuasion. Their method is to tie all the four feet of the animal together, bring it to the ground, and, turning its head back, to cut the throat at once down to the bone, with a long, very sharp, but not pointed knife, dividing all the large vessels of the neck. In this way the blood is discharged quickly and completely. The effect is indeed said to be so obvious, that some Christians will eat no meat but what has been killed by a Jew butcher. Calves, pigs, sheep, and lambs, are all killed by dividing at once the large vessels of the neck.

2097. *Animals which are killed by accident*, as by being drowned, hanged, or frozen, or by a fall, or ravenous animal, are not absolutely unwholesome. Indeed, they only differ from those killed methodically in not being bled, which is also the case with animals that are snared, and with those killed by hounds. Animals which die a natural death should never be eaten, as it is an undeniable instance of disease, and even death to the consumer being the consequence.

2098. *Animals frequently undergo some preparation before they are killed.* They are commonly kept without food for some time, as if killed with full stomachs their flesh is considered not to keep well. Oxen are commonly made to fast for two or three days, smaller animals for a day; but it is evident that the practice must not be carried too far, as the opposite effect will be produced by the animal falling off or getting feverish. Dr. Lister has stated that nothing contributes more to the whiteness and tenderness of the flesh of calves than often bleeding them, by which the colouring matter of the blood is exhausted, and nothing but colourless serum remains. A much more cruel method of preparation for slaughter used to be practised, though now much less frequently, in regard to the bull. By some ancient municipal laws, no butcher was allowed to expose any bull beef for sale unless it had been previously baited. The reason of this regulation probably was, that baiting had the effect of rendering the flesh or muscular fibre much more tender; for it is a universal law of the animal economy that, when animals have undergone excessive fatigue immediately before death, or have suffered from a lingering death, their flesh, though it becomes sooner rigid, also becomes sooner tender than when suddenly deprived of life in a state of health. The flesh of hunted animals also is soon tender and soon spoils (*Recherches de Physiologie et de Chimie Pathologique, par P. N. Nysten.* 8vo. Paris, 1811); and it is upon this principle only, that the quality of pig's flesh could be improved by the horrid cruelty, said to be practised by the Germans, of whipping the animal to death.

BOOK III.

OF THE STUDY OF THE MINERAL KINGDOM AND THE ATMOSPHERE, WITH REFERENCE TO AGRICULTURE.

2099. The nature of the vegetable and animal kingdom having undergone discussion, the next step in the study of the science of agriculture is to enquire into *the composition and nature of material bodies, and the laws of their changes.* The earthy matters which compose the surface of the globe, the air and light of the atmosphere, the water precipitated from it, the heat and cold produced by the alternation of day and night, and by chemical composition and resolution, include all the elements concerned in vegetation. These elements have all been casually brought into notice in the study of the vegetable kingdom; but we shall now examine more minutely their properties, in as far as they are connected with cultivation. To study them completely, reference must be had to systems of chemistry and natural philosophy, of which those of Dr. Thomson (*System of Chemistry*) and Dr. Young (*Lectures on Natural Philosophy*) may be especially recommended.

Chap. I.

Of Earths and Soils.

2100. *Earths are the productions of the rocks* which are exposed on the surface of the globe, *and soils are earths mixed with more or less of the decomposed organised matter afforded by dead plants and animals.* Earths and soils, therefore, must be as various as the rocks which produce them ; and hence to understand their nature and formation it is necessary to begin by considering the geological structure of the territorial surface, and the manner in which earths and soils are produced. We shall next consider in succession the Nomenclature, Quality, Use, and Improvement of Soils.

Sect. I. *Of the Geological Structure of the Globe and the Formation of Earths and Soils.*

2101. *The crust of our earth,* when examined, will be found to be composed of various stony bodies, differing in their structure and composition. Some of these are arranged in *strata* of greater or less regularity, and more or less inclined to the horizon ; others show no marks of stratification, but constitute large mountain masses, without any definite shape, or fill up fissures in other rocks, forming *veins.* Some rocks show an evident compound or aggregated structure ; others appear, to the naked eye, of a uniform texture : some stony bodies contain undoubted remains of animals and vegetables, which chiefly belong to species of organised beings no longer known to exist in a living state ; other rocks are always destitute of every trace of organised remains. These peculiarities have given rise to different classifications of rocks. One sect of geologists divide rocks into *simple* and *compound ;* and again subdivide these classes according as the structure of the rock is *compact, granular, slaty, porphyritic,* or *amygdaloidal.* The greatest number of geologists, however, are not satisfied with that arrangement, but have ventured to speculate on the relative age or era of the formation of the different kinds of rock. The data on which they proceed are, chiefly, the presence or absence of organic remains, and the superposition of one kind of rocky bed on another. All geologists are agreed in considering stratified rocks as arranged and deposited by the agency of water, and therefore the relative age of such rocks may be generally inferred from their relative position ; but philosophers differ both with regard to the origin and era of the unstratified rocks, and also of the minerals which occupy veins. It is not our business here to enter into this discussion, but we shall content ourselves by a slight sketch of the most generally received arrangement of rocks, which, though it involves theoretic considerations, is convenient to the student of mineralogy. The crust of our globe may be considered as composed of five series of rocks : primitive, transition, floëtz, alluvial, and volcanic.

2102. *Primitive rocks.* These, from the absence of organic remains, are conceived to have been deposited, in their present situation, before the creation of animals, and, from most usually lying below other rocks, are supposed to be the most ancient. Of these the chief species are *granite* (including *syenite*), *gneiss, mica slate* (including *talc slate*), *clay slate, primitive limestone, primitive trap, serpentine, quartz rock,* and some kinds of *porphyry.*

2103. *Rocks of transition.* In these a few organic remains occur, but neither frequently nor in large quantity. They are supposed to have obtained their present form during the transition of the surface of the earth from a *chaotic* to a habitable state. The principal members of this series are *greywacke,* one kind of *limestone,* and occasionally most of the rocks of the first series.

2104. *Floëtz rocks* are so named from their generally occurring in nearly horizontal strata. They were formerly termed *secondary,* in contradistinction to the primitive series, and they constitute the *terrain secondaire* of the French geologists. The principal rocks of this class are sandstone or freestone, which appears to be of different ages, though comprehended still in the floëtz series ; *limestone* (including *alpine limestone, magnesian limestone, oölite, chalk, gypsum.* and the calcareous beds of the *Paris basin*), *coal,* and the accompanying rocks of our great coal-fields ; trap rocks, including basalt, wacke, and the great body of kindred rocks, which often form the summits of considerable hills.

2105. *Alluvial deposits,* chiefly consisting of beds of clay, sand, gravel, and some cemented rocks. The first three formations appear to be universally distributed over the globe, and are supposed to owe their formation to causes acting before the land had yet appeared above the waves. The alluvial formations are conceived to be produced by the action of water on the rocks already mentioned.

2106. *Volcanic rocks.* Of this series different kinds of lava, scoria, puzzuolana, &c., are undoubted members ; and most geologists now include in it certain varieties of *trap, trachyte, obsidian,* and *pumice ;* while others are disposed to consider all trap rocks, and even granite, as the products of either recent or ancient volcanic fire, acting under the modifying circumstance of pressure. All the members of these formations are not every where to be found: sometimes one or more species of rock may be wanting in the series; but a skilful geologist can generally detect a wonderful degree of regularity in the superposition of strata, which, to an unpractised eye, present only a mass of confusion.

2107. *The relative situation of these rocks* in Britain is as follows: The primitive rocks are usually observed constituting a portion of the most elevated parts of the surface of the earth; the rocks of transition usually form the less elevated ridges; the floëtz rocks, with alluvial matter, generally constitute the bases of plains, or of an *undulated* country. The two latter formations constitute by far the greatest portion of England and the low parts of Scotland: the mountains of Cumberland and Wales are chiefly composed of rocks of transition, while Cornwall and the Highlands of Scotland have generally a basis of primitive rocks, over which some rocks of the transition series are occasionally *superimposed.*

2108. The *original* authorities for the geological distribution of English strata are *Smith's Map and Sections; Greenough's Map; Coneybeare's and Phillips's Geology of England; Sedgewicke's* papers in the *Geological Transactions; Webster's Isle of Wight,* &c. These are all authorities of weight with mineralogists.

2109. *The surface earth,* or that which forms the outer coating of the dry parts of the globe, is formed by the detritus, or worn off parts of rocks and rocky substances. For in some places, as in chasms and vacuities between rocky layers or masses, earth occupies many feet in depth; and in others, as on the summits of chalk hills or granite mountains, it hardly covers the surface.

2110. *Earths are therefore variously composed,* according to the rocks or strata which have supplied their particles. Sometimes they are chiefly formed from slate-rocks, as in blue clays; at other times from sandstone, as in silicious soils; and mostly of a mixture of clayey, slaty, and limestone rocks, blended in proportions as various as their situations. Such we may suppose to have been the state of the surface of the dry part of the globe immediately after the last disruption of its crust; but in process of time the decay of vegetables and animals forms additions to the outer surface of the earths, and constitute what are called *soils;* the difference between which and earths is, that the former always contain a portion of vegetable or animal matter.

2111 *The manner in which rocks are converted into soils,* Sir H. Davy observes (*Elem. of Agric. Chem.,* 188.), may be easily conceived by referring to the instance of soft granite, or porcelain granite. This substance consists of three ingredients, quartz, feldspar, and mica. The quartz is almost pure silicious earth in a crystalline form. The feldspar and mica are very compounded substances; both contain silica, alumina, and oxide of iron; in the feldspar there is usually lime and potassa; in the mica, lime and magnesia. When a granite rock of this kind has been long exposed to the influence of air and water, the lime and the potassa contained in its constituent parts are acted upon by water or carbonic acid; and the oxide of iron, which is almost always in its least oxidised state, tends to combine with more oxygen: the consequence is, that the feldspar decomposes, and likewise the mica; but the first the most rapidly. The feldspar, which is as it were the cement of the stone, forms a fine clay: the mica, partially decomposed, mixes with it as sand; and the undecomposed quartz appears as gravel, or sand of different degrees of fineness. As soon as the smallest layer of earth is formed on the surface of a rock, the seeds of lichens, mosses, and other imperfect vegetables which are constantly floating in the atmosphere, and which have made it their resting-place, begin to vegetate; their death, decomposition, and decay, afford a certain quantity of organisable matter, which mixes with the earthy materials of the rock; in this improved soil more perfect plants are capable of subsisting; these in their turn absorb nourishment from water and the atmosphere; and, after perishing, afford new materials to those already provided: the decomposition of the rock still continues; and at length, by such slow and gradual processes, a soil is formed in which even forest trees can fix their roots, and which is fitted to reward the labours of the cultivator.

2112. *The formation of peaty soils* is produced from very opposite causes, and it is interesting to contemplate how the same effect may be produced by different means, and the earth which supplies almost all our wants may become barren alike from the excessive application of art, or the utter neglect of it. Continual pulverisation, and cropping, without manuring, will certainly produce a hungry barren soil; and the total neglect of fertile tracts will, from their accumulated vegetable products, produce peat soils and bogs. Where successive generations of vegetables have grown upon a soil, Sir H. Davy observes, unless part of their produce has been carried off by man, or consumed by animals, the vegetable matter increases in such a proportion, that the soil approaches to a peat in its nature: and if in a situation where it can receive water from a higher district, it becomes spongy and permeated with that fluid, and is generally rendered incapable of supporting the nobler classes of vegetables.

2113. *Spurious peaty soil.* Lakes and pools are sometimes filled up by the accumulation of the remains of aquatic plants; and in this case a sort of spurious peat is formed. The fermentation in these cases, however, seems to be of a different kind. Much more gaseous matter is evolved; and the neighbourhood of morasses, in which aquatic vegetables decompose, is usually aguish and unhealthy; whilst that of the true peat, or peat formed on soils originally dry, is always salubrious.

2114. *Soils may generally be distinguished from mere masses of earth* by their friable texture and dark colour, and by the presence of some vegetable fibre or carbonaceous matter. In uncultivated grounds, soils occupy only a few inches in depth on the surface, unless in crevices, where they have been washed in by rains; and in cultivated soils their depth is generally the same as that to which the implements used in cultivation have penetrated.

2115. *Much has been written on soils,* and, till lately, to very little purpose. All the Roman authors on husbandry treated the subject at length; and in modern times, in this country, copious philosophical discourses on soils were published by Bacon, Evelyn, Bradley, and others; but it may be truly said, that in no department of cultivation was ever so much written of which so little use could be made by practical men.

Sect. II. *Classification and Nomenclature of Soils.*

2116. *Systematic order and an agreed nomenclature* are as necessary in the study of soils as in that of plants or animals. The number of provincial terms for soils which have found their way into the books on cultivation is one reason why so little use can be made of their directions.

2117. *A correct classification of soils* may be founded on the presence or absence of organic and inorganic matter in their basis. This will form two grand classes, viz. *primitive soils*, or those composed entirely of inorganic matter, and *secondary soils*, or those composed of organic and inorganic matter in mixtures. These classes may be subdivided into orders founded on the presence or absence of saline, metallic, and carbonic matter. The orders may be subdivided into genera founded on the prevailing earths, salts, metals, or carbon; the genera into species founded on their different mixtures; the species into varieties founded on colour, or texture; and sub-varieties founded on moisture, dryness, richness, lightness, &c.

2118. *In naming the genera of soils*, the first thing is to discover the prevailing earth or earths; either the simple earths, as clay, lime, sand, or the particular rocks from which the soil has been produced, as granite, basalt, &c. When one earth prevails, the generic name should be taken from that earth, as clayey soil, calcareous soil, &c.; when two prevail to all appearance equally, then their names must be conjoined in naming the genus, as clay and sand, lime and clay, basalt and sand, &c. The great thing is precision in applying the terms. Thus, as Sir H. Davy has observed, the term sandy soil should never be applied to any soil that does not contain at least seven eighths of sand; sandy soils which effervesce with acids should be distinguished by the name of calcareous sandy soil, to distinguish them from those that are silicious. The term clayey soil should not be applied to any land which contains less than one sixth of impalpable earthy matter, not considerably effervescing with acids; the word loam should be limited to soils, containing at least one third of impalpable earthy matter, copiously effervescing with acids. A soil to be considered as peaty, ought to contain at least one half of vegetable matter. In cases where the earthy part of a soil evidently consists of the decomposed matter of one particular rock, a name derived from the rock may with propriety be applied to it. Thus, if a fine red earth be found immediately above decomposing basalt, it may be denominated basaltic soil. If fragments of quartz and mica be found abundant in the materials of the soil, which is often the case, it may be denominated granitic soil; and the same principles may be applied to other like instances. In general, the soils, the materials of which are the most various and heterogeneous, are those called alluvial, or which have been formed from the depositions of rivers; and these deposits may be designated as silicious, calcareous, or argillaceous; and in some cases the term saline may be added as a specific distinction, applicable, for example, at the embouchure of rivers, where their alluvial remains are overflown by the sea.

2119. *In naming the species of soils*, greater nicety is required to determine distinctions than in naming the genera; and there is also some difficulty in applying or devising proper terms. The species are always determined by the mixture of matters, and never by the colour or texture of that mixture which belongs to the nomenclature of varieties. Thus a clayey soil with sand is a sandy clay, this is the name of the species; if the mass is yellow, and it is thought worth while to notice that circumstance, then it is a yellow sandy clay, which express at once the genus, species, and variety. A soil containing equal parts of clay, lime, and sand, would, as a generic term, be called clay, lime, and sand; if it contained no other mixture in considerable quantity, the term entire might be added as a specific distinction; and if notice was to be taken of its colour or degree of comminution, it might be termed a brown, a fine, a coarse, a stiff, or a free entire clay, lime, and sand.

2120. The following *Table enumerates the more common genera, species, and varieties of soils.* The application of the terms will be understood by every cultivator, though to attempt to describe the soils either chemically or empirically (as by sight, smell, or touch), would be a useless waste of time. From a very little experience in the field or garden, more may be gained in the study of soils, than from a volume of such descriptions. This Table corresponds with the nomenclature adopted in the agricultural establishments of Fellenberg at Hofwyl in Switzerland, and of Professor Thaer at Mœgelin in Prussia, with the nomenclature employed by Professor Thouin in his lectures at Paris, and in general with that of all the Continental professors. It is therefore very desirable that it should become as generally adopted as that of the Linnean system of nomenclature in botany. The principle of the Table may be extended so as to include any other soil whatever.

Class.	*Order.*	*Genus.*	*Species.*	*Variety.*	*Sub-Variety.*
Primitive Soils.	Earths alone	Clay	Entire	Black	Moist.
					Dry.
					Rich.
					Poor.
					Sterile.
				Red	Moist, dry, &c.
				Yellow	Moist, dry, &c.
				Coarse	Moist, dry, &c.
				Fine	Moist, dry, &c.
		Lime	Entire	Black, red, yellow, coarse, fine, &c.	Moist, dry, rich, &c.
		Sand	Entire	Black, red, yellow, coarse, fine, &c.	Moist, dry, &c.
	Earths and Salts or Metals.	Clay	Ferruginous	Black, red, yellow, coarse, fine, &c.	Moist, dry, &c.
			Cupreous	Black, red, &c.	Moist, dry, &c.
			Saline	Black, red, &c.	Moist, dry, &c.
		Lime	Ferruginous	Black, red	Moist, dry, &c.
			Cupreous	Black, red	Moist, dry, &c.
			Saline	Black, red, yellow, coarse, fine, &c.	Moist, dry, rich, &c.
		Sand	Ferruginous	Black, red, yellow, coarse, fine, &c.	Moist, dry, rich, &c.
			Cupreous	Black	Moist.
			Saline	Black	Moist, dry, &c.
Secondary Soils.	Earths and organic remains alone.	Clay	Loamy	Black, red, yellow, &c.	Moist, dry, &c.
			Peaty	Black, red, yellow, &c.	Moist.
			Mouldy	Black	Moist.
			Limy	Black	Moist.
			Sandy	Black	Moist.
		Lime	Clayey	Black, red, yellow, &c.	Moist, dry.
			Loamy	Black	Moist.
			Sandy	Black	Moist.
			Peaty	Black	Moist.
			Mouldy	Black	Moist.
		Sand	Clayey	Black	Moist.
			Loamy	Black	Moist.
			Limy	Black	Moist.
			Peaty	Black	Moist.
			Mouldy	Black	Moist.
	Earths and organic remains, with metals, salts, and rocks.	Clay	Ferruginous, loamy, &c.	Black	Moist.
			Ferruginous, limy, &c.	Black	Moist.
			Ferruginous, sandy, &c.	Black	Moist.
			Ferruginous, peaty, &c.	Black	Moist.
			Ferruginous, mouldy, &c.	Black	Moist.
			Cupreous, loamy, &c.	Black	Moist.
			Saline, loamy, &c.	Black	Moist.
			Cinerous, loamy, &c.	Black	Moist.
		Lime	Ferruginous, loamy, &c.	Black	Moist.
			Ferruginous, sandy, &c.	Black	Moist.
			Cupreous, loamy, &c.	Black	Moist.
			Cupreous, sandy, &c.	Black	Moist.
			Saline, loamy, &c.	Black	Moist.
			Saline, sandy, &c.	Black	Moist.
			Cinereous, loamy, &c.	Black	Moist.
			Cinereous, limy, &c.	Black	Moist.
		Sand	Ferruginous, loamy, &c.	Black	Moist.
			Ferruginous, limy, &c.	Black	Moist.
			Cupreous, loamy, &c.	Black	Moist.
			Cupreous, limy, &c.	Black	Moist.
			Saline, loamy, &c.	Black	Moist.
			Saline, limy, &c.	Black	Moist.
			Cinereous, loamy, &c.	Black	Moist.
			Cinereous, limy, &c.	Black	Moist.
		Granite	Ferruginous, &c.	Black, red, yellow, &c.	Moist, dry, &c.
			Quartzose, &c.	Black	Moist.
		Basalt	Ferruginous, &c.	Black, red, yellow, &c.	Moist, dry, &c.
			Columnar, &c.	Black	Moist.
			Whinstone, &c.	Black	Moist.
		Schist	Ferruginous, &c.	Black, red, yellow, &c.	Moist, &c.
			Micaceous, &c.	Black	Moist.
			Chlorite, &c.	Black	Moist.
		Sandstone	Ferruginous, &c.	Black, &c.	Moist, &c.
			Calcareous, &c.	Black	Moist.
			Argillaceous, &c.	Black	Moist.
			Cupreous, &c.	Black	Moist.
		Limestone	Chalky, &c.	Black, red, &c.	Moist, dry, &c.
			Marble, &c.	Black	Moist.
			Shelly, &c.	Black	Moist.
			Magnesian, &c.	Black	Moist.
			Sulphuric, &c.	Black	Moist.
			Ferruginous, &c.	Black	Moist.
			Cupreous, &c.	Black	Moist.
			Argillaceous, &c.	Black	Moist.
			Silicious, &c.	Black	Moist.
		Coal	Slaty, &c.	Black, red, yellow, &c.	Moist, dry, rich, &c.
			Pyritic, &c.	Black	Moist.
			Stony, &c.	Black	Moist.
			Woody, &c.	Black	Moist.

Sect. III. *Of discovering the Qualities of Soils.*

2121. *The value of soils to the cultivator* is discoverable botanically, chemically, and mechanically; that is, by the plants that grow on them naturally; by chemical analysis; and by their sensible qualities of roughness, smoothness, taste, smell, and fracture.

Subsect. 1. *Of discovering the Qualities of Soils by means of the Plants which grow on them.*

2122. *Plants are the most certain indicators of the nature of a soil;* for while no practical cultivator would engage with land of which he knew only the results of a chemical analysis, or examined by the sight and touch a few bushels which were brought to him, yet every gardener or farmer, who knew the sort of plants it produced, would be at once able to decide as to its value for cultivation.

2123. *The leading soils for the cultivator* are the clayey, calcareous, sandy, ferruginous, peaty, saline, moist or aquatic, and dry. The following are the plants by which such soils are distinguished in most parts of Europe: —

2124. *Argillaceous.* Common coltsfoot (*Tussilàgo Fárfara*); goose tansy (*Potentílla Anserìna*), silvery (*argéntea*), and creeping (*réptans*); yellow meadow rue (*Thalictrum* flàvum); Càrex, many species; Júncus, various species; tuberous bitter vetch (*O*'robus tuberòsus); greater bird's-foot trefoil (*L*òtus màjor), and small-horned (corniculàtus); officinal soapwort (Saponària officinàlis): but the *T*ussilàgo *F*árfara is a certain and universal sign of an argillaceous soil, and is the chief plant found on the alum grounds of Britain, France, and Italy.

2125. *Calcareous.* Spiked speedwell (*Verónica* spicàta), little bedstraw (*G*àlium pusíllum), officinal gromwell (*L*ithospérmum officinàle) and purple-blue (purpùro-cærùleum), clustered bell-flower (Campánula glomeràta), hybrid prismatocarpus (Prismatocárpus hýbridus), round-*headed* rampion (*P*hyteùma orbiculàre), lychnitis mullein (*V*erbáscum *L*ychnìtis), wayfaring tree (*V*ibúrnum Lantàna), common berberry (*Bérberis* vulgàris), common *dwarf* sun rose (Heliánthemum vulgàre), *common* pulsatilla anemone (*A*nemòne *Pulsatílla*), white vine, virgin's bower, or traveller's joy (*C*lématis Vitálba), cultivated saintfoin (*O*nobrỳchis satìva).

2126. *Silicious.* Three-leaved speedwell (*Verónica* triphýllos) and vernal (vérna), Italian viper's bugloss (*E*'chium itálicum), smooth rupture-wort (Herniària glàbra) and hairy hirsùta), English catchfly (Silène ánglica) and other species, red sandwort (Arenària rùbra), &c., corn-field spurrey (Spérgula arvénsis), hybrid poppy (*P*apàver hýbridum), Argemòne, &c.

2127. *Ferrugineous.* Common sorrel (*R*ùmex Acetòsa) and sheep's sorrel (Acetosélla).

2128. *Peaty.* Bilberry (*V*accínium Myrtíllus), bleaberry (uliginòsum), cranberry (Oxycóccus palústris) heath, (*E*rìca) 4 sp., awl-*shaped* spurrey (Spérgula subulàta), officinal septfoil (Tormentílla officinàlis).

2129. *Saline.* Glasswort (Salicórnia) 4 species, marine wrackgrass (*Z*ostèra marìna), sea ruppia (Rúppia marítima), sea lung-wort (Pulmonària marítima), Soldanella bearbind (Calystègia Soldanélla), whorled knotgrass (*I*llécebrum verticillàtum), sea goosefoot (Chenopòdium marítimum) and shrubby (fruticòsum), kali saltwort (Salsòla *Kàli*), whorl-*leaved* honeywort (*S*ìson verticillàtum), marine sandwort (Arenària marìna), &c., fringed orache (*A*'triplex laciniàta).

2130. *Aquatic.* Marsh marigold (*C*áltha palústris), common mare's-tail (*H*ippùris vulgàris), common butterwort (Pinguícula vulgàris), European water-horehound (Lycòpus europæ'us), diœcious valerian (*Valeriàna* dioíca), marsh violet (*V*ìola palústris), Valerandi's brookweed (*S*amòlus Valerándi), marsh thysselinum (Thysselìnum palústre), square-stalked epilobium (Epilòbium tetragònum), willow lythrum (*L*ýthrum Salicària), tongue-*leaved* crowfoot (*R*anúnculus Língua) and spearwort (Flámmula).

2131. *Very dry.* Red sandwort (Arenària rùbra), sheep's sorrel (*R*ùmex Acetosélla), wild thyme (*T*hýmus *S*erpýllum), common acynos (*A*'cynos vulgàris), field trefoil (*T*rifòlium arvénse).

2132. *These plants are not absolutely to be depended on,* however, even in Britain; and in other countries they are sometimes found in soils directly opposite. Still, the cultivated saintfoin (*O*nobrỳchis satìva) is almost always an indication of a calcareous soil; the common coltsfoot (*T*ussilàgo *F*árfara), of blue clay; the red sandwort (Arenària rùbra), of poor sand; and the sheep's sorrel (*R*ùmex Acetosélla), of the presence of iron, or of peat. The common reed (*P*hragmìtes commùnis) and the amphibious polygonum (*P*olýgonum amphíbium) grow on alluvial soils, which yield excellent crops if properly drained; but where the corn horse-tail (*E*quisètum arvénse) grows freely, it indicates a cold and retentive subsoil. The corn-field pimpernel (*A*nagállis arvénsis), the corn-field madder (Sherárd*ia* arvénsis), the corn-field gromwell (*L*ithospérmum arvénse), and the salad lamb's lettuce (*Valerianélla* olitòria), grow on cultivated lands, where the soil is a strong black loam on a dry bottom; when such a soil is wet, the clown's all-heal (*S*tàchys palústris) makes its appearance. A light sandy soil is known by the presence of the purple archangel (*L*àmium purpùreum); the shepherd's purse (Capsélla búrsa pastòris). If the parsley piert (*Alchemílla* A'phanes) is found, the soil is rather unproductive; if the corn-field spurrey (Spérgula arvénsis) grows very thick, the ground has likely been rendered too fine by the harrow; the common ragwort (*S*enècio Jacobæ'*a*), and the cornfield cirsium (*C*írsium arvénse), grow indiscriminately on light and strong loams, but always indicate a fertile soil. The wall draba (*D*ràba muràlis) and the annual knawel (Sclerânthus ánnuus) grow on soils that are dry, sandy, and poor in the extreme. The spiny rest-harrow (*O*nònis spinòsa) is often found on dry pasture, and where the soil is incumbent on rotten rock. The aquatic, peaty, and saline soils are almost every where indicated by their appropriate plants; a proof, as we have before stated, that the climate and natural irrigation of plants have much more influence on their habits than mere soil. (*Galpine's Compendium; Flora Brit.; Loudon's Hortus Brit.; Kent's Hints; Farmers' Mag.* Feb. 1819; and the *Quarterly Journal of Agric.* for Aug. 1828.)

Subsect. 2. *Of discovering the Qualities of Soils by Chemical Analysis.*

2133. *Chemical analysis is much too nice an operation for general purposes.* It is not likely that many practical cultivators will ever be able to conduct the analytic process with sufficient accuracy, to enable them to depend on the result: but, still, such a knowledge of chemistry as shall enable the cultivator to understand the nature of the process and its results, when made and presented to him by others, is calculated to be highly useful, and ought to be acquired by every man whose object is to join theoretical to practical knowledge. If it so happens that he can perform the operations of analysis himself, so much the better, as far as that point is concerned; but, on the whole, such knowledge and adroitness are not to be expected from men who have so many other points demanding their attention, and who will, therefore, effect their purpose much better by collecting proper specimens of the soils to be studied, and sending them for analysis to a respectable operative chemist.

2134. *In selecting specimens,* where the general nature of the soil of a field is to be ascertained, portions of it should be taken from different places, two or three inches below the surface, and examined as to the similarity of their properties. It sometimes happens, that upon plains, the whole of the upper stratum of the land is of the same kind, and in this case, one analysis will be sufficient: but in valleys, and near the beds of rivers, there are very great differences, and it now and then occurs that one part of a field is calcareous, and another part silicious; and in this case, and in analogous cases, the portions different from each other should be separately submitted to experiment. Soils, when collected, if they cannot be immediately examined, should be preserved in phials quite filled with them, and closed with ground glass stoppers. The quantity of soil most convenient for a perfect analysis is from two to four hundred grains. It should be collected in dry weather, and exposed to the atmosphere till it becomes dry to the touch.

2135. *The soil best suited for culture,* according to the analysis of Bergman, contains four parts of clay, three of sand, two of calcareous earth, and one of magnesia; and, according to the analysis of Fourcroy and Hassenfratz, 9216 parts of fertile soil contained 305 parts of carbon, together with 279 parts of oil; of which, according to the calculations of Lavoisier, 220 parts may be regarded as carbon: so that the whole of the carbon contained in the soil in question may be estimated at about 525 parts, exclusive of the roots of vegetables, or to about one sixteenth of its weight. Young observed that equal weights of different soils, when dried and reduced to powder, yielded by distillation quantities of air somewhat corresponding to the ratio of their values. The air was a mixture of fixed and inflammable airs, probably derived from the decomposition of water, either by the chemical affinities of the ingredients of the soil, or by the process of vegetation, while the carbonic acid or fixed air may be absorbed from the atmosphere, or produced by living vegetables under certain circumstances. The following is the analysis of a fertile soil, as occurring in the neighbourhood of Bristol: — In 400 grains, there were of water, 52; silicious sand, 240; vegetable fibre, 5; vegetable extract, 3; alumine, 48; magnesia, 2; oxide of iron, 14; calcareous earth, 30; loss, 6. But Kirwan has shown in his *Geological Essays,* that the fertility of a soil depends in a great measure upon its capacity for retaining water; and if so, soils containing the same ingredients must be also equally fertile, all other circumstances being the same, though it is plain that their actual fertility will depend ultimately upon the quantity of rain that falls, because the quantity suited to a wet soil cannot be the same that is suited to a dry soil; and hence it often happens that the ingredients of the soil do not correspond to the character of the climate. Silica exists in the soil under the modification of sand, and alumine under the modification of clay; but the one or the other is often to be met with in excess or defect. Soils in which the sand preponderates retain the least moisture, and soils in which the clay preponderates retain the most; the former are dry soils, the latter are wet soils: but it may happen that neither of them is sufficiently favourable to culture; in which case, their peculiar defect or excess must be supplied or retrenched before they can be brought to a state of fertility.

2136. *Use of the result of analysis* In the present state of chemical science, Dr Ure observes, no certain system can be devised for the improvement of lands, independent of experiment; but there are few cases in which the labour of analytical trials will not be amply repaid by the certainty with which they denote the best methods of melioration; and this will particularly happen, when the defect of composition is found in the proportions of the primitive earths. In supplying organic matter, a temporary food only is provided for plants, which is in all cases exhausted by means of a certain number of crops; but when a soil is rendered of the best possible constitution and texture, with regard to its earthy parts, its fertility may be considered as permanently established. It becomes capable of attracting a very large portion of vegetable nourishment from the atmosphere, and of producing its crops with comparatively little labour and expense. (*Dict. of Chem.*, art. *Soil.*)

SUBSECT. 3. *Of discovering the Qualities of a Soil mechanically and empirically.*

2137. *The physical properties* of soils, and some of their most important constituents relatively to the cultivator, may be ascertained to a certain extent by various and very simple means.

2138. *The specific gravity of a soil,* or the relation of its weight to that of water, may be ascertained by introducing into a phial, which will contain a known quantity of water, equal volumes of water and of soil, and this may be easily done by pouring in water till it is half full, and then adding the soil till the fluid rises to the mouth; the difference between the weight of the soil and that of the water will give the result. Thus if the bottle contains four hundred grains of water, and gains two hundred grains when half filled with water and half with soil, the specific gravity of the soil will be 2, that is, it will be twice as heavy as water, and if it gained one hundred and sixty-five grains, its specific gravity would be 1825, water being 1000.

2139. *The presence of clay and sand* in any soil is known, the first by its tenacity, the other by its roughness to the touch, and by scratching glass when rubbed on it.

2140. *The presence of calcareous matter* in soil may be ascertained by simply pouring any acid on it, and observing if it effervesces freely. Muriatic acid is the best for this purpose. Calcareous soils, magnesian soils, and clays, are, for the most part, softer to the touch than arenaceous soils. To ascertain the quantity of calcareous earth present, dry soil thoroughly, and weigh 100 grains of it, which gradually add to one drachm of muriatic acid diluted with two drachms of water in a phial poised in a balance: the loss of weight will indicate the escape of carbonic acid, which will be 44 per cent of the quantity of calcareous earth in the soil.

2141. *The presence of organised matter* in any soil may be ascertained very satisfactorily by weighing it after being thoroughly dried; then subjecting it to a red heat and weighing it again, the weight last found will be the proportion of organic matter and carbonic acid gas, if there should have been any. The same object may also be attained by ascertaining the specific gravity of the soil, but with less accuracy.

2142. *The presence of metallic oxides* in a soil may generally be known by their colour. Ferrugineous soils are red or yellow; cupreous soils, interspersed with greenish streaks, &c. Cupreous impregnations of soils are rare; and the usual green matter in such soils as the *green sand* of English geologists, appears to be coloured by iron, which is almost the only metallic impregnation in considerable quantity in any soil.

2143. *The presence of salt, sulphur, coal,* &c., may be known by the absence or peculiarity of vegetation, as well as by colour, and the appearance of the water of such soils. Saline soils may be distinguished by the taste; sulphureous soils by their smell when thrown on a hot iron; and the presence of coal by its fragments, which will be left after the soluble matters are removed by water and muriatic acid.

2144. *The capacity of a soil for retaining water* may be thus ascertained. An equal portion of two soils, perfectly dry, may be introduced into two tall glass cylindrical vessels (*fig.* 203.), in the middle of each of which a glass tube has been previously placed. The soils should be put into each in the same manner, not compressed very hard, but so as to receive a solidity approaching to that which they possessed when first obtained for trial. If, after this preparation, a quantity of water be poured into the glass tubes, it will subside; and the capillary attraction of the soils will conduct it up the cylinders towards the tops of the vessels. That which conducts it most rapidly, provided it does not rise from the weight of the incumbent column of water in the tube, may be pronounced to be the better soil. (*Grisenthwaite.*)

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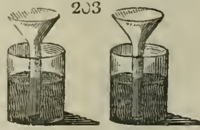

SECT. IV. *Of the Uses of the Soil to Vegetables.*

2145. *Soils afford to plants a fixed abode and medium of nourishment.* Earths, exclusively of organised matter and water, are allowed by most physiologists to be of no other use to plants than that of supporting them, or furnishing a medium by which they may fix themselves to the globe. But earths and organic matter, that is, soils, afford at once support and food.

2146. *The pure earths merely act as mechanical and indirect chemical agents in the soil.* The earths all appear to be metallic bases united to oxygen: these oxides have not been completely decomposed; but there is no reason to suppose that their earthy bases are convertible into the elements of organised compounds, that is, into carbon, hydrogen, and azote. Plants have been made to grow in given quantities of earth. They consume very small portions only; and what is lost may be accounted for by the quantities found in their ashes; that is to say, it has not been converted into any new products. The carbonic acid united to lime or magnesia, if any stronger acid happens to be formed in the soil during the fermentation of vegetable matter, which will disengage it from the earths, may be decomposed; but the earths themselves cannot be supposed convertible into other substances, by any process taking place in the soil. In all cases the ashes of plants contain some of the earths of the soil in which they grow; but these earths, as has been ascertained from the ashes afforded by different plants, never equal more than one fiftieth of the weight of the plant consumed. If they be considered as necessary to the vegetable, it is as giving hardness and firmness to its organisation. Thus, it has been mentioned that wheat, oats, and many of the hollow-stalked grasses, have an epidermis principally of silicious earth; the use of which seems to be to strengthen them, and defend them from the attacks of insects and parasitical plants.

2147. *The true nourishment of plants is water and decomposing organic matter;* both these exist only in soils, not in pure earths: but the earthy parts of the soils are useful in retaining water, so as to supply it in the proper proportions to the roots of the vegetables, and they are likewise efficacious in producing the proper distribution of the animal or vegetable matter. When equally mixed with it they prevent it from decomposing too rapidly; and by their means the soluble parts are supplied in proper proportions.

2148. *The soil is necessary to the existence of plants,* both as affording them nourishment, and enabling them to fix themselves in such a manner as to obey those laws by which their radicles are kept below the surface, and their leaves exposed to the free atmosphere. As the systems of roots, branches, and leaves are very different in different vegetables, so they flourish most in different soils: plants which have bulbous roots require a looser and a lighter soil than such as have fibrous roots; plants possessing only short fibrous radicles demand a firmer soil than such as have tap-roots or extensive lateral roots.

2149. *The constituent parts of the soil, which give tenacity and coherence, are the finely divided matters;* and they possess the power of giving those qualities in the highest degree when they contain much alumina. A small quantity of finely divided matter is sufficient to fit a soil for the production of turnips and barley; and a tolerable crop of turnips has been produced on a soil containing 11 parts out of 12 of sand. A much greater proportion of sand, however, always produces absolute sterility. The soil of Bagshot heath, which is entirely devoid of vegetable covering, contains less than one twentieth of finely divided matter: 400 parts of it, which had been heated red, afforded 380 parts of coarse silicious sand; 9 parts of fine silicious sand, and 11 parts of impalpable matter, which was a mixture of ferruginous clay with carbonate of lime. Vegetable or animal matters, when finely divided, not only give coherence, but likewise softness and penetrability; but neither they nor any other part of the soil must be in too great proportion; and a soil is unproductive if it consists entirely of impalpable matters. Pure alumina or silica, pure carbonate of lime or carbonate of magnesia, are incapable of supporting healthy vegetation; and no soil is fertile that contains as much as 19 parts out of 20 of any of these constituents.

2150. *A certain degree of friability or looseness of texture* is also required in soils, in order that the operations of culture may be easily conducted; that moisture may have free access to the fibres of the roots, that heat may be readily conveyed to them, and that evaporation may proceed without obstruction. These are commonly attained by the presence of sand. As alumina possesses all the properties of adhesiveness in an eminent degree, and silex those of friability, it is obvious that a mixture of these two earths, in suitable proportions, would furnish every thing wanted to form the most perfect soil, as to water and the operations of culture. In a soil so compounded, water will be presented to the roots by capillary attraction. It will be suspended in it, in the same manner as it is suspended in a sponge, not in a state of aggregation, but of minute division, so that every part may be said to be moist, but not wet. (*Grisenthwaite.*)

2151. *The water chemically combined* amongst the elements of soils, unless in the case of the decomposition of animal or vegetable substances, cannot be absorbed by the roots of plants; but that adhering to the parts of the soil is in constant use in vegetation. Indeed, there are few mixtures of the earths found in soils which contain any chemically combined water; water is expelled from the earth by most substances which combine with them. Thus, if a combination of lime and water be exposed to carbonic acid, the carbonic acid takes the place of water; and compounds of alumina and silica, or other compounds of the earths, do not chemically unite with water; and soils, as it has been stated, are formed either by earthy carbonates, or compounds of the pure earths and metallic oxides. When saline substances exist in soils, they may be united with water both chemically and mechanically; but they are always in too small a quantity to influence materially the relations of the soil to water.

2152. *The power of the soil to absorb water by capillary attraction* depends in great measure upon the state of division of its parts; the more divided they are, the greater is their absorbent power. The different constituent parts of soils likewise appear to act, even by cohesive attraction, with different degrees of energy. Thus vegetable substances seem to be more absorbent than animal substances; animal substances more so than compounds of alumina and silica; and compounds of alumina and silica more absorbent than carbonates of lime and magnesia: these differences may, however, possibly depend upon the differences in their state of division, and upon the surface exposed.

2153. *The power of soil to absorb water from air* is much connected with fertility. When this power is great, the plant is supplied with moisture in dry seasons; and the effect of evaporation in the day is counteracted by the absorption of aqueous vapour from the atmosphere, by the interior parts of the soil during the day, and by both the exterior and interior during the night. The stiff clays approaching to pipe-clays in their nature, which take up the greatest quantity of water when it is poured upon them in a fluid form, are not the soils which absorb most moisture from the atmosphere in dry weather. They cake, and present only a small surface to the air; and the vegetation on them is generally burnt up almost as readily as on sands. The soils most efficient in supplying the plant with water by atmospheric absorption are those in which there is a due mixture of sand, finely divided clay, and carbonate of lime, with some animal or vegetable matter, and which are so loose and light as to be freely permeable by the atmosphere. With respect to this quality, carbonate of lime, and animal and vegetable matter, are of great use in soils; they give absorbent power to the soil, without giving it likewise tenacity; sand, which also destroys tenacity, on the contrary, gives little absorbent power. The absorbent power of soils, with respect to atmospheric moisture, is always greatest in the most fertile; so that it affords one method of judging of the productiveness of land.

2154. *Examples of the absorbent powers of soils.* 1000 parts of a celebrated soil from Ormiston, in East Lothian, which contained more than half its weight of finely divided matter, of which 11 parts were carbonate of lime, and 9 parts vegetable matter, when dried at 212°, gained in an hour, by exposure to air saturated with moisture, at a temperature of 62°, 18 grains. 1000 parts of a very fertile soil from the banks of the river Parret, in Somersetshire, under the same circumstances, gained 16 grains. 1000 parts of a soil from Mersea, in Essex, gained 13 grains. 1000 grains of a fine sand, from Essex, gained 11 grains. 1000 of a coarse sand gained only 8 grains. 1000 of a soil from Bagshot Heath gained only 3 grains.

2155. *The absorbent powers of soils ought to vary with the climate* in which they are situated. The absorption of moisture ought to be much greater in warm or dry countries, than in cold and moist ones; and the quantity of clay, or vegetable, or animal matter in soils greater. Soils also on declivities ought to be more absorbent than in plains or in the bottoms of valleys. Their productiveness likewise is influenced by the nature of the subsoil, or the stratum on which they rest. When soils are immediately situated upon a bed of rock or stone, they are much sooner rendered dry by evaporation than where the subsoil is of clay or marl; and a prime cause of the great fertility of the land in the moist climate of Ireland, is the proximity of the rocky strata to the soil. A clayey sub-soil will sometimes be of material advantage to a sandy soil; and in this case it will retain moisture in such a manner as to be capable of supplying that lost by the earth above, in consequence of evaporation or the consumption of it by plants. A sandy or gravelly sub-soil often corrects the imperfections of too great a degree of absorbent power in the true soil. In calcareous countries, where the surface is a species of marl, the soil is often found only a few inches above the limestone; and its fertility is not impaired by the proximity of the rock; though in a less absorbent soil, this situation would occasion barrenness; and the sandstone and limestone hills in Derbyshire and North Wales may be easily distinguished at a distance, in summer, by the different tints of the vegetation. The grass on the sandstone hills usually appears brown and burnt up; that on the limestone hills flourishing and green. There is a considerable difference between the sandy soils of the east and west coasts of Scotland. All along the west coast from the Solway Frith to the Clyde, such soils are more productive than soils of a similar quality on the east coast, under the same circumstances of management The extensive culture of potatoes for instance, and the succession of corn crops in Dumfriesshire and Galloway, would soon reduce to a state of sterility much of the best sandy soils of Roxburghshire and the Lothians.

2156 *In a moist climate* where the quantity of rain which falls annually equals from 40 to 60 inches, as in Lancashire, Cornwall, and some parts of Ireland, a silicious sandy soil is much more productive than in dry districts; and in such situations wheat and beans will require a less coherent and absorbent soil than in drier situations; and plants having bulbous roots will flourish in a soil containing as much as 14 parts out of 15 of sand. Even the exhausting powers of crops will be influenced by like circumstances. In cases where plants cannot absorb sufficient moisture, they must take up more manure; and in Ireland, Cornwall, and the western Highlands of Scotland, corn will exhaust less than in dry inland situations. Oats, particularly, in dry climates, are impoverishing in a much higher degree than in moist ones.

2157. *Many soils are popularly distinguished as cold or hot;* and the distinction, though at first view it may appear to be founded on prejudice, is really just. Some soils are much more *heated* by the rays of the sun, all other circumstances being equal, than others; and soils brought to the same degree of heat cool in different times, i. e. some cool much faster than others. This property has been very little attended to in a philosophical point of view; yet it is of the highest importance in culture. In general, soils which consist principally of a stiff white clay are with difficulty heated; and, being usually very moist, they retain their heat but for a short time. Chalks are similar in one respect, the difficulty with which they are heated; but, being drier, they retain their heat longer, less being consumed in causing the evaporation of their moisture. A black soil, containing much soft vegetable matter, is most heated by the sun and air; and the coloured soils, and the soils containing much carbonaceous or ferruginous matter, exposed under equal circumstances to the sun, acquire a much higher temperature than pale soils.

2158. *When soils are perfectly dry, those which most readily become heated by the solar rays likewise cool most rapidly;* but the darkest-coloured dry soil (that which contains abundance of animal or vegetable matter, substances which most facilitate the diminution of temperature), when heated to the same degree, provided it be within the common limits of the effect of solar heat, will cool more slowly than a wet pale soil entirely composed of earthy matter. Sir H. Davy "found that a rich black mould, which contained nearly one fourth of vegetable matter, had its temperature increased in an hour from 65° to 88° by exposure to sunshine; whilst a chalk soil was heated only to 69° under the same circumstances: but the mould removed into the shade, where the temperature was 62°, lost, in half an hour, 15°; whereas the chalk, under the same circumstances, had lost only 4°. We may also refer to the influence of black earth in melting snow, as practised empirically on the Alps, and tried philosophically by Franklin and Saussure. The latter placed on the top of the high Alpine mountain Cramont a box lined with black cloth, with the side next the sun closed by three panes of glass at a little distance apart the one from the other, and found the thermometer rise thirty degrees in two hours, from the concentration of the sun's rays. (*Agriculture appliquée, &c.* tom. i. 82.) A brown fertile soil and a cold barren clay were each artificially heated to 88°, having been previously dried, they were then exposed in a temperature of 57°; in half an hour the dark soil was found to have lost 9° of heat, the clay had lost only 6°. An equal portion of the clay containing moisture, after being heated to 88°, was exposed in a temperature of 55°; in less than a quarter of an hour it was found to have cooled to the temperature of the room. The soils in all these experiments were placed in small tin-plate trays, two inches square, and half an inch in depth; and the temperature was ascertained by a delicate thermometer. Thus the temperature of the surface, when bare and exposed to the rays of the sun, affords at least one indication of the degree of its fertility; and the thermometer may be sometimes a useful instrument to the purchaser or improver of lands."

2159. *The moisture in the soil and sub-soil materially affects their temperature,* and prevents, as in the case of constantly saturated aquatic soils, their ever attaining to any great degree either of heat or cold. The same observation will apply to moist peaty soils, or peat-bogs.

2160. *Chemical agency of soils.* Besides these uses of soils, which may be considered mechanical, there is, Sir H. Davy observes, another agency between soils and organisable matters, which may be regarded as chemical in its nature. The earths, and even the earthy carbonates, have a certain degree of chemical attraction for many of the principles of vegetable and animal substances. This is easily exemplified in the instance of alumina and oil; if an acid solution of alumina be mixed with a solution of soap, which consists of oily matter and potassa, the oil and the alumina will unite and form a white powder, which will sink to the bottom of the fluid. The extract from decomposing vegetable matter, when boiled with pipe-clay or chalk, forms a combination by which the vegetable matter is rendered more difficult of decomposition and of solution. Pure silica and silicious sands have little action of this kind; and the soils which contain the most alumina and carbonate of lime are those which act with the greatest chemical energy in preserving manures. Such soils merit the appellation, which is commonly given to them, of rich soils; for the vegetable nourishment is long preserved in them, unless taken up by the organs of plants. Silicious sands, on the contrary, deserve the term hungry, which is commonly applied to them; for the vegetable and animal matters they contain, not being attracted by the earthy constituent parts of the soil, are more liable to be decomposed by the action of the atmosphere, or carried off from them by water. In most of the black and brown rich vegetable moulds, the earths seem to be in combination with a peculiar extractive matter, afforded during the decomposition of vegetables; this is slowly taken up or attracted from the earths by water, and appears to constitute a prime cause of the fertility of the soil.

2161. *Thus all soils are useful to plants,* as affording them a fixed abode and a range for their roots to spread in search of food; but some are much more so than others, as better adapted by their constituent parts, climate, inclination of surface, and sub-soil, for attracting and supplying food.

Sect. V. *Of the Improvement of Soils.*

2162. *Soils may be rendered more fit for answering the purposes of vegetation* by pulverisation, by consolidation, by exposure to the atmosphere, by an alteration of their constituent parts, by changing their condition in respect to water, by changing their position in respect to atmospherical influence, and by a change in the kinds of plants cultivated. All these improvements are independent of the application of manures.

Subsect. 1. *Pulverisation.*

2163. *The mechanical division of the parts of soils* is a very obvious improvement, and applicable to all in proportion to their adhesive texture. Even a free silicious soil will, if left untouched, become too compact for the proper admission of air, rain, and heat, and for the free growth of the fibres; and strong upland clays, not submitted to the plough or the spade, will, in a few years, be found in the possession of fibrous-rooted perennial grasses, which form a clothing on their surface, or strong tap-rooted trees, as the oak, which force their way through the interior of the mass. Annuals and ramentaceous-rooted herbaceous plants cannot penetrate into such soils.

2164. *The first object of pulverisation is give scope to the roots of vegetables,* for without abundance of roots no plant will become vigorous, whatever may be the richness of the soil in which it is placed. The fibres of the roots, as we have seen (1538.), take up the extract of the soil by intro-susception; the quantity taken up, therefore, will not depend alone on the quantity in the soil, but on the number of absorbing fibres. The more the soil is pulverised, the more these fibres are increased, the more extract is absorbed, and the more vigorous does the plant become. Pulverisation, therefore, is not only advantageous previously to planting or sowing, but also during the progress of vegetation, when applied in the intervals between the plants. In the latter case it operates also in the way of pruning, and by cutting off or shortening the extending fibres, causes them to branch out numerous others, by which the mouths or pores of the plants are greatly increased, and such food as is in the soil has the better chance of being sought after, and taken up by them. Tull and Du Hamel relate various experiments which decidedly prove that, *cæteris paribus,* the multiplication of the fibres is as the inter-pulverisation; but the strength of the vegetable, in consequence of this multiplication of fibres, must depend a good deal on the quantity of food or of extract within their reach. The root of a willow tree, as we have seen (1590.), has the fibres prodigiously increased by coming in contact with the water in a river, and so have various other aquatic plants, as alder, mint, Lysimàchia thyrsiflòra, Cálla palústris, Œnánthe fistulòsa, &c.; but their herbage is proportionally increased unless the water be impregnated with organised remains.

2165. *Pulverisation increases the capillary attraction,* or sponge-like property, of soils, by which their humidity is rendered more uniform. It is evident this capillary attraction must be greatest where the particles of the earth are finely divided; for gravels and sands hardly retain water at all, while clays, not opened by pulverisation or other means, either do not absorb water, or when, by long action, it is absorbed, they retain too much. Water is not only necessary as such to the growth of plants, but it is essential to the production of extract from the vegetable matters which they contain; and unless the soil, by pulverisation or otherwise, is so constituted as to retain the quantity of water requisite to produce this extract, the addition of manures will be in vain. Manure is useless to vegetation till it becomes soluble in water, and it would remain useless in a state of solution, if it so abounded as wholly to exclude air, for then the fibres or mouths, unable to perform their functions, would soon decay and rot off. Pulverisation, in a warm season, is of great advantage in admitting the nightly dews to the roots of plants. Chaptal, in his *Agriculture appliquée à Chimie,* relates the great benefit he found from the practice, in this respect, to his corn crops; and shows of what importance it is in the culture of vineyards in France.

2166. *The temperature of a soil is greatly promoted* by pulverisation. Earths, Grisenthwaite observes, are also among the worst conductors of heat with which we are acquainted, and consequently it would be a considerable time before the gradually increasing temperature of spring could communicate its genial warmth to the roots of vegetables, if their lower strata were not heated by some other means. To remove this defect, which always belongs to a close compact soil, it is necessary to have the land open, that there may be a free ingress of the warm air and tepid rains of spring.

2167. *Pulverisation contributes to the increase of vegetable food.* Water is known to be a condenser and solvent of carbonic acid gas, which, when the land is open, can be immediately carried to the roots of vegetables, and contribute to their growth; but if the land be close, and the water lie on or near its surface, then the carbonic acid gas, which always exists in the atmosphere and is carried down by rains, will soon be dissipated. An open soil is also most suitable for effecting those changes in the manure itself, which are equally necessary to the preparation of such food. Animal and vegetable substances, exposed to the alternate action of heat, moisture, light, and air, undergo spontaneous decompositions, which would not otherwise take place.

2168. *By means of pulverisation a portion of atmospheric air is buried in the soil.* This air, so confined, is decomposed by the moisture retained in the earthy matters. Ammonia is formed by the union of the hydrogen of the water with the nitrogen of the atmosphere; and nitre, by the union of oxygen and nitrogen; the oxygen may also unite with the carbon contained in the soil, and form carbonic acid gas, and carburetted hydrogen. Heat is given out during these processes, and "hence," as Dr. Darwin remarks (*Phytologia*, sect. xii. 1.), "the great propriety of cropping lands immediately after they have been comminuted and turned over; and this the more especially, if manure has been added at the same time, as the process of fermentation will go on faster when the soil is loose, and the interstices filled with air, than afterwards, when it becomes compressed with its own gravity, the relaxing influence of rains, and the repletion of the partial vacuums formed by the decomposition of the enclosed air. The advantage of the heat thus obtained in exciting vegetation, whether in a seed or root, especially in spring, when the soil is cold, must be very considerable."

2169. *The great advantages of pulverisation deceived Tull,* who fancied that no other assistances were required in the well-management of the business of husbandry. A knowledge of chemistry, in its present improved state, would have enabled him to discover that the pulverisation of the soil was of no other benefit to the plants that grow in it than as it "increased the number of their fibrous roots or mouths by which they imbibe their food, facilitated the more speedy and perfect preparation of this food, and conducted the food so prepared more regularly to their roots." Of this food itself it did not produce one particle.

2170. *The depth of pulverisation,* Sir H. Davy observes, "must depend upon the nature of the soil, and of the subsoil. In rich clayey soils it can scarcely be too deep; and even in sands, unless the subsoil contains some principles noxious to vegetables, deep comminution should be practised. When the roots are deep, they are less liable to be injured either by excessive rain or drought; the radicles are shot forth into every part of the soil; and the space from which the nourishment is derived is more considerable than when the seed is superficially inserted in the soil."

2171. *Pulverisation should, in all cases, be accompanied with the admixture of the parts of soils* by turning them over. It is difficult, indeed, to pulverise without effecting this end, at least by the implements in common use; but, if it could be effected, it would be injurious, because the difference of gravity between the organised matters and the earths has a constant tendency to separate them, and stirring a soil only with forks or pronged implements, such as cultivators, would, in a short time, leave the surface of the soil too light and spongy, and the lower part too compact and earthy.

Subsect. 2. *Of the Improvement of Soils by Compression.*

2172. *Mechanical consolidation* will improve some soils, such as spongy peats and light dusty sands. It is but a limited source of improvement, but still it deserves to be noticed.

2173. *The proper degree of adhesiveness* is best given to loose soils by the addition of earthy matters; but mere rolling and treading are not to be altogether rejected. To be benefited by rolling a soil must be dry, and the operation must not be carried too far. A peat-bog drained and rolled will sooner become covered with grasses than one equally well drained and left to itself. Drifting sands may be well rolled when wet, and by repeating the process after rains they will in time acquire a surface of grass or herbage. Every agriculturist knows the advantages of rolling light soils after sowing, or even treading them with sheep. Gardeners also tread in seeds on certain soils.

Subsect. 3. *Of the Improvement of Soils by Aeration or Fallowing.*

2174. *Soils are benefited by the free admission of the weather to their interior parts.* This is generally considered as one of the advantages of fallowing, and its use in gardening is experienced in compost heaps, and in winter and summer ridging. The precise advantages, however, of exposure to the air, independently of the concurrent influence of water, heat, and the other effects mentioned as attendant on pulverisation, do not seem at present to be correctly ascertained. It is allowed that carbonic acid gas may be absorbed by calcareous earths, and Dr. Thomson considers that the earths alone may thus probably administer food to plants; but Sir H. Davy seems to consider mere exposure to the atmosphere of no benefit to soils whatever. "It has been supposed by some writers," he says, "that certain principles necessary to fertility are derived from the atmosphere, which are exhausted by a succession of crops, and that these are again supplied during the repose of the land, and the exposure of the pulverised soil to the influence of the air; but this in truth is not the case. The earths commonly found in soils cannot be combined with more oxygen; none of them unite to azote; and such of them as are capable of attracting carbonic acid, are always saturated with it in those soils on which the practice of fallowing is adopted."

2175. *Aeration and repose, or summer fallow.* "The vague ancient opinion of the use of nitre, and of nitrous salts in vegetation," Sir H. Davy says, "seems to have been one of the principal speculative reasons for the defence of summer fallows. Nitrous salts are produced during the exposure of soils containing vegetable and animal remains, and in greatest abundance in hot weather; but it is probably by the combination of the azote from these remains with oxygen in the atmosphere that the acid is formed; and at the expense of an element which otherwise would have formed ammonia; the compounds of which are much more efficacious than the nitrous compounds in assisting vegetation." It is proper to observe that this reason is more speculative than experimental, and seems influenced, in some degree, by the opinion adopted by the author, that fallows are of little use in husbandry. One obvious advantage of aeration in summer, or a summer fallow, is, that the soil may thus be heated by the sun to a degree which it never could be if partially covered with the foliage of even the widest drilled crops. For this purpose, if the soil is laid up in large lumps, it is evident it will receive more heat by exposing a greater surface to the atmosphere, and it will retain this heat for a period of unexpected duration, from the circumstance of the lumps reflecting back the rays of heat radiated by each other. A clayey soil, in this way, it is said (*Farmer's Magazine*, 1815), may be heated to 120°, which may in some degree alter its absorbent powers as to water, and contribute materially to the destruction of vegetable fibre, insects, and their eggs. By the aeration of lands in winter, minute mechanical division is obtained by the freezing of the water in the soil; for, as water in the solid state occupies more space than when fluid, the particles of earthy matters and of decomposing stones are thus rent asunder, and crumble down in a fine mould. Rough stony soils will thus receive an accession to their finer soil every winter. Soils which have been soured, sodden, or baked by the tread of cattle, or by other means, in wet weather, are more speedily sweetened, as the expression is, by exposure to the sun during the hottest weather of summer, than by exposure to the frost of winter; but in summer it is contended that the drying influence of the sun and air exhausts the soil of its vegetable matter to such an extent as to counteract the good effects of extreme heating by the sun. Those who maintain this doctrine contend that the only use of a summer fallow is to admit of freeing the soil of root-weeds.

2176. *Agricultural experience* has fully proved that fallows are the only means by which stiff clays in moist climates can be effectually cleared of weeds. Supposing therefore that no other advantage whatever was obtained, that no nutritive matter was imbibed from the atmosphere, and the soil was neither chemically nor mechanically benefited by aeration, this benefit alone, the effectual eradication of weeds, is sufficient to justify the use of fallows on such soils.

2177. *Many of the objections to fallows* have arisen in consequence of the parties not previously agreeing as to what a summer fallow is. In England generally, or at least formerly, a fallow was a portion of land left a year without culture or cropping, unless being once or twice ploughed can be denominated the former, and an abundant growth of coarse grasses and weeds can constitute the latter. The *jachères* of the French are the same thing. In Scotland, and in the best-cultivated districts, a summer fallow is a portion of land begun to be cultivated after the crop is removed in autumn, and is frequently, as need requires, ploughed, harrowed, and otherwise comminuted, and freed from stones, weeds, inequalities, &c., till the autumnal seed-time of the following year: it is thus for twelve months in a state of constant tillage and movement. The result is, that the land is thoroughly freed from roots of weeds; from many seeds of weeds, which are thus made to germinate, and are then destroyed; and from many eggs of insects which are thus hatched, but being without plants to nourish them in their larva state, speedily die. The land is also thoroughly pulverised, and the top, bottom, and middle mixed together; stones are picked out, inequalities unfavourable to surface drainage removed or lessened, and various other useful objects attained. Such a fallow can no more be compared with what usually passes under that name, than the plough of Virgil (112.) with that of Small.

2178. *That fallows of the common kind* are much more universal than is necessary, there can be little doubt; but there can be as little doubt that fallows such as we have described are much less frequent than they should be, and that wherever they are practised, the agriculturist's produce and profits will be found far superior to where they are omitted: turnip soils are of course to be excepted, because the preparation for that crop, on light soils, effects the same purpose in eight months, that the fallow does in twelve.

2179. *The origin of fallows* is commonly traced to the idea, that land naturally requires rest as well as animals: but a want of hands first, and afterwards a want of manure, are much more likely causes. Men must very early have observed, from what took place in the spots they cultivated as gardens, that pulverisation and manure would insure perpetual crops on the same soil; but they must at the same time have felt, that they had neither the requisite labourers to bestow the cultivation, nor cattle to produce the manure. Hence they would find it easier to break up one piece of fresh ground after another, and after they had gone a round in this way, as extensive as their limits or other circumstances permitted, they would return to where they began. As their limits became circumscribed by the increase of population, or other causes, they would return the oftener, till at last, when property became more rigidly defined, and more valuable, they would return at short intervals regularly. Then it was that the necessity and advantage of working fallows would be felt, and the practice become systematised as at the present day, and from the earliest records in civilised countries. The practice of fallowing in Italy, during the time of the Romans (128.), differed in nothing from that of the same country, and of the rest of Europe, at the present day: and if we trace field culture among savage and semibarbarous nations, and gradually through such as are more wealthy and refined, we shall find the fallow in all its gradations, from breaking up at random, to the triennial, quintennial, and septennial operations of the best British farmers.

Subsect. 4. *Alteration of the constituent Parts of Soils.*

2180. *The constituent parts of soils may be altered by the addition or subtraction of ingredients* in which they are deficient or superabound, and by the chemical change of some constituent part or parts by the action of fire.

2181. *In ascertaining the composition of faulty soils, with a view to their improvement by adding to their constituent parts,* any particular ingredient which is the cause of their unproductiveness should be particularly attended to; if possible, they should be compared with fertile soils in the same neighbourhood, and in similar situations, as the difference of the composition may, in many cases, indicate the most proper methods of improvement. If, on washing a sterile soil, it is found to contain the salts of iron, or any acid matter, it may be ameliorated by the application of quicklime. A soil of good apparent texture, containing sulphate of iron, will be sterile; but the obvious remedy is a top-dressing with lime, which converts the sulphate into manure. If there be an excess of calcareous matter in the soil, it may be improved by the application of sand or clay. Soils too abundant in sand are benefited by the use of clay, or marl, or vegetable matter. Light sands are often benefited by a dressing of peat, and peats by a dressing of sand; though the former is in its nature but a temporary improvement. When peats are acid, or contain ferruginous salts, calcareous matter is absolutely necessary in bringing them into cultivation. The best natural soils are those of which the materials have been derived from different strata, which have been minutely divided by air and water, and are intimately blended together; and in improving soils artificially, the cultivator cannot do better than imitate the processes of nature. The materials necessary for the purpose are seldom far distant; coarse sand is often found immediately on chalk, and beds of sand and gravel are common below clay. The labour of improving the texture or constitution of the soil is repaid by great permanent advantages; less manure is required, and its fertility insured; and capital laid out in this way secures for ever the productiveness, and consequently the value, of the land.

2182. *The removal of superabundant ingredients in soils* may sometimes be one of the simplest and most effectual means of their improvement. It occasionally happens that the surface of a well proportioned soil is thickly covered with peat, with drifted sand, with gravel, or with small stones. Extensive examples of the former occur in Stirlingshire, and of the latter in Norfolk. In such cases, a simple and effectual mode of improvement consists in removing the superincumbent strata, and cultivating that below. This can seldom be put in practice on a large scale, with such heavy materials as gravel or stones; but some hundreds of acres of rich alluvial soil, deeply covered by peat, have been bared and cultivated in Blair-Drummond moss in Stirlingshire; an operation commenced by the celebrated Lord Kaimes (*Gen. Rep. of Scot., App.* v. 5.), copied by his neighbours, and continued by his and their successors. The moss is floated off by streams of water, which empty themselves in the Firth of Forth. In this river, by the winds and tides, it is cast on shore in the bays and recesses, impregnated with salt; and here it engenders vegetation on the encroaching surfaces of sand and gravel. Coatings of sand or gravel can seldom be removed on a scale of sufficient extent for agriculture, but have, in some instances, for the purposes of gardening. Sometimes this improvement may be effected by trenching down the surface, and raising up a stratum of better earth.

2183. *The moss of Kinkardine* or Blair-Drummond is situated in the parish of that name not far from Stirling, and contains upwards of 2000 acres, 1500 of which belong to the estate of Blair-Drummond. It lies upon a bed of clay, which is a continuation of the rich alluvial soil which forms the flat vales called *Carses* of Stirling and Falkirk. This vale or plain had been covered with trees, which appear to have been felled by the Romans, and this, by stagnating the water, ended in producing the moss. This moss consists of three different strata: the first, black and heavy, appears to have been formed of bent grass and fallen trees; the second is composed principally of Sphágnum palústre, and is brown and of an elastic texture; the third is about a foot thick, and consists of heath and a little bent grass. In general these three strata occupy to the depth of seven feet. Lord Kaimes took possession of this moss in 1766, and, soon after, conceived the idea of floating off the moss into the Firth of Forth, and exposing the alluvial soil for corn culture. After various experiments, which, however interesting, it would occupy too much room to detail, the following may be given as the result.

2184. *Manner of floating off the moss.* A stream of water sufficient to turn a common corn-mill will carry off as much moss as twenty men can throw into it, provided they be stationed at the distance of 100 yards from each other. The first step is to make in the clay, alongside of the moss, a drain to convey the water; and, for this operation, the Carse clay below the moss is peculiarly favourable, being perfectly free from stones and all other extraneous substances; and at the same time, when moist, as slippery as soap, so that not only is it easily dug, but its lubricity greatly facilitates the progress of the water when loaded with moss. The dimensions proper for the drain are found to be, two feet for the breadth, and the same for the depth. If smaller, it could not conveniently receive the spadefuls of moss; if larger, the water would escape, leaving the moss behind. The drain has an inclination of one foot in a hundred yards: the more regularly this inclination is observed throughout, the less will the moss be liable to obstructions in its progress with the water. The drain being formed, the operator marks off to a convenient extent, alongside of it, a section of moss ten feet broad; the greatest distance from which he can heave his spadeful into the drain. This he repeatedly does, till the entire moss be removed down to the clay. He then digs a new drain at the foot of the moss bank, turns the water into it, and proceeds as before, leaving the moss to pursue its course into the river Forth; upon the fortunate situation of which, happily forming for several miles the southern boundary of the estate, without the interposition of any other property, depended in some measure the very existence of the whole operations.

2185. *When the moss is entirely removed*, the clay is found to be incumbered with the roots of different sorts of trees, often very large, remaining in it as they grew: their trunks also are frequently found lying beside them, as has been already observed. All these the tenants remove, often with great labour. In the course of their operations they purposely leave a few inches of moss upon the clay. This, in spring, when the season is favourable, they reduce to ashes, which in a great measure insures the first crop. The ground thus cleared is turned over, where the dryness admits, with a plough; and, where too soft, with a spade. A month's exposure to the sun, wind, and frost, reduces the clay to such a state as fits it for the seed in March and April. A crop of oats is the first produce, which seldom fails of being plentiful, yielding from eight to ten bolls after one. (*Farm. Mag.*, vol. xviii.)

2186. *To procure water for floating off the moss* was found to be the greatest difficulty; but it was readily overcome by Mr. Whitworth, an eminent engineer, and Mr. George Meikle, of Alloa, a skilful millwright, the son of the well known inventor of the thrashing-machine. (799.) Mr. Meikle gave a model of a wheel of his own and his father's invention, of an entirely new construction. This wheel is so exceedingly simple, and acts in a manner so easy, natural, and uniform, that a common observer is apt to undervalue the invention; but persons skilled in mechanics view machinery with a very different eye, for to them simplicity is the first recommendation a machine can possess. Accordingly, upon seeing the model set to work, Mr. Whitworth, with that candour and liberality of mind which generally accompany genius and knowledge, not only gave it the greatest praise, but declared that, for the purpose required, it was superior to what had been recommended by himself, and advised it to be adopted without hesitation. (*Farm. Mag.*, vol. xviii.)

2187. *The water-wheel at Blair-Drummond* is twenty-eight feet in diameter and ten feet broad. It is driven by water operating on the float-boards, in the same way as an ordinary mill-wheel. At the extremities of the radii, or arms, of the wheel, immediately within the float-boards and circumference, is fixed a double row of buckets, as they have been called, borrowing a word from the Persian wheel, to which this part of the present machine has no resemblance, which are more like a section of Louvre boards, or Venetian blinds, or a set of scales, opening upwards when at the bottom of the circumference, and downwards when at the top. These receive two streams of water, which are poured into them within the circumference, when below, which water they discharge when they ascend, and are inverted by the revolution of the wheel into a trough or cistern so placed as to receive it above. By this means a level is gained of 17 feet, which is sufficient to make the water run to the surface of the moss. The water is conveyed from the cistern of the wheel to the moss for 354 yards below ground, in wooden pipes hooped with iron, 18 inches in diameter within; and afterwards rises from the pipes into an open aqueduct above 1400 yards in length, and elevated from eight to ten feet above the level of the adjacent grounds.

2188. *The wheel makes nearly four revolutions in a minute*, in which time it discharges into the cistern 40 hogsheads of water, and it is capable of lifting no less than 60 hogsheads in a minute; but the pipes will not admit such a quantity of water, nor would it be safe or expedient to drive the machine with a force sufficient to raise so great a quantity. It is probable that the first idea of this machine was derived from the Persian wheel; but its superiority in many respects is so conspicuous as to entitle it to little less praise than the first invention. (*Farm. Mag.*, vol xviii.) The wheel was completed and at work in October 1827, and the total expense exceeded 1000*l.* It has been twice rebuilt. The tenants voluntarily agreed to pay interest on whatever sum it might cost; but their generous landlord relieved them at once from their engagement.

2189. *The details of the Blair-Drummond wheel* (*fig.* 204) are thus given in the very copious and inter-

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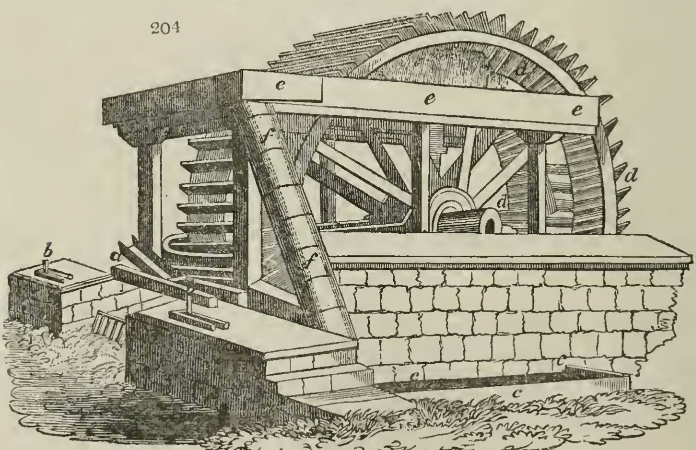

esting account in the *Farmer's Magazine*, vol. xviii., from which the present is extracted. *Fig.* 204. *a*, is a sluice through which is admitted the water that moves the wheel; *b b*, two sluices through which is admitted the water raised by the wheel; *c c c*, a part of one of two wooden troughs and an aperture in the wall, through which the above water is conveyed into the buckets; the other trough is hid by two stone walls that support the wheel; *d d d*, buckets, of which 80 are arranged on each side of the arms of the wheel, in all 160; *e e e*, a cistern, into which the water raised by the buckets is discharged; *f f f*, wooden barrel pipes, through which the water descends from the cistern under ground.

2190. *The cistern of the Blair-Drummond wheel*, as seen from above (*fig.* 205.), shows the two troughs into which the buckets empty themselves (*g g*); the space through which the water flows to the barrel pipes (*f f* in *fig.* 204.) (*h*); the place where the arms of the wheel move (*i*), and where the float boards and buckets descend (*k*). The buckets are filled from two side troughs (*fig.* 206. *l*), which communicate with the head of water which drives the wheel, as seen at *e* in *fig.* 204. (*Farm. Mag.*, vol. xviii.)

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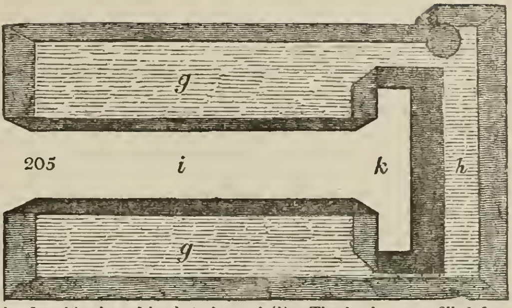

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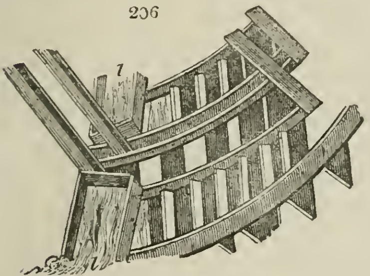

2191. *Incineration.* The chemical changes which can be effected in soils by incineration are considerable. This practice was known to the Romans, is more or less in use in most parts of Europe, is mentioned as an approved practice by our oldest agricultural writers, and has lately excited some degree of attention from the successful experiments of different cultivators. (*Farmer's Magazine*, 1810 to 1815, and *Farmer's Journal*, 1814 to 1821)

2192. *The theory of burning soils* is thus given by Sir H. Davy. It rests, he says, entirely on chemical doctrines. The bases of all common soils are mixtures of the primitive earths and oxide of iron; and these earths have a certain degree of attraction for each other. To regard this attraction in its proper point of view, it is only necessary to consider the composition of any common silicious stone. Feldspar, for instance, contains silicious, aluminous, and calcareous earths, fixed alkali, and oxide of iron, which exist in one compound, in consequence of their chemical attractions for each other. Let this stone be ground into impalpable powder, it then becomes a substance like clay; if the powder is heated very strongly, it fuses, and on cooling forms a coherent mass similar to the original stone; the parts separated by mechanical division adhere again in consequence of chemical attraction. If the powder be heated less strongly, the particles only superficially combine with each other, and form a gritty mass, which, when broken into pieces, has the characters of sand. If the power of the powdered feldspar to absorb water from the atmosphere before and after the application of the heat is estimated, it is found much less in the latter case. The same effect takes place when the powder of other silicious or aluminous stones is made the subject of experiment; and two equal portions of basalt ground into impalpable powder, of which one half had been strongly ignited, and the other exposed only to a temperature equal to that of boiling water, gained very different weights in the same time when exposed to air. In four hours the one had gained only two grains, whilst the other had gained seven grains. When clay or tenacious soils are burnt, the effect is of the same kind; they are brought nearer to a state analogous to that of sands. In the manufacture of bricks the general principle is well illustrated; if a piece of dried brick earth be applied to the tongue, it will adhere to it very strongly, in consequence of its power to absorb water; but after it has been burnt, there will be scarcely a sensible adhesion.

2193. *The advantages of burning* are, that it renders the soil less compact, less tenacious, and less retentive of moisture; and when properly applied, may convert a matter which was stiff, damp, and, in consequence, cold, into one powdery, dry, and warm, and much more proper as a bed for vegetable life.

2194. *The great objection* made by speculative chemists to paring and burning is, that it destroys vegetable and animal matter, or the manure in soil: but in cases in which the texture of its earthy ingredients is permanently improved, there is more than a compensation for this temporary disadvantage; and in some soils where there is an excess of inert vegetable matter, the destruction of it must be beneficial; and the carbonaceous matter remaining in the ashes may be more useful to the crop than the vegetable fibre from which it was produced.

2195. *Three specimens of ashes* from different lands which had undergone paring and burning were examined by chemical analysis. The first was from a chalk soil, and 200 grains contained 80 of carbonate of lime, 11 gypsum, 9 charcoal, 15 oxide of iron, 3 saline matter, sulphate of potash, muriate of magnesia, with a minute quantity of vegetable alkali; the remainder alumina and silica. Suppose 2660 bushels to be the common produce of an acre of ground, then, according to this calculation, they would give 172,900 lbs., containing carbonate of lime 69,160 lbs., gypsum 9509·5., oxide of iron 12,967·5., saline matter 2593·5., charcoal 7780·5. In this instance there was undoubtedly a very considerable quantity of matter capable of being active as manure produced in the operation of burning. The charcoal very finely divided, and exposed on a large surface, must be gradually converted into carbonic acid; and gypsum and oxide of iron seem to produce the very best effects when applied to lands containing an excess of carbonate of lime. The second specimen was from a soil near Coleorton, in Leicestershire, containing only 4 per cent of carbonate of lime, and consisting of three fourths light silicious sand, and about one fourth clay. This had been turf before burning, and 100 parts of the ashes gave 6 parts charcoal, 3 muriate of soda and sulphate of potash, with a trace of vegetable alkali, 9 oxide of iron, and the remainder the earths. In this instance, as in the other, finely divided charcoal was found, the solubility of which would be increased by the presence of the alkali. The third instance was that of a stiff clay, from Mount's Bay, Cornwall. This land had been brought into cultivation from a heath, by burning, about ten years before: but having been neglected, furze was springing up in different parts of it, which gave rise to the second paring and burning. 100 parts of the ashes contained 8 parts of charcoal, 2 of saline matter, principally common salt, with a little vegetable alkali, 7 oxide of iron, 2 carbonate of lime, the remainder alumina and silica. Here the quantity of charcoal was greater than in the other instances. The salt was probably owing to the vicinity of the sea, it being but two miles off. In this land there was certainly an excess of dead vegetable fibre, as well as unprofitable living vegetable matter.

2196. *Causes of the effects of burning soil.* Many obscure causes have been referred to for the purpose of explaining the effects of paring and burning; but they may be referred entirely to the diminution of the coherence and tenacity of clays, and to the destruction of inert and useless vegetable matter, and its conversion into a manure. Dr. Darwin, in his *Phytologia*, has supposed that clay, during torrefaction, may absorb some nutritive principles from the atmosphere which afterwards may be supplied to plants; but the earths are pure metallic oxides, saturated with oxygen; and the tendency of burning is to expel any other volatile principles which they may contain in combination. If the oxide of iron in soils is not saturated with oxygen, torrefaction tends to produce its further union with this principle; and hence, in burning, the colour of clay changes to red. The oxide of iron, containing its full proportion of oxygen, has less attraction for acids than any other oxide, and is consequently less likely to be dissolved by any fluid acids in the soil; and it appears in this state to act in the same manner as the earths. A very ingenious author, Naismith (*Elements of Agr.*), supposes that the oxide of iron, when combined with carbonic acid, is poisonous to plants; and that one use of torrefaction is to expel the carbonic acid from it; but the carbonate of iron is not soluble in water, and is a very inert substance; and a luxuriant crop of cresses has been raised in a soil composed of one fifth carbonate of iron, and four fifths carbonate of lime. Carbonate of iron abounds in some of the most fertile soils in England, particularly the red hop soil; and there is no theoretical ground for supposing that carbonic acid, which is an essential food of plants, should, in any of its combinations, be poisonous to them; and it is known that lime and magnesia are both noxious to vegetation, unless combined with this principle.

2197. *The soils improved by burning* are all such as contain too much dead vegetable fibre, and which consequently lose from one third to one half their weight by incineration; and all such as contain their earthy constituents in an impalpable state of division, i. e. the stiff clays and marls, are improved by burning: but in coarse sands, or rich soils containing a just mixture of the earths, and in all cases in which the texture is sufficiently loose, or the organisable matter sufficiently soluble, the process of torrefaction cannot be useful.

2198. *All poor silicious sands are injured by burning.* Young, in his *Essay on Manures*, states "that he found burning injure sand; and the operation is never performed by good cultivators upon silicious sandy soils, after they have once been brought into cultivation."

Subsect. 5. *Changing the Condition of Lands in respect to Water.*

2199. *The water of the soil where superabundant may be withdrawn, and when deficient supplied:* these operations with water are independent of its supply as a manure, or as affording the stimulus of heat or cold.

2200. *Stagnant water* may be considered as injurious to all the useful classes of plants, by obstructing perspiration and intro-susception, and thus diseasing their roots and submerged parts. Where the surface-soil is properly constituted, and rests on a subsoil moderately porous, both will hold water by capillary attraction, and what is not so retained will sink into the interior strata by its gravity; but where the subsoil is retentive, it will resist, or not admit with sufficient rapidity, the percolation of water to the strata below, which accumulating in the surface-soil till its proportion becomes excessive as a component part, not only carries off the extractive matter, but diseases the plants. Hence the origin of surface-draining, that is, laying land in ridges or beds, or intersecting it with small open gutters.

2201. *Springs.* Where the upper stratum is porous in some places, and retentive in others, and on a retentive base, the water, in its progress along the porous bed or layer, will be interrupted by the retentive places in a great variety of ways, and there accumulating will burst through the upper surface in the form of springs, which are more injurious than surface-water, as being colder, and generally permanent in their operation. Hence the origin of under-draining in all its varieties of collecting, extracting, and conveying water.

2202. *The water of rivers* may become injurious to lands on their banks, by too frequently overflowing their surface. In this case the stream may be included by mounds of earth or other materials impervious to water: and thus aquatic soils rendered dry and fit for useful herbage and aration. The same may be said of lands occasionally overflown by the sea. Hence the origin of embanking, an art carried to a great extent in Holland and Italy. (See *Smeaton's Posthumous Works; Sigismondi, Agr. Tosc.; Raccolta dei Autori che trattano dell' Aque;* and our article *Embankment*, in *Supp. Encyc. Brit.* 1819.)

2203. *Irrigation.* Plants cannot live without water, any more than they can prosper in soils where it is superabundant; and it is therefore supplied by art on a large scale, either by surface or subterraneous irrigation. In both practices the important points are to imitate nature in producing motion, and in applying the water in the mornings or evenings, or under a clouded sky, and also at moderate intervals. The effects of water constantly employed would, in most cases, be such as attend stagnated water, aquatic soils, or land-springs; and employed in hot sunshine, or after violent heats, it may check evaporation and destroy life, exactly as it happens to those who may have bathed in cold spring water after long and violent exercise in a hot day. (*Phytologia*, xv. 3. 5.)

2204. *In surface irrigation* the water is conveyed in a system of open channels, which require to be most numerous in such grounds as are under drilled annual crops, and least so in such as are sown in breadths, beds, or ridges, under perennial crops. This mode of watering has existed from time immemorial. The children of Israel are represented as sowing their seed and "watering it with their foot;" that is, as Calmet explains it, raising the water from the Nile by a machine worked by the feet, from which it was conducted in such channels as we have been describing. It is general in the south of France and Italy; but less required in Britain.

2205. *The Persian wheel*, or *Noria*, an oriental invention of great power and of the most remote antiquity, was introduced into Spain by the Moors, and is yet extensively used in the southern and eastern provinces of that kingdom. It consists of a series of earthen jars attached to an endless rope passing over a vertical drum put into motion by a trundle and cog horizontal wheel, which last is usually turned by one bullock or more.

2206. *Subterraneous irrigation* may be effected by a system of drains or covered gutters in the subsoil, which, proceeding from a main conduit or other supply, can be charged with water at pleasure. For grounds under the culture of annual plants, this mode would be more convenient, and for all others more economical, as to the use of water, than surface irrigation. Where the under-stratum is gravelly, and rests on a retentive stratum, this mode of watering may take place without drains, as it may also on perfectly flat lands, by filling to the brim, and keeping full for several days, surrounding trenches; but the beds or fields between the trenches must not be of great extent. This practice is used in Lombardy on the alluvial lands near the embouchures of the Po. In Lincolnshire the same mode is practised by shutting up the flood gates of the mouths of the great drains in the dry seasons, and thus damming up the water through all the ramifications of the drainage from the sea to their source. This was first suggested by G. Rennie and Sir Joseph Banks, after the drainage round Boston, completed about 1810. A similar plan, on a smaller scale, had been practised in Scotland, where deep mosses had been drained and cultivated on the surface, but where, in summer, vegetation failed from deficiency of moisture. It was first adopted by J. Smith (See *Essay on the Improvement of Peat-moss,* 1795) on a farm in Ayrshire, and has subsequently been brought into notice by J. Johnston, the first delineator and professor of Elkington's system of draining.

2207. *Flooding and warping* are modes of irrigation, the former for manuring grass lands, and the latter for enriching the surface of arable lands; while both at the same time gradually raise up the surface of the soil. Irrigation with a view to conveying additions to the soil has long been practised, and is an evident imitation of the overflowing of alluvial lands, whether in meadow or aration. In the former case it is called irrigation or flooding, and in the latter warping. Warping is used chiefly as a mode of enriching the soil by an increase of the alluvial depositions, or warp of rivers, during winter, where the surface is not under crop, and is common on the banks of the Ouse.

2208. *The Italian process called colmata* (*fullness*) is nothing more than a variety of the British process called warping. In the Val di Chiana in Tuscany, fields which are too low are raised and fertilised by the process called colmata, which is done in the following manner:—The field is surrounded by an embankment to confine the water; the dike of the rivulet is broken down so as to admit the muddy water of the high floods; the Chiana itself is too powerful a body of water to be used for this purpose, it is only the streams that flow into the Chiana that are used. This water is allowed to settle and deposit its mud on the field. The water is then let off into the river at the lower end of the field by a discharging course called *scolo*, and, in French, *canal d'écoulement*. The water-course which conducts the water from a river, either to a fall for irrigation, or to a mill, is called *gora*. In this manner a field will be raised five and a half, and sometimes seven and a half feet, in ten years. If the dike is broken down to the bottom, the field will be raised the same height in seven years; but then, in this case, gravel is also carried in along with the mud. In a field of twenty-five acres, which had been six years under the process of colmata, in which the dike was broken down to within three feet of the bottom, the process was seen to be so far advanced that only another year was requisite for its completion. The floods in this instance had been much charged with soil. The water which comes off cultivated land completes the process sooner than that which comes off hill and woodlands. Almost the whole of the Val di Chiana has been raised by the process of colmata.

2209. *A proprietor whose field is not adjacent to a stream* may conduct the stream through the intervening lands of another proprietor on paying the damage he occasions. The process of colmata is expensive, because the ground is unproductive during the seven or eight years that the process lasts; but this is soon repaid with great profit by the fertility of the newly deposited soil.

2210. *By the gravel which the rivers carry and deposit* their bed is much raised above the level of the adjoining fields; so that, in order to carry off the rain water from the fields, drains are formed which pass in arched conduits under the embanked rivers, and go into larger drains which pass to the lowest part of the plain near Arezzo, and there enter the Chiana.

2211. *The soil in the Val di Chiana* is generally the same to the depth of six feet from the surface, and under that is gravel or sand. After the completion of the process of colmata, the expense of which is always repaid with profit, the ground is cultivated for five years on the proprietor's own account; and the produce during these five years repays the expense of the process of colmata with profit. The first two years it is sown with Indian corn (granturco), and sometimes hemp, the soil being then too strong for wheat. The next three it is sown with wheat, without any manure. The produce of wheat in this highly fertile state of the soil is twenty from one, whilst in the usual state of the ground the return of wheat is from twelve to fourteen from one. After this the field is let out in the ordinary way to the farmers, the *contadini*. (*Farm. Mag.*, vol. xxi.)

2212. *The rationale of irrigation* is thus given by Sir H. Davy:—"In general, in nature, the operation of water is to bring earthy substances into an extreme state of division: but in the artificial watering of meadows, the beneficial effects depend upon many different causes, some chemical, some mechanical. Water is absolutely essential to vegetation; and when land has been covered by water in the winter, or in the beginning of spring, the moisture which has penetrated deep into the soil, and even the subsoil, becomes a source of nourishment to the roots of the plants in the summer, and prevents those bad effects which often happen in lands in their natural state, from a long continuance of dry weather. When the water used in irrigation has flowed over a calcareous country, it is generally found impregnated with carbonate of lime; and in this state it tends, in many instances, to ameliorate the soil. Common river water also generally contains a certain portion of organisable matter, which is much greater after rains than at other times; or which exists in the largest quantity when the stream rises in a cultivated country. Even in cases where the water used for flooding is pure, and free from animal or vegetable substances, it acts by causing a more equable diffusion of nutritive matter existing in the land; and in very cold seasons it preserves the tender roots and leaves of the grass from being affected by frost. Water is of greater specific gravity at 42° Fahrenheit, than at 32°, the freezing point; and hence, in a meadow irrigated in winter, the water immediately in contact with the grass is rarely below 40°, a degree of temperature not at all prejudicial to the living organs of plants. In 1804, in the month of March, the temperature in a water meadow near Hungerford was examined by a very delicate thermometer. The temperature of the air at seven in the morning was 29°. The water was frozen above the grass. The temperature of the soil below the water in which the roots of the grass were fixed, was 43°." Water may also operate usefully in warm seasons by moderating temperature, and thus retarding the over-rapid progress of vegetation. The consequence of this retardation will be greater magnitude and improved texture of the grosser parts of plants, a more perfect and ample developement of their finer parts, and, above all, an increase in the size of their fruits and seeds. We apprehend this to be one of the principal uses of flooding rice-grounds in the East; for it is ascertained that the rice-plant will perfect its seeds in Europe, and even in this country, without any water beyond what is furnished by the weather, and the natural moisture of a well constituted soil. It may also be noticed that one variety of rice grows on the declivities of hills without artificial irrigation; as in St. Domingo and in certain parts of India. "In general, those waters which breed the best fish are the best fitted for watering meadows; but most of the benefits of irrigation may be derived from any kind of water. It is, however, a general principle, that waters containing ferruginous impregnation, though possessed of fertilising effects when applied to a calcareous soil, are injurious on soils which do not effervesce with acids; and that calcareous waters, which are known by the earthy deposit they afford when boiled, are of most use on silicious soils, or other soils containing no remarkable quantity of carbonate of lime."

Subsect. 6. *Changing the Condition of Lands, in respect to Atmospherical Influence.*

2213. *The influence of the weather on soils* may be affected by changing the position of their surface and by sheltering or shading.

2214. *Changing the condition of lands, as to solar influence,* is but a limited means of improvement; but is capable of being turned to some account in gardening. It is effected by altering the position of their surface, so as that surface may be more or less at a right angle to the plane of the sun's rays, according as heat or cold is to be increased or diminished. The influence of the sun's rays upon any plane are demonstrated to be as their number and perpendicularity to that plane, the effects of the atmosphere being excepted. Hence one advantage of ridging lands, provided the ridges run north and south; for on such surfaces the rays of the morning sun will take effect sooner on the east side, and those of the afternoon will remain longer in operation on the west side; whilst at mid-day his elevation will compensate, in some degree, for the obliquity of his rays to both sides of the ridge. In culture, on a small scale, ridges or sloping beds for winter-crops may be made south-east and north-west, with their slope to the south, at an angle of forty degrees, and as steep on the north side as the mass can be got to stand; and on the south slope of such ridge, *cæteris paribus*, it is evident much earlier crops may be produced than on level ground. The north side, however, will be lost during this early cropping; but as early crops are soon gathered, the whole can be laid level in time for a main crop. Hence all the advantage of grounds sloping to the south south-east, or south-west, in point of precocity, and of those sloping to the north for lateness and diminished evaporation. Another advantage of such surfaces is, that they dry sooner after rains, whether by the operation of natural or artificial drainage; or, in the case of sloping to the south, by evaporation.

2215. *Shelter*, whether by walls, hedges, strips of plantation, or trees scattered over the surface, may be considered, generally, as increasing or preserving heat, and lessening evaporation from the soil. But if the current of air should be of a higher temperature than the earth, screens against wind will prevent the earth from being so soon heated; and from the increased evaporation arising from so great a multiplication of vegetable surface by the trees, more cold will be produced after rains, and the atmosphere kept in a more moist state, than in grounds perfectly naked. When the temperature of a current of air is lower than that of the earth, screens will prevent its carrying off so much heat; but more especially scattered trees, the tops of which will be chiefly cooled whilst the under surfaces of their lower branches reflect back the rays of heat as they radiate from the surface of the soil. Heat, in its transmission from one body to another, follows the same laws as light; and, therefore, the temperature of the surface in a forest will, in winter, be considerably higher than that of a similarly constituted soil exposed to the full influence of the weather. The early flowering of plants, in woods and hedges, is a proof of this: but as such soils cannot be so easily heated in summer, and are cooled like others after the sinking in of rains, or the melting of snows, the effect of the reflection as to the whole year is nearly neutralised, and the average temperature of the year of such soils and situations will probably be found not greater than that of open lands.

2216. *Shading* the ground, whether by umbrageous trees, spreading plants, or covering it with tiles, slates, moss, litter, or other materials, has a tendency to exclude atmospherical heat and retain moisture. Shading dry loose soils, by covering them with litter, slates, or tiles, laid round the roots of plants, is found very beneficial.

Subsect. 7. *Rotation of Crops.*

2217. *Growing different crops in succession* is a practice which every cultivator knows to be highly advantageous, though its beneficial influence has not yet been fully accounted for by chemists. The most general theory is, that though all plants will live on the same food, as the chemical constituents of their roots and leaves are nearly the same, yet that many species require particular substances to bring their seeds or fruits to perfection, as the analysis of these seeds or fruits often afford substances different from those which constitute the body of the plant. A sort of rotation may be said to take place in nature, for perennial herbaceous plants have a tendency to extend their circumference, and rot and decay at their centre, where others of a different kind spring up and succeed them. This is more especially the case with travelling roots, as in mint, strawberry, creeping crowfoot, &c.

2218. *The rationale of rotation* is thus given by Sir H. Davy: — "It is a great advantage in the convertible system of cultivation, that the whole of the manure is employed; and that those parts of it which are not fitted for one crop, remain as nourishment for another. Thus, if the turnip is the first in the order of succession, this crop, manured with recent dung, immediately finds sufficient soluble matter for its nourishment; and the heat produced in fermentation assists the germination of the seed and the growth of the plant. If, after turnips, barley with grass-seeds is sown, then the land, having been little exhausted by the turnip crop, affords the soluble parts of the decomposing manure to the grain. The grasses, rye-grass, and clover remain, which derive a small part only of their organised matter from the soil, and probably consume the gypsum in the manure which would be useless to other crops: these plants, likewise, by their large systems of leaves, absorb a considerable quantity of nourishment from the atmosphere, or probably retain the nutritive qualities in the soil, for a covering of slates or any other covering would have nearly the same effect; and when ploughed in at the end of two years, the decay of their roots and leaves affords manure for the wheat crop; and at this period of the course, the woody fibre of the farm-yard manure, which contains the phosphate of lime, and the other difficultly soluble parts, is broken down: and as soon as the most exhausting crop is taken, recent manure is again applied. Peas and beans, in all instances, seem well adapted to prepare ground for wheat; and in some rich lands they are raised in alternate crops for years together. Peas and beans contain a small quantity of a matter analagous to albumen; but it seems that the azote, which forms a constituent part of this matter, is derived from the atmosphere. The dry bean-leaf, when burnt, yields a smell approaching to that of decomposing animal matter; and in its decay in the soil, may furnish principles capable of becoming a part of the gluten in wheat. Though the general composition of plants is very analogous, yet the specific difference in the products of many of them, prove that they must derive different materials from the soil; and though the vegetables having the smallest system of leaves will proportionably most exhaust the soil of common nutritive matter, yet particular vegetables, when their produce is carried off, will require peculiar principles to be supplied to the land in which they grow. Strawberries and potatoes at first produce luxuriantly in virgin mould, recently turned up from pasture; but in a few years they degenerate, and require a fresh soil. Lands, in a course of years, often cease to afford good cultivated grasses; they become (as it is popularly said) tired of them; and one of the probable reasons for this is, the exhaustion of the gypsum contained in the soil." — "Experience," Mr. Main, the editor of the *British Farmer's Magazine*, observes, "has proved that land, whatever may be its quality, should not be sown with clover at shorter intervals than five years."

2219. *The power of vegetables to exhaust the soil of the principles* necessary to their growth, is remarkably exemplified in certain *funguses*. Mushrooms are said never to rise in two successive seasons on the same spot; and the production of the phenomena called fairy rings has been ascribed by Dr. Wollaston to the power of the peculiar fungus which forms it, to exhaust the soil of the nutriment necessary for the growth of the species. The consequence is, that the ring annually extends; for no seeds will grow where their parents grew before them, and the interior part of the circle has been exhausted by preceding crops; but where the fungus has died, nourishment is supplied for grass, which usually rises within the circle, coarse, and of a dark green colour.

2220. *A rotation is unnecessary, according to Grisenthwaite*; and, in a strict chemical sense, what he asserts cannot be denied. His theory is a refinement on the common idea of the uses of a rotation stated above; but by giving some details of the constituent parts of certain grains and certain manures, he has presented it in a more clear and striking point of view than has hitherto been done. To apply the theory in every case, the constituent parts of all manures and of all plants (1st, their roots and leaves, and 2dly, their seeds, fruits, or grains) must be known. In respect to manures this is the case, and it may be said to be in a great degree the case as to the most useful agricultural plants: but the same cannot be said of garden productions in general, which are very numerous; though no branch of culture can show the advantage of a rotation of crops more than horticulture, in the practice of which it is found that grounds become tired of particular crops, notwithstanding that manures are applied at pleasure. If the precise effects of a rotation were ascertained, and the ingredients peculiarly necessary to every species pointed out, nothing could be more interesting than the results of experimental trials; and whoever shall point out a simple and economical mode by which the potato may be grown successively in the same soil, and produce annually, the effects of climate being excepted, as dry and well flavoured tubers, or nearly so, as they generally produce the first and second years on a new soil, will confer a real benefit on society. That wheat may be grown many years on the same soil by the use of animal manures, or such as contain gluten, Grisenthwaite's theory would justify us in believing; and it ought to be fairly tried by such cultivators as Coke and Curwen. Till this is done in the face of the whole agricultural world, and the produce of every crop, and all the particulars of its culture, accurately reported on annually, the possibility of the thing may be assented to from the premises, but will not be acted on; and, in fact, even the best agricultural chemists do not consider that we are sufficiently advanced in that branch of the science to draw any conclusion, *à priori*, very much at variance with general opinion and experience. It should always be kept in mind, that it is one thing to produce a crop, and a different thing to grow crops with profit.

2221. *The principles of rotations of crops* are thus laid down by Yvart and Ch. Pictet (*Cours complet d'Agriculture*, articles *Assolement*, and *Succession de Culture*; and *Traité des Assolemens*. Paris, 8vo): —

The *first principle*, or fundamental point, is, that every plant exhausts the soil.
The *second*, that all plants do not exhaust the soil equally.
The *third*, that plants of different kinds do not exhaust the soil in the same manner.
The *fourth*, that all plants do not restore to the soil the same quantity, nor the same quality of manure.
The *fifth*, that all plants are not equally favourable to the growth of weeds.

2222. *The following consequences* are drawn from these fundamental principles: —

First. However well a soil may be prepared, it cannot long nourish crops of the same kind in succession, without becoming exhausted.
Second. Every crop impoverishes a soil more or less, as more or less is restored to the soil by the plant cultivated.
Third. Perpendicular-rooting plants, and such as root horizontally, ought to succeed each other.
Fourth. Plants of the same kind should not return too frequently in a rotation.
Fifth. Two plants favourable to the growth of weeds, ought not to succeed each other.
Sixth. Such plants as eminently exhaust the soil, as the grains and oil plants, should only be sown when the land is in good heart.
Seventh. In proportion as a soil is found to exhaust itself by successive crops, plants which are least exhausting ought to be cultivated.

2223. *Influence of rotations in destroying insects.* Olivier, member of the Institute of France, has described all the insects, chiefly *Típulæ* and *Múscæ*, which live upon the collar or crown of the roots of the cereal grasses, and he has shown that they multiply themselves without end, when the same soil presents the same crop for several years in succession, or even crops of analogous species. But when a crop intervenes on which these insects cannot live, as beans or turnips after wheat or oats, then the whole race of these insects perish from the field, for want of proper nourishment for their larvæ. (*Mém. de la Société Royale et Centrale d'Agr. de Paris*, vol. vii.)

Chap. II.

Of Manures.

2224. *Every species of matter capable of promoting the growth of vegetables* may be considered as manure. On examining the constituents of vegetables, we shall find that they are composed of oxygen, hydrogen, carbon, and nitrogen, or azote, with a small proportion of saline bodies. It is evident, therefore, that the substances employed as manure should also be composed of these elements, for, unless they are, there will be a deficiency in some of the elements in the vegetable itself; and it is probable that such deficiency may prevent the formation of those substances within it, for which its peculiar organisation is contrived, and upon which its healthy existence depends. The elementary bodies above enumerated are all contained in animal, and the first three in vegetable, matters. Sometimes, though very seldom, vegetables contain a small quantity of nitrogen. As certain salts are also constantly found to be present in healthy living vegetables, manures or vegetable food may, consequently, be distinguished into animal, vegetable, and saline. Kirwan, Dundonald, Darwin, and Davy, who produced the first chemical treatises on soils, were also the first to treat chemically of manures. Of these, the latest in the order of time is Sir H. Davy, from whose highly satisfactory work we shall extract the greater part of this chapter.

Sect. I. *Of Manures of Animal and Vegetable Origin.*

2225. *Decaying animal and vegetable substances* constitute by far the most important class of manures, or vegetable food, and may be considered as to the theory of their operation, their specific kinds, and their preservation and application in practice.

Subsect. 1. *The Theory of the Operation of Manures of Animal and Vegetable Origin.*

2226. *The rationale of organic manures* is very satisfactorily given by Sir H. Davy, who, after having proved that no solid substances can enter in that state into the plant, explains the manner in which nourishment is derived from vegetable and animal substances.

2227. *Vegetable and animal substances deposited in the soil*, as it is shown by universal experience, are consumed during the process of vegetation; and they can only nourish the plant by affording solid matters capable of being dissolved by water, or gaseous substances capable of being absorbed by the fluids in the leaves of vegetables; but such parts of them as are rendered gaseous, and pass into the atmosphere, must produce a comparatively small effect, for gases soon become diffused through the mass of the surrounding air. The great object, therefore, in the application of manure should be to make it afford as much soluble matter as possible to the roots of the plant; and that in a slow and gradual manner, so that it may be entirely consumed in forming its sap and organised parts.

2228. *Mucilaginous, gelatinous, saccharine, oily, and extractive fluids, carbonic acid, and water,* are substances that in their unchanged states contain almost all the principles necessary for the life of plants; but there are few cases in which they can be applied as manures in their pure forms; and vegetable manures, in general, contain a great excess of fibrous and insoluble matter, which must undergo chemical change, before it can become the food of plants.

2229. *The nature of the changes on these substances;* of the causes which occasion them, and which accelerate or retard them; and of the products they afford, have been scientifically stated and explained by our great agricultural chemist. If any fresh vegetable matter which contains sugar, mucilage, starch, or other of the vegetable compounds soluble in water, be moistened, and exposed to air, at a temperature from 55° to 80°, oxygen will soon be absorbed, and carbonic acid formed; heat will be produced, and elastic fluids, principally carbonic acid, gaseous oxide of carbon, and hydro-carbonate will be evolved; a dark-coloured liquid, of a slightly sour or bitter taste, will likewise be formed; and if the process be suffered to continue for a time sufficiently long, nothing solid will remain, except earthy and saline matter, coloured black by charcoal. The dark-coloured fluid formed in the fermentation always contains acetic acid; and when albumen or gluten exists in the vegetable substance, it likewise contains volatile alkali. In proportion as there is more gluten, albumen, or matters soluble in water, in the vegetable substances exposed to fermentation, so in proportion, all other circumstances being equal, will the process be more rapid. Pure woody fibre alone undergoes a change very slowly; but its texture is broken down, and it is easily resolved into new aliments, when mixed with substances more liable to change, containing more oxygen and hydrogen. Volatile and fixed oils, resins, and wax, are more susceptible of change than woody fibre, when exposed to air and water; but much less liable than the other vegetable compounds; and even the most inflammable substances, by the absorption of oxygen, become gradually soluble in water. Animal matters in general are more liable to decompose than vegetable substances; oxygen is absorbed and carbonic acid and ammonia formed in the process of their putrefaction. They produce fetid, compound, elastic fluids, and likewise azote: they afford dark-coloured acid and oily fluids, and leave a residuum of salts and earths mixed with carbonaceous matter.

2230. *The principal animal substances* which constitute their different parts, or which are found in their blood, their secretions, or their excrements, are gelatine, fibrine, mucus, fatty or oily matter, albumen, urea, uric acid, and other acid, saline, and earthy matters.

2231. *General treatment of organic manures.* Whenever manures consist principally of matter soluble in water, it is evident that their fermentation or putrefaction should be prevented as much as possible; and the only cases in which these processes can be useful, are when the manure consists principally of vegetable or animal fibre. The circumstances necessary for the putrefaction of animal substances are similar to those required for the fermentation of vegetable substances; a temperature above the freezing point, the presence of water, and the presence of oxygen, at least in the first stage of the process. To prevent manures from decomposing, they should be preserved dry, defended from the contact of air, and kept as cool as possible. Salt and alcohol appear to owe their powers of preserving animal and vegetable substances to their attraction for water, by which they prevent its decomposing action, and likewise to their excluding air.

Subsect. 2. *Of the different Species of Manures of Animal and Vegetable Origin.*

2232. *The properties and nature of the manures in common use* should be known to every cultivator: for as different manures contain different proportions of the elements necessary to vegetation, so they require a different treatment to enable them to produce their full effects in culture.

2233. *All green succulent plants* contain saccharine or mucilaginous matter, with woody fibre, and readily ferment. They cannot, therefore, if intended for manure, be used too soon after their death. Hence the advantage of digging or ploughing in green crops, whether natural or sown on purpose; they must not, however, be turned in too deep, otherwise, as Mrs. Ibbetson has shown (*Philos. Mag.* 1816), fermentation will be prevented by compression and exclusion of air. Green crops should be ploughed in, if it be possible, when in flower, or at the time the flower is beginning to appear; for it is at this period that they contain the largest quantity of easily soluble matter, and that their leaves are most active in forming nutritive matter. Green crops, pond-weeds, or the parings of hedges or ditches, require no preparation to fit them for manure, nor does any kind of fresh vegetable matter. The decomposition slowly proceeds beneath the soil; the soluble matters are gradually dissolved; and the slight fermentation which goes on, checked by the want of a free communication of air, tends to render the woody fibre soluble without occasioning the rapid dissipation of elastic matter. When old pastures are broken up and made arable, not only has the soil been enriched by the death and slow decay of the plants which have left soluble matters in the soil, but the leaves and roots of the grasses living at the time, and occupying so large a part of the surface, afford saccharine, mucilaginous, and extractive matters, which become immediately the food of the crop, and, from their gradual decomposition, afford a supply for successive years.

2234. *Rape-cake*, which is used with great success as manure, contains a large quantity of mucilage, some albuminous matter, and a small quantity of oil. This manure should be used recent, and kept as dry as possible before it is applied. It forms an excellent dressing for turnip crops; and is most economically applied by being thrown into the soil at the same time with the seed.

2235. *Malt-dust* consists chiefly of the infant radicle separated from the grain. Sir H. Davy never made any experiment upon this manure; but had great reason to suppose that it must contain saccharine matter, and this substance will account for its powerful effects. Like rape-cake, it should be used as dry as possible, and its fermentation prevented.

2236. *Linseed-cake* is too valuable as a food for cattle to be much employed as a manure. The water in which flax and hemp are steeped, for the purpose of obtaining the pure vegetable fibre, has considerable fertilising powers. It appears to contain a substance analogous to albumen, and likewise much vegetable extractive matter. It putrefies very readily. By the watering process, a certain degree of fermentation is absolutely necessary to obtain the flax and hemp in a proper state; the water to which they have been exposed should therefore be used as a manure as soon as the vegetable fibre is removed from it: but as flax is generally watered in deep ponds, and sometimes even in streams, it is but seldom that the water is sufficiently impregnated with extractive matter to be worth applying to agricultural purposes.

2237. *Sea-weeds*, consisting of different species of *F*ùci, *A*lgæ, and *C*onférvæ, are much used as a manure on the sea-coasts of Britain and Ireland. In the Orkney Islands the *F*ùcus digitàtus is preferred, on account of its greater substance. When driven on shore by the winter storms or the gales of spring, it is collected and laid on the land, into which it is then ploughed. In summer it is burnt, with other *F*ùci, into *kelp*. It is a powerful fertiliser, but its benefits do not extend beyond one or at most two seasons. By digesting the common *F*ùcus, which is the sea-weed usually most abundant on the coast, in boiling water, one eighth of a gelatinous substance will be obtained, with characters similar to mucilage. A quantity distilled gave nearly four fifths of its weight of water, but no ammonia; the water had an empyreumatic and slightly sour taste; the ashes contained sea salt, corbonate of soda, and carbonaceous matter. The gaseous matter afforded was small in quantity, principally carbonic acid, and gaseous oxide of carbon, with a little hydro-carbonate. This manure is transient in its effects, and does not last for more than a single crop; which is easily accounted for from the large quantity of water, or the elements of water, which it contains. It decays without producing heat when exposed to the atmosphere, and seems, as it were, to melt down and dissolve away. A large heap has been entirely destroyed in less than two years, nothing remaining but a little black fibrous matter. Some of the firmest part of a *F*ùcus was suffered to remain in a close jar, containing atmospheric air, for a fortnight: in this time it had become very much shrivelled; the sides of the jar were lined with dew. The air examined was found to have lost oxygen, and to contain carbonic acid gas. Sea-weed is sometimes suffered to ferment before it is used; but this process seems wholly unnecessary, for there is no fibrous matter rendered soluble in the process, and a part of the manure is lost. The best cultivators use it as fresh as it can be procured; and the practical results of this mode of applying it are exactly conformable to the theory of its operation. The carbonic acid formed by its incipient fermentation must be partly dissolved by the water set free in the same process; and thus become capable of absorption by the roots of plants. The effects of the sea-weed, as manure, must principally depend upon this carbonic acid, and upon the soluble mucilage the weed contains. Some *F*ùcus which had fermented so as to have lost about half its weight, afforded less than one twelfth of mucilaginous matter; from which it may be fairly concluded that some of this substance is destroyed in fermentation.

2238. *Dry straw* of wheat, oats, barley, beans, and peas, spoiled hay, or any similar kind of dry vegetable matter, is, in all cases, useful manure. In general, such substances are made to ferment before they are employed, though Sir Humphrey Davy states " it may be doubted whether the practice should be indiscriminately adopted. From 400 grains of dry barley-straw eight grains of matter soluble in water were obtained, which had a brown colour, and tasted like mucilage. From 400 grains of wheaten-straw were obtained five grains of a similar substance. There can be no doubt that the straw of different crops, immediately ploughed into the ground, affords nourishment to plants; but there is an objection to this method of using straw, from the difficulty of burying long straw, and from its rendering the husbandry foul. When straw is made to ferment, it becomes a more manageable manure; but there is likewise, on the whole, a great loss of nutritive matter. More manure is perhaps supplied for a single crop; but the land is less improved than it would be, supposing the whole of the vegetable matter could be finely divided and mixed with the soil. It is usual to carry straw that can be employed for no other purpose to the dunghill, to ferment and decompose; but it is worth experiment, whether it may not be more economically applied when chopped small by a proper machine, and kept dry till it be ploughed-in for the use of a crop. In this case, though it would decompose much more slowly, and produce less effect at first, yet its influence would be much more lasting."

2239. *Sir Humphrey Davy's opinion as to the application of farm-yard manure* is in several points directly at variance with the experience of farmers. There may often be an error in allowing such manure to reach too high a degree of fermentation and putrefaction before it is applied to the soil; but in no case has it ever been found advantageous to apply it before the process of fermentation has actually begun. As to its fermenting after being spread upon the soil and ploughed down, it must be evident, upon a little reflection, either that no sensible fermentation would take place at all, unless the quantity were very large, or that its gases would be speedily exhaled through the loose covering of earth, and lost in the atmosphere. Mr. Coke of Holkham's practice, which has been so often referred to in support of the use of long or fresh dung, is in fact not different from that of the best turnip-land farmers of Scotland. Mr. Blaikie, his steward, a native of Roxburghshire, prepares his farm-yard manure for turnips in what are called pyes or camps in much the same way, and the dung undergoes much the same degree of fermentation in them as is done with the square or oblong dunghills of the turnip counties of Scotland (*C.*)

2240. *Mere woody fibre* seems to be the only vegetable matter that requires fermentation to render it nutritive to plants. Tanners' spent bark is a substance of this kind. A. Young, in his excellent *Essay on Manure*, states "that spent bark seemed rather to injure than assist vegetation;" which he attributes to the astringent matter that it contains. But, in fact, it is freed from all soluble substances, by the operation of water in the tan-pit; and, if injurious to vegetation, the effect is probably owing to its agency upon water, or to its mechanical effects. It is a substance very absorbent and retentive of moisture, and yet not penetrable by the roots of plants.

2241. *Inert peaty matter* is a substance of the same kind. It remains for years exposed to water and air without undergoing change, and in this state yields little or no nourishment to plants. Woody fibre will not ferment, unless some substances are mixed with it which act the same part as the mucilage, sugar, and extractive or albuminous matters with which it is usually associated in herbs and succulent vegetables. Lord Meadowbank has judiciously recommended a mixture of common farm-yard dung for the purpose of bringing peat into fermentation: any putrescible or fermentable substance will answer the end; and the more a substance heats, and the more readily it ferments, the better will it be fitted for the purpose. Lord Meadowbank states, that one part of dung is sufficient to bring three or four parts of peat into a state in which it is fitted to be applied to land; but, of course, the quantity must vary according to the nature of the dung and of the peat. In cases in which some living vegetables are mixed with the peat, the fermentation will be more readily effected.

2242. *Tanners' spent bark*, shavings of wood, and saw-dust, will probably require as much dung to bring them into fermentation as the worst kind of peat. Woody fibre may be likewise prepared, so as to become a manure, by the action of lime. It is evident, from the analysis of woody fibre by Guy Lussac and Thénard (which shows that it consists principally of the elements of water and carbon, the carbon being in larger quantities than in the other vegetable compounds), that any process which tends to abstract carbonaceous matter from it must bring it nearer in composition to the soluble principles; and this is done in fermentation by the absorption of oxygen and production of carbonic acid; and a similar effect, it will be shown, is produced by lime.

2243. *Wood-ashes*, imperfectly formed, that is, wood-ashes containing much charcoal, are said to have been used with success as a manure. A part of their effects may be owing to the slow and gradual consumption of the charcoal, which seems capable, under other circumstances than those of actual combustion, of absorbing oxygen, so as to become carbonic acid. In April 1803, some well burnt charcoal was enclosed by Sir H. Davy in a tube, which was half filled with pure water and half with common air, and then hermetically sealed. The tube was opened under pure water, in the spring of 1804, at a time when the atmospheric temperature and pressure were nearly the same as at the commencement of the experiment. Some water rushed in; and, on analysing a little air, which was expelled from the tube by the agency of heat, it was found to contain only seven per cent of oxygen. The water in the tube, when mixed with lime-water, produced a copious precipitate; so that carbonic acid had evidently been formed and dissolved by the water.

2244. *Manures from animal substances*, in general, require no chemical preparation to fit them for the soil. The great object of the farmer is to blend them with the earthy constituents in a proper state of division, and to prevent their too rapid decomposition.

2245. *The entire parts of the muscles of land animals* are not commonly used as manure, though there are many cases in which such an application might be easily made. Horses, dogs, sheep, deer, and other quadrupeds that have died accidentally or of disease, after their skins are separated, are often suffered to remain exposed to the air, or immersed in water till they are destroyed by birds or beasts of prey, or entirely decomposed ; and, in this case, most of their organised matter is lost for the land in which they lie, and a considerable portion of it employed in giving off noxious gases to the atmosphere. By covering dead animals with five or six times their bulk of soil, mixed with one part of lime, and suffering them to remain for a few months, their decomposition would impregnate the soil with soluble matter, so as to render it an excellent manure ; and by mixing a little fresh quicklime with it at the time of its removal, the disagreeable effluvia would be in a great measure destroyed, and it might be applied to crops in the same way as any other manure.

2246. *Fish* forms a powerful manure, in whatever state it is applied ; but it cannot be ploughed in too fresh, though the quantity should be limited. A. Young records an experiment, in which herrings spread over a field, and ploughed in for wheat, produced so rank a crop, that it was entirely laid before harvest. The refuse pilchards in Cornwall are used throughout the county as a manure, with excellent effects. They are usually mixed with sand or soil, and sometimes with sea weed, to prevent them from raising too luxuriant a crop. The effects are perceived for several years. In the fens of Lincolnshire, Cambridgeshire, and Norfolk, the little fishes called sticklebacks are caught in the shallow waters in such quantities, that they form a great article of manure in the land bordering on the fens. It is easy to explain the operation of fish as a manure. The skin is principally gelatine, which, from its slight state of cohesion, is readily soluble in water ; fat or oil is always found in fishes, either under the skin or in some of the viscera ; and their fibrous matter contains all the essential elements of vegetable substances.

2247. Amongst *oily substances*, blubber has been employed as a manure. It is most useful when mixed with clay, sand, or any common soil, so as to expose a large surface to the air, the oxygen of which produces soluble matter from it. Lord Somerville used blubber with great success at his farm in Surrey. It was made into a heap with soil, and retained its powers of fertilising for several successive years. The carbon and hydrogen abounding in oily substances fully account for their effects ; and their durability is easily explained from the gradual manner in which they change by the action of air and water.

2248. *Bones* are much used as a manure in various parts of England, and especially in Lincolnshire and Yorkshire. They are also used in Scotland wherever they can be got, and a knowledge of their great value is spreading rapidly over the Continent. After being broken, and boiled for grease, they are sold to the farmer. The more divided they are, the more powerful are their effects. The expense of grinding them in a mill is amply repaid by the increase of their fertilising powers ; and in the state of powder they are used in the drill husbandry, and delivered with the seed in the same manner as rape-cake. Bone-dust and bone-shavings, the refuse of the turning manufacture, may be advantageously employed in the same way. The basis of bone is constituted by earthy salts, principally phosphate of lime, with some carbonate of lime and phosphate of magnesia ; the easily decomposable substances in bone are fat, gelatine, and cartilage, which seems of the same nature as coagulated albumen. According to the analysis of Fourcroy and Vauquelin, ox-bones are composed of decomposable animal matter 51, phosphate of lime 37·7, carbonate of lime 10, phosphate of magnesia 1·3 ; total 100. To apply bone manure with effect, it is essential that the soil be dry.

2249. *Horn* is a still more powerful manure than bone, as it contains a larger quantity of decomposable animal matter. From 500 grains of ox-horn, Hatchett obtained only 1·5 grains of earthy residuum, and not quite half of this was phosphate of lime. The shavings or turnings of horn form an excellent manure, though they are not sufficiently abundant to be in common use. The animal matter in them seems to be of the nature of coagulated albumen, and it is slowly rendered soluble by the action of water. The earthy matter in horn, and still more that in bones, prevents the too rapid decomposition of the animal matter, and renders it very durable in its effects.

2250 *Hair, woollen rags, and feathers*, are all analogous in composition, and principally consist of a substance similar to albumen united to gelatine. This is shown by the ingenious researches of Hatchett. The theory of their operation is similar to that of bone and horn shavings.

2251. *The refuse of the different manufactures of skin and leather* forms very useful manures ; such as currier's shavings, furrier's clippings, and the offals of the tan-yard and of the glue-manufactory. The gelatine contained in every kind of skin is in a state fitted for its gradual solution or decomposition; and when buried in the soil, it lasts for a considerable time, and constantly affords a supply of nutritive matter to the plants in its neighbourhood.

2252. *Blood* contains certain quantities of all the principles found in other animal substances, and is consequently a very good manure. It has been already stated that it contains fibrine; it likewise contains albumen; the red particles in it, which have been supposed by many foreign chemists to be coloured by iron in a particular state of combination with oxygen and acid matter, Brande considers as formed of a peculiar animal substance containing very little iron. The scum taken from the boilers of the sugar-bakers, which is used as manure, principally consists of bullocks' blood which has been employed for the purpose of separating the impurities of common brown sugar, by means of the coagulation of its albuminous matter by the heat of the boiler.

2253. *The different species of corals, corallines, and sponges* must be considered as substances of animal origin. From the analysis of Hatchett, it appears that all these substances contain considerable quantities of a matter analogous to coagulated albumen; the sponges afford likewise gelatine. According to Merat Guillot, white coral contains equal parts of animal matter and carbonate of lime; red coral 46·5 of animal matter, and 53·5 of carbonate of lime; articulated coralline 51 of animal matter, and 49 of carbonate of lime. These substances are never used as manure in this country, except in cases when they are accidentally mixed with sea-weed; but it is probable that the corallines might be advantageously employed, as they are found in considerable quantity on the rocks, and bottoms of the rocky pools on many parts of our coast, where the land gradually declines towards the sea; and they might be detached by hoes, and collected without much trouble. On many parts of the Scottish coast, banks of shells have been deposited by the sea, and are applied with great advantage, both as a substitute for lime and in improving the mechanical texture of the clay soils within their reach.

2254. Amongst *excrementitious animal substances* used as manures, urine is the one upon which the greatest number of chemical experiments have been made, and the nature of which is best understood. The urine of the cow contains, according to the experiments of Brande: water 65; phosphate of lime 3; muriates of potassa and ammonia 15; sulphate of potassa 6; carbonates, potassa, and ammonia 4; urea 4.

2255. *The urine* of the horse, according to Fourcroy and Vauquelin, contains, of carbonate of lime 11, carbonate of soda 9, benzoate of soda 24, muriate of potassa 9, urea 7, water and mucilage 940. In addition to these substances, Brande found in it phosphate of lime. The urine of the ass, the camel, the rabbit, and domestic fowls, have been submitted to different experiments, and their constitution has been found similar. In the urine of the rabbit, in addition to most of the ingredients above mentioned, Vauquelin detected gelatine; and the same chemist discovered uric acid in the urine of domestic fowls. Human urine contains a greater variety of constituents than any other species examined. Urea, uric acid, and another acid similar to it in nature called rosacic acid, acetic acid, albumen, gelatine, a resinous matter, and various salts are found in it. The human urine differs in composition, according to the state of the body, and the nature of the food and drink made use of. In many cases of disease there is a much larger quantity of gelatine and albumen than usual in the urine, and in diabetes it contains sugar. It is probable that the urine of the same animal must likewise differ according to the different nature of the food and drink used; and this will account for discordances in some of the analyses that have been published on the subject. Urine is very liable to change, and to undergo the putrefactive process; and that of carnivorous animals more rapidly than that of graminivorous animals. In proportion as there is more gelatine or albumen in urine, so in proportion does it putrefy more quickly. The species of urine which contain most albumen, gelatine, and urea, are the best as manures; and all urine contains the essential elements of vegetables in a state of solution. During the putrefaction of urine the greatest part of the soluble animal matter that it contains is destroyed: it should consequently be used as fresh as possible; but if not mixed with solid matter, it should be diluted with water, as, when pure, it contains too large a quantity of animal matter to form a proper fluid nourishment for absorption by the roots of plants.

2256. *Putrid urine* abounds in ammoniacal salts; and though less active than fresh urine, is a very powerful manure. According to a recent analysis published by Berzelius, 1000 parts of urine are composed of, water 933; urea 30·1; uric acid 1; muriate of ammonia, free lactic acid, lactate of ammonia, and animal matter 17·14. The remainder different salts, phosphates, sulphates, and muriates.

2257. *Dung of birds.* Amongst excrementitious solid substances used as manures, one of the most powerful is the dung of birds that feed on animal food, particularly the dung of sea-birds. The guano, which is used to a great extent in South America, and which is the manure that fertilises the sterile plains of Peru, is a production of this kind. It exists abundantly, as we are informed by Humboldt, on the small islands in the South Sea, at Chinche, Ilo, Iza, and Arica. Fifty vessels are laden with it annually at Chinche, each of which carries from 1500 to 2000 cubical feet. It is used as a manure only in very small quantities; and particularly for crops of maize. Some experiments were made on specimens of guano in 1805. It appeared as a fine brown powder; it blackened by heat, and gave off strong ammoniacal fumes; treated with nitric acid, it afforded uric acid. In 1806, Fourcroy and Vauquelin published an elaborate analysis of guano. They state that it contains a fourth part of its weight of uric acid, partly saturated with ammonia, and partly with potassa; some phosphoric acid combined with the bases, and likewise with lime; small quantities of sulphate and muriate of potassa; a little fatty matter; and some quartzose sand. It is easy to explain its fertilising properties: from its composition it might be supposed to be a very powerful manure. It requires water for the solution of its soluble matter, to enable it to produce its full beneficial effect on crops.

2258. *The dung of sea-birds* has never been much used as a manure in this country; but it is probable that even the soil of the small islands on our coast much frequented by them would fertilise. Some dung of sea-birds, brought from a rock on the coast of Merionethshire, produced a powerful, but transient, effect on grass. The rains in our climate must tend very much to injure this species of manure, where it is exposed to them soon after its deposition; but it may probably be found in great perfection in caverns or clefts in rocks haunted by cormorants and gulls. Some recent cormorants' dung, when examined, had not at all the appearance of guano; it was of a greyish-white colour; had a very fetid smell, like that of putrid animal matter; when acted on by quicklime, it gave abundance of ammonia; treated with nitric acid, it yielded uric acid.

2259. *Night soil*, it is well known, is a very powerful manure, and very liable to decompose. It differs in composition; but always abounds in substances composed of carbon, hydrogen, azote, and oxygen. From the analysis of Berzelius, it appears that a part of it is always soluble in water; and in whatever state it is used, whether recent or fermented, it supplies abundance of food to plants. The disagreeable smell of night-soil may be destroyed by mixing it with quicklime; and if exposed to the atmosphere in thin layers, strewed over with quicklime in fine weather, it speedily dries, is easily pulverised, and in this state may be used in the same manner as rape-cake, and delivered into the furrow with the seed. The Chinese, who have more practical knowledge of the use and application of manures than any other people existing, mix their night-soil with one third of its weight of fat marl, make it into cakes, and dry it by exposure to the sun. These cakes, we are informed by the French missionaries, have no disagreeable smell, and form a common article of commerce of the empire. The earth, by its absorbent powers, probably prevents, to a certain extent, the action of moisture upon the dung, and likewise defends it from the effects of air. Desiccated night-soil, in a state of powder, forms an article of internal commerce in France, and is known under the name of *poudrette*; in London it is mixed with quicklime, and sold in cakes under the name of "desiccated night-soil."

2260. *Pigeon's dung* comes next in order, as to fertilising power. 100 grains, digested in hot water for some hours, produced 23 grains of soluble matter; which afforded abundance of carbonate of ammonia by distillation, and left carbonaceous matter, saline matter principally common salt, and carbonate of lime, as a residuum. Pigeons' dung, when moist, readily ferments, and after fermentation contains less soluble matter than before; from 100 parts of fermented pigeons' dung, only eight parts of soluble matter were obtained, which gave proportionably less carbonate of ammonia in distillation than recent pigeons' dung. It is evident that this manure should be applied as new as possible; and, when dry, it may be employed in the same manner as the other manures capable of being pulverised. The soil in woods, where great flocks of wood-pigeons roost, is often highly impregnated with their dung, and, it cannot be doubted, would form a valuable manure. Such soil will often yield ammonia when distilled with lime. In the winter, likewise, it usually contains abundance of vegetable matter, the remains of decayed leaves; and the dung tends to bring the vegetable matter into a state of solution. Manuring with pigeons' dung was, and still is, in great esteem in Persia.

2261. *The dung of domestic fowls* approaches very nearly in its nature to pigeons' dung. Uric acid is common to it and the dung of birds of every kind. It gives carbonate of ammonia by distillation, and immediately yields soluble matter to water. It is very liable to ferment. The dung of fowls is employed, in common with that of pigeons, by tanners, to bring on a slight degree of putrefaction in skins that are to be used for making soft leather. For this purpose the dung is diffused through water, in which state it rapidly undergoes putrefaction, and brings on a similar change in the skin. The excrements of dogs are employed by the tanner with similar effects. In all cases, the contents of the *grainer*, as the pit is called in which soft skins are prepared by dung, must form a very useful manure.

2262. *Rabbits' dung* has never been analysed. It is used with great success as a manure by some farmers, who find it profitable to keep rabbits in such a manner as to preserve their dung. It is laid on as fresh as possible, and is found better the less it has fermented.

2263. *The dung of cattle*, oxen, and cows has been chemically examined by Einhof and Thaer. They found that it contained matter soluble in water; and that it gave in fermentation nearly the same products as vegetable substances, absorbing oxygen, and producing carbonic acid gas.

2264. The recent *dung of sheep and of deer* affords, when long boiled in water, soluble matters which equal from two to three per cent of their weight. These soluble substances, procured by solution and evaporation, when examined, contain a very small quantity of matter analogous to animal mucus; and are principally composed of a bitter extract, soluble both in water and in alcohol. They give ammoniacal fumes by distillation, and appear to differ very little in composition. Some blades of grass were watered for several successive days with a solution of these extracts; they evidently became greener in consequence, and grew more vigorously than grass in other respects under the same circumstances. The part of the dung of cattle, sheep, and deer, not soluble in water, appears to be mere woody fibre, and precisely analogous to the residuum of those vegetables that form their food after they have been deprived of all their soluble materials.

2265. *The dung of horses* gives a brown fluid, and this, when evaporated, yields a bitter extract, which affords ammoniacal fumes more copiously than that from the dung of oxen.

2266. *In the treatment of the pure dung of cattle, sheep, and horses*, there seems no reason why it should be made to ferment except in the soil, like the other pure dungs; or, if suffered to ferment, it should be only in a very slight degree. The grass, in the neighbourhood of recently voided dung, is always coarse and dark green; some persons have attributed this to a noxious quality in unfermenting dung; but it seems to be rather the result of an excess of food furnished to the plants.

2267. *Street and road dung and the sweepings of houses* may be all regarded as composite manures; the constitution of them is necessarily various, as they are derived from a number of different substances. These manures are usually applied without being fermented.

2268. *Soot*, which is principally formed from the combustion of pit-coal or coal generally, contains likewise substances derived from animal matters. This is a very powerful manure. It affords ammoniacal salts by distillation, and yields a brown extract to hot water, of a bitter taste. It likewise contains an empyreumatic oil. Its great basis is charcoal, in a state in which it is capable of being rendered soluble by the action of oxygen and water. This manure is well fitted to be used in the dry state thrown into the ground with the seed, and requires no preparation.

2269. *Liquid Manure.* — The farmers of German Switzerland give the name of *gülle*, in French *lizier*, to the liquid manure obtained from their stalls and stables, and collected into underground pits or reservoirs, in which it is allowed to ferment in a mucous or slimy state. The manner of collecting it adopted by the agriculturists of Zurich is as follows: — The floor on which the cattle are stalled is formed of boards, with an inclination of four inches from the head to the hinder part of the animal, whose excrements fall into a gutter behind, in the manner usual in English cow-houses: the depth of this gutter is 15 inches, its width 10 inches. It should be so formed as to be capable of receiving, at pleasure, water to be supplied by a reservoir near it; it communicates with five pits by holes, which are opened for the passage of the slime, or closed as occasion requires. The pits or reservoirs of manure are covered over with a floor of boarding, placed a little below that on which the animals stand. This covering is important as facilitating the fermentation. The pits or reservoirs are made in masonry, well cemented, and should be bottomed in clay, well beaten, in order to avoid infiltration. They should be five, in order that the liquid may not be disturbed during the fermentation, which lasts about four weeks. Their dimensions should be calculated according to the number of animals the stable holds, so that each may be filled in a week. But whether full or not, the pit must be closed at the week's end, in order to maintain the regularity of the system of emptying. The reservoirs are emptied by means of portable pumps. In the evening the keeper of the stables lets a proper quantity of water into the gutter; and on returning to the stable in the morning, he carefully mixes with the water the excrement that has fallen into it, breaking up the more compact parts, so as to form of the whole an equal and flowing liquid. On the perfect manner in which this process is performed the quality of the manure mainly depends. The liquid ought neither to be thick, for then the fermentation would be difficult; nor too thin, for in that case it would not contain sufficient nutritive matter. When the mixture is made, it is allowed to run off into the pit beneath, and the stable-keeper again lets water into the trench. During the day, whenever he comes into the stable, he sweeps whatever excrement may be found under the cattle into the trench, which may be emptied as often as the liquid it contains is found to be of a due thickness. The best proportion of the mixture is three fourths of water to one fourth of excrement, if the cattle be fed on corn; if in a course of fattening, one fifth of excrement to four fifths of water will be sufficient. (*Bull. du Comité d'Agri. de la Soc. des Arts de Genève.*) This mode of increasing the manure produced by stalled cattle and cows is in general use in Holland and the Netherlands; and we have seen it practised in France at Trappe and Grignion near Versailles, at Roville near Nancy, at Ebersberg, and Schleissheim near Munich, and at Hohenheim and Weil near Stuttgard. We would strongly recommend the practice to the British farmer, and not to the farmer only, but to every cottager who keeps a cow or pig; nay, to the cottager who is without these comforts, but who has a garden, in which he could turn the great accession of manure so acquired to due account. Let him sink five tubs or large earthen vessels in the ground, and let the contents of the portable receiver of his water-closet, all the water used for washing in the house, soap-suds, slops, and fermentable offals of every description during a week be carried, and poured into one of these tubs; and if not full on the Saturday night, let it be filled up with water of any kind, well stirred up, the lid replaced, and the whole left for a week. Begin on the Monday morning with another tub, and when after five weeks the whole five are filled, empty the first at the roots of a growing crop, and refill. Or use two larger tubs, and continue filling one for a month; then begin the other, and at the end of a month empty the first; and so on. (*Gard. Mag.* vol. v. p. 549.)

Subsect. 3. *Of the Fermenting, Preserving, and Applying of Manures of Animal and Vegetable Origin.*

2270. On *the management of organic manures* depends much of their value as food to plants. The great mass of manures procured by the cultivator are a mixture of animal and vegetable matters, and the great source of supply is the farm or stable-yard. Here the excrementitious matter of horses, cattle, swine, and poultry, is mixed with straw, haulm, chaff, and various kinds of litter. To what degree should this be fermented before it is applied to the soil? and how can it best be preserved when not immediately wanted?

2271. *A slight incipient fermentation* is undoubtedly of use in the dunghill; for, by means of it, a disposition is brought on in the woody fibre to decay and dissolve, when it is carried to the land, or ploughed into the soil; and woody fibre is always in great excess in the refuse of the farm. Too great a degree of fermentation is, however, very prejudicial to the composite manure in the dunghill: it is better that there should be no fermentation at all before the manure is used, than that it should be carried too far. The excess of fermentation tends to the destruction and dissipation of the most useful part of the manure; and the ultimate results of this process are like those of combustion. It is a common practice amongst farmers to suffer the farm-yard dung to ferment till the fibrous texture of the vegetable matter is entirely broken down; and till the manure becomes perfectly cold, and so soft as to be easily cut by the spade. Independently of the general theoretical views unfavourable to this practice, founded upon the nature and composition of vegetable substances, there are many arguments and facts which show that it is prejudicial to the interests of the farmer.

2272. During *the violent fermentation* which is necessary for reducing farm-yard manure to the state in which it is called short muck, not only a large quantity of fluid, but likewise of gaseous matter, is lost; so much so, that the dung is reduced one half, or two thirds in weight: the principal elastic matter disengaged is carbonic acid with some ammonia; and both these, if retained by the moisture in the soil, as has been stated before, are capable of becoming a useful nourishment of plants. In October, 1808, Sir H. Davy filled a large retort, capable of containing three pints of water, with some hot fermenting manure, consisting principally of the litter and dung of cattle; he adapted a small receiver to the retort, and connected the whole with a mercurial pneumatic apparatus, so as to collect the condensible and elastic fluids which might rise from the dung. The receiver soon became lined with dew, and drops began in a few hours to trickle down the sides of it. Elastic fluid likewise was generated; in three days thirty-five cubical inches had been formed, which, when analysed, were found to contain twenty-one cubical inches of carbonic acid; the remainder was hydrocarbonate mixed with some azote, probably no more than existed in the common air in the receiver. The fluid matter collected in the receiver at the same time amounted to nearly half an ounce; it had a saline taste and a disagreeable smell, and contained some acetate and carbonate of ammonia. Finding such products given off from fermenting litter, he introduced the beak of another retort, filled with similar dung, very hot at the time, into the soil amongst the roots of some grass in the border of a garden. In less than a week a very distinct effect was produced on the grass; upon the spot exposed to the influence of the matter disengaged in fermentation, it grew with much more luxuriance than the grass in any other part of the garden. — Besides the dissipation of gaseous matter, when fermentation is pushed to the extreme, there is another disadvantage in the loss of heat, which, if excited in the soil, is useful in promoting the germination of the seed, and in assisting the plant in the first stage of its growth, when it is most feeble and most liable to disease; and the fermentation of manure in the soil must be particularly favourable to the wheat crop, in preserving a genial temperature beneath the surface late in autumn and during winter. Again, it is a general principle in chemistry, that, in all cases of decomposition, substances combine much more readily at the moment of their disengagement, than after they have been perfectly formed. Now, in fermentation beneath the soil, the fluid matter produced is applied instantly, even whilst it is warm, to the organs of the plant, and consequently is more likely to be efficient, than that from manure which has gone through the process, and of which all the principles have entered into new combinations.

2273. *Checking fermentation by covering.* "There are reasons sufficiently strong," Grisenthwaite observes, "to discourage the practice of allowing dung heaps to ferment and rot without interruption. It appears that public opinion has slowly adopted the decisions of chemical reasoning, and *dung-pies*, as they are called, have been formed with a view to save what was before lost; a stratum of mould, sustaining the heap, being placed to receive the fluid parts, and a covering of mould being applied to prevent the dissipation of the aerial or gaseous products. These purposes and contrivances, unfortunately, like many of the other operations of husbandry, were not directed by scientific knowledge. To cover is so commonly believed to confine, that there is no wonder that the practical cultivator adopted it in this instance from such a consideration; but it is in vain; the elasticity of the gases generated is such as no covering whatever could possibly confine. If it were perfectly compact, it could only preserve as much carbonic acid as is equal to the volume or bulk of air within it; a quantity too inconsiderable to be regarded, could it even be saved: but every particle of it must be disengaged, and lost, when the covering is removed."

2274. *Checking fermentation by watering* is sometimes recommended; but this practice is inconsistent with just chemical views. It may cool the dung for a short time; but moisture, as before stated, is a principal agent in all processes of decomposition. Dry fibrous matter will never ferment. Water is as necessary as air to the process; and to supply it to fermenting dung, is to supply an agent which will hasten its decay. In all cases when dung is fermenting, there are simple tests by which the rapidity of the process, and consequently the injury done, may be discovered. If a thermometer, plunged into the dung, does not rise to above one hundred degrees of Fahrenheit, there is little danger of much aeriform matter flying off. If the temperature is higher, the dung should be immediately spread abroad. When a piece of paper, moistened in muriatic acid, held over the steams arising from a dunghill, gives dense fumes, it is a certain test that the decomposition is going too far; for this indicates that volatile alkali is disengaged.

2275. *In favour of the application of farm-yard dung in a recent state*, a great variety of arguments may be found in the writings of scientific agriculturists; but the practice of the best farmers, both in Scotland and in the Netherlands and other parts of the Continent, is against the theory.

2276. *Farm-yard manure in Scotland* is never laid on the ground without being more or less prepared. For turnips it is regularly removed from the fold or stable yard before the middle or end of April. It is then laid up in a regular heap on a secluded spot of ground, generally in one corner of the field, not much exposed to wind, or liable to be flooded by water. The height of the heap should seldom be less than from 4 to 4½ feet, and its breadth, for the convenience of being turned over when necessary, and on other accounts, may be about two thirds of its length, sufficiently broad at least to admit two carts or more to be loaded at a time, as may be necessary; and great care should be taken, not to put either horse or cart upon it, which is easily avoided, by backing the cart to the pile, and laying the dung compactly together with a dung fork. It is not unusual to cover the dunghill with a coat of earth or moss, which keeps in the moisture, and prevents the sun and wind from doing injury, by evaporating those fluid substances, which arise from a valuable part of the dung. Dung, when managed in this manner, generally ferments very rapidly; but if it is discovered to be in a backward state, it is turned over about the first of May, when the weather becomes warm; and the better it is shaken about and mixed, the sooner will the object in view be accomplished. (*Gen. Rep. Scot.* vol. ii.) For wheat crops sown on fallow in autumn, or for beans, potatoes, or other crops sown or planted in spring, the farm or fold yard manure is carried out at different times, during the preceding summer and winter, and formed into large dunghills in the fields where they are to be used. These dunghills are turned once or twice, and moistened by watering, or covered by earth or moss, so as to accelerate or retard the fermentation, according to the period when the material may be wanted for use. The test of their fitness for this purpose is that degree of tenderness which admits of the easy separation of the littery parts when a dung fork is inserted and a forkful taken up.

2277. The doctrine of *the proper application* of manures from organised substances, offers an illustration of an important part of the economy of nature, and of the happy order in which it is arranged. The death and decay of animal substances tend to resolve organised forms into chemical constituents; and the pernicious effluvia disengaged in the process seem to point out the propriety of burying them in the soil, where they are fitted to become the food of vegetables. The fermentation and putrefaction of organised substances in the free atmosphere are noxious processes; beneath the surface of the ground, they are salutary operations. In this case the food of plants is prepared where it can be used; and that which would offend the senses and injure the health, if exposed, is converted by gradual processes into forms of beauty and of usefulness; the fetid gas is rendered a constituent of the aroma of the flower, and what might be poison becomes nourishment to animals and to man.

2278. *To preserve dung for any time,* the situation in which it is kept is of importance. It should, if possible, be defended from the sun. To preserve it under sheds would be of great use; or to make the site of a dunghill on the north side of a wall. The floor on which the dung is heaped should, if possible, be paved with flat stones; and there should be a little inclination from each side towards the centre, in which there should be drains connected with a small well, furnished with a pump, by which any fluid matter may be collected for the use of the land. It too often happens that a dense mucilaginous and extractive fluid is suffered to drain away from the dunghill, so as to be entirely lost to the farm.

Sect. II. *Of Manures of Mineral Origin.*

2279. *Earthy and saline manures* are probably of more recent invention, and doubtless of more uncertain use, than those of animal and vegetable origin. The conversion into original forms of matter which has belonged to living structures, is a process that can be easily understood; but it is more difficult to follow those operations by which earthy and saline matters are consolidated in the fibre of plants, and by which they are made subservient to their functions. These are capable of being materially elucidated by modern chemistry; and shall here be considered as to the theory of their operation and as to their specific kinds.

Subsect. 1. *Theory of the Operation of Mineral Manures.*

2280. *Saline and calcareous substances* form the principal fossil manures. Much has been written on lime and common salt, both in the way of speculation and reasoning from facts, which, from want of chemical knowledge, has turned to no useful account, and cultivators till very lately contented themselves with stating that these substances acted as stimuli to the soil, something like condiments to the digestive organs of animals. Even chemists themselves are not yet unanimous in all their opinions; but still the result of their enquiries will be found of great benefit to the scientific cultivator.

2281. *Various opinions* exist as to the rationale of the operation of mineral manures. "Some enquirers," Sir H. Davy observes, "adopting that sublime generalisation of the ancient philosophers, that matter is the same in essence, and that the different substances, considered as elements by chemists, are merely different arrangements of the same indestructible particles, have endeavoured to prove, that all the varieties of the principles found in plants, may be formed from the substances in the atmosphere; and that vegetable life is a process in which bodies, that the analytical philosopher is unable to change or to form, are constantly composed and decomposed. But the general results of experiments are very much opposed to the idea of the composition of the earths, by plants, from any of the elements found in the atmosphere, or in water, and there are various facts contradictory to the idea." Jacquin states, that the ashes of glass-wort (Salsòla *Sòda*), when it grows in inland situations, afford the vegetable alkali; when it grows on the sea-shore, where compounds which afford the fossil or marine alkali are more abundant, it yields that substance. Du Hamel found that plants which usually grow on the sea-shore made small progress when planted in soils containing little common salt. The sun-flower, when growing in lands containing no nitre, does not afford that substance; though when watered by a solution of nitre it yields nitre abundantly. The tables of De Saussure show that the ashes of plants are similar in constitution to the soils in which they have vegetated. De Saussure made plants grow in solutions of different salts; and he ascertained that, in all cases, certain portions of the salts were absorbed by the plants, and found unaltered in their organs. Even animals do not appear to possess the power of forming the alkaline and earthy substances. Dr. Fordyce found that when canary birds, at the time they were laying eggs, were deprived of access to carbonate of lime, their eggs had soft shells; and if there is any process for which nature may be conceived most likely to supply resources of this kind, it is that connected with the reproduction of the species.

2282. *It seems a fair conclusion,* as the evidence on the subject now stands, that the different earths and saline substances found in the organs of plants, are supplied by the soils in which they grow; and in no cases composed by new arrangements of the elements in air or water. What may be our ultimate view of the laws of chemistry, or how far our ideas of elementary principles may be simplified, it is impossible to say. We can only reason from facts. We cannot imitate the powers of composition belonging to vegetable structures; but at least we can understand them: and as far as our researches have gone, it appears that in vegetation compound forms are uniformly produced from simple ones; and the elements in the soil, the atmosphere, and the earth absorbed and made parts of beautiful and diversified structures. The views which have been just developed lead to correct ideas of the operation of those manures which are not necessarily the result of decayed organised bodies, and which are not composed of different proportions of carbon, hydrogen, oxygen, and azote. They must produce their effect, either by becoming a constituent part of the plant, or by acting upon its more essential food, so as to render it more fitted for the purposes of vegetable life.

Subsect. 2. *Of the different Species of Mineral Manures.*

2283. *Alkaline earths, or alkalies and their combinations*, which are found unmixed with the remains of any organised beings, are the only substances which can with propriety be called fossil manures. The only alkaline earths which have been hitherto applied in this way are lime and magnesia; though potassa and soda, the two fixed alkalies, are both used to a limited extent in certain of their chemical compounds.

2284. *The most common form in which lime is found* on the surface of the earth, is in a state of combination with carbonic acid or fixed air. If a piece of limestone or chalk be thrown into a fluid acid, there will be an effervescence. This is owing to the escape of the carbonic acid gas. The lime becomes dissolved in the liquor. When limestone is strongly heated, the carbonic acid gas is expelled, and then nothing remains but the pure alkaline earth; in this case there is a loss of weight; and if the fire has been very high, it approaches to one half the weight of the stone; but in common cases, limestones, if well dried before burning, do not lose much more than 35 to 40 per cent, or from seven to eight parts out of twenty.

2285. *When burnt lime is exposed to the atmosphere*, in a certain time it becomes mild, and is the same substance as that precipitated from lime-water; it is combined with carbonic acid gas. Quicklime, when first made, is caustic and burning to the tongue, renders vegetable blues green, and is soluble in water; but when combined with carbonic acid, it loses all these properties, its solubility, and its taste: it regains its power of effervescing, and becomes the same chemical substance as chalk or limestone. Very few limestones or chalks consist entirely of lime and carbonic acid. The statuary marbles, or certain of the rhomboidal spars, are almost the only pure species; and the different properties of limestones, both as manures and cements, depend upon the nature of the ingredient mixed in the limestone; for the true calcareous element, the carbonate of lime, is uniformly the same in nature, properties, and effects, and consists of one proportion of carbonic acid 41·4, and one of lime 55. When a limestone does not copiously effervesce in acids, and is sufficiently hard to scratch glass, it contains silicious, and probably aluminous earth; when it is deep brown or red, or strongly coloured of any of the shades of brown or yellow, it contains oxide of iron; when it is not sufficiently hard to scratch glass, but effervesces slowly, and makes the acid in which it effervesces milky, it contains magnesia; and when it is black, and emits a fetid smell if rubbed, it contains coaly or bituminous matter. Before any opinion can be formed of the manner in which the different ingredients in limestones modify their properties, it will be necessary to consider the operation of pure lime as a manure.

2286. *Quicklime, in its pure state*, whether in powder or dissolved in water, is injurious to plants. In several instances grass has been killed by watering it with lime-water. But lime, in its state of combination with carbonic acid, is a useful ingredient in soils. Calcareous earth is found in the ashes of the greater number of plants; and exposed to the air, lime cannot long continue caustic, for the reasons that were just now assigned, but soon becomes united to carbonic acid. When newly burnt lime is exposed to air, it soon falls into powder: in this case it is called slacked lime; and the same effect is immediately produced by throwing water upon it, when it heats violently, and the water disappears. Slacked lime is merely a combination of lime, with about one third of its weight of water; i. e. fifty-five parts of lime absorb seventeen parts of water; and in this case it is composed of a definite proportion of water, and is called by chemists *hydrate of lime;* and when hydrate of lime becomes carbonate of lime by long exposure to air, the water is expelled, and the carbonic acid gas takes its place. When lime, whether freshly burnt or slacked, is mixed with any moist fibrous vegetable matter, there is a strong action between the lime and the vegetable matter, and they form a kind of compost together, of which a part is usually soluble in water. By this kind of operation, lime renders matter which was before comparatively inert, nutritive; and as charcoal and oxygen abound in all vegetable matters, it becomes at the same time converted into carbonate of lime.

2287. *Mild lime, powdered limestone, marls, or chalks*, have no action of this kind upon vegetable matter; they prevent the too rapid decomposition of substances already dissolved; but they have no tendency to form soluble matters. It is obvious from these circumstances, that the operations of quicklime, and marl, or chalk, depend upon principles altogether different. Quicklime, in being applied to land, tends to bring any hard vegetable matter that it contains into a state of more rapid decomposition and solution, so as to render it a proper food for plants. Chalk, marl, or carbonate of lime, will only improve the texture of the soil, or its relation to absorption ; it acts merely as one of its earthy ingredients. Chalk has been recommended as a substance calculated to correct the sourness of land. It would surely have been a wise practice to have previously ascertained the certainty of this existence of acid, and to have determined its nature, in order that it might be effectually removed. The fact really is, that no soil was ever yet found to contain any notable quantity of uncombined acid. The acetic and carbonic acids are the only two that are likely to be generated by any spontaneous decomposition of animal or vegetable bodies, and neither of these has any fixity when exposed to the air. Chalk having no power of acting on animal and vegetable substances, can be no otherwise serviceable to land than as it alters its texture. Quicklime, when it becomes mild, operates in the same manner as chalk ; but in the act of becoming mild, it prepares soluble out of insoluble matter. Bouillon la Grange says that gelatine oxygenised becomes insoluble, and vegetable extract we know becomes so from the same cause ; now lime has the property of attracting oxygen, and, consequently, of restoring the property of solubility to those substances which have been deprived of it, from a combination with oxygen. Hence the uses of lime on peat lands, and on all soils containing an excess of vegetable insoluble matter. (*Grisenthwaite.*)

2288. *Marl, and even shell sand*, have been known to act chemically on peat bogs, and to produce astonishing benefits. True and genuine peat bogs contain a considerable quantity of an acid which has some affinity to *gallic* acid, and often yield phosphoric acid to analysis. It appears to be these acids which confer on peat earth its highly antiseptic qualities, and prevent the complete decay of woody fibre in such situations. When either true marl or shell sand is laid as a manure in such soils, a rapid decomposition of the vegetable matter takes place, owing to the calcareous matter uniting with the acid which before impregnated the woody fibre ; and such land soon becomes very productive, probably also because the carbonic acid of the marl and shell sand is applied to the growth of living vegetables as it is gradually disengaged by the union of these acids with the lime. (*T. S. T.*)

2289. *Effect of lime on wheat crops.* When lime is employed upon land where any quantity of animal matter is present, it occasions the evolution of a quantity of ammonia, which may, perhaps, be imbibed by the leaves of plants, and afterwards undergo some change so as to form gluten. It is upon this circumstance that the operation of lime in the preparation for wheat crops depends ; and its efficacy in fertilising peat, and in bringing into a state of cultivation all soils abounding in hard roots, dry fibres, or inert vegetable matter.

2290. *General principles for applying lime.* The solution of the question whether quicklime ought to be applied to a soil, depends upon the quantity of inert vegetable matter that it contains. The solution of the question, whether marl, mild lime, or powdered limestone ought to be applied, depends upon the quantity of calcareous matter already in the soil. All soils which do not effervesce with acids are improved by mild lime, and ultimately by quicklime ; and sands more than clays. When a soil, deficient in calcareous matter, contains much soluble vegetable manure, the application of quicklime should always be avoided, as it either tends to decompose the soluble matters by uniting to their carbon and oxygen so as to become mild lime, or it combines with the soluble matters, and forms compounds having less attraction for water than the pure vegetable substance. The case is the same with respect to most animal manures ; but the operation of the lime is different in different cases, and depends upon the nature of the animal matter. Lime forms a kind of insoluble soap with oily matters, and then gradually decomposes them by separating from them oxygen and carbon. It combines likewise with the animal acids, and probably assists their decomposition by abstracting carbonaceous matter from them combined with oxygen ; and consequently it must render them less nutritive. It tends to diminish, likewise, the nutritive powers of albumen from the same causes ; and always destroys, to a certain extent, the efficacy of animal manures, either by combining with certain of their elements, or by giving to them new arrangements. Lime should never be applied with animal manures, unless they are too rich, or for the purpose of preventing noxious effluvia. It is injurious when mixed with any common dung, and tends to render the extractive matter insoluble. According to Chaptal (*Chimie appliquée, &c.* i. 153.), lime forms insoluble composts with almost all animal and vegetable substances that are soft, and thus destroys their fermentative properties. Such compounds, however, exposed to the continued action of the air, alter in course of time ; the lime becomes carbonate ; the animal or vegetable matters decompose by degrees, and furnish new products as vegetable nourishment. In this view, lime presents two great advantages for the nutrition of plants ; the first, that of disposing certain insoluble bodies to form soluble compounds ; the second, that of prolonging the action and nutritive qualities of substances, beyond the term during which they would be retained if these substances were not made to enter into combination with lime. Thus the nutritive qualities of blood, as it exists in the compound of lime and blood known as sugarbaker's scum, are moderated, prolonged, and given out by degrees; blood alone, applied directly to the roots of plants, will destroy them with few or no exceptions.

2291. *Lime promotes fermentation.* In those cases in which fermentation is useful to produce nutriment from vegetable substances, lime is always efficacious. Some moist spent tanners' bark was mixed with one fifth of its weight of quicklime, and suffered to remain in a close vessel for three months; the lime had become coloured, and was effervescent: when water was boiled upon the mixture, it gained a tint of fawn-colour, and by evaporation furnished a fawn-coloured powder, which must have consisted of lime united to vegetable matter, for it burnt when strongly heated, and left a residuum of mild lime.

2292. *Different kinds of limestones* have different effects. The limestones containing alumina and silica are less fitted for the purposes of manure than pure limestones; but the lime formed from them has no noxious quality. Such stones are less efficacious, merely because they furnish a smaller quantity of quicklime. There is very seldom any considerable portion of coaly matter in bituminous limestones; never as much as five parts in 100; but such limestones make very good lime. The carbonaceous matter can do no injury to the land, and may, under certain circumstances, become a food of the plant.

2293. *The subject of the application of the magnesian limestone* is one of great interest. It had been long known to farmers in the neighbourhood of Doncaster, that lime made from a certain limestone, when applied to the land, often injured the crops considerably. Tennant, in making a series of experiments upon this peculiar calcareous substance, found that it contained magnesia; and on mixing some calcined magnesia with soil, in which he sowed different seeds, he found that they either died or vegetated in a very imperfect manner, and the plants were never healthy. With great justice and ingenuity he referred the bad effects of the peculiar limestone to the magnesian earth it contains.

2294. *Magnesian limestone is used with good effect in some cases.* Magnesia has a much weaker attraction for carbonic acid than lime, and will remain in the state of caustic or calcined magnesia for many months, though exposed to the air; and, as long as any caustic lime remains, the magnesia cannot be combined with carbonic acid, for lime instantly attracts carbonic acid from magnesia. When a magnesian limestone is burnt, the magnesia is deprived of carbonic acid much sooner than the lime; and, if there is not much vegetable or animal matter in the soil to supply by its decomposition carbonic acid, the magnesia will remain for a long while in the caustic state, in which state it acts as a poison to certain vegetables; and that more magnesian lime may be used upon rich soils, seems to be owing to the circumstance, that the decomposition of the manure in them supplies carbonic acid. Magnesia in its mild state, i. e. fully combined with carbonic acid, seems to be always a useful constituent of soils. Carbonate of magnesia (procured by boiling the solution of magnesia in supercarbonate of potassa) was thrown upon grass, and upon growing wheat and barley, so as to render the surface white, but the vegetation was not injured in the slightest degree; and one of the most fertile parts of Cornwall, the Lizard, is a district in which the soil contains mild magnesian earth. It is obvious, from what has been said, that lime from the magnesian limestone may be applied in large quantities to peats; and that where lands have been injured by the application of too large a quantity of magnesian lime, peat will be a proper and efficient remedy.

2295. A simple *test of magnesia in a limestone* is its slight effervescence with acids, and its rendering diluted nitric acid, or aqua fortis, milky. From the analysis of Tennant, it appears to contain from 20·3 to 22·5 magnesia; 29·5 to 31·7 lime; 47·2 carbonic acid; 0·8 clay and oxide of iron. Magnesian limestones are usually of a brown or pale yellow colour. They are found in Somersetshire, Leicestershire, Derbyshire, Shropshire, Durham, and Yorkshire; and in many parts of Ireland, particularly near Belfast. In general, when limestones are not magnesian, their purity will be indicated by their loss of weight in burning; the more they lose, the larger is the quantity of calcareous matter they contain. The magnesian limestones contain more carbonic acid than the common limestones; and I have found all of them lose more than half their weight by calcination.

2296. *Gypsum.* Besides being used in the forms of lime and carbonate of lime, calcareous matter is applied for the purposes of agriculture in other combinations. One of these bodies is gypsum or sulphate of lime. This substance consists of sulphuric acid (the same body that exists combined with water in oil of vitriol) and lime; and when dry it is composed of 55 parts of lime and 75 parts of sulphuric acid. Common gypsum or selenite, such as that found at Shotover Hill, near Oxford, contains, besides sulphuric acid and lime, a considerable quantity of water; and its composition may be thus expressed: sulphuric acid one proportion 75; lime one proportion 55; water two proportions 34.

2297. *The nature of gypsum* is easily demonstrated: if oil of vitriol be added to quicklime, there is a violent heat produced; when the mixture is ignited, water is given off, and gypsum alone is the result, if the acid has been used in sufficient quantity; and gypsum mixed with quicklime, if the quantity has been deficient. Gypsum, free from water, is sometimes found in nature, when it is called anhydrous selenite; it is distinguished from common gypsum by giving off no water when heated. When gypsum, free from water, or deprived of water by heat, is made into a paste with water, it rapidly sets by combining with that fluid. Plaster of Paris is powdered dry gypsum, and its property as a cement, and its use in making casts, depend upon its solidifying a certain quantity of water, and making with it a coherent mass. Gypsum is soluble in about 500 times its weight of cold water, and is more soluble in hot water; so that when water has been boiled in contact with gypsum, crystals of this substance are deposited as the water cools. Gypsum is easily distinguished by its properties of affording precipitates to solutions of oxalates and of barytic salts. It has been much used in America, where it was first introduced by Franklin on his return from Paris, where he had been much struck with its effects. He sowed the words, *This has been sown with gypsum*, on a field of lucern, near Washington; the effects astonished every passenger, and the use of the manure quickly became general, and signally efficacious. It has been advantageously used in Kent, but in most counties of England it has failed, though tried in various ways, and upon different crops.

2298. *Very discordant notions have been formed as to the mode of operation of gypsum.* It has been supposed by some persons to act by its power of attracting moisture from the air; but this agency must be comparatively insignificant. When combined with water, it retains that fluid too powerfully to yield it to the roots of the plant, and its adhesive attraction for moisture is inconsiderable; the small quantity in which it is used likewise is a circumstance hostile to this idea. It has been erroneously said, that gypsum assists the putrefaction of animal substances, and the decomposition of manure.

2299. *The ashes of saintfoin, clover, and rye-grass, afford considerable quantities of gypsum;* and the substance probably is intimately combined as a necessary part of their woody fibre. If this be allowed, it is easy to explain the reason why it operates in such small quantities; for the whole of a clover crop, or saintfoin crop, on an acre, according to estimation, would afford by incineration only three or four bushels of gypsum. The reason why gypsum is not generally efficacious, is probably because most cultivated soils contain it in sufficient quantities for the use of the grasses. In the common course of cultivation, gypsum is furnished in the manure; for it is contained in stable dung, and in the dung of all cattle fed on grass: and it is not taken up in corn crops, or crops of peas and beans, and in very small quantities in turnip crops; but where lands are exclusively devoted to pasturage and hay, it will be continually consumed. Should these statements be confirmed by future enquiries, a practical inference of some value may be derived from them. It is possible, that lands which have ceased to bear good crops of clover or artificial grasses, may be restored by being manured with gypsum. This substance is found in Oxfordshire, Gloucestershire, Somersetshire, Derbyshire, Yorkshire, &c., and requires only pulverisation for its preparation.

2300. *Upon the use of sulphate of iron, or green vitriol,* which is a salt produced from peat in Bedfordshire, some very interesting documents have been produced by Dr. Pearson; and there is little doubt that the peat salt and the vitriolic water acted chiefly by producing gypsum. The soils on which both are efficacious are calcareous; and sulphate of iron is decomposed by the carbonate of lime in such soils. The sulphate of iron consists of sulphuric acid and oxide of iron, and is an acid and a very soluble salt; when a solution of it is mixed with carbonate of lime, the sulphuric acid quits the oxide of iron to unite to the lime, and the compounds produced are insipid and comparatively insoluble.

2301. *Vitriolic impregnations* in soils where there is no calcareous matter are injurious; but it is probably in consequence of their supplying an excess of ferruginous matter to the sap. Oxide of iron, in small quantities, forms a useful part of soils; it is found in the ashes of plants, and probably is hurtful only in its acid combinations. The ashes of all peats do not afford gypsum. In general, when a recent peat-ash emits a strong smell, resembling that of rotten eggs when acted upon by vinegar, it will furnish gypsum. There is a curious agency of iron in soils which may here be mentioned. Soils containing iron at a minimum of oxidation decompose carbonic acid: the oleaginous parts of manures, by converting the brown oxide, which occurs in every soil, into that with a minimum of oxygen, form a substance capable of aiding the nutrition of plants, by affording them carbon from carbonic acid. (*T.*)

2302. *Phosphate of lime* is a combination of phosphoric acid and lime, one proportion of each. It is a compound insoluble in pure water, but soluble in water containing any acid matter. It forms the greatest part of calcined bones. It exists in most excrementitious substances, and is found both in the straw and grain of wheat, barley, oats, and rye, and likewise in beans, peas, and tares. It exists in some places in these islands native, but only in very small quantities. Phosphate of lime is generally conveyed to the land in the composition of other manure, and it is probably necessary to corn crops and other white crops.

2303. *Bone-ashes* calcined and ground to powder will probably be found useful on arable lands containing much vegetable matter, and may perhaps enable soft peats to produce wheat; but the powdered bone in an uncalcined state is much to be preferred in all cases when it can be procured.

2304. *The saline compounds of magnesia* will require very little discussion with regard to their uses as manures. In combination with sulphuric acid, magnesia forms a soluble salt. This substance, it is stated by some enquirers, has been found of use as a manure; but it is not found in nature in sufficient abundance, nor is it capable of being made by art sufficiently cheap to be of useful application in the common course of husbandry.

2305. *Wood-ashes* consist principally of the vegetable alkali united to carbonic acid; and as this alkali is found in almost all plants, it is not difficult to conceive that it may form an essential part of their organs. The general tendency of the alkalies is to give solubility to vegetable matters; and in this way they may render carbonaceous and other substances capable of being taken up by the tubes in the radical fibres of plants. Vegetable alkali likewise has a strong attraction for water, and even in small quantities may tend to give a due degree of moisture to the soil, or to other manures; though this operation, from the small quantities used or existing in the soil, can be only of a secondary kind.

2306. *The mineral alkali or soda* is found in the ashes of sea-weed, and may be procured by certain chemical agencies from common salt. Common salt consists of the metal named sodium, combined with chlorine; and pure soda consists of the same metal united to oxygen. When water is present, which can afford oxygen to the sodium, soda may be obtained in several modes from salt. The same reasoning will apply to the operation of the pure mineral alkali, or the carbonated alkali, as to that of the vegetable alkali; and when common salt acts as a manure, it is probably by entering into the composition of the plant in the same manner as gypsum, phosphate of lime, and the alkalies. Sir John Pringle has stated, that salt in small quantities assists the decomposition of animal and vegetable matter. This circumstance may render it useful in certain soils. Common salt, likewise, is offensive to insects. In small quantities it is sometimes a useful manure, and it is probable that its efficacy depends upon many combined causes. Some persons have argued against the employment of salt; because, when used in large quantities, it either does no good, or renders the ground sterile; but this is a very unfair mode of reasoning. That salt in large quantities rendered land barren, was known long before any records of agricultural science existed. We read in the Scriptures, that Abimelech took the city of Shechem, " and beat down the city, and sowed it with salt;" that the soil might be for ever unfruitful. Virgil reprobates a salt soil; and Pliny, though he recommends giving salt to cattle, yet affirms, that when strewed over land it renders it barren. But these are not arguments against a proper application of it. Refuse salt in Cornwall, which, however, likewise contains some of the oil and exuviæ of fish, has long been known as an admirable manure; and the Cheshire farmers contend for the benefit of the peculiar produce of their county. It is not unlikely, that the same causes as those which act in modifying the operation of gypsum influence the effects of salt. Most lands in this island, particularly those near the sea, probably contain a sufficient quantity of salt for all the purposes of vegetation; and in such cases the supply of it to the soil will not only be useless, but may be injurious. In great storms the spray of the sea has been carried more than fifty miles from the shore; so that from this source salt must be often supplied to the soil. Salt is found in almost all sandstone rocks, and it must exist in the soil derived from these rocks. It is a constituent likewise of almost every kind of animal and vegetable manure. A variety of curious and often contradictory experiments on this subject will be found in *The Gardener's Magazine*, vols. ii. and iii.

2307. *Other compounds.* Besides these compounds of the alkaline earths and alkalies, many others have been recommended for the purposes of increasing vegetation; such are nitre, or the nitrous acid combined with potassa. Sir Kenelm Digby states that he made barley grow very luxuriantly by watering it with a very weak solution of nitre; but he is too speculative a writer to awaken confidence in his results. This substance consists of one proportion of azote, six of oxygen, and one of potassium; and it is not unlikely that it may furnish azote to form albumen or gluten in those plants which contain them; but the nitrous salts are too valuable for other purposes to be used as manures.

Dr. Home states that sulphate of potassa, which was just now mentioned as found in the ashes of some peats, is a useful manure: but Naismith (*Elements of Agriculture*, p. 78.) questions his results; and quotes experiments hostile to his opinions, and, as he conceives, unfavourable to the efficacy of any species of saline manure. Much of the discordance of the evidence relating to the efficacy of saline substances depends upon the circumstance of their having been used in different proportions, and, in general, in quantities much too large.

2308. *Solutions of saline substances* were used twice a week, in the quantity of two ounces, on spots of grass and corn, sufficiently remote from each other to prevent any interference of results. The substances tried were bi-carbonate, sulphate, acetate, nitrate, and muriate of potassa; sulphate of soda; and sulphate, nitrate, muriate, and carbonate of ammonia. It was found, that, in all cases when the quantity of the salt equalled one thirtieth part of the weight of the water, the effects were injurious; but least so in the instance of the carbonate, sulphate, and muriate of ammonia. When the quantities of the salts were one three-hundredth part of the solution, the effects were different. The plants watered with the solutions of the sulphates grew just in the same manner as similar plants watered with rain-water. Those acted on by the solution of nitre, acetate, and carbonate of potass, and muriate of ammonia, grew rather better. Those treated with the solution of carbonate of ammonia grew most luxuriantly of all. This last result is what might be expected, for carbonate of ammonia consists of carbon, hydrogen, azote, and oxygen. There was, however, another result which was not anticipated; the plants watered with solution of nitrate of ammonia did not grow better than those watered with rain-water. The solution reddened litmus paper; and probably the free acid exerted a prejudicial effect, and interfered with the result.

2309. *Soot* doubtless owes part of its efficacy to the ammoniacal salts it contains. The liquor produced by the distillation of coal contains carbonate and acetate of ammonia, and is said to be a very good manure.

2310. *Soapers' waste* has been recommended as a manure, and it has been supposed that its efficacy depended upon the different saline matters it contains; but their quantity is very minute indeed, and its principal ingredients are mild lime and quicklime. In the soapers' waste, from the best manufactories, there is scarcely a trace of alkali. Lime, moistened with sea-water, affords more of this substance, and is said to have been used in some cases with more benefit than common lime.

2311. *The result of Sir H. Davy's discussion as to the extent of the effects of saline substances on vegetation* is, that except the ammoniacal compounds, or the compounds containing nitric, acetic, and carbonic acid, none of them can afford by their decomposition any of the common principles of vegetation, viz. carbon, hydrogen, and oxygen. The alkaline sulphates and the earthy muriates are so seldom found in plants, or are found in such minute quantities, that it can never be an object to apply them to the soil. The earthy and alkaline substances seem never to be formed in vegetation; and there is every reason to believe that they are never decomposed; for, after being absorbed, they are found in the ashes. The metallic bases of them cannot exist in contact with aqueous fluids; and these metallic bases, like other metals, have not as yet been resolved into any other forms of matter by artificial processes; they combine readily with other elements, but they remain indestructible, and can be traced undiminished in quantity through their diversified combinations.

Chap. III.

Of the Agency of Heat, Light, Electricity, and Water, in Vegetable Culture.

2312. The particular *agency of heat, light, and water*, in vegetation and culture, has been so frequently illustrated, that it only remains to give a general idea of their natures, and to offer some remarks on electricity.

Sect. I. *Of Heat and Light.*

2313. *The heat of the sun is the cause of growth, and its light the cause of maturity*, in the vegetable kingdom. This is universally acknowledged: animals will live without light or with very little; but no plants whatever can exist for any time without the presence of this element. The agency of electricity in vegetation is less known.

2314. *Two opinions are current respecting the nature of heat.* By some philosophers it is conceived to be a peculiar subtile fluid, of which the particles repel each other, but have a strong attraction for the particles of other matter: by others it is considered as a motion or vibration of the particles of matter, which is supposed to differ in velocity in different cases, and thus to produce the different degrees of temperature. Whatever decision be ultimately made respecting these opinions, it is certain that there is matter moving in the space between us and the heavenly bodies capable of communicating heat; the motions of which are rectilineal: thus the solar rays produce heat in acting on the surface of the earth. The beautiful experiments of Dr. Herschel have shown that there are rays transmitted from the sun which do not illuminate, and which yet produce more heat than the visible rays; and Ritter and Dr. Wollaston have shown that there are other invisible rays distinguished by their chemical effects.

2315. *Heat is radiated by the sun to the earth,* and if suffered to accumulate, Dr. Wells observes, would quickly destroy the present constitution of our globe. This evil is prevented by the radiation of heat from the earth to the heavens, during the night, when it receives from them little or no heat in return. But through the wise economy of means, which is witnessed in all the operations of nature, the prevention of this evil is made the source of great positive good; for the surface of the earth, having thus become colder than the neighbouring air, condenses a part of the watery vapour of the atmosphere into dew, the utility of which is too manifest to require elucidation. This fluid appears chiefly where it is most wanted, on herbage and low plants, avoiding, in great measure, rocks, bare earth, and considerable masses of water. Its production, too, tends to prevent the injury that might arise from its own cause; since the precipitation of water, upon the tender parts of plants, must in them lessen the cold which occasions it. The prevention, either wholly or in part, of cold, from radiation, in substances on the ground, by the interposition of any solid body between them and the sky, arises in the following manner: the lower body radiates its heat upwards, as if no other intervened between it and the sky; but the loss, which it hence suffers, is more or less compensated by what is radiated to it, from the body above, the under surface of which possesses always the same, or very nearly the same temperature as the air. The manner in which clouds prevent, or occasion to be small, the appearance of a cold at night, upon the surface of the earth, is by radiating heat to the earth, in return for that which they intercept in its progress from the earth towards the heavens. For although, upon the sky becoming suddenly cloudy during a calm night, a naked thermometer, suspended in the air, commonly rises 2 or 3 degrees, little of this rise is to be attributed to the heat evolved by the condensation of watery vapour in the atmosphere; for the heat so extricated must soon be dissipated, whereas the effect of greatly lessening, or preventing altogether, the appearance of a superior cold on the earth to that of the air, will be produced by a cloudy sky, during the whole of a long night.

2316. *Dense clouds, near the earth, reflect back the heat they receive from it* by radiation. But similar dense clouds, if very high, though they equally intercept the communication of the earth with the sky, yet being, from their elevated situation, colder than the earth, will radiate to it less heat than they receive from it, and may, consequently, admit of bodies on its surface becoming several degrees colder than the air. Islands, and parts of continents close to the sea, being, by their situations, subject to a cloudy sky, will, from the smaller quantity of heat lost by them through radiation to the heavens, at night, in addition to the reasons commonly assigned, be less cold in winter than countries considerably distant from any ocean. But the chief cause why islands, and the coasts of the ocean, are more temperate than continents and inland situations is, that the temperature of the ocean a little from the surface, and where not cooled by contact with ice, is very uniformly about 54° Fahr. in all latitudes. The ocean is the great equaliser of heat. (*T.*)

2317. *Fogs, like clouds, will arrest heat,* which is radiated upwards by the earth, and if they are very dense, and of considerable perpendicular extent, may remit to it as much as they receive. Fogs do not, in any instance, furnish a real exception to the general rule, that whatever exists in the atmosphere, capable of stopping or impeding the passage of radiant heat, will prevent or lessen the appearance at night of a cold on the surface of the earth, greater than that of the neighbouring air. The water deposited upon the earth, during a fog at night, may sometimes be derived from two different sources, one of which is a precipitation of moisture from a considerable part of the atmosphere, in consequence of its general cold; the other, a real formation of dew, from the condensation, by means of the superficial cold of the ground, of the moisture of that portion of the air which comes in contact with it. In such a state of things, all bodies will become moist, but those especially which most readily attract dew in clear weather.

2318. *When bodies become cold by radiation,* the degree of effect observed must depend, not only on their radiating power, but in part also on the greater or less ease with which they can derive heat, by conduction, from warmer substances in contact with them. Bodies, exposed in a clear night to the sky, must radiate as much heat to it during the prevalence of wind, as they would do if the air were altogether still. But in the former case, little or no cold will be observed upon them above that of the atmosphere, as the frequent application of warm air must quickly return a heat equal, or nearly so, to that which they had lost by radiation. A slight agitation of the air is sufficient to produce some effect of this kind; though, as has already been said, such an agitation, when the air is very pregnant with moisture, will render greater the quantity of dew; one requisite for a considerable production of this fluid being more increased by it, than another is diminished.

2319. It has been remarked that *the hurtful effects of cold occur chiefly in hollow places.* If this be restricted to what happens on the serene and calm nights, two reasons from different sources are to be assigned for it. The first is, that the air being stiller in such a situation, than in any other, the cold, from radiation, in the bodies contained in it, will be less diminished by renewed applications of warmer air; the second, that from the longer continuance of the same air in contact with the ground, in depressed places than in others, less dew will be deposited, and therefore less heat extricated during its formation.

2320. An observation closely connected with the preceding, namely, that, *in clear and still nights, frosts are less severe upon the hills, than in the neighbouring plains,* has excited more attention, chiefly from its contradicting what is commonly regarded an established fact, that the cold of the atmosphere always increases with the distance from the earth. But on the contrary the fact is certain, that, in very clear and still nights, the air near to the earth is colder than that which is more distant from it, to the height of at least 220 feet, this being the greatest to which experiments relate. If then a hill be supposed to rise from a plain to the height of 220 feet, having upon its summit a small flat surface covered with grass; and if the atmosphere, during a calm and serene night, be admitted to be 10° warmer there than it is near the surface of the low grounds, which is a less difference than what sometimes occurs in such circumstances, it is manifest that, should both the grass upon the hill, and that upon the plain, acquire a cold of 10° by radiation, the former will, notwithstanding, be 10° warmer than the latter. Hence also the tops of trees are sometimes found dry when the grass on the ground's surface has been found covered with dew.

2321. *A very slight covering will exclude much cold.* I had often, observes Dr. Wells, in the pride of half knowledge, smiled at the means frequently employed by gardeners, to protect tender plants from cold, as it appeared to me impossible that a thin mat, or any such flimsy substance, could prevent them from attaining the temperature of the atmosphere, by which alone I thought them liable to be injured. But, when I had learned that bodies on the surface of the earth become, during a still and serene night, colder than the atmosphere, by radiating their heat to the heavens, I perceived immediately a just reason for the practice, which I had before deemed useless. Being desirous, however, of acquiring some precise information on this subject, I fixed, perpendicularly, in the earth of a grass-plot, four small sticks, and over their upper extremities, which, were six inches above the grass, and formed the corners of a square, the sides of which were two feet long, drew tightly a very thin cambric handkerchief. In this disposition of things, therefore, nothing existed to prevent the free passage of air from the exposed grass, to that which was sheltered, except the four small sticks, and there was no substance to radiate heat downwards to the latter grass, except the cambric handkerchief. The temperature of the grass, which was thus shielded from the sky, was, upon many nights afterwards, examined by me, and was always found higher than that of neighbouring grass, which was uncovered, if this was colder than the air. When the difference in temperature, between the air several feet above the ground and the unsheltered grass did not exceed 5°, the sheltered grass was about as warm as the air. If that difference, however, exceeded 5°, the air was found to be somewhat warmer than the sheltered grass. Thus, upon one night, when fully exposed grass was 11° colder than the air, the latter was 3° warmer than the sheltered grass; and the same difference existed on another night, when the air was 14° warmer than the exposed grass. One reason for this difference, no doubt, was that the air, which passed from the exposed grass, by which it had been very much cooled, to that under the handkerchief, had deprived the latter of part of its heat; another, that the handkerchief, from being made colder than the atmosphere by the radiation of its upper surface to the heavens, would remit somewhat less heat to the grass beneath, than what it received from that substance. But still, as the sheltered grass, notwithstanding these drawbacks, was upon one night, as may be collected from the preceding relation, 8°, and upon another 11°, warmer than grass fully exposed to the sky, a sufficient reason was now obtained for the utility of a very slight shelter to plants, in averting or lessening injury from cold, on a still and serene night.

2322. *The covering has most effect when placed at a little distance above the plants* or objects to be sheltered. A difference in temperature, of some magnitude, was always observed on still and serene nights, between bodies sheltered from the sky by substances touching them, and similar bodies, which were sheltered by a substance a little above them. I found, for example, upon one night, that the warmth of grass, sheltered by a cambric handkerchief raised a few inches in the air, was 3° greater than that of a neighbouring piece of grass which was sheltered by a similar handkerchief actually in contact with it. On another night the difference between the temperatures of two portions of grass, shielded in the same manner as the two above mentioned from the influence of the sky, was 4°. Possibly, continues Dr. Wells, experience has long ago taught gardeners the superior advantage of defending tender vegetables, from the cold of clear and calm nights, by means of substances not directly touching them; though I do not recollect ever having seen any contrivance for keeping mats, or such like bodies, at a distance from the plants which they were meant to protect.

2323. *Heat produced by walls.* Walls, Dr. Wells observes, as far as warmth is concerned, are regarded as useful, during a cold night, to the plants which touch them, or are near to them, only in two ways; first, by the mechanical shelter which they afford against cold winds, and secondly, by giving out the heat which they had acquired during the day. It appearing to me, however, that, on clear and calm nights, those on which plants frequently receive much injury from cold, walls must be beneficial in a third way, namely, by preventing, in part, the loss of heat, which the plants would sustain from radiation, if they were fully exposed to the sky; the following experiment was made for the purpose of determining the justness of this opinion. A cambric handkerchief having been placed, by means of two upright sticks, perpendicularly to a grass-plot, and at right angles to the course of the air, a thermometer was laid upon the grass close to the lower edge of the handkerchief, on its windward side. The thermometer thus situated was several nights compared with another lying on the same grass-plot, but on a part of it fully exposed to the sky. On two of these nights, the air being clear and calm, the grass close to the handkerchief was found to be 4° warmer than the fully exposed grass. On a third, the difference was 6°. An analogous fact is mentioned by Gersten, who says that a horizontal surface is more abundantly dewed than one which is perpendicular to the ground.

2324. *Heat from a covering of snow.* The covering of snow, the same author observes, which countries in high latitudes enjoy during the winter, has been very commonly thought to be beneficial to vegetable substances on the surface of the earth, as far as their temperature is concerned, solely by protecting them from the cold of the atmosphere. But were this supposition just, the advantage of the covering would be greatly circumscribed; since the upper parts of trees and of tall shrubs are still exposed to the influence of the air. Another reason, however, is furnished for its usefulness, by what has been said above; which is, that it prevents the occurrence of the cold, which bodies on the earth acquire, in addition to that of the atmosphere, by the radiation of their heat to the heavens during still and clear nights. The cause, indeed, of this additional cold does not constantly operate; but its presence, during only a few hours, might effectually destroy plants which now pass unhurt through the winter. Again, as things are, while low vegetable productions are prevented, by their covering of snow, from becoming colder than the atmosphere in consequence of their own radiation, the parts of trees and tall shrubs, which rise above the snow, are little affected by cold from this cause; for their uttermost twigs, now that they are destitute of leaves, are much smaller than the thermometers suspended by me in the air, which in this situation very seldom became more than 2° colder than the atmosphere. The larger branches, too, which, if fully exposed to the sky, would become colder than the extreme parts, are, in a great degree, sheltered by them; and, in the last place, the trunks are sheltered both by the smaller and larger parts, not to mention that the trunks must derive heat, by conduction through the roots, from the earth kept warm by the snow. In a similar way is partly to be explained the manner in which a layer of earth or straw preserves vegetable matters in our own fields from the injurious effects of cold in winter. (*Essay on Dew.*)

2325. *The nature of light* is totally unknown. the light which proceeds from the sun seems to be composed of three distinct substances. Scheele discovered that a glass mirror held before the fire reflected the rays of light, but not the rays of caloric; but when a metallic mirror was placed in the same situation, both heat and light were reflected. The mirror of glass became hot in a short time, but no change of temperature took place on the metallic mirror. This experiment shows that the glass mirror absorbed the rays of caloric, and reflected those of light; while the metallic mirror, suffering no change of temperature, reflected both. If a glass plate be held before a burning body, the rays of light are not sensibly interrupted, but the rays of caloric are intercepted; for no sensible heat is observed on the opposite side of the glass; but when the glass has reached a proper degree of temperature, the rays of caloric are transmitted with the same facility as those of light; and thus the rays of light and caloric may be separated. But the curious experiments of Dr. Herschel have clearly proved that the invisible rays which are emitted by the sun have the greatest heating power. In those experiments, the different coloured rays were thrown on the bulb of a very delicate thermometer, and their heating power was observed. The heating power of the violet, green, and red rays were found to be to each other as the following numbers : — Violet, 16·0 ; Green 22·4 ; Red, 55·0. The heating power of the most refrangible rays was least, and this power increases as the refrangibility diminishes. The red ray, therefore, has the greatest heating power, and the violet, which is the most refrangible, the least. The illuminating power, it has been already observed, is greatest in the middle of the spectrum, and it diminishes towards both extremities ; but the heating power, which is least at the violet end, increases from that to the red extremity ; and when the thermometer was placed beyond the limit of the red ray, it rose still higher than in the red ray, which has the greatest heating power in the spectrum. The heating power of these invisible rays was greatest at the distance of half an inch beyond the red ray, but it was sensible at the distance of one inch and a half.

2326. *The influence of the different solar rays on vegetation* has not yet been studied; but it is certain that the rays exercise an influence independent of the heat they produce. Thus plants kept in darkness, but supplied with heat, air, and moisture, grow for a short time, but they never gain their natural colours ; their leaves are white and pale, and their juices watery and peculiarly saccharine : according to Knight they merely expend the sap previously generated under the influence of light. (*Notes to Sir H. Davy's Agr. Chem.* p. 402.)

Sect. II. *Of Electricity.*

2327. *Electrical changes are constantly taking place* in nature, on the surface of the earth, and in the atmosphere ; but as yet the effects of this power on vegetation have not been correctly estimated. It has been shown by experiments made by means of the voltaic battery, that compound bodies in general are capable of being decomposed by electrical powers ; and it is probable that the various electrical phenomena occurring in our system, must influence both the germination of seeds and the growth of plants. It has been found that corn sprouted much more rapidly in water positively electrified by the voltaic instrument, than in water negatively electrified ; and experiments made upon the atmosphere show that clouds are usually negative ; and, as when a cloud is in one state of electricity, the surface of the earth beneath is brought into the opposite state, it is probable that in common cases the surface of the earth is positive. A similar experiment is related by Dr. Darwin. (*Phytologia*, sect. xiii. 2, 3.)

2328. *Respecting the nature of electricity* different opinions are entertained amongst scientific men. By some, the phenomena are conceived to depend upon a single subtile fluid in excess in the bodies said to be positively electrified, and in deficiency in the bodies said to be negatively electrified ; a second class suppose the effects to be produced by two different fluids, called by them the vitreous fluid and the resinous fluid ; and others regard them as affections or motions of matter, or an exhibition of attractive powers similar to those which produce chemical combination and decomposition, but usually exerting their action on masses.

2329. *A profitable application of electricity*, Dr. Darwin observes, to promote the growth of plants is not yet discovered ; it is nevertheless probable, that, in dry seasons, the erection of numerous metallic points on the surface of the ground, but a few feet high, might in the night time contribute to precipitate the dew by facilitating the passage of electricity from the air into the earth ; and that an erection of such points higher in the air by means of wires wrapped round tall rods, like angling rods, or elevated on buildings, might frequently precipitate showers from the higher parts of the atmosphere. Such points erected in gardens might promote a quicker vegetation of the plants in their vicinity, by supplying them more abundantly with the electric ether. (*Phytologia*, xiii. 4.) J. Williams (*Climate of Great Britain*, 348.), enlarging on this idea, proposes to erect large electrical machines, to be driven by wind, over the general face of the country, for the purpose of improving the climate, and especially for lessening that superabundant moisture which he contends is yearly increasing from the increased evaporating surface, produced by the vegetation of improved culture, and especially from the increase of pastures, hedges, and ornamental plantations.

Sect. III. *Of Water.*

2330. *Water is a compound of oxygen and hydrogen gas*, though primarily reckoned a simple or elementary substance. " If the metal called potassium be exposed in a glass tube to a small quantity of water, it will act upon it with great violence ; elastic fluid will be disengaged, which will be found to be hydrogen ; and the same effects will be produced upon the potassium, as if it had absorbed a small quantity of oxygen ; and the hydrogen disengaged, and the oxygen added to the potassium, are in weight as 2 to 15 ; and if two in volume of hydrogen, and one in volume of oxygen, which have the weights of 2 and 15, be introduced into a close vessel, and an electrical spark passed through them, they will inflame and condense into 17 parts of pure water."

2331. *Water is absolutely necessary to the economy of vegetation* in its elastic and fluid states; and it is not devoid of use even in its solid form. Snow and ice are bad conductors of heat; and when the ground is covered with snow, or the surface of the soil or of water is frozen, the roots or bulbs of the plants beneath are protected by the congealed water from the influence of the atmosphere, the temperature of which, in northern winters, is usually very much below the freezing point; and this water becomes the first nourishment of the plant in early spring. The expansion of water during its congelation, at which time its volume increases one twelfth, and its contraction of bulk during a thaw, tend to pulverise the soil, to separate its parts from each other, and to make it more permeable to the influence of the air.

Chap. IV.

Of the Agency of the Atmosphere in Vegetation.

2332. *The aerial medium which envelopes the earth* may be studied chemically and physically: the first study respects the elements of which the atmosphere is composed; and the second their action in a state of combination, and as influenced by various causes, or those phenomena which constitute the weather.

Sect. I. *Of the Elements of the Atmosphere.*

2333. *Water, carbonic acid gas, oxygen, and azote,* are the principal substances composing the atmosphere; but more minute enquiries respecting their nature and agencies are necessary to afford correct views of its uses in vegetation.

2334. *That water exists in the atmosphere* is easily proved. If some of the salt, called muriate of lime, which has been just heated red, be exposed to the air, even in the driest and coldest weather, it will increase in weight, and become moist; and in a certain time will be converted into a fluid. If put into a retort and heated, it will yield pure water; will gradually recover its pristine state, and, if heated red, its former weight: so that it is evident that the water united to it was derived from the air. That it existed in the air in an invisible and elastic form, is proved by the circumstances, that if a given quantity of air be exposed to the salt, its volume and weight will diminish, provided the experiment be correctly made.

2335. *The quantity of water which exists in air,* as vapour, varies with the temperature. In proportion as the weather is hotter, the quantity is greater. At 50° of Fahrenheit, air contains about $\frac{1}{50}$ of its volume of vapour; and, as the specific gravity of vapour is to that of air nearly as 10 to 15, this is about $\frac{1}{75}$ of its weight. At 100°, supposing that there is a free communication with water, it contains about $\frac{1}{14}$ part in volume, or $\frac{1}{21}$ in weight. It is the condensation of vapour, by diminution of the temperature of the atmosphere, which is probably the principal cause of the formation of clouds, and of the deposition of dew, mist, snow, or hail.

2336. *The power of different substances to absorb aqueous vapour* from the atmosphere by cohesive attraction has been already referred to. The leaves of living plants appear to act upon this vapour in its elastic form, and to absorb it. Some vegetables increase in weight from this cause, when suspended in the atmosphere and unconnected with the soil; such are the house-leek, and different species of the aloe. In very intense heats, and when the soil is dry, the life of plants seems to be preserved by the absorbent power of their leaves; and it is a beautiful circumstance in the economy of nature, that aqueous vapour is most abundant in the atmosphere when it is most needed for the purposes of life; and that when other sources of its supply are cut off, this is most copious.

2337. *The existence of carbonic acid gas in the atmosphere* is proved by the following process: if a solution of lime and water be exposed to the air, a pellicle will speedily form upon it, and a solid matter will gradually fall to the bottom of the water, and in a certain time the water will become tasteless; this is owing to the combination of the lime which was dissolved in the water with carbonic acid gas, which existed in the atmosphere, as may be proved by collecting the film and the solid matter, and igniting them strongly in a little tube of platina or iron; they will give out carbonic acid gas, and will become quicklime, which, added to the same water, will again bring it to the state of lime-water.

2338. *The quantity of carbonic acid gas in the atmosphere* is very small. It is not easy to determine it with precision, and it must differ in different situations; but where there is a free circulation of air, it is probably never more than one 500th, nor less than one 800th, of the volume of air. Carbonic acid gas is nearly one third heavier than the other elastic parts of the atmosphere in their mixed state; hence, at first view, it might be supposed that it would be most abundant in the lower regions of the atmosphere; but unless it has been immediately produced at the surface of the earth in some chemical process, this does not seem to be the case; elastic fluids of different specific gravities have a tendency to equable mixture by a species of attraction, and the different parts of the atmosphere are constantly agitated and blended together by winds or other causes. De Saussure found lime-water precipitated on Mount Blanc, the highest point of land in Europe; and carbonic acid gas has been always found, apparently in due proportion, in the air brought down from great heights in the atmosphere by aeronautic adventurers.

2339. *The principal consumption of the carbonic acid* in the atmosphere seems to be in affording nourishment to plants; and some of them appear to be supplied with carbon chiefly from this source.

2340. *The formation of carbonic acid gas* takes place during fermentation, combustion, putrefaction, respiration, and a number of operations taking place upon the surface of the earth; and there is no other extensive operation known in nature, by which it can be destroyed but by vegetation.

2341. *Oxygen and azote* are the remaining constituents of the atmosphere. After a given portion of common air has been deprived of aqueous vapour and carbonic acid gas, it appears little altered in its properties; it remains a compound of oxygen and azote, which supports combustion and animal life. There are many modes of separating these two gases from each other. A simple one is by burning phosphorus in a confined volume of air; this absorbs the oxygen and leaves the azote; and 100 parts in volume of air, in which phosphorus has been burnt, yield 79 parts of azote; and by mixing this azote with 21 parts of fresh oxygen gas artificially procured, a substance having the original characters of air is produced. To procure pure oxygen from air, quicksilver may be kept heated in it, at about 600°, till it becomes a red powder; this powder, when ignited, will be restored to the state of quicksilver by giving off oxygen.

2342. *Oxygen is necessary to some functions of vegetables*; but its great importance in nature is its relation to the economy of animals. It is absolutely necessary to their life. Atmospheric air taken into the lungs of animals, or passed in solution in water through the gills of fishes, loses oxygen; and for the oxygen lost, about an equal volume of carbonic acid appears.

2343. *The effects of azote in vegetation* are not distinctly known. As it is found in some of the products of vegetation, it may be absorbed by certain plants from the atmosphere. It prevents the action of oxygen from being too energetic, and serves as a medium in which the more essential parts of the air act; nor is this circumstance unconformable to the analogy of nature; for the elements most abundant on the solid surface of the globe are not those which are the most essential to the existence of the living beings belonging to it.

2344. *The action of the atmosphere on plants* differs at different periods of their growth, and varies with the various stages of the developement and decay of their organs. If a healthy seed be moistened and exposed to air at a temperature not below 45°, it soon germinates, and shoots forth a plume, which rises upwards, and a radicle which descends. If the air be confined, it is found that in the process of germination the oxygen, or a part of it, is absorbed. The azote remains unaltered; no carbonic acid is taken away from the air; on the contrary, some is added. Seeds are incapable of germinating, except when oxygen is present. In the exhausted receiver of the air-pump, in pure azote, or in pure carbonic acid, when moistened they swell, but do not vegetate; and if kept in these gases, lose their living powers, and undergo putrefaction. If a seed be examined before germination, it will be found more or less insipid, at least not sweet; but after germination it is always sweet. Its coagulated mucilage, or starch, is converted into sugar in the process; a substance difficult of solution is changed into one easily soluble; and the sugar carried through the cells or vessels of the cotyledons is the nourishment of the infant plant. The absorption of oxygen by the seed in germination has been compared to its absorption in producing the evolution of fœtal life in the egg; but this analogy is only remote. All animals, from the most to the least perfect classes, require a supply of oxygen. From the moment the heart begins to pulsate till it ceases to beat, the aeration of the blood is constant, and the function of respiration invariable: carbonic acid is given off in the process; but the chemical change produced in the blood is unknown; nor is there any reason to suppose the formation of any substance similar to sugar. It is evident, that in all cases of semination, the seeds should be sown so as to be fully exposed to the influence of the air; and one cause of the unproductiveness of cold clayey adhesive soils is, that the seed is coated with matter impermeable to air. In sandy soils the earth is always sufficiently penetrable by the atmosphere; but in clayey soils there can scarcely be too great a mechanical division of parts. Any seed not fully supplied with air, always produces a weak and diseased plant. We have already seen that carbon is added to plants from the air by the process of vegetation in sunshine; and oxygen is added to the atmosphere at the same time. It is worthy of remark that the *absence* of light is necessary to the formation of sugar in the germination of seeds; and its *presence* to the production of sugar in fruits. The following is the late Dr. Murray's ingenious explanation of these remarkable facts. The seed consists chiefly of farinaceous matter, which requires oxygen to convert it into sugar. Now living vegetables appear to absorb oxygen in the dark: unripe fruits usually contain an acid, that is, have *an excess of oxygen;* and light is favourable to the evolution of oxygen from living plants. (*T.*)

2345. *Those changes in the atmosphere which constitute the most important meteorological phenomena* may be classed under five distinct heads; the alterations that occur in the weight of the atmosphere; those that take place in its temperature; the changes produced in its quantity by evaporation and rain; the excessive agitation to which it is frequently subject; and the phenomena arising from electric and other causes, which at particular times occasion or attend the precipitations and agitations alluded to. All the above phenomena prove to demonstration that constant changes take place, the consequences of new combinations and decompositions rapidly following each other.

2346. With respect to *the changes in the weight of the atmosphere,* it is generally known that the instrument called the barometer shows the weight of a body of air immediately above it, extending to the extreme boundary of the atmosphere, and the base of which is equal to that of the mercury contained within it. As the level of the sea is the lowest point of observation, the column of air over a barometer placed at that level is the longest that can be obtained.

2347. *The variations of the barometer* between the tropics are very trifling; they increase gradually as the latitude advances towards the poles, till in the end it amounts to two or three inches. The following Table will explain this gradual increase:—

Latitude.	Places.	Range of the Barometer.	
		Greatest.	Annual.
0° 0′	Peru - - -	0 20	— —
22 23	Calcutta - -	0 77	— —
33 55	Cape Town -	— —	0 89
40 55	Naples - - -	1 00	— —
51 8	Dover - - -	2 47	1 80
53 13	Middlewich -	3 00	1 94
53 23	Liverpool - -	2 89	1 96
59 56	Petersburgh -	3 45	2 77

2348. *The range of the barometer is considerably less in North America than in the corresponding latitudes of Europe,* particularly in Virginia, where it never exceeds 1·1. The range is more considerable at the level of the sea than on mountains; and in the same degree of latitude it is in the inverse ratio of the height of the place above the level of the sea. Cotte composed a table, which has been published in the *Journal de Physique,* from which it appears extremely probable, that the barometer has an invariable tendency to rise between the morning and the evening, and that this impulse is most considerable from two in the afternoon till nine at night, when the greatest elevation is accomplished; but the elevation at nine differs from that at two by four twelfths, while that of two varies from the elevation of the morning only by one twelfth, and that in particular climates the greatest elevation is at two o'clock. The observations of Cotte confirm those of Luke Howard; and from them it is concluded, that the barometer is influenced by some depressing cause at new and full moon, and that some other makes it rise at the quarters. This coincidence is most considerable in fair and calm weather; the depression in the interval between the quarters and conjunctions amounts to one tenth of an inch, and the rise from the conjunctions to the quarters is to the same amount. The range of this instrument is found to be greater in winter than in summer; for instance, the mean at York, during the months from October to March inclusive, in the year 1774, was 1·42, and in the six summer months 1·016.

2349. *The more serene and settled the weather, the higher the barometer ranges:* calm weather, with a tendency to rain, depresses it; high winds have a similar effect on it; and the greatest elevation occurs with easterly and northerly winds; but the south produces a directly contrary effect.

2350. *The variations in the temperature of the air* in any particular place, exclusive of the differences of seasons and climates, are very considerable. These changes cannot be produced by heat derived from the sun, as its rays concentrated have no kind of effect on air; these, however, heat the surface of our globe, from which heat is communicated to the immediate atmosphere; it is through this fact that the temperature is highest where the place is so situated as to receive with most effect the rays of the sun, and that it varies in each region with the season; it is also the cause why it decreases in proportion to the height of the air above the surface of the earth. The most perpendicular rays falling on the globe at the equator, there its heat is the greatest, and that heat decreases gradually to the poles, of course the temperature of the air is in exact unison; from this it appears that the air acquires the greatest degree of warmth at the equator, whence it becomes insensibly cooler till we arrive at the poles; in the same manner the air immediately above the equator cools gradually. Though the temperature sinks as it approaches the pole, and is highest at the equator, yet as it varies continually with the seasons, it is impossible to form an accurate idea of the progression without forming a mean temperature for a year, from that of the temperature of every degree of latitude for every day of the year, which may be accomplished by adding together the whole of the observations and dividing by their number, when the quotient will be the mean temperature for the year. The " diminution," says Dr. Thomson, " from the pole to the equator takes place in arithmetical progression; or to speak more properly, the annual temperature of all the latitudes are arithmetical means between the mean annual temperature of the equator and the pole; and, as far as heat depends on the action of solar rays, that of each month is as the mean altitude of the sun, or rather as the sine of the sun's altitude. Later observations, however, have shown that all the formulæ for calculating the mean temperatures of different latitudes, which are founded on Mayer's

Empirical Equation, though tolerably accurate in the Northern Atlantic Ocean, to latitude 60°, are totally irreconcileable with observations in very high latitudes; and on the meridians, from 70° to 90° W. and E. of London. The results of late arctic voyages, and of Russian travels, have been satisfactorily shewn, by Dr. Brewster (*Edin. Phil. Tr.*), to prove the existence of *two meridians of greatest cold* in the northern hemisphere; and the mean temperature of particular countries varies, not only according to the parallels of latitude, but also according to their proximity to these two *cold meridians.* (*T.*)

2351. *Inconsiderable seas*, in temperate and cold climates, are colder in winter and warmer in summer than the main ocean, as they are necessarily under the influence of natural operations from the land. Thus the Gulf of Bothnia is generally frozen in winter, but the water is sometimes heated in the summer to 70°, a state which the opposite part of the Atlantic never acquires; the German Sea is five degrees warmer in summer than the Atlantic, and more than three colder in winter; the Mediterranean is almost throughout warmer both in winter and summer, which therefore causes the Atlantic to flow into it; and the Black Sea, being colder than the Mediterranean, flows into the latter.

2352. *The eastern parts of North America*, as it appears from meteorological tables, have a much colder air than the opposite European coast, and fall short of the standard by about ten or twelve degrees. There are several causes which produce this considerable difference. The greatest elevation in North America is between the 40th and 50th degree of north latitude, and the 100th and 110th of longitude west from London; and there the most considerable rivers have their origin. The height alone will partly explain why this tract is colder than it would otherwise be; but there are other causes, and those are most extensive forests, and large swamps and morasses, all of which exclude heat from the earth, and consequently prevent it from ameliorating the rigour of winter. Many extensive lakes lie to the east, and Hudson's Bay more to the north; a chain of mountains extends on the south of the latter, and those equally prevent the accumulation of heat; besides, this bay is bounded on the east by the mountainous country of Labrador, and has many islands; from all which circumstances arise the lowness of the temperature, and the piercing cold of the north-west winds. The annual decrease of the forests for the purpose of clearing the ground, and the consumption for building and fuel, is supposed to have occasioned a considerable decrease of cold in the winter; and if this should be the result, much will yet be done towards bringing the temperature of the European and American continents to something like a level.

2353. *Continents* have a colder atmosphere than islands situated in the same degree of latitude; and countries lying to the windward of the superior classes of mountains, or forests, are warmer than those which are to the leeward. Earth always possessing a certain degree of moisture, has a greater capacity to receive and retain heat than sand or stones, the latter therefore are heated and cooled with more rapidity: it is from this circumstance that the intense heats of Africa and Arabia, and the cold of Terra del Fuego, are derived. The temperature of growing vegetables changes very gradually; but there is a considerable evaporation from them: if those exist in great numbers, and congregated, or in forests, their foliage preventing the rays of the sun from reaching the earth, it is perfectly natural that the immediate atmosphere must be greatly affected by the ascent of chilled vapours.

2354. Our next object is *the ascent and descent of water:* the principal appearances of this element are vapour, clouds, dew, rain, frost, hail, snow, and ice.

2355. *Vapour* is water rarefied by heat, in consequence of which, becoming lighter than the atmosphere, it is raised considerably above the surface of the earth, and afterwards by a partial condensation forms clouds. It differs from exhalation, which is properly a dispersion of dry particles from a body. When water is heated to 212° it boils, and is rapidly converted into steam; and the same change takes place in much lower temperatures; but in that case the evaporation is slower, and the elasticity of the steam is smaller. As a very considerable proportion of the earth's surface is covered with water, and as this water is constantly evaporating and mixing with the atmosphere in the state of vapour, a precise determination of the rate of evaporation must be of very great importance in meteorology. Evaporation is confined entirely to the surface of the water; hence it is, in all cases, proportional to the surface of the water exposed to the atmosphere. Much more vapour of course rises in maritime countries or those interspersed with lakes, than in inland countries. Much more vapour rises during hot weather than during cold: hence the quantity evaporated depends in some measure upon temperature. The quantity of vapour which rises from water, even when the temperature is the same, varies according to circumstances. It is least of all in calm weather, greater when a breeze blows, and greatest of all with a strong wind. From experiments, it appears, that the quantity of vapour raised annually at Manchester is equal to about 25 inches of rain. If to this we add five inches for the dew, with Dalton, it will make the annual evaporation 30 inches. Now, if we consider the situation of England, and the greater quantity of vapour raised from water, it will not surely be considered as too great an allowance, if we estimate the mean annual evaporation over the whole surface of the globe at 35 inches.

2356. *A cloud* is a mass of vapour, more or less opaque, formed and sustained at considerable height in the atmosphere, probably by the joint agencies of heat and electricity. The first successful attempt to arrange the diversified forms of clouds, under a few general modifications, was made by Luke Howard, Esq. We shall give here a brief account of his ingenious classification.

2357. *The simple modifications* are thus named and defined: — 1. Cirrus, parallel, flexuous, or diverging fibres, extensible in any or in all directions (*fig.* 207. *a*);

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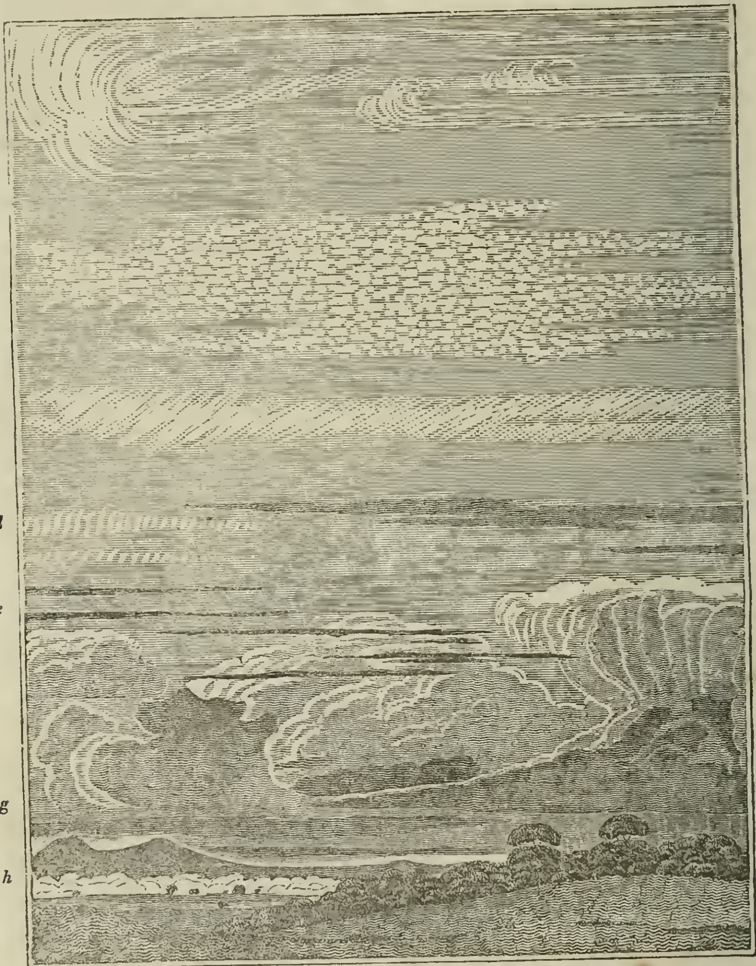

2. Cumulus, convex or conical heaps, increasing upwards from a horizontal base (*b*); 3. Stratus, a widely-extended, continuous, horizontal sheet, increasing from below (*c*).

2358. *The intermediate modifications* which require to be noticed are, 4. Cirro-cumulus, small, well defined, roundish masses, in close horizontal arrangement (*d*); 5. Cirro-stratus, horizontal, or slightly inclined masses, attenuated towards a part or the whole of their circumference, bent downward or undulated, separate, or in groups consisting of small clouds having these characters (*e*).

2359. *The compound modifications* are, 6. Cumulo-stratus, or twain cloud; the cirro-stratus blended with the cumulus, and either appearing intermixed with the heaps of the latter, or superadding a wide-spread structure to its base (*f*); 7. Cumulo-cirro-stratus, or Nimbus; the rain-cloud, a cloud or system of clouds from which rain is falling. It is a horizontal sheet, above which the cirrus spreads, while the cumulus enters it laterally and from beneath (*g*, *g*); 8. The Fall Cloud, resting apparently on the surface of the ground (*h*).

2360. *The cirrus* appears to have the least density, the greatest elevation, the greatest variety of extent and direction, and to appear earliest in serene weather, being indicated by a few threads pencilled on the sky. Before storms they appear lower and denser, and usually in the quarter opposite to that from which the storm arises. Steady high winds are also preceded and attended by cirrous streaks, running quite across the sky in the direction they blow in.

2361. *The cumulus* has the densest structure, is formed in the lower atmosphere, and moves along with the current next the earth. A small irregular spot first appears, and is, as it were, the nucleus on which they increase. The lower surface continues irregularly plane, while the upper rises into conical or hemispherical heaps; which may afterwards continue long nearly of the same bulk, or rapidly rise into mountains. They will begin, in fair weather, to form some hours after sunrise, arrive at their maximum in the hottest part of the afternoon, then go on diminishing, and totally disperse about sunset. Previously to rain the cumulus increases rapidly, appears lower in the atmosphere, and with its surface full of loose fleeces or protuberances. The formation of large cumuli to leeward in a strong wind, indicates the approach of a calm with rain. When they do not disappear or subside about sunset, but continue to rise, thunder is to be expected in the night.

2362. *The stratus* has a mean degree of density, and is the lowest of clouds, its inferior surface commonly resting on the earth in water. This is properly the cloud of night, appearing about sunset. It comprehends all those creeping mists which in calm weather ascend in spreading sheets (like an inundation of water) from the bottoms of valleys, and the surfaces of lakes and rivers. On the return of the sun, the level surface of this cloud begins to put on the appearance of cumulus, the whole at the same time separating from the ground. The continuity is next destroyed, and the cloud ascends and evaporates, or passes off with the appearance of the nascent cumulus. This has long been experienced as a prognostic of fair weather.

2363. *Transition of forms.* The cirrus having continued for some time increasing or stationary, usually passes either to the cirro-cumulus or the cirro-stratus, at the same time descending to a lower station in the atmosphere. This modification forms a very beautiful sky, and is frequently in summer an attendant on warm and dry weather. The cirro-stratus, when seen in the distance, frequently gives the idea of shoals of fish. It precedes wind and rain; is seen in the intervals of storms; and sometimes alternates with the cirro-cumulus in the same cloud, when the different evolutions form a curious spectacle. A judgment may be formed of the weather likely to ensue by observing which modification prevails at last. The solar and lunar haloes, as well as the parhelion and paraselene (mock sun and mock moon), prognostics of foul weather, are occasioned by this cloud. The cumulo-stratus precedes, and the nimbus accompanies rain.

2364. *Dew* is the moisture insensibly deposited from the atmosphere on the surface of the earth. This moisture is precipitated by the cold of the body on which it appears, and will be more or less abundant, not in proportion to the coldness of that body, but in proportion to the existing state of the air in regard to moisture. It is commonly supposed that the formation of dew produces cold, but like every other precipitation of water from the atmosphere, it must eventually produce heat.

2365. *Phenomena of dew.* Aristotle justly remarked, that dew appears only on calm and clear nights. Dr. Wells shows, that very little is ever deposited in opposite circumstances; and that little only when the clouds are very high. It is never seen on nights both cloudy and windy; and if in the course of the night the weather, from being serene, should become dark and stormy, dew which has been deposited will disappear. In calm weather, if the sky be partially covered with clouds, more dew will appear than if it were entirely uncovered. Dew probably begins in the country to appear upon grass in places shaded from the sun, during clear and calm weather, soon after the heat of the atmosphere has declined, and continues to be deposited through the whole night, and for a little after sunrise. Its quantity will depend in some measure on the proportion of moisture in the atmosphere, and is consequently greater after rain than after a long tract of dry weather; and in Europe, with southerly and westerly winds, than with those which blow from the north and the east. The direction of the sea determines this relation of the winds to dew; for in Egypt, dew is scarcely ever observed except while the northerly or Etesian winds prevail. Hence also dew is generally more abundant in spring and autumn than in summer. It is always very copious on those clear nights which are followed by misty mornings, which show the air to be loaded with moisture; and a clear morning following a cloudy night determines a plentiful deposition of the retained vapour. When warmth of atmosphere is compatible with clearness, as is the case in southern latitudes, though seldom in our country, the dew becomes much more copious, because the air then contains more moisture. Dew continues to form with increased copiousness as the night advances, from the increased refrigeration of the ground.

2366. *Cause of dew.* Dew, according to Aristotle, is a species of rain, formed in the lower atmosphere, in consequence of its moisture being condensed by the cold of the night into minute drops. Opinions of this kind, says Dr. Wells, are still entertained by many persons, among whom is the very ingenious Professor Leslie. (*Relat. of Heat and Moisture*, p. 37. and 132.) A fact, however, first taken notice of by Garstin, who published his *Treatise on Dew* in 1773, proves them to be erroneous; for he found that bodies a little elevated in the air often become moist with dew, while similar bodies, lying on the ground, remain dry, though necessarily, from their position, as liable to be wetted, by whatever falls from the heavens, as the former. The above notion is perfectly refuted by the fact, that metallic surfaces exposed to the air in a horizontal position remain dry, while every thing around them is covered with dew. After a long period of drought, when the air was very still and the sky serene, Dr. Wells exposed to the sky, 28 minutes before sunset, previously weighed parcels of wool and swandown, upon a smooth, unpainted, and perfectly dry fir table, 5 feet long, 3 broad, and nearly 3 in height, which had been placed, an hour before, in the sunshine, in a large level grassfield. The wool, 12 minutes after sunset, was found to be 14° colder than the air, and to have acquired no weight. The swandown, the quantity of which was much greater than that of the wool, was at the same time 13° colder than the air, and was also without any additional weight. In 20 minutes more the swandown was $14\frac{1}{2}$° colder than the neighbouring air, and was still without any increase of its weight. At the same time the grass was 15° colder than the air four feet above the ground. Dr. Wells, by a copious induction of facts derived from observation and experiment, establishes the proposition, that bodies become colder than the neighbouring air before they are dewed. The cold therefore, which Dr. Wilson and M. Six conjectured to be the effect of dew, now appears to be its cause. But what makes the terrestrial surface colder than the atmosphere? The radiation or projection of heat into free space. Now the researches of Professor Leslie and Count Rumford have demonstrated that different bodies project heat with very different degrees of force. In the operation of this principle therefore, conjoined with the power of a concave mirror of cloud, or any other awning, to reflect or throw down again those caloric emanations which would be dissipated in a clear sky, we shall find a solution of the most mysterious phenomena of dew.

2367. *Rain.* Luke Howard, who may be considered as our most accurate scientific meteorologist, is inclined to think that rain is in almost every instance the result of the electrical action of clouds upon each other.

2368. *Phenomena of rain.* Rain never descends till the transparency of the air ceases, and the invisible vapours become vesicular, when clouds form, and at length the drops fall: clouds, instead of forming gradually at once throughout all parts of the horizon, generate in a particular spot, and imperceptibly increase till the whole expanse is obscured.

2369. *The cause of rain* is thus accounted for by Hutton and Dalton. If two masses of air of unequal temperatures are, when saturated with vapour, intermixed by the ordinary currents of the winds, a precipitation ensues. If the masses are under saturation, then less precipitation takes place, or none at all, according to the degree. Also the warmer the air, the greater is the quantity of vapour precipitated in like circumstances. Hence the reason why rains are heavier in summer than in winter, and in warm countries than in cold.

2370. *The quantity of rain*, taken at an annual mean, is the greatest at the equator, and it lessens gradually to the poles; at which there are fewer days of rain, the number increasing in proportion to the distance from them. From north latitude 12° to 43° the mean number of rainy days is 78; from 43° to 46° the mean number is 103; from 46° to 50°, 134; and from 51° to 60°, 161. Winter often produces a greater number of rainy days than summer, though the quantity of rain is more considerable in the latter than in the former season; at Petersburgh rain and snow fall on an average 84 days of the winter, and the quantity amounts to about five inches; on the contrary, the summer produces eleven inches in about the same number of days. Mountainous districts are subject to great falls of rain; among the Andes particularly, it rains almost incessantly, while the flat country of Egypt is consumed by endless drought. Dalton estimates the quantity of rain falling in England at 31 inches. The mean annual quantity of rain for the whole globe is 34 inches.

2371. *The cause why less rain falls in the first six months of the year than in the last six months* is thus explained. The whole quantity of water in the atmosphere in January is usually about three inches, as appears from the dew point, which is then about 32°; now the force of vapours of that temperature is 0·2 of an inch of mercury, which is equal to 2·8 or three inches of water. The dew point in July is usually about 58° or 59°, corresponding to 0·5 of an inch of mercury, which is equal to seven inches of water. Thus it is evident that, in the latter month, the atmosphere contains four inches of water more than in the former month. Hence, supposing the usual intermixture of currents of air in both the intervening periods to be the same, the rain ought to be four inches less in the former period of the year than the average, and four inches more in the latter period, making a difference of eight inches between the two periods, which nearly accords with the preceding observations.

2372. *The mean monthly and annual quantities of rain* at various places, deduced from the average for many years, by Dalton, is given in the following Table; —

	Manchester, 33 years.	Liverpool, 18 years.	Chatsworth, 16 years.	Lancaster, 20 years.	Kendal, 25 years.	Dumfries, 16 years.	Glasgow, 17 years.	London, 40 years.	Paris, 15 years.	Viviers, 40 years.	General Average.
	Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Fr. In.*	*Fr. In.*	*Inch.*
January -	2·310	2·177	2·196	3·461	5·299	3·095	1·595	1·464	1·228	2·477	2·530
February -	2·568	1·847	1·652	2 995	5·126	2·837	1 741	1·250	1·232	1·700	2·295
March - -	2·098	1·523	1·322	1·753	3·151	2·164	1·184	1·172	1·190	1·927	1·748
April - -	2·010	2·104	2·078	2·180	2·986	2·017	0·979	1·279	1·185	2·686	1·950
May - -	2·895	2·573	2·118	2·460	3·480	2·568	1·641	1·636	1·767	2·931	2·407
June - -	2·502	2·816	2·286	2·512	2·722	2·974	1·343	1·738	1·697	2·562	2·315
July - -	3·697	3·663	3·006	4·140	4·959	3·256	2·303	2·448	1·800	1·882	3·115
August -	3·665	3·311	2·435	4·581	5·089	3·199	2·746	1·807	1·900	2·347	3·103
September	3·281	3·654	2·289	3·751	4·874	4·350	1·617	1·842	1·550	4·140	3·135
October -	3·922	3·724	3·079	4·151	5·439	4·143	2·297	2·092	1·780	4·741	3·537
November	3·360	3·441	2·634	3·775	4·785	3·174	1·904	2·222	1·720	4·187	3·120
December -	3·832	3·288	2·569	3·955	6·084	3·142	1·981	1·736	1·600	2·397	3·058
	36·140	34·121	27·664	39·714	53·944	36·919	21·331	20·686	18·649	33·977	

2373. *Frost, being derived from the atmosphere*, naturally proceeds from the upper parts of bodies downwards; so the longer a frost is continued, the thicker the ice becomes upon the water in ponds, and the deeper into the earth the ground is frozen. In about 16 or 17 days' frost, Boyle found it had penetrated 14 inches into the ground. At Moscow, in a hard season, the frost will penetrate two feet deep into the ground; and Captain James found it penetrated 10 feet deep in Charlton Island, and the water in the same island was frozen to the depth of six feet. Scheffer assures us, that in Sweden the frost pierces two cubits (a Swedish ell) into the earth, turning what moisture is found there into a whitish substance like ice; and into standing water three ells or more. The same author also mentions sudden cracks or rifts in the ice of the lakes of Sweden, nine or ten feet deep, and many leagues long; the rupture being made with a noise not less loud than if many guns were discharged together. By such means, however, the fishes are furnished with air, so that they are rarely found dead.

2374. *The history of frosts* furnishes very extraordinary facts. The trees are often scorched and burnt up, as with the most excessive heat, in consequence of the separation of water from the air, which is therefore very drying. In the great frost in 1683, the trunks of oak, ash, walnut, and other trees, were miserably split and cleft, so that they might be seen through, and the cracks often attended with dreadful noises like the explosion of fire-arms.

2375. *Hail* is generally defined as frozen rain; it differs from it in that the hailstones for the most part are not formed of single pieces of ice, but of many little spherules agglutinated together; neither are those spherules all of the same consistence; some of them being hard and solid, like perfect ice; others soft, and mostly like snow hardened by a severe frost. Hailstone has sometimes a kind of core of this soft matter; but more frequently the core is solid and hard, while the outside is formed of a softer matter. Hailstones assume various figures, being sometimes round, at other times pyramidal, crenated, angular, thin or flat, and sometimes stellated with six radii, like the small crystals of snow. Natural historians furnish us with various accounts of surprising showers of hail, in which the hailstones were of extraordinary magnitude.

2376. *Snow* is formed by the freezing of the vapours in the atmosphere. It differs from hail and hoar frost, in being as it were crystallised, while they are not. As the flakes fall down through the atmosphere, they are continually joined by more of these radiated spicula, and they increase in bulk like the drops of rain or hailstones. The lightness of snow, although it is firm ice, is owing to the excess of its surface in comparison with the matter contained under it: as gold itself may be extended in surface till it will ride upon the least breath of air. The whiteness of snow is owing to the small particles into which it is divided; for ice when pounded will become equally white.

2377. *Snow is of great use to the vegetable kingdom.* Were we to judge from appearance only, we might imagine, that, so far from being useful to the earth, the cold humidity of snow would be detrimental to vegetation: but the experience of all ages asserts the contrary. Snow, particularly in those northern regions where the ground is covered with it for several months, fructifies the earth, by guarding the corn or other vegetables from the intenser cold of the air, and especially from the cold piercing winds. It has been a vulgar opinion, very generally received, that snow fertilises the land on which it falls more than rain, in consequence of the nitrous salts which it is supposed to acquire by freezing: but it appears from the experiments of Margraaf, in the year 1731, that the chemical difference between rain and snow-water is exceedingly small; that the latter contains a somewhat less proportion of earth than the former; but neither of them contains either earth, or any kind of salt, in any quantity which can be sensibly efficacious in promoting vegetation. The peculiar agency of snow as a fertiliser, in preference to rain, may be ascribed to its furnishing a covering to the roots of vegetables, by which they are guarded from the influence of the atmospherical cold, and the internal heat of the earth is prevented from escaping. Different vegetables are able to preserve life under different degrees of cold, but all of them perish when the cold which reaches their roots is extreme. Providence has, therefore, in the coldest climates, provided a covering of snow for the roots of vegetables, by which they are protected from the influence of the atmospherical cold. The snow keeps in the internal heat of the earth, which surrounds the roots of vegetables, and defends them from the cold of the atmosphere.

2378. *Ice* is water in the solid state, during which the temperature remains constant, being 32 degrees of the scale of Fahrenheit. Ice is considerably lighter than water, namely, about one eighth part; and this increase of dimensions is acquired with prodigious force, sufficient to burst the strongest iron vessels, and even pieces of artillery. Congelation takes place much more suddenly than the opposite process of liquefaction; and of course, the same quantity of heat must be more rapidly extricated in freezing than it is absorbed in thawing; the heat thus extricated being disposed to fly off in all directions, and little of it being retained by the neighbouring bodies, more heat is lost than is gained by the alternation: so that where ice has once been formed, its production is in this manner redoubled.

2379. *The northern ice* extends during summer about 9° from the pole; the southern 18° or 20°; in some parts even 30°; and floating ice has occasionally been found in both hemispheres as far as 40° from the poles, and sometimes, as it has been said, even in latitude 41° or 42°. Between 54° and 60° south latitude, the snow lies on the ground, at the sea-side, throughout the summer. The line of perpetual congelation is three miles above the surface at the equator, where the mean heat is 84°; at Teneriffe, in latitude 28°, two miles; in the latitude of London, a little more than a mile; and in latitude 80° north, only 1250 feet. At the pole, according to the analogy deduced by Kirwan, from Mayer's Formula, and which is not however found to agree very exactly with what takes place, from a comparison of various observations, the mean temperature should be 31°.

In London the mean temperature is 50°; at Rome and at Montpellier, a little more than 60°; in the island of Madeira, 70°; and in Jamaica, 80°.

2380. *Wind.* Were it not for this agitation of the air, putrid effluvia arising from the habitations of man, and from vegetable substances, besides the exhalations from water, would soon render it unfit for respiration, and a general mortality would be the consequence. The prevailing winds of our own country, which were ascertained by order of the Royal Society of London, *at London*, are,

Winds.	*Days.*	*Winds.*	*Days.*	*Winds.*	*Days.*
South-west	112	West	53	South	18
North-east	58	South-eas	32	North	16
North-west	50	East	26		

The westerly winds blow more upon an average in each month of the year than any other, particularly in July and August; the north-east wind prevails during January, March, April, May, and June, and is most unfrequent in February, July, September, and December; the north-west occurring more frequently from November to March, and less so in September and October than in any other months.

2381. *Near Glasgow*, the average is stated as follows: —

Winds.	*Days.*	*Winds.*	*Days.*
South-west	174	North-east	104
North-west	40	South-east	47

2382. *In Ireland*, the prevailing winds are the west and south-west.

2383. *The different degrees of motion of wind* next excite our attention; and it seems almost superfluous to observe, that it varies in gradation from the mildest zephyr, which plays upon the leaves of plants, gently undulating them, to the furious tempest, calculated to inspire horror in the breast of the most callous. It is also a remarkable fact, that violent currents of air pass along, as it were, within a line, without sensibly agitating that beyond them. An instance of the fury of the wind being bounded "by a line" occurs in the hurricane of America; where its devastating course is often accurately marked in the forests for a great extent in one direction.

2384. *Causes of wind.* There are many circumstances attending the operations of the air, which we term wind, which serve for a basis for well-founded conjectures, and those, united to the result of daily observation, render the explanation of its phenomena tolerably satisfactory.

2385. *It must be clear to the most common capacity*, that as the rays of the sun descend perpendicularly on the surface of the earth under the torrid zone, that part of it must receive a greater proportion of heat than those parts where they fall obliquely; the heat thus acquired communicates to the air, which it rarefies, and causes to ascend, and the vacuum occasioned by this operation is immediately filled by the chill air from the north and south. The diurnal motion of the earth gradually lessens to the poles from the equator, at which point it moves at the rate of fifteen geographical miles in a minute, and this motion is communicated to the atmosphere in the same degree; but if part of the atmosphere were conveyed instantaneously to the equator from latitude 30°, it would not directly acquire the equatorial velocity; consequently, the ridges of the earth must meet it, and give it the appearance of an east wind. The effect is similar upon the cold air proceeding from the north and south, and this similarity must be admitted to extend to each place particularly heated by the beams of the sun. The moon, being a large body situated comparatively near the earth, is known to affect the atmosphere; and this, and the continual shifting of the point of the earth's surface over which the sun is vertical, to the west, are given as the causes of the tides and of the trade winds. The moon's revolutions, by pressing the atmosphere upon the sea, cause the flux and reflux which we call tides; it cannot, therefore, be doubted, that some of the winds we experience are caused by the moon's motion.

2386. *The regular motion of the atmosphere*, known by the name of *land and sea breezes*, may be explained by the effects of rarefaction: the air heated over the land rises up, because rarefied, and its place is supplied by the cooler air which flows in from the sea; this produces the *sea breeze;* at sunset, the equilibrium is first restored; but as the earth cools faster by radiation than the water, the air over it becomes cooler than that over the sea, especially if there be mountains in the vicinity; the air over the land then displaces the light air from the sea, and thus the land breeze is formed. Granting that the attraction of the moon and the diurnal movement of the sun affect our atmosphere, there cannot be a doubt but a westward motion of the air must prevail within the boundaries of the trade-winds, the consequence of which is an easterly current on each side: from this, then, it proceeds that south-west winds are so frequent in the western parts of Europe, and over the Atlantic Ocean. Kirwan attributes our constant south-west winds, particularly during winter, to an opposite current prevailing between the coast of Malabar and the Moluccas at the same period: this, he adds, must be supplied from regions close to the pole, which must be recruited in its turn from the countries to the south of it, in the western parts of our hemisphere.

2387. *The variable winds* cannot be so readily accounted for; yet it is evident, that though they seem the effect of capricious causes, they depend upon a regular system, arranged by the great Author of nature. That accurate and successful observer of part of his works, the celebrated Franklin, discovered in 1740, that winds originate at the precise points towards which they blow. This philosopher had hoped to observe an eclipse of the moon at Philadelphia, but was prevented by a north-east storm, that commenced at seven in the evening. This he afterwards found did not occur at Boston till eleven; and upon enquiry, he had reason to suppose, it passed to the north-east at the rate of about 100 miles an hour. The manner in which he accounts for this retrograde proceeding is so satisfactory, that we shall give it in his own words, particularly as his assertions are supported by recent observations, both in America and Scotland. He argued thus: — "I suppose a long canal of water, stopped at the end by a gate. The water is at rest till the gate is opened; then it begins to move out through the gate, and the water next the gate is put in motion and moves on towards the gate; and so on successively, till the water at the head of the canal is in motion, which it is last of all. In this case all the water moves indeed towards the gate; but the successive times of beginning the motion are in the contrary way, viz. from the gate back to the head of the canal. Thus to produce a north-east storm, I suppose some great rarefaction of the air in or near the Gulf of Mexico; the air rising thence has its place supplied by the next more northern, cooler, and therefore denser and heavier air; a successive current is formed, to which our coast and inland mountains give a north-east direction." According to the observations made by Captain Cook, the north-east winds prevail in the Northern Pacific Ocean during the same spring months they do with us, from which facts it appears the cold air from America and the north of Europe flows at that season into the Pacific and Atlantic Oceans.

2388. *Other descriptions of winds* may arise from a variety of causes. The atmosphere has been ascertained to be composed of air, vapour, and carbonic acid and water; and as it is well known that these frequently change their aerial form, and combine with different substances, and the reverse, consequently partial winds and accumulations must continually occur, which occasion winds of different degrees of violence, continuance, and direction.

2389. *The principal electrical phenomena of the atmosphere* are thunder and lightning.

2390. *Thunder* is the noise occasioned by the explosion of a flash of lightning passing through the air: or it is that noise which is excited by a sudden explosion of electrical clouds, which are therefore called thunder-clouds.

2391. *The rattling*, in the noise of thunder, which makes it seem as if it passed through arches, is probably owing to the sound being excited among clouds hanging over one another, between which the agitated air passes irregularly.

2392. *The explosion*, if high in the air and remote from us, will do no mischief, but when near, it may; and it has, in a thousand instances, destroyed trees, animals, &c. This proximity, or small distance, may be estimated nearly by the interval of time between seeing the flash of lightning and hearing the report of the thunder, reckoning the distance after the rate of 1142 feet to a second of time, or $3\frac{1}{2}$ seconds to the mile. Dr. Wallis observes, that commonly the difference between the two is about seven seconds, which, at the rate above-mentioned, gives the distance almost two miles: but sometimes it comes in a second or two, which argues the explosion very near to us, and even among us; and in such cases, the doctor assures us, he has sometimes foretold the mischiefs that happened.

2393. *Season of thunder.* Although in this country thunder may happen at any time of the year, yet the months of July and August are those in which it may almost certainly be expected. Its devastations are of very uncertain continuance; sometimes only a few peals will be heard at any particular place during the whole season; at other times the storm will return, at intervals of three or four days, for a month, six weeks, or even longer; not that we have violent thunder in this country directly vertical in any one place so frequently in any year, but in many seasons it will be perceptible that thunder-clouds are formed in the neighbourhood, even at these short intervals. Hence it appears, that during this particular period, there must be some natural cause operating for the production of this phenomenon, which does not take place at other times. This cannot be the mere heat of the weather, for we have often a long tract of hot weather without any thunder; and besides, though not common, thunder is sometimes heard in the winter also. As therefore the heat of the weather is common to the whole summer, whether there is thunder or not, we must look for the causes of it in those phenomena, whatever they are, which are peculiar to the months of July, August, and the beginning of September. Now it is generally observed, that from the month of April, an east or south-east wind generally takes place, and continues with little interruption till towards the end of June. At that time, sometimes sooner and sometimes later, a westerly wind takes place; but as the causes producing the east wind are not removed, the latter opposes the west wind with its whole force. At the place of meeting, there are naturally a most vehement pressure of the atmosphere, and friction of its parts against one another; a calm ensues, and the vapours brought by both winds begin to collect and form dark clouds, which can have little motion either way, because they are pressed almost equally on all sides. For the most part, however, the west wind prevails, and what little motion the clouds have is towards the east: whence, the common remark in this country, that "thunder-clouds move against the wind." But this is by no means universally true: for if the west wind happens to be excited by any temporary cause before the natural period when it should take place, the east wind will very frequently get the better of it; and the clouds, even although thunder is produced, will move westward. Yet in either case, the motion is so slow, that the most superficial observers cannot help taking notice of a considerable resistance in the atmosphere.

2394. *Thunderbolts.* When lightning acts with extraordinary violence, and breaks or shatters any thing, it is called a thunderbolt, which the vulgar, to fit it for such effects, suppose to be a hard body, and even a stone. But that we need not have recourse to a hard solid body to account for the effects commonly attributed to the thunderbolt, will be evident to any one who considers those of gunpowder, and the several chemical fulminating powders, but more especially the astonishing powers of electricity, when only collected and employed by human art, and much more when directed and exercised in the course of nature. When we consider the known effects of electrical explosions, and those produced by lightning, we shall be at no loss to account for the extraordinary operations vulgarly ascribed to thunderbolts. As stones and bricks struck by lightning are often found in a vitrified state, we may reasonably suppose, with Beccaria, that some stones in the earth, having been struck in this manner, gave occasion to the vulgar opinion of the thunderbolt.

2395. *Thunder-clouds* are those clouds which are in a state fit for producing lightning and thunder. The first appearance of a thunder-storm, which usually happens when there is little or no wind, is one dense cloud, or more, increasing very fast in size, and rising into the higher regions of the air. The lower surface is black, and nearly level; but the upper finely arched, and well defined. Many of these clouds often seem piled upon one another, all arched in the same manner; but they are continually uniting, swelling, and extending their arches. At the time of the rising of this cloud, the atmosphere is commonly full of a great many separate clouds, which are motionless, and of odd whimsical shapes; all these, upon the appearance of the thunder-cloud, draw towards it, and become more uniform in their shapes as they approach; till, coming very near the thunder-cloud, their limbs mutually stretch towards one another, and they immediately coalesce into one uniform mass. Sometimes the thunder-cloud will swell, and increase very fast, without the conjunction of any adscititious clouds; the vapours in the atmosphere forming themselves into clouds whenever it passes. Some of the adscititious clouds appear like white fringes, at the skirts of the thunder-cloud, or under the body of it; but they keep continually growing darker and darker, as they approach to unite with it. When the thunder-cloud is grown to a great size, its lower surface is often ragged, particular parts being detached towards the earth, but still connected with the rest. Sometimes the lower surface swells into various large protuberances, bending uniformly downward; and sometimes one whole side of the cloud will have an inclination to the earth, and the extremity of it will nearly touch the ground. When the eye is under the thunder-cloud, after it is grown large and well formed, it is seen to sink lower, and to darken prodigiously; at the same time that a number of small adscititious clouds (the origin of which can never be perceived) are seen in a rapid motion, driving about in very uncertain directions under it. While these clouds are agitated with the most rapid motions, the rain commonly falls in the greatest plenty; and if the agitation be exceedingly great, it commonly hails.

2396. *Lightning.* While the thunder-cloud is swelling, and extending its branches over a large tract of country, the lightning is seen to dart from one part of it to another, and often to illuminate its whole mass. When the cloud has acquired a sufficient extent, the lightning strikes between the cloud and the earth, in two opposite places; the path of the lightning lying through the whole body of the cloud and its branches. The longer this lightning continues, the less dense does the cloud become, and the less dark its appearance; till at length it breaks in different places, and shows a clear sky. Those thunder-clouds are said to be sometimes in a positive as well as a negative state of electricity. The electricity continues longer of the same kind, in proportion as the thunder-cloud is simple and uniform in its direction; but when the lightning changes its place, there commonly happens a change in the electricity of the atmosphere over which the clouds passed. It changes suddenly after a very violent flash of lightning; but gradually when the lightning is moderate, and the progress of the thunder-cloud slow.

2397 *Lightning is an electrical explosion or phenomenon.* Flashes of lightning are usually seen in broad and undefined masses; when their path appears angular or zigzag, they are reckoned most dangerous. They strike the highest and most pointed objects in preference to others, as hills, trees, spires, masts of ships, &c.; so all pointed conductors receive and throw off the electric fluid more readily than those that are terminated by flat surfaces. Lightning is observed to take and follow the readiest and best conductor; and the same is the case with electricity in the discharge of the Leyden phial; whence it is inferred, that in a thunder-storm it would be safer to have one's clothes wet than dry. Lightning burns, dissolves metals, rends some bodies, sometimes strikes persons blind, destroys animal life, deprives magnets of their virtue, or reverses their poles; and all these are well known properties of electricity.

2398. *With regard to places of safety in times of thunder and lightning*, Dr. Franklin's advice is to sit in the middle of a room, provided it be not under a metal lustre suspended by a chain, sitting on one chair, and laying the feet on another. It is still better, he says, to bring two or three mattresses or beds into the middle of the room, and folding them double, to place the chairs upon them; for as they are not so good conductors as the walls, the lightning will not be so likely to pass through them. But the safest place of all is in a hammock hung by silken cords, at an equal distance from all the sides of the room. Dr. Priestley observes, that the place of most perfect safety must be the cellar, and especially the middle of it; for when a person is lower than the surface of the earth, the lightning must strike it before it can possibly reach him. In the fields, the place of safety is within a few yards of a tree, but not quite near it. Beccaria cautions persons not always to trust too much to the neighbourhood of a higher or better conductor than their own body, since he has repeatedly found that the lightning by no means descends in one undivided track, but that bodies of various kinds conduct their share of it at the same time, in proportion to their quantity and conducting power.

SECT. II. *Of the Means of Prognosticating the Weather.*

2399. *The study of atmospherical changes* has, in all ages, been more or less attended to by men engaged in the culture of vegetables, or the pasturage of animals; and we, in this country, are surprised at the degree of perfection to which the ancients attained in this knowledge: but it ought to be recollected, that the study of the weather in the countries occupied by the ancients, as Egypt, Greece, Italy, and the continent of Europe, is a very different thing from its study in an island situated like ours. It is easy to foretell weather in countries where months pass away without rain or clouds, and where some weeks together, at stated periods, are as certainly seasons of rain or snow. It may be asserted with truth, that there is a greater variety of weather in London in one week, than in Rome, Moscow, or Petersburgh in three months. It is not, therefore, entirely a proof of our degeneracy, or the influence of our artificial mode of living, that we cannot predict the weather with such certainty as the ancients; but a circumstance rather to be accounted for from the peculiarities of our situation.

2400. *A variable climate, such as ours*, admits of being studied, both generally and locally; but it is a study which requires habits of observation and reflection like all other studies; and to be brought to any useful degree of perfection must be attended to, not as it commonly is, as a thing by chance, and which every body knows, or is fit for, but as a serious undertaking. The weather may be foretold from natural data, artificial data, and from precedent.

2401. *The natural data* for this study are, 1. The vegetable kingdom; many plants shutting or opening their flowers, contracting or expanding their parts, &c. on approaching changes in the humidity or temperature of the atmosphere: 2. The animal kingdom; most of those familiar to us exhibiting signs on approaching changes, of which those by cattle and sheep are more especially remarkable; and hence shepherds are generally, of all others, the most correct in their estimate of weather: 3. The mineral kingdom; stones, earths, metals, salts, and water of particular sorts, often showing indications of approaching changes: 4. Appearances of the atmosphere, the moon, the general character of seasons, &c. The characters of clouds, the prevalence of particular winds, and other signs are very commonly attended to.

2402. *The influence of the moon on the weather* has, in all ages, been believed by the generality of mankind: the same opinion was embraced by the ancient philosophers; and several eminent philosophers of later times have thought the opinion not unworthy of notice. Although the moon only acts (as far at least as we can ascertain) on the waters of the ocean by producing tides, it is nevertheless highly *probable*, according to the observations of Lambert, Toaldo, and Cotte, that in consequence of the lunar influence, great variations do take place in the atmosphere, and consequently in the weather. The following principles will show the grounds and reasons for their embracing the received notions on this interesting topic: —

2403. *There are ten situations in the moon's orbit* when she must particularly exert her influence on the atmosphere; and when, consequently, changes of the weather most readily take place. These are, —
1st, The *new*, and 2d, The *full* moon, when she exerts her influence in conjunction with, or in opposition to, the sun.

3d and 4th, The quadratures, or those aspects of the moon when she is 90° distant from the sun; or when she is in the middle point of her orbit, between the points of conjunction and opposition, namely, in the first and third quarters.

5th, The *perigee*, and 6th, The *apogee*, or those points of the moon's orbit, in which she is at the *least* and *greatest* distance from the earth.

7th and 8th, The two passages of the moon over the equator, one of which Toaldo calls the moon's *ascending*, and the other the moon's *descending*, equinox; or the two *lunistices*, as De la Lande terms them.

9th, The *boreal lunistice*, when the moon approaches as near as she can in each lunation (or period between one new moon and another) to our zenith (that point in the horizon which is directly over our heads).

10th, The *austral lunistice*, when she is at the greatest distance from our zenith, for the action of the moon varies greatly according to her obliquity. With these ten points Toaldo compared a table of forty-eight years' observations; the result is, that the probabilities, that the weather will change at a certain period of the moon, are in the following proportions: New moon, 6 to 1. First quarter, 5 to 2. Full moon, 5 to 2. Last quarter, 5 to 4. Perigee, 7 to 1. Apogee, 4 to 1. Ascending equinox, 13 to 4. Northern lunistice, 11 to 4. Descending equinox, 11 to 4. Southern lunistice, 3 to 1.

2404. *That the new moon will bring with it a change of weather* is in the doctrine of chances as 6 to 1. Each situation of the moon alters that state of the atmosphere which has been occasioned by the preceding one: and it seldom happens that any change in the weather takes place without a change in the lunar situations. These situations are combined, on account of the inequality of their revolutions, and the greatest effect is produced by the union of the syzigies, or the conjunction and opposition of a planet with the sun, with the apsides, or points in the orbits of planets, in which they are at the greatest and least distance from the sun or earth. The proportions of their powers to produce variations are as follows: — New moon coinciding with the perigee, 33 to 1. Ditto, with the apogee, 7 to 1. Full moon coinciding with the perigee, 10 to 1. Ditto, with the apogee, 8 to 1. The combination of these situations generally occasions storms and tempests: and this perturbing power will always have the greater effect, the nearer these combined situations are to the moon's passage over the equator, particularly in the months of March and September. At the new and full moons, in the months of March and September, and even at the solstices, especially the winter solstice, the atmosphere assumes a certain character, by which it is distinguished for three and sometimes six months. The new moons which produce no change in the weather are those that happen at a distance from the apsides. As it is perfectly true that each situation of the moon alters that state of the atmosphere which has been produced by another, it is also observed, that many situations of the moon are favourable to good and others to bad weather.

2405. *The situations of the moon favourable to bad weather* are the perigee, new and full moon, passage of the equator, and the northern lunistice. Those belonging to the former are, the apogee, quadratures, and the southern lunistice. Changes of the weather seldom take place on the very days of the moon's situations, but either precede or follow them. It has been found by observation, that the changes affected by the lunar situations in the six winter months precede, and in the six summer months follow them.

2406. *The octants.* Besides the lunar situations to which the above observations refer, attention must be paid also to the fourth day before new and full moon, which days are called the octants. At these times the weather is inclined to changes; and it may be easily seen, that these will follow at the next lunar situation. Virgil calls this fourth day a very sure prophet. If on that day the horns of the moon are clear and well defined, good weather may be expected; but if they are dull, and not clearly marked on the edges, it is a sign that bad weather will ensue. When the weather remains unchanged on the fourth, fifth, and sixth day of the moon, we may conjecture that it will continue so till full moon, even sometimes till the next new moon; and in that case the lunar situations have only a very weak effect. Many observers of nature have also remarked, that the approach of the lunar situations is somewhat critical for the sick. According to Dr. Herschel, the nearer the time of the moon's entrance at full, change, or quarters, is to midnight (that is within two hours before and after midnight), the more fair the weather is in summer, but the nearer to noon the less fair. Also, the moon's entrance, at full, change, or quarters, during six of the afternoon hours, viz. from four to ten, may be followed by fair weather; but this is mostly dependent on the wind. The same entrance during all the hours after midnight, except the first two, is unfavourable to fair weather; the like, nearly, may be observed in winter.

2407. *The artificial data* are the barometer, hygrometer, rain-gauge, and thermometer.

2408. By means of *the barometer*, Taylor observes, we are enabled to regain, in some degree at least, that foreknowledge of the weather, which the ancients unquestionably did possess; though we know not the data on which they founded their conclusions. Chaptal considers that the value of the barometer, as an indicator of the approaching weather, is greater than that of the lunar knowledge of the most experienced countryman, and indeed of all other means put together. (*Agriculture appliquée à Chimie, &c.*) We shall therefore annex such rules as have hitherto been found most useful in ascertaining the changes of the weather by means of the barometer.

2409. *The rising of the mercury* presages, in general, fair weather; and its falling foul weather, as rain, snow, high winds, and storms.

2410. *The sudden falling of the mercury* foretells thunder, in very hot weather, especially if the wind is south.

2411. *The rising in winter* indicates frost; and in frosty weather, if the mercury falls three or four divisions, there will follow a thaw: but if it rises in a continued frost, snow may be expected.

2412. *When foul weather happens soon after the falling of the mercury* it will not be of long duration; nor are we to expect a continuance of fair weather, when it soon succeeds the rising of the quicksilver.

2413. *If, in foul weather, the mercury rises* considerably, and continues rising for two or three days before the foul weather is over, a continuance of fair weather may be expected to follow.

2414. *In fair weather, when the mercury falls* much and low, and continues falling for two or three days before rain comes, much wet must be expected, and probably high winds.

2415. *The unsettled motion of the mercury* indicates changeable weather.

2416. *Respecting the words engraved on the register plate of the barometer,* it may be observed, that their exact correspondence with the state of the weather cannot be strictly relied upon, though they will in general agree with it as to the mercury rising and falling. The engraved words are to be regarded only as indicating probable consequences of the varying pressure of the atmosphere. The barometer, in fact, only shows the pressure of the aerial column; and the precipitation of rain, or the agitations of the atmosphere are merely events which experience has shown usually to accompany the sinking of the mercurial column, but are not necessarily connected with fluctuations of pressure. The words deserve to be particularly noticed when the mercury removes from "changeable" upwards; as those on the lower part should be adverted to, when the mercury falls from "changeable" downwards. In other cases, they are of no use: for, as its rising in any part forebodes a tendency to fair, and its falling to foul, weather, it follows that, though it descend in the tube from settled to fair, it may nevertheless be attended with a little rain, and when it rises from the words "much rain" to "rain" it shows only an inclination to become fair, though the wet weather may still continue in a less considerable degree than it was when the mercury began to rise. But if the mercury, after having fallen to "much rain," should ascend to "changeable," it foretells fair weather, though of a shorter continuance than if the mercury had risen still higher; and so, on the contrary, if the mercury stood at "fair" and descends to "changeable," it announces foul weather, though not of so long continuance as if it had fallen lower.

2417. *Concavity of the surface of the mercury.* Persons who have occasion to travel much in the winter, and who are doubtful whether it will rain or not, may easily ascertain this point by the following observation: — A few hours before he departs, let the traveller notice the mercury in the upper part of the tube of the barometer; if rain is about to fall, it will be indented, or concave; if otherwise, convex or protuberant.

2418. *Barometer in spring.* Towards the end of March, or more generally in the beginning of April, the barometer sinks very low with bad weather; after which it seldom falls lower than 29 degrees 5 minutes till the latter end of September or October, when the quicksilver falls again low with stormy winds, for then the winter constitution of the air takes place. From October to April, the great falls of the barometer are from 29 degrees 5 minutes to 28 degrees 5 minutes, and sometimes lower; whereas, during the summer constitution of the air, the quicksilver seldom falls lower than 29 degrees 5 minutes. It therefore follows that a fall of one tenth of an inch, during the summer, is as sure an indication of rain, as a fall of between two and three tenths is in the winter.

2419. *The hygrometer* is of various sorts, but cord, fiddle-string, and most of the substances commonly used, become sensibly less and less accurate, so as at length not to undergo any visible alteration from the different states of the air, in regard to dryness or moisture. The most common of all barometers is that formed of the beard of the wild oat, *Avèna fátua.*

2420. *A sponge makes a good hygrometer* on this account, as being less liable to be changed by use than cord. To prepare the sponge, first wash it in water, and when dry wash it again in water wherein sal ammoniac or salt of tartar has been dissolved; and let it dry again. Now, if the air becomes moist, the sponge will grow heavier; and if dry, it will become lighter.

2421. *Oil of vitriol* is found to grow sensibly lighter or heavier in proportion to the less or greater quantity of moisture it imbibes from the air. The alteration is so great, that it has been known to change its weight from three drachms to nine. The other acid oils, or, as they are usually called, spirits, or oil of tartar *per deliquium*, may be substituted for the oil of vitriol.

2422. *Steel-yard hygrometer.* In order to make a hygrometer with those bodies which acquire or lose weight in the air, place such a substance in a scale on the end of a steel-yard, with a counterpoise which shall keep it *in equilibrio* in fair weather; the other end of the steel-yard, rising or falling, and pointing to a graduated index, will show the changes.

2423 *Line and plummet.* If a line be made of good well dried whipcord, and a plummet be fixed to the end of it, and the whole be hung against a wainscot, and a line be drawn under it, exactly where the plummet reaches, in very moderate weather it will be found to rise above such line, and to sink below it when the weather is likely to become fair.

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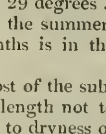
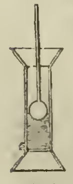


2424. *The hair hygrometer of Saussure, and the whalebone hygrometer,* originally invented by De Luc, are esteemed two of the best now in use.

2425. *The best and, indeed, only perfect hygrometer* is that of professor Leslie. It consists of a siphon tube, with a ball blown at each end (*fig.* 208.), and filled with air. A coloured liquid fills one leg of the siphon; the ball on the opposite limb, smoothly coated with tissue paper, is the evaporating surface; this is kept perpetually moist by means of a thread passing from a jar with water as high as the instrument to the covered ball. The cold produced by evaporation causes the air in that ball to contract, and the coloured liquid is forced into that stem by the elasticity of the air included in the naked ball. This rise is exactly proportional to the dryness of the air. (*T.*)

2426. *The rain-gauge, pluviometer, or hyetometer,* is a machine for measuring the quantity of rain that falls.



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2427. *A hollow cylinder* forms one of the best-constructed rain-gauges; it has within it a cork ball attached to a wooden stem (*fig.* 209.), which passes through a small opening at the top, on which is placed a large funnel. When this instrument is placed in the open air in a free place, the rain that falls within the circumference of the funnel will run down into the tube and cause the cork to float; and the quantity of water in the tube may be seen by the height to which the stem of the float is raised. The stem of the float is so graduated as to show by its divisions the number of perpendicular inches of water which fell on the surface of the earth since the last observation. After every observation the cylinder must be emptied.

2428. *A copper* funnel forms another very simple rain-gauge : the area of the opening must be exactly ten square inches. Let this funnel be fixed in a bottle, and the quantity of rain caught is ascertained by multiplying the weight in ounces by 173, which gives the depth in inches and parts of an inch.

2429. *In fixing these gauges,* care must be taken that the rain may have free access to them; hence the tops of buildings are usually the best places, though some conceive that the nearer the rain-gauge is placed to the ground the more rain it will collect.

2430. In order *to compare the quantities of rain collected* in pluviometers at different places, the instruments should be fixed at the same heights above the ground in all such places; because, at different heights, the quantities are always different, even at the same place.

2431. *Thermometer.* As the weight of the atmosphere is measured by the barometer, so the thermometer shows the variations in the temperature of the weather; for every change of the weather is attended with a change in the temperature of the air, which a thermometer placed in the open air will point out, sometimes before any alteration is perceived in the barometer.

2432. *The scales of different thermometers* are as follows: — In Fahrenheit's the freezing point is 32 degrees, and the boiling point 212 degrees. In Reaumur's the freezing point is 0, and the boiling point 80 degrees. In the centigrade thermometer, which is generally used in France, and is the same as that of Celsius, which is the thermometer of Sweden, the freezing point is 0, and the boiling point 100 degrees. As a rule for comparing or reducing these scales, it may be stated, that 1 degree of Reaumur's scale contains 2¼ degrees of Fahrenheit, and to convert the degrees of the one to the other, the rule is to multiply by 9, divide by 84, and add 32. One degree of the centigrade scale is equal to one degree and eight tenths of Fahrenheit; and the rule here is to multiply by 9, divide by 5, and add 32. Any of these thermometers may be proved by immersing it in pounded ice for the freezing point, and in boiling water for the boiling point, and if the space between these points is equally divided, the thermometer is correct.

2433. *The study of the weather from precedent,* affords useful hints as to the character of approaching seasons. From observing *the general character of seasons* for a long period, certain general results may be deduced. On this principle, Kirwan, on comparing a number of observations taken in England from 1677 (*Trans. Ir. Acad.* v. 20.) to 1789, a period of 112 years, found:

That when there has been *no storm before or after the vernal equinox,* the ensuing summer is generally *dry,* at least five times in six.

That *when a storm happens from an easterly point,* either on the 19th, 20th, or 21st of May, the succeeding summer is generally *dry,* at least four times in five.

That when *a storm arises on the 25th, 26th, or 27th of March,* and not before, in any point, the succeeding summer is generally *dry,* four times in five.

If there be *a storm at S. W. or W. S. W.* on the 19th, 20th, 21st, or 22d of March, the succeeding summer is generally *wet,* five times in six.

In this country *winters and springs, if dry, are most commonly cold; if moist, warm:* on the contrary, dry summers and autumns are usually hot, and moist summers cold; so that, if we know the moistness or dryness of a season, we can form a tolerably accurate judgment of its temperature. In this country also, it generally rains less in March than in November, in the proportion at a medium of 7 to 12. It generally rains less in April than October, in the proportion of 1 to 2 nearly at a medium. It generally rains less in May than September; the chances that it does so are at least 4 to 3; but, when it rains plentifully in May, as 1·8 inches or more, it generally rains but little in September; and when it rains one inch, or less, in May, it rains plentifully in September.

2434. *The probabilities of particular seasons being followed by others* have been calculated by Kirwan; and although his rules chiefly relate to the climate of Ireland, yet as there exists but little difference between that island and Great Britain, in the general appearance of the seasons, we shall mention some of his conclusions.

In forty-one years there were 6 wet springs, 22 dry, and 13 variable; 20 wet summers, 16 dry, and 5 variable; 11 wet autumns, 11 dry, and 19 variable.

2435. *A season is accounted wet,* when it contains two wet months. In general, the quantity of rain, which fall in dry seasons, is less than five inches, in wet seasons more; variable seasons are those, in which there fall between 30 lbs. and 36 lbs., a pound being equal to ·157639 of an inch.

2436. *January is the coldest month* in every latitude; and July is the warmest month in all latitudes above 48 degrees: in lower latitudes, August is generally the warmest. The difference between the hottest and coldest months increases in proportion to the distance from the equator. Every habitable latitude enjoys a mean heat of 60 degrees for at least two months; which heat is necessary for the production of corn.

Sect. III. *Of the Climate of Britain.*

2437. *The climate of the British isles,* relatively to others in the same latitude, is temperate, humid, and variable. The moderation of its temperature and its humidity are owing to our being surrounded by water, which being less affected by the sun than the earth, imbibes less heat in summer, and, from its fluidity, is less easily cooled in winter. As the sea on our coast never freezes, its temperature must always be above 33° or 34°; and hence, when air from the polar regions at a much lower temperature passes over it, that air must be in some degree heated by the radiation from the water. On the other hand, in summer, the warm currents of air from the south necessarily give out part of their heat in passing over a surface so much lower in temperature. The variable nature of our climate is chiefly owing to the unequal breadths of watery surface which surround us; on one side, a channel of a few leagues in breadth; on the other, the Atlantic Ocean. The temperature of the British seas rarely descends below 53° or 54°.

2438. *The British climate varies materially within itself:* some districts are dry, as the east; others moist, as the west coast; in the northern extremity, dry, cold, and windy; in the south, warm and moist. Even in moist districts some spots are excessively dry, as part of Wigtonshire, from the influence of the Isle of Man in warding off the watery clouds of the Atlantic; and, in dry districts, some spots are moist, from the influence of high mountains in attracting and condensing clouds charged with watery vapour. The mean temperature of London equals 50° 36; that of Edinburgh equals 47° 84′; and the probable mean temperature of all Britain will equal 48°. The usual range of the barometer is within three inches. The mean annual rain is probably about 32 inches. The climate is variable, and subject to sudden alternations of heat and cold, which are supposed to render pulmonary complaints common with us: but on the whole it is healthy, and the moisture of our clouded atmosphere clothes our fields with a lasting verdure unknown to the more favoured regions of Southern Europe. (*T.*)

2439. *The deterioration of the British climate* is an idea entertained by some; but whether in regard to general regularity, temperature, moisture, or wind, the alleged changes are unsupported by satisfactory proofs. It is not improbable but the humidity of our climate, as Williams alleges (*Climate of Britain*, &c. 1816), has of late years been increased by the increase of evaporating surface, produced by the multiplicity of hedges and plantations; a surface covered with leaves being found to evaporate considerably more than a naked surface. If the humidity of the climate were greater before the drainage of morasses and the eradication of forests for agricultural purposes, a comparative return to the same state, by artificial planting and irrigation, must have a tendency to produce the same results. However, it will be long before the irrigation of lands is carried to such a degree as to produce the insalubrious effects of undrained morasses; and as to our woods and hedges, we must console ourselves with the beauty and the shelter which they produce, for the increase of vapour supposed to proceed from them.

BOOK IV.

OF THE MECHANICAL AGENTS EMPLOYED IN AGRICULTURE.

2440. Having taken a view of the vegetable and animal kingdoms, as supplying the subjects of agricultural improvement, and of the mineral kingdom, manures, and the weather, as the natural agents of their growth and culture; our next course is to examine the mechanical agents, or *implements, machines, and buildings employed in agricultural operations.* In a rude state of husbandry few implements are required besides the plough and the cart, and few buildings besides the stable and the barn. The ground is ploughed and the seed thrown in and covered with a bush; at harvest it is cut down and carted to the barn; and the three grand operations of the farmer are sowing, reaping, and threshing: but in our improved state of society, where all the science of mechanics as well as of chemistry is made to bear on agriculture, the implements, machines, and buildings become numerous, and equally so the operations. So numerous are the former, indeed, that the theoretical enquirer is often puzzled in making a selection. The whole of the most improved agriculture, however, may be, and in fact is, carried on with a very limited variety both of implements and buildings. Intricate and complicated machines are not adapted for a rustic art like agriculture, and a great variety are not required for one, the operations of which are so simple as almost to be universally understood and practised. In our enumeration we shall include a number that we do not consider of much consequence; but we shall always distinguish between the essential, and such as are comparatively objects of superfluous ingenuity and expense. We shall adopt the order of Implements of Manual Labour, Implements or Machines impelled by Quadrupeds or other Powers, Structures, and Buildings. We shall give a considerable variety, not altogether on account of their individual excellence, but to assist the mechanical reader in inventing for himself.

Chap. I.

Of the Implements of Manual Labour used in Agriculture.

2441. Though the most important implements of agriculture are drawn or put in action by beasts of labour, yet a few, which cannot be dispensed with, are used *by man alone*. These may be arranged as tools, or simple implements for performing operations on the soil; instruments for performing operations on plants or animals, or for other more delicate operations; utensils for the deportation of materials; and hand machines for various purposes.

Sect. I. *Tools used in Agriculture.*

2442. *The lever* is an inflexible straight bar of iron or wood, employed in connection with a prop or fulcrum, on which it is supported. There are three kinds, but the most common is that in which the fulcrum is between the power and the weight. Its use in the removal of large stones or other heavy bodies is well known, and the advantage of its application depends on the distance of the power from the fulcrum, and the proximity of the weight.

2443. *The pick or mattock* consists of two parts: the handle, which ought to be formed of sound ash timber or oak, such as is obtained from the root or butt end of a middle-aged tree; and the head, which should be formed of the best iron and pointed with steel. The handle ought to be perfectly cylindrical, as in using it one hand slides along it from the end next the operator towards the head. There are several varieties: the first the pick, with the ends of the head pointed, used for loosening hard ground, gravel, &c.; the second, the pick-axe, with the ends wedge-shaped in reverse positions, used in digging up trees; the third, the grubber, for grubbing up heath or small brush-wood; and there are also the road pick, and some others.

2444. *The spade* consists of two parts, the handle of ash, generally about two feet nine inches long, and the blade of plate iron. The blade consists of two parts, the plate which cuts and carries the soil, and the tread, which is a piece of strong iron fixed on the upper edge of the blade, to receive the impulse of the foot of the operator. There are several varieties: 1. with a curved outline to the extremity of the blade, by which it may be made to enter a stiff soil with less exertion on the part of the digger; 2. with a perforated blade, which in adhesive soils frees itself better from earth in the using; 3. with a sub-semicylindrical blade, which enters a stiff soil easier than the common form, is much stronger as a lever, and also frees itself well from the spitful of earth: this variety is what canal diggers chiefly use, and is called by them a grafting tool. There are other varieties and subvarieties used in draining, and for particular purposes; which will be noticed at the proper place. Elwell's spades, from the manner in which they are manufactured, for which Mr. E. has a patent, are said to be much stronger than any others.

2445. *The Flemish spade* (*fig.* 210.) has a long handle, in some cases 6 or 8 feet, but no tread for the foot of the operator. The long handle forming a very powerful lever, when the soil is easily penetrated it may be dug with greater ease with this spade than with any of the forms in common use, and carts may be

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filled with earth, and earth thrown to a greater distance by this implement for the same reason. Add to this, that in no manner of using the Flemish spade, is the operator required to stoop as much as with the English one. (*Gard. Mag.* vol. ii.)

2446. *The shovel* differs from the spade in being made with a broader and thinner blade; its use being to lift, rather than to cut and separate. There are several varieties, differing in the form and magnitude of the blade. One variety, the barn shovel, has the blade generally of wood, sometimes edged with iron.

2447. *The turf-spade* consists of a cordate or scutiform blade, joined to a handle by a kneed or bent iron shank. It is used for cutting turf from pastures, and in removing ant-hills and other inequalities. A thin section is first removed, then the protuberance of earth is taken out and the section replaced, which, cut thin, and especially on the edges, readily refits; and the operation is finished with gentle pressure by the foot, back of the spade, or roller. One variety, (*fig.* 211.) has one edge turned up, and is preferable where the turfs are to be cut square-edged and somewhat thick.

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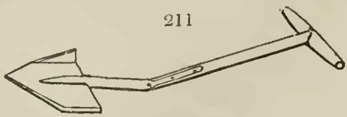
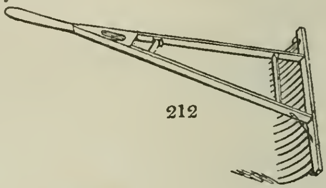


2448. *The fork* is of several kinds; the dung-fork for working in littery dung, consisting of a handle like that of the shovel, and three or more prongs instead of a blade; the hay or pitch-fork, for working with sheaves of corn or straw or hay, consisting of a long handle and two prongs; and the wooden fork, consisting of a shoot of willow, ash, or other young tree or sapling, forked at the extremity, barked and formed into a rude fork, sometimes used in hay-making and similar operations. The prongs of forks to take up loose materials should be made square; those for sheaves or more compact matters or very littery dung will work easiest when the prongs are round.

2449. *The rake* used in agriculture is of two kinds, the hay-rake and the corn-rake. Both consist of a handle and head set with teeth; in the corn-rake these are generally of iron. The garden-rake is sometimes used for covering small seeds.

2450. *The hay-rake* is usually made of willow, that it may be light and easy to work; and the teeth should be short, otherwise they are apt to pull up the stubble or roots of the grass in raking. Sometimes the teeth are made to screw into the head, and fasten with nuts, which prevents their dropping out in dry seasons.

2451. *The corn-rake* (*fig.* 212.) is of different dimensions and constructions in different counties. In general the length of the rake is about four feet; and the teeth of iron about four inches long, and set from one to two inches apart. Young (*Report of Norfolk*) mentions one of these dimensions which had two wheels of nine inches' diameter for the purpose of rendering it easier to draw: the wheels were so fixed that the teeth might be kept in any posture at the will of the holder. It was used both for hay and corn, and answered the purpose well.



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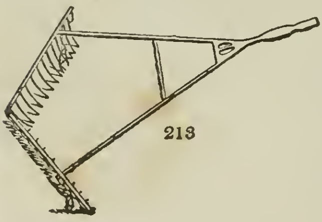
2452. *In East Lothian a corn-rake* has been tried, which, according to Somerville (*Survey*, &c.), has been found to answer much better than the common corn-rake. In this, the length of the head is from ten to fifteen feet, and the handle about seven feet, with a piece of wood across the end of it, by which it is drawn by two men. The teeth are of wood or iron; the last are the best, as well as the most durable, and are a little bent forward at the point, which gives them the power of retaining and carrying the ears along with them much better than they would otherwise do. To make clean work, especially if the ridges are rounded, the field is raked across; in that way every thing is taken up; but when it is preferred to draw the rake in the direction of the ridges, it may be considerably improved by cutting the head into two or three lengths (*fig.* 213.), and joining them with hinges, which will allow it to bend and accommodate itself to the curvature of the ridges. The advantage of this kind of rake has been found considerable, even in cases where every possible attention has been paid to the cutting of the crop.



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2453. *The stubble, or dew, rake*, is merely a coarser sort of corn rake.

2454. *The daisy-rake* (*fig.* 214.) has teeth sharpened on both edges like lancets, and is used for raking or tearing off the flower heads or buds of daisies and other plants in grass lawns.

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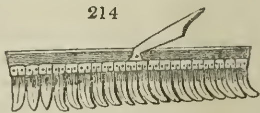
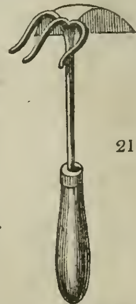


2455. *The drill rake* is a large-headed rake, in which the teeth are triangular in section, like small coulters; and they are set at six or twelve inches' distance, according to circumstances. The implement is used to draw drills across beds or ridges, for sowing field crops of small seeds or roots, such as onions, early turnips, carrots, &c., or for planting saffron or Indian corn.

2456. *The dung-drag*, or dung-hack, is a two or three-pronged implement, with a long handle, for drawing the dung out of carts in different portions. The form of the prongs should be flat.

2457. *The earth-hack* resembles a large hoe, and is used for emptying loads of earth or lime, or other pulverulent matters, in the same manner as the dung-drag is used for emptying dung; it is sometimes also used as a hoe, and for scraping and cleaning.

2458. *The hand-hoe* commonly used in agriculture is of two kinds: that with an entire, and that with a perforated, blade. The latter variety is preferable for thinning crops or destroying weeds, as it does not collect the soil and the weeds together in heaps; but where earthing up is the object, the common square blade is the best. The breadth of the blade may vary from two to twelve inches, according to the adhesiveness or looseness of the soil, or the distance to which the plants are to be thinned. An improvement for hoes to be used in stirring stiff soils, consists in forming the blade with a prong or prongs on the opposite side of the broad blade (*fig.* 215.), which can be used in very stiff places to loosen the earth, by the operator's merely altering the position of the handle. The blades of all hoes enter the soil easier when curved than when straight, the wedge in the former case being narrower.



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2459. Various *improvements in hoes* have been attempted by agriculturists. One with a triangular blade has been recommended as adapted to thin either at a greater or less distance, according to the depth it is thrust into the soil. Lord Somerville recommends the forked tool (*fig.* 215. *a.*) or heavy hoe, used in the vineyards on the Continent; but it is an implement more oppressive to the cultivator than a spade, as it requires him to stoop very low. Ducket, jun. recommends a treble hoe (*b*) for thinning; another of a different description (*c*) for making drills by drawing; one for making them by striking in a line, in order to form a trench for dung and potatoes (*f*); one for forming a drill in the common way (*e*); and, lastly, one for hoeing both sides of a drill at once (*d*). It is said that by this last tool two acres of barley may be hoed in a day, and that it makes good work among oats or wheat: but such hoeing, even on the slightest soils, can be little more than a mere scraping of the surface; and though the weeds may be cut, yet this is only one object of hoeing.

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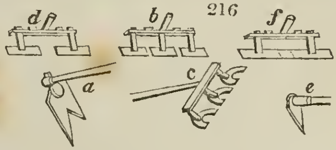

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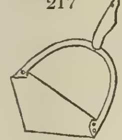

2460. *The Dutch hoe* is more frequently used in gardening than in agriculture; but, as it may sometimes be found preferable to the spade or dew-hoe, in cutting the weeds at the roots of young hedges and trees, where it is not desirable to stir the soil more than an inch deep, we shall introduce a figure of the most improved form (*fig.* 217.)

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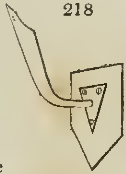

2461. *The thrust hoe* (*fig.* 218.) is an improvement on the Dutch hoe. (*Gard. Mag.* vol. i. p. 343.)

2462. *The Spanish hoe* (*fig.* 219.) may be usefully employed on some occasions in stirring the soil among potatoes, where roots and weeds are abundant. To render stooping unnecessary, it should have a long handle. (*Gard. Mag.* vol. ii. p. 65.)

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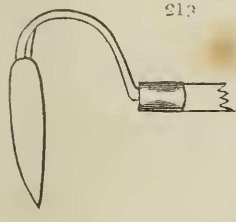

2463. *The hoe-fork* may be used as the Spanish hoe, and is most valuable where the roots of couch-grass abound. (*Gard. Mag.* vol. ii.)

2464. *The scraper* may be described as a broad hoe, of treble the usual size and strength, used in cleaning roads or court-yards, and sometimes in cleaning grassy surfaces. One with the ends of the blade turned inwards an inch or two is found more effective in scraping the mud or dust from roads.

2465. *Of weeding-tools* used in agriculture there are three or four kinds; one with a long handle and fulcrum to the blade, for digging docks and other tap-rooted plants from pastures; a common spud or spadelet for cutting smaller weeds in hedges or standing corn; a thistle-spud for cutting and rooting out thistles in pastures; besides short-handled weeders of different kinds, to be used in hand-weeding young and delicate broad-cast crops, as onions, &c. in stiff soils.

2466. *Baker's thistle extirpator* (*fig.* 220.) is an effective implement where that weed

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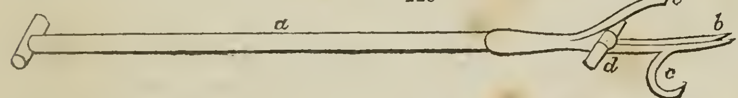

abounds. It consists of a handle about four feet six inches long (*a*), claws between which the thistle is received (*b*), a fulcrum over which the purchase is obtained for extracting the root (*c*), and an iron rod or bar upon which the foot is placed to thrust the claws into the ground (*d*). In case the root of the thistle breaks while the operator is endeavouring to extract it, there is a curved blade, which has a sharp end like a chisel (*e*), which is thrust into the ground, in order to cut off the underground stem, some inches below the surface, and thus prevent or retard the re-appearance of the weed.

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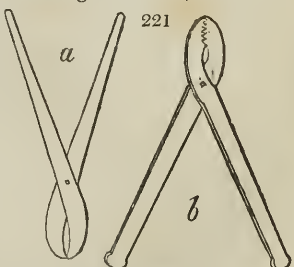

2467. *Weeding-pincers*, or *thistle-drawers* (*fig.* 221. *a*, *b*) are sometimes used for pulling thistles out of hedges and from among standing corn: the handles are about two feet six inches long, and the blades faced with plate iron made rough by cross channels or indentations. There is a variety of this implement called the Havre pincers (*b*), which is used in France both for pulling thistles and other weeds, and for taking tench and eels from the ponds. (*Thouin.*)

2468. *The besoms* used in farming are commonly small faggots with handles, formed of birch spray, for the stables and cattle-houses, and of broom, heath, straw, &c. for the barns.

2469. *The straw-rope-twister, or twisting-crook* (*fig.* 222.) is used for twisting straw ropes, and consists of a stick or rod from two to three feet long, and from one inch to

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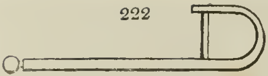
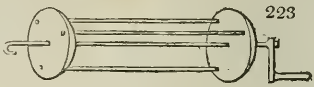


two inches in diameter, either naturally or artificially crooked. At one end is a ring, through which a cord is passed, and the implement tied to the waist; at the other is a notch, on which the commencement of the rope is made. An improved tool of this sort (*fig.* 223.) is now used by the best farmers; it is held under the left arm, and turned with the right hand.



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2470. *The potato-dibber* is exclusively used in planting potatoes in fine moulds; but drilling is a mode generally to be preferred, as providing a better bed and a closer covering to the sets.

2471. *The common dibber* used in agriculture has several teeth or dibbles proceeding from a head, which, having a handle, is pressed into the ground, and forms several holes at once, according to the number of dibbles, and these are regulated by the hardness of the soil. In strong clays the common garden dibber, shod with iron, is often used.

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2472. *The double-dibber* (*fig.* 224.) is chiefly used in Norfolk and Suffolk, for dibbling wheat; but the more enlightened agriculturists of the present day consider that the pressing plough effects the same object, that of making a firm bed for the seed, more effectually and at less expense.

2473. *Coggin's dibbling machine* consists of a box fixed on wheels, to which are attached two conical dibbling irons, and the whole is to be moved forward by the foot of the operator. (*Newton's Journal*, vol. ii. p. 88.) It appears to us much too intricate ever to come into use; nor do we see the necessity of dibbling by manual labour at all, since we have the pressing plough, which is allowed to be preferable for wheat, and various drill machines, which are at least as good as the hand dibble, for beans.

2474. *The flail* is a well known implement for beating out corn, now happily going out of use in the most improved districts, as it would go every where, were the value of the hand-threshing machine generally known.

2475. *The essential agricultural tools* are the pick, spade, shovel, dung and hay-fork, hay-rake, common hand-hoe, rope-twister, and besom.

SECT. II. *Instruments.*

2476. *The instruments used in agriculture* may be classed as the executive and the scientific; the former are used in executing, the latter chiefly in designing and laying out, operations.

SUBSECT. 1. *Instruments of Labour.*

2477. *The instruments of labour peculiar to agriculture* are few, and chiefly the scythe, reaping-hook, and hay-knife; but there are some others common to agriculture and gardening, which are occasionally used, and they also shall be enumerated.

2478. *The scythe* is of three kinds: one for cutting grass or herbage crops for hay, which consists of a thin steel blade attached at right angles to a handle of six or eight feet long; the second for cutting corn, to which what is called a cradle is attached; the third is of smaller dimensions, and is exclusively used for cutting corn; it is called the Hainault scythe.

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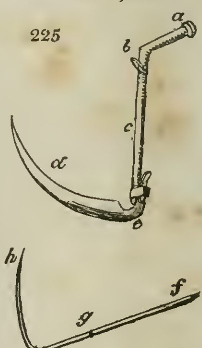
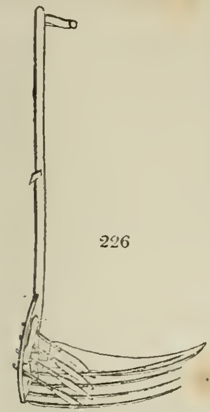


2479. *The Hainault scythe* (*fig.* 225.) has a wooden handle an inch and a quarter in diameter, and is held in the mower's right hand by the bent part (a, b) about five inches long. The straight part of the handle (c) is from 16 to 22 inches long, according to the height of the mower. There is a leathern loop (b) through which the fore finger is passed, and there is a knob (a) at the extremity, which would prevent the hand slipping off, if the loop should break, or the finger slip out of it. The blade (d) is about 2 feet long, and $2\frac{3}{4}$ inches broad at the middle. The handle is attached to the blade in such a manner as that its plane makes an angle with that of the latter, by which means the mower is able to cut a little upwards, but almost close to the ground, without stooping, while the handle inclines to the horizon about 60 or 70 degrees. The line of the crooked part of the handle (a, b), if produced, would nearly pass through the point of the blade, which thus gives the means of controlling that point; whilst the fore finger in the loop commands the heel (e). Along with the scythe a light staff (f, g), terminating in an iron hook (h), is used by the mower. With the scythe in his right hand, he holds the hook in his left by the middle, the curved part of it over the scythe in a similar position to its blade, and above it, their points being exactly over each other. In working, the mower moves both together, making the hook to pass behind the straw at about the middle of its height, to separate and press it slightly down towards the left hand, while the blade follows with a motion from right to left, to cut off the straw at from two to four inches above the ground. A great advantage of this implement is, that the operator is not required to stoop, by which his strength is less exhausted, and he is said to cut double the quantity of corn which can be cut in the same time with the reaping-hook, and with less loss of straw. The Highland Society of Scotland made extraordinary exertions to introduce this instrument among the farmers of that country, in 1825, and, through the assistance of the Chevalier Masclet, then the French consul at Edinburgh, and two young Flemings, brought over by the Highland Society, which accompanied this excellent man in a tour through the country, it succeeded in making a great many trials. The general result, as communicated in the

Society's Report of December, 1825, is, that by the use of this instrument, as compared with the sickle, in the cutting of wheat, there is a saving, at an average of the different statements given, of 26 per cent. Notwithstanding this circumstance, however, the Hainault scythe has been very little used since in Scotland, partly, no doubt, owing to the difficulty of overcoming established prejudices; partly, also, because any workman whose frame has been accustomed to use one description of instrument, must begin by undergoing a good deal of bodily suffering and loss of labour before he can so far master another, so very different as the Hainault scythe is from the sickle, as to do the same quantity of work with the one as with the other; but principally, we suspect, because the instrument has, if any, no great advantage over the scythe hook. Young persons alone are to be expected to learn the use of difficult instruments, and bring them finally into general reputation. The editor of the Highland Society's *Transactions*, in speaking of this Report (vol. vii. p. 249.), says that, considering its favourable nature, "a somewhat different result might have been anticipated than has really occurred. But, although three years have elapsed since these experiments with the Hainault scythe were made, the instrument itself has nowhere come into general use. That it is an important and useful mode of reaping cannot be reasonably disputed; but we ought not, perhaps, to anticipate any important change in harvest-work until that great era (we hope not very remote) when the acquisition of a horse-machine, applicable to all ordinary circumstances, shall secure our crops, and sweep every prejudice before it." Still, as there will always be small farmers and cottagers who cannot afford to have reaping machines, we think it highly desirable that the Hainault scythe should have further trials, and we earnestly recommend it to our friends in America and Australia.



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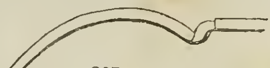
2480. *The cradle-scythe* is variously constructed: sometimes the cradle or receptacle into which the corn is gathered is of net-work (*fig.* 226.), and at other times it consists of woven laths or wicker-work. (See § 405.)

2481. *The reaping-hook* is a curved blade of steel, fixed in a short wooden handle; it is of two kinds; one serrated like a fine saw, which is used in cutting corn by handfuls, and is called a sickle hook; the other smooth and sharp like a scythe, which is used to hack the corn over in the peculiar manner called bagging, and is called a cutting hook. The most improved form (*fig.* 227.) has a kneed handle.



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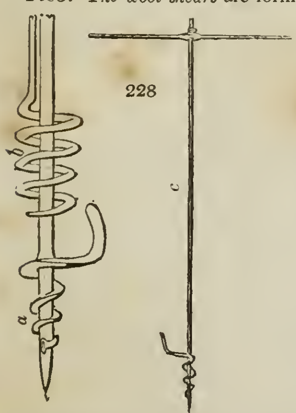
2482. *The smooth reaping-hook*, or, as it is called in East Lothian, the scythe-hook, was first introduced into the West and South-west of Scotland, probably from Ireland, and has now spread over most of the Lowlands. It is considered much preferable to the common reaping-hook in our best corn counties. (See *Farm. Mag.*, vol. xxiii. p. 55.) Where the crop is very thin and short, it requires some attention to make clean work, and in such cases the teethed hook, or Hutton's improved reaping-hook, may do it better; but, upon all ordinary good and strong crops, the scythe-hook is by far the better implement, the reaper, with equal ease to himself, cutting down a third or fourth more than with the old teethed hook. The impression of some of the best Scotch farmers is, that a labourer will do as much work with it as with the Hainault scythe, and cut the straw almost if not altogether as close to the ground.

2483. *Hutton's improved reaping-hook* is serrated from the point through half its length like a sickle, and the remainder is smooth and sharp. The advantage is, that the straws are not cut in entering the hook, as is the case where the point is of the cutting kind, by which means fewer drop and are lost. With sickles reapers invariably make cleaner work than with the hooks for the above reason; with hooks the straws are cut with less labour. (*Trans. Soc. Arts*, vol. xxviii.)

2484. *The hay-knife* consists of a straight blade, set at right angles to a short wooden handle; both of considerable strength. It is used for cutting hay or straw when consolidated in the rick or stack. An improvement of this instrument has been proposed, which consists in forming the blade like that of a common spade, sharp at the edges, by which the operator will cut downwards instead of obliquely, and not being obliged to stoop, will effect the same work with far less trouble.

2485. *The wool-shears* are formed wholly of iron or steel, and worked with one hand.



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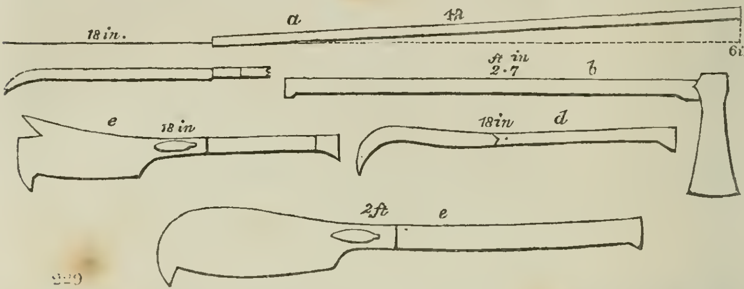
2486. *The hedge-shears* are of different kinds; that called the averruncator is to be preferred for cutting off large shoots, as it makes a clean draw-cut like a knife. Shears, however, are not used in dressing hedges by the best agriculturists.

2487. *The thatching-knife* consists of a blade similar to that of a scythe, inserted in a wooden handle like that of a reaping-hook. For thatching with reeds, heath, or any rough and rigid thatch, the blade has a handle affixed to each end to enable the operator to work it with both hands.

2488. *The stack-borer* consists of two parts, a cutting screw or blade (*fig.* 228. *a*), and a drawing screw (*b*). Both are worked by cross handles in the usual manner (*c*). In using this instrument, which is of great importance where hay has acquired a dangerous degree of heat, first cut away the loose hay where the borer is intended to be applied, therein insert the point of the borer, and by means of the cross handle turn it round till the stack is pierced either quite through, or to a sufficient depth; then withdraw the cutter, and, by means of the drawing screw repeatedly applied, take out the plug of hay which has been detached. If, however, the hay be in a moist, heating state, it will occasionally coil round the cutter in proportion as it is pierced, and impede its action. In such cases, the drawing screw must be slipped over the rod of the cutter, and must be applied from time to time, to draw out the hay, in proportion as it is detached from the mass. (*Newton's Journal*, vol. v. p. 308.)

2489. *The hedge-bill* is of various kinds. The scimitar (*fig.* 229. *a*) has a handle four



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feet long, bent a little out of the direction of the blade in order to admit the free action of the operator's arm while standing by the side of a hedge and cutting upwards. The axe (*b*) is used for cutting strong boughs or small trees; the bill-hook (*c*) for faggoting, and stopping gaps in hedges; the dress-hook (*d*) for cutting the twigs in very young hedges, and for dressing faggots; and the bill-hook (*e*) for lopping branches close at hand. A chisel with a handle eight or ten feet long is used for cutting off branches eighteen or twenty feet from the operator, and is of considerable use in pruning forest trees in plantations or hedges, and also fruit trees in orchards.

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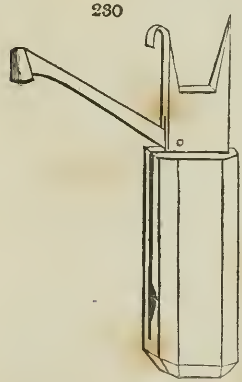

2490. *The axe, saw, wedges and hammers*, of different kinds and sizes, are used in agriculture, in felling trees, cutting them up, preparing fuel, driving nails, &c.; but these and other instruments common to various arts need not be described.

2491. *The scorer* (*fig.* 230.) is a well known instrument used by woodmen in marking numbers on timber trees.

2492. *The line and reel* is occasionally wanted for the manual operations of agriculture, and should be procured rather stronger and with a longer line than those used in gardens.

2493. *The potato set scoop* is of two kinds; one a hollow semiglobe, (*fig.* 231. *a*), and the other (*b*) a section of that figure. They are only used when potatoes are very scarce, as in ordinary cases the larger the set the more strength and rapidity of growth in the young plant.

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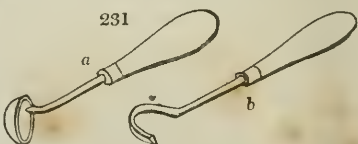

2494. *The Edinburgh potato-scoop* (*fig.* 232.) is by far the best, and indeed the only one deserving of use. The handle (*a*) has a round stem which passes through a piece of metal (*d*), and has there a semicircular knife or cutter (*c*) fixed to it. This cutter is sharp on both edges, and turns on a pivot fitted in a piece of brass formed out of a piece of plate (*b*, *c*). This plate forms a shield to hold the instrument firm upon the potato, by placing the thumb of the left hand upon it, and pressing the point in which the cutter is fixed into the tuber. Then by turning the handle half round with the right hand, the semicircular knife cuts out a set, which is a segment of a small sphere (*e*, *f*, *g*). The only attention necessary in the use of this instrument is, to place it upon the potato, with the eye or bud in the centre of the diameter of the semicircle of the knife when laid flat on the tuber. The advantages of this scoop, besides that it is very quick in its operation, is that the pieces being all exactly of one size, that is about an inch in diameter, may be planted by a bean-harrow or drill machine, with much less labour and more accuracy than by the hand.

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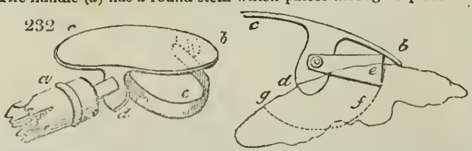

2495. *The essential instruments of labour* are the scythe, reaping-hook, hay-knife, wool-shears, hedge-bill, axe, saw, hammer, and line and reel.

Subsect. 2. *Instruments of Science.*

2496. *Scientific instruments* are not much required in agriculture; the principal are for levelling, boring, and measuring.

2497. *The level* is frequently required in agriculture, for arranging surfaces for irrigation, tracing strata in order to cut off springs, well-making, and a variety of other purposes. The simplest form is the common road or mason's level, and the most complete the spirit level, with a telescope and compass, such as is used by land-surveyors; but when operations of only moderate extent are to be performed, very convenient and economical substitutes, and if used with care, equally accurate instruments, may be found in Parker's level, the road or common level, water level, the triangular and the square level.

2498. *Parker's level* (*fig.* 233.) consists of two cylindrical receivers of about five eighths of an inch in interior diameter, and full three inches high each, for holding quicksilver, fixed at right angles upon a wooden stand, and about eighteen inches asunder. A small groove is cut lengthwise in the stand, and closely covered over, through which channel a communication is effected between the two cylinders; and consequently the surfaces of the quicksilver in the cylinders must be on a level with each other. The two floats are equal to each other as to weight and length, and the surfaces (about five eighths of an inch in diameter) which rest on the quicksilver in each cylinder; and consequently the tops of the floats must also be on a level with each other. The different parts of the level are closely fitted, and the whole rendered portable by screwing up the floats into the caps of their respective cylinders. About three minute grooves are cut in the lower, or hemispherical ends of the floats, through which the quicksilver rises upon a slight pressure of the floats, and falls back again under the floats as soon as the pressure is taken off. The tops of the cylinders are a little concave, for saving any particles of quicksilver which may lodge in the screws, when the instrument has been shaken in the carriage. Constructed and sold by Mr. Appleton of Drury Lane, London, turner: price 14*s*. each; staff with cords and pulleys, 8*s*., and three legs five feet high, 4*s*.

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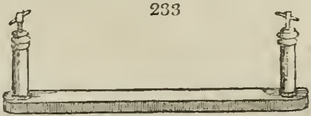

2499. *The common level* (*fig.* 234.) is in general use among masons and bricklayers, and for the purposes of road-making and irrigation it is furnished with plates of iron with adjusting screws, for the purpose of determining the slopes of surfaces.

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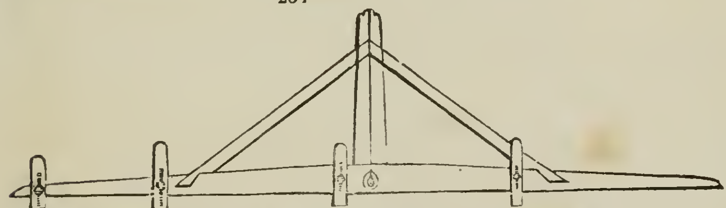
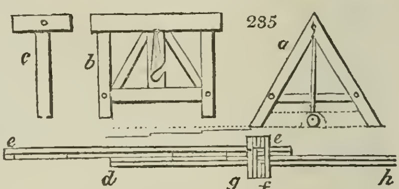


2500. *The water-level* is that which shows the horizontal line by means of a surface of water or other fluid; founded on this principle, that water always places itself level or horizontal. The most simple level of this kind is made of a long wooden trough or canal, which being equally filled with water, its surface shows the line of level. It is also made with two cups, fitted to the two ends of a straight tube, about an inch in diameter, and three or four feet long, by means of which the water communicates from the one cup to the other, and this pipe being movable on its stand by means of a ball and socket, when the two cups shew equally full of water, their two surfaces mark the line of level. It may also be made with two short cylinders of glass, three or four inches long, fastened at each extremity of the pipe with wax or mastic. The pipe is filled with common or coloured water, which shows itself through the cylinders, by means of which the line of level is determined; the height of the water with respect to the centre of the earth being always the same in both cylinders. This level is very simple and commodious for levelling small distances.

2501. *The American or triangular level* (*fig.* 235. *a*) is formed of two pieces of thin wood joined by a cross bar, the whole in the form of the letter A. The manner of using it is simply thus: At the place from which the level is to be taken, drive a wooden peg into the ground, close in to the top, upon which one of the legs of the frame or A may rest; then bringing round the other leg till it touch the ground, there drive in a second peg, turning round the other leg as before; and where it touches the ground again, drive in another peg, and so on along the whole line to be levelled. Thus, with very little trouble, and with as much accuracy as with the finest spirit-level, may the course of a drain be easily ascertained. But as it is necessary that a drain should have sufficient declivity to allow the water to run freely, it will be requisite, in taking the level, to regulate the direction of the line accordingly. Half an inch fall, in the length of the frame, will be sufficient. For this purpose, it will be expedient to have, besides a number of wooden pegs, one iron pin with inches and halves marked regularly upon the sides of it from the top downwards. After having driven in the first wooden peg at the point whence you mean to conduct the drain, and having rested the one leg of the frame upon it, turn round the other till it be level with the first peg; there put in the iron pin, so that this leg of the frame may rest on the top of it, when level; then drive in a wooden peg so far as that the top of it may be half an inch lower than that of the iron pin. Place the leg of the frame again upon this second peg, turn it round to a level, putting in the iron pin till the top of it be equal with the foot of the frame; then drive in another wooden peg close by the side of it, till the top of the wooden one be half an inch lower than that of the iron pin. Proceed in this manner as far as you mean to carry the drain, which will have the same degree of declivity all the way along. When made on a smaller scale, it is useful in ascertaining the proper descent along the bottom of a drain, while the workmen are laying it; but when made for this purpose, the cross-bar must be fixed to the bottom of the legs, so that the A becomes a Δ, or delta.

2502. *The square level* (*fig.* 235. *b*), is made of several pieces; the usual length generally five feet and a half, and the height four feet, or four feet and a half. It may be either used like the water level, or the American level. According to Marshal, it has been found "preferable to any level now in use, as being equally accurate in ascertaining the relative heights of distant objects, as in minutely tracing step by step the required line of communication, so as to give every part of it an equal and uniform descent."

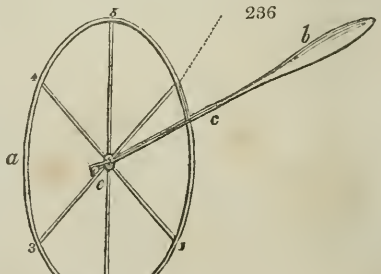


2503. *The object staff* (*fig.* 235. *c*) is used with the water or square level: for either it should be exactly of the same height as the level; the cross piece at top should be a foot or more in length, and three inches broad, painted white on one side for opposing to dark objects, and black on the other for opposing to such as are white.

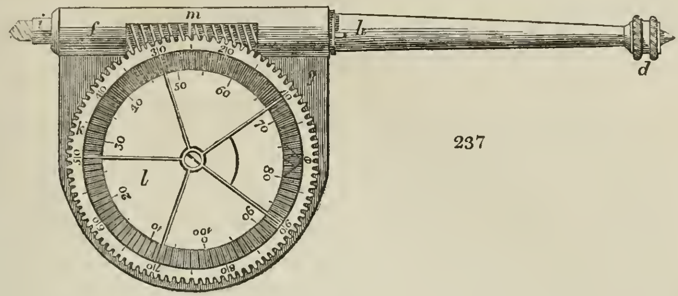
2504. *The levelling staff* is composed of two pieces (*fig.* 235. *d*, *h*, and *e*, *e*), which slide on each other: they are each of about five feet in length, so as to form, when fully extended, a rod of ten feet. They have a line of feet graduated into hundredth parts. The index (*f*) slides firmly on them; and is moved up or down (by signal) by the attendant who carries the staff, till the observer finds it coincide with the intersecting wires of his telescope. Its height on the staff, of course, marks the difference of the level. It has two horizontal and parallel black stripes, which at considerable distances are of use to direct the eye more readily to the fiducial edge (*g*).

2505. *The measuring-chain, measuring-rod, pocket-rule,* poles for setting out straight lines, stakes for driving in at fixed points, and a variety of other instruments, and their appendages, are occasionally required by the agriculturist who lays out estates, or effects territorial improvements: but these, not being strictly agricultural implements, do not require to be described.

2506. *The odometer* (*odos*, a way, and *metreō*, to measure) is a very ingenious instrument, invented in 1821 by Mr. Hunter, of Thurston in Scotland, who has given the following description of it to the Highland Society. The wheel *a* (*fig.* 236.) is made of light iron, and measures two yards in circumference, being divided by six spokes into feet. One spoke must be painted white. The handle is divided at *c*, like a fork, and embraces each end of the axis by its elasticity. Through the axis is a hole into which the end *h* of the way-wiser fits, and is held fast by a nut *d*. The way-wiser (*fig.* 237.) consists of a frame *f g*; *f* being hollow to receive a perpetual screw *h*, a part of which is visible near the index *m*. At the other end of the screw is a nut *i*, which keeps it in its place. The screw turns two brass concentric cogged wheels *k* and *l*; *k* conceals the scale of *l*, except where a piece is cut out, leaving an index at the beginning of the scale of *k*, and which in the drawing points to 78 of *l*. The scale of *k* is numbered towards the left, and that of *l* to the right. The wheel *k* has 100 cogs or teeth, and *l* 101; consequently, as the same endless screw turns both wheels, it is evident, that when *k* has made a complete revolution of 100 teeth, *l* will also have made a revolution of 100 teeth; and the index of *k* will point to 1 of *l*, because *l* has 101 teeth. After a second revolution it will point to 2, and so on; the number



it points to marking the number of revolutions; each revolution showing 100 turns of the iron wheel *a*. Accordingly, *a* measures 6 feet, or 1 turn; *k* 100 times 6 feet, or 600 feet, or 1 revolution; and *l* 101 times 600 feet, or 60,600 feet, equal to nearly 11½ English miles, the range of the instrument: 88 turns of this wheel make a mile. It is advisable always to commence with the way-wiser set at 0 or zero; to do this, take out the screw in the centre, when the brass wheels *k* and *l* can both be set at zero, and the screw replaced. Set the wheel *a* upon the ground with the white spoke undermost, and fix the way-wiser into the wheel by means of the nut *d*, always observing to put it on the left side, as shown in the plate at *c*. At any period of measuring you can tell exactly how far you have gone, and proceed without again setting the way-wiser at 0. Suppose, as in the figure, the spoke No. 2 at the ground, the index *m* pointing at 26 of *k*, and the index of *k* pointing at 78 of *l*; then the distance measured is 7826 turns of *a* and two feet; and as *a* measures two yards, 7826 × 2 = 151652 yards, to which add the two feet. In reading off, particular care must be taken always to read the large figures (viz. those on the wheel *l*) first, and afterwards to add the small figures (viz. those on the wheel *k*); and, if the figures on *k* amount to less than 10, a 0 must be prefixed, so that *k* shall always show two figures; for instance, *l* being at 46 and *k* at 4, the sum is 4604. The easiest way to guard against error is to read 46 and add the word hun-



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dred; thus, forty-six hundred and four, and not four thousand six hundred and four. It is hardly necessary to point out the advantage of having such an instrument. No country gentleman, who takes the smallest charge of his own affairs, should be without one; as, by merely walking from one end to the other of any road, hedge, wall, ditch, &c. with the odometer (which is not more troublesome than a walking stick), he can tell the length of it much more correctly than by a measuring chain, which, to say the least of it, requires two honest men, one at each end, and who must be both paid for their trouble; whereas the gentleman himself, whose honesty cannot be doubted, as he is not likely to cheat himself, can, at no expense, measure with this instrument at least four times as quickly as those with the chain, who have it also in their power to mismeasure, if I may use the expression, six inches every time a peg is put into the ground; but its principal uses are to check measurements already made, and to measure off the size of any proposed improvements, such as plantations, gardens, &c. (*Trans. H. Soc.*, vol. vi. p. 603.)

2507. *Good's improved instruments for boring* the earth for water, draining, and other purposes, may now be considered as having superseded all others, and we shall shortly describe them.

2508. *The auger* (*fig.* 238. *a*) is to be connected by the screw-head to the length of rods by which the boring is carried on. This auger is for boring in soft clay or sand; it is cylindrical, and has a slit or opening from end to end, and a bit or cutting-piece at bottom. When the earth is loose, or wet, an auger of the same form is to be employed, but with the slit or opening reduced in width, or even without a slit or opening. A similar auger is used for cutting through chalk, but the point or bit at bottom should then project lower, and for that purpose some of these cylindrical augers are made with moveable bits, to be attached by screws, which is extremely desirable in grinding them to cutting edges.

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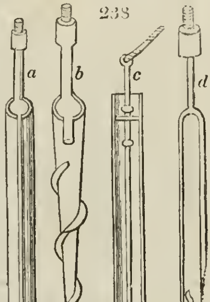

2509. *The hollow conical auger* (*b*), for boring loose sandy soils, has a spiral cutting edge coiled round it, which, as it turns, causes the loose soil to ascend up the inclined plane and deposit itself in the hollow within.

2510. *The hollow cylinder or tube* (*c*), with a foot valve, and a bucket to be raised by a rod or cord attached at top, is a pumping tool for the purpose of getting up water and sand that would not rise by the auger. When this cylinder is lowered to the bottom of the bore, the bucket is lifted up by the rod and cord, and descends again by its own gravity, having a valve in the bucket, opening upwards like other lift pumps, which at every stroke raises a quantity of water and sand in the cylinder equal to the stroke, the ascent and descent of the bucket being limited by a guide-piece at the top of the cylinder, and two small nobs upon the rod, which stop against the cross-guide.

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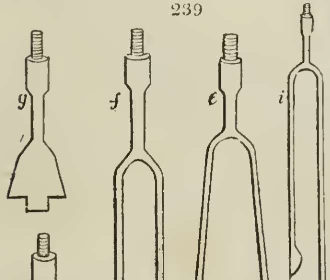

2511. *The tool for getting up broken rods* (*d*) consists of a rod with a small cylindrical piece at bottom, which the broken rod slips through when it is lowered, and a small catch with a knife-edge, acted upon by a back-spring. In rising, the tool takes hold of the broken rod, and thereby enables the workmen at top to draw it up.

2512. *Another tool for the same purpose* (*fig.* 239. *e*) is like a pair of tongs; it is intended to be slidden down the bore, in order that the broken rod may pass between the two catches, which, pressed by back springs, will, when drawn up, take fast hold of the broken rod.

2513. *The tool for widening the hole* (*f*) is to be connected, like all the others, to the end of the length of rods passed down the bore; this tool has two cutting pieces extending on the sides at bottom, by which, as the tool is turned round in the bore, the earth is pulled away.

2514. *The chisel or punch-pipe* (*g*) has a projecting piece to be used for penetrating through stone. This chisel is by rising and falling made to peck the stone and pulverise it, the small middle part breaking it away first, and afterwards the broad part coming into action. Another chisel, or punching-tool (*h*), is twisted on its cutting edge, and is used for breaking away a greater portion of the stone.

2515. *A lifting tool* (*i*) is used when it happens that an auger breaks in the hole. On one side of this tool a curved piece is attached, for the purpose of a guide to conduct it past the cylindrical auger;

and at the end of the other side is a hook, which taking hold of the bottom edge of the auger enables it to be drawn up.

2516. *The triangular claw* (*fig.* 240. *k*) is used when loose stones lie at the bottom of the hole, which are too large to be brought up by the cylindrical auger, and cannot be conveniently broken. The internal notches of this instrument take hold of the stone, and as the tool rises it brings them up. For raising broken rods a tool (*l*) is sometimes employed, which has an angular claw that slips under the shoulder of the rod, and holds it fast while drawing up. (*Newton's Journal*, vol. viii. p. 247.)

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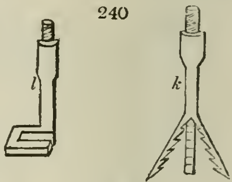

2517. Other tools connected with the subject of boring for water, also invented by Mr. Good, will be described when the operation of boring is treated of, in Part III. Book III. Chap. III. (See Contents.)

2518. *Busby's borer for quicksand* (*fig.* 241.) consists of a tube called a sludger, from five to six feet in length, made of plate iron, with a valve at its lower extremity, made partly of iron and partly of leather, which works upon an iron hinge, and a hole at the top (*a*) through which it is emptied. In boring through quicksands a metal pipe is inserted into the borehole, and the sand is withdrawn from it by the sludger, which, by means of the valve at its lower end, acts as a pump. A second metal pipe is added to the first, and so on to any depth. (*Trans. High. Soc.* vol. vi. p. 611.)

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2519. *The peat-borer* (*fig.* 242.) is a larger sort of borer, employed in peaty soils that are boggy, for the purpose of removing wetness. It has been used with advantage in some peat-mosses in Lancashire, by Eccleston.

2520. *The blasting auger, timber measure,* and other scientific instruments, not in general use in agriculture, will be best described in treating of the departments in which they are applied.

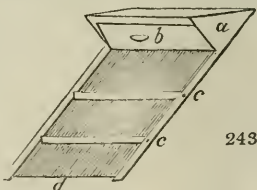
2521. *The only essential scientific instrument* is the common level, which may be wanted to level drains and water furrows, adjust the surface of roads, &c.

Sect. III. *Utensils used in Agriculture.*

2522. *The principal agricultural utensils* are sieves, baskets, corn-measures, and sacks.

2523. *Sieves* are textures of basketwork, wire, gut, or hair, stretched on a broad wooden hoop. Sometimes, also, they are formed of skins or plate iron pierced with holes, and so stretched. They are used for separating corn, or other seed, from dust or other extraneous matters. There are different varieties for wheat, beans, oats, rape-seed, &c.

2524. *The corn-screen* (*fig.* 243.) consists of a hopper (*a*), with a sliding board (*b*) for giving more or less feed; slips of wood (*c c*) fixed on pivots to prevent the grain from passing too quickly down; and the screen, which is composed of parallel wires (*d*).



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2525. *Baskets* are made of wickerwork, of different shapes, but generally forming some section of a globose figure: they vary much in size; those in most general use in agriculture are from twenty inches to two feet in diameter, and are used for carrying roots, chaff, cut straw, &c., from one place to another in the farmery. A very good substitute for a basket for filling sacks (*fig.* 244.), formed of iron, is in use in Nottinghamshire, Lincolnshire, and other counties. (*Gard. Mag.* vol. v. p. 674.)

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2526. *The seed-carrier or seed-basket* (*fig.* 245.) is sometimes made of thin veneers of wood, bent into an irregular oval, with a hollow to fit the seedsman's side, and a strap to pass over his head, and rest on his shoulder. In some places, a linen bag of a shape adapted to be borne by the right shoulder, and to suspend the seed under the left arm, is used for the same purpose.

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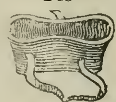

2527. *The feeding tub or trough* may be of any shape and size; it is used for giving short or liquid food to swine, sheep, and other live stock.

2528. *The pail* is used for carrying water, or other liquid food.

2529. *The turnip tray* is a shallow movable trough or box, used to prevent waste when sheep are fed upon turnips.

2530. *The corn bin, or corn chest,* for containing oats or other grain for horses, may be an oblong box of any convenient size. Sometimes it is placed in the loft over the stable, and the corn is drawn out by a hopper below; but for a farm stable this is needless trouble: there it is commonly placed in the broad passage behind the horses, or in any spare corner. It should be stout, and have good hinges, and a safe lock and key.

2531. *The flexible tube,* for relieving cattle that are hoven or choked, consists of a strong leathern tube about four feet long and about half an inch in diameter, with a leaden nozzle pierced with holes at the insertion end. It should be kept in every farmery. There is a similar one, on a smaller scale, for sheep, which should be kept by all shepherds. Both will be found figured and described in Part III. Book VII.

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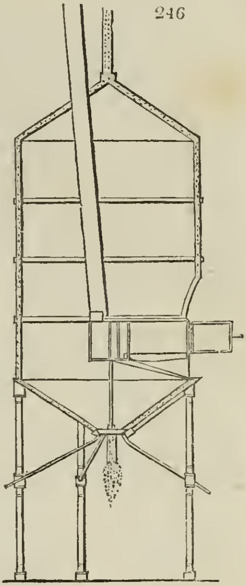


2532. *Jones's kiln-drying apparatus* (*fig.* 246. section) consists of two concentric cylinders about six feet in diameter, and is from the bottom to the top of its cones twelve feet high. The outer cylinder may either be perforated with small holes, or made of wire gauze. In the centre of the inner cylinder are a fire-place and chimney. The grain to be dried is admitted between the cylinders through a hopper at top, and distributing itself round the internal cone, it is discharged through a spout into a sack or receiver. In passing the grain becomes heated, and the moisture evaporates, and passes off through the perforations of the exterior cylinder. (*Newton's Journal,* vol. vii. p. 214.)

2533. *Corn measures* consist of the lippie, peck, and bushel, with the strike or rolling pin to pass over the surface, and determine their fulness. The local measures of every country are numerous; the imperial bushel is now the standard corn-measure of the three kingdoms.

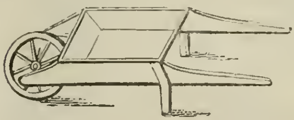
2534. *Corn sack or bags* are strong hempen bags, calculated to hold four bushels; and in Scotland four firlots.

2535. *Other utensils,* as those of the dairy, poultry, and cider-house, will be described in their appropriate places.

2536. *The essential agricultural utensils* are the sieve, basket, seed-carrier, tub, pail, corn chest, flexible tube, corn measure, and corn sack.

Sect. IV. *Hand Machines used in Agriculture.*

2537. *Agricultural hand machines* are generally portable; some are exclusively put in action by man, as the wheel-barrow; and others, as the straw-cutter, sometimes by horses, water, or other powers.



2538. *The common ladder* is the simplest of manual machines, and is in constant use for forming and thatching ricks, and for other purposes; with or without the use of trestles and scaffolding.

2539. *The wheel-barrow* is of three kinds: — the new ground work barrow (*fig.* 247.) used in moving earth or stones; the dung barrow (*fig.* 248.) for the farmyard; and the corn barrow (*fig.* 249.) for conveying corn from the stackyard to the barn. The body of the latter (*b*) may be made to separate from the frame and wheel, and by means of levers (*a*) to be carried like the hand-barrow.

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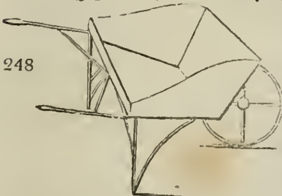

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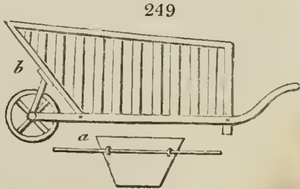

2540. *Barrows for hay and straw* may be variously constructed, and near towns (*figs.* 250, 251.) may be used for wheeling light packages.

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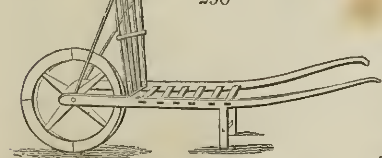

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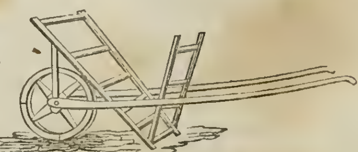

2541. *The sack-barrow* is a two-handed lever of the first kind, the fulcrum of which is a pair of low wheels: it is a convenient machine for moving sacks in a granary or barn floor, from one point to another.

2542. *The Normandy wheel-barrow* (*fig.* 252.) is said to be exceedingly useful on a farm. The handles or trams (*a a*) are nearly fifteen feet in length, by which, when loaded, nearly all the weight is thrown on the axle, so that the man has almost nothing to carry, and has only to push. He is thus saved from being bent down while at work, and consequently from acquiring a habit of stooping. A shoulder strap (*b*) is commonly used by the operator. (*Morel Vindé, and Gard. Mag.* vol. vi.)

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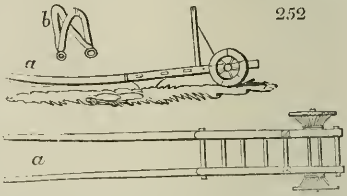

2543. *The truck* (*fig.* 253.) is a machine of the barrow kind for conveying compact heavy weights, such as stones, metals, &c.

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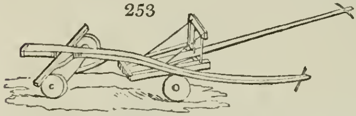

2544. *The hand-barrow* is of different kinds (*figs.* 254, 255, 256.), and is in frequent use in various departments of agriculture, where the soil is soft, or the surface uneven. Its bottom should be close and strong for carrying stones; but may be light and open for dung or corn.

2545. *The winnowing machine*, originally introduced from Holland to East Lothian by Mr. James Meikle of Saltoun, father to Mr. Andrew Meikle, the inventor of the threshing machine (799.), is in use for cleaning corn in most of the improved districts. There are different forms, but the best are those founded on the Meikle or Berwickshire winnower, which, instead of one screen, has a set of sieves put in motion by the machine, by which means the corn comes out, in most cases, ready to be meted up in sacks. A highly-improved form of this machine, and the most perfect, we believe, at present in use (*fig.* 257.) is manufactured by Weir and Co. of London.

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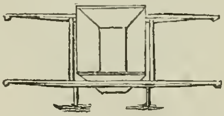

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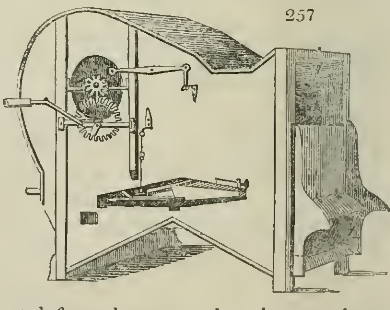

2546. *The hand threshing-machine* (*fig.* 258.) is worked by two men and one woman, and is sometimes used for threshing the corn of a small farm, or for threshing clover or other small seeds. The advantage consists chiefly in the completeness in which the grain is separated from the straw; there is no saving of human labour, unless the power of horses or water is applied.

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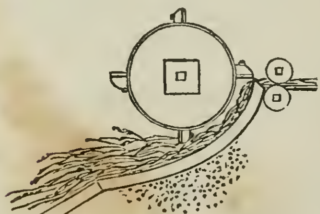

2547. *The potato cleaner* is a hollow or perforated cylinder or barrel, with a wooden axle through its long diameter, and a handle at one end, by which it is turned like a barrel churn. A hinged board forms an opening for putting in and taking out the potatoes, which fastens with an iron hasp and staple. It is filled one third with potatoes or other roots, and then placed in a cistern of water, by means of a crane or otherwise. In this state, being two thirds immersed in the water, and one third full of potatoes, it is turned round a few times, when the latter are found cleaned, and the barrel is lifted out by the crane, emptied, filled, and replaced.

2548. *A locomotive steam threshing-machine*, capable of propelling itself and a man, has been constructed in the county of Northumberland. It is intended for the small farmers, as it can be moved from one farm to another, and thus enable them to thresh out their corn expeditiously and perfectly clean. The steam engine is not intended to be confined to threshing, as, by particular arrangements, it may be applied to the drawing of waggons, pumping of water, breaking of stones, &c.

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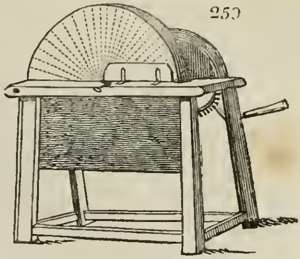

2549. *The maize-sheller* (*fig.* 259.) is composed of a thin vertical wheel covered with iron on one side, made rough by punctures; which wheel works in a trough, and separates the grains from the stalks by rubbing. The ears or spikes of corn are thrown in by hand one at a time; and while the separated grains pass through a funnel below, the naked stalk is brought up at the end of the wheel opposite to that at which it was put in. The wheel may either be made rough on both sides, or on one side, according to the quantity of work required to be done, and the force to be applied.

2550. *Mariott's improved maize separator* (*fig.* 260.) is the most perfect machine of this kind at present in use; it has not hitherto been much used in England, but a good many have been exported to America and the colonies. A machine for the same purpose, by Cobbett, will be figured and described in Part III. Book VI.

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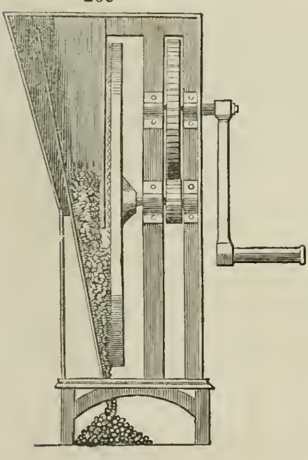

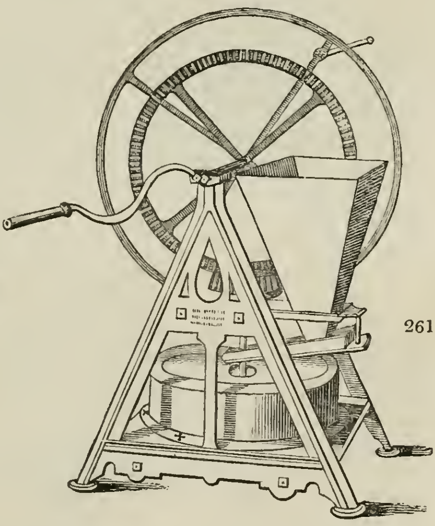

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2551. *A hand flour-mill* (*fig.* 261.), for grinding Indian corn, consists of one wheel and pinion, a fixed French burstone, and a similar stone in motion over it. The corn passes through a hopper in the usual manner, and comes out from the stones fit for the bolting machine. The hand flour-mill is chiefly used for Indian corn; but it will also grind wheat and other corns into meals of tolerable fineness. It requires two men to work it, and the price in London is from ten to sixteen guineas.

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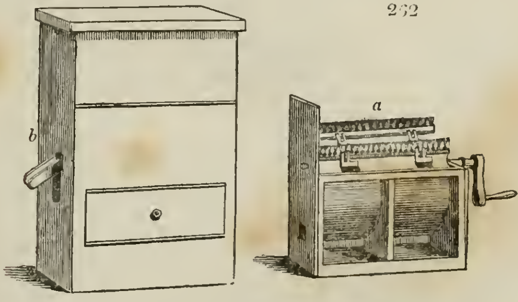
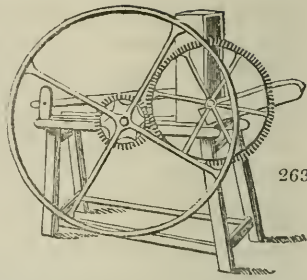


2552. *A hand bolting-machine* (*fig.* 262.), consists of a half cylinder of wire with cross brushes (*a*), enclosed in a box (*b*) about four feet long by twenty inches on the sides. It may be considered a necessary appendage to the hand flour-mill, and costs in London from three to five guineas.

2553. *The furze-bruiser* (*fig.* 263.) is an ingenious and most useful machine where furze is either grown or found naturally. The shoots are bruised and cut into short lengths by hammers which operate like those in the mills for hammering iron. When the material is not sufficiently bruised, it is afterwards passed between rollers.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2554. *The bone-breaking machine* (*fig.* 264.) consists of two rollers grooved and indented, and with pinions on their ends, by which they may be moved either by animals, water, or steam power. The surfaces of the rollers are filled with indentations and strong teeth, which penetrate and break the bones to pieces. This is accomplished by employing separate cast-iron wheels placed side by side upon an axis, to compose the rollers; the wheels have coarse teeth similar to those of a saw or ratchet wheel; each wheel of the lower roller is an inch thick; and they are placed at distances of an inch and a half asunder, having circles of hard wood or iron placed between them, which are two inches less in diameter. The bones should be supplied rather gradually to the machine at first, to avoid choking it, and the rollers should then be adjusted to a considerable distance asunder; but when the bones have once passed through in this way, the rollers are screwed closer by screws placed for that purpose, and the fragments ground a second time. The pinions (*a a*) must have deep cogs to enable them to take deep hold of each other, when the rollers are set only half an inch distant to grind fine, and without the cogs being liable to slip when the centres are separated so far as to leave a space of one inch or one inch and a quarter between the rollers, for the passage of the large bones the first time. The rollers will act most effectually, if the different wheels are fixed upon their axles in such a position that the teeth will not correspond or form lines parallel to the axes, and then no piece of bone can escape without being broken by some of the teeth. The bones which have passed through the rollers slide down an inclined board, and collect at the bottom in a

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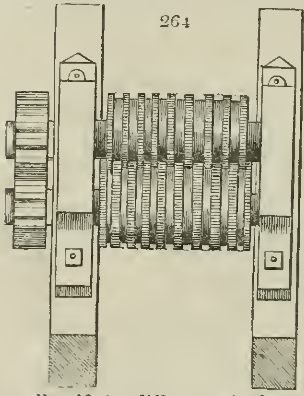

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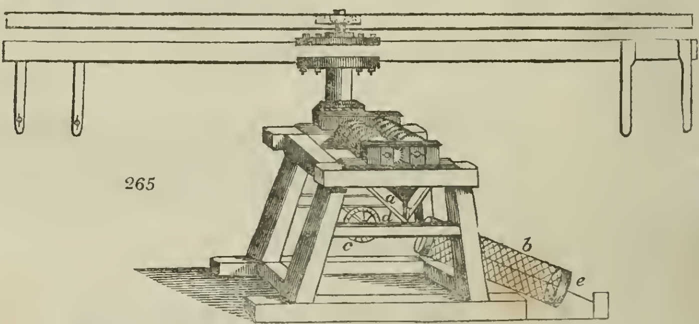

large heap. When all the stock of bones are thus coarsely broken, a labourer takes them up in a shovel and throws them again to the hopper to be ground a second time. (*Supp. to Encyc. Brit. Art. Agr.*) In a modification of this machine to be impelled by horse power, manufactured by Weir of London (*fig.* 265.), the bones, after passing through the rollers, are conducted by the hopper (*a*) into a revolving screen (*b*), which is driven by a bevel wheel (*c*) working into a pinion on the screen shaft (*d*, *e*).

2555. *The oil-cake bruiser* is composed of two rollers ground and toothed like the rollers of the bone-mill, but it is on a smaller scale so as to be worked by one man. The object is to bruise the oil-cake to a dust or powder. Below the rollers is a screen for separating the grosser pieces which are set apart for feeding cattle, and the finer material or dust is reserved for sheep or for manure. Price in London from 8 to 11 guineas.

2556. *A stone-breaking machine impelled by steam* may be constructed of two fluted rollers, placed side by side, about an inch apart, and turning different ways. The stones are put into a kind of hopper above, and pushed down with a rake, affording a regular supply to the roller. It is worked by one of Kay and Routledge's rotatory engines, of one-horse power, and will completely break a ton of hard pebbles in about six or eight minutes. (*Newton's Journal*, vol. vi. p. 152.)

2557. *The root-breaker or bruiser* (*fig.* 266.) is composed of two widely fluted rollers, placed under a hopper, turned by two men. It is used for breaking or bruising potatoes, turnips, carrots, or other raw roots, into small or moderate sized pieces, before giving them to cattle or horses. The same implement may be set so close by means of two screws, as to serve for a whin-bruiser, or for breaking beans or corn of any kind.

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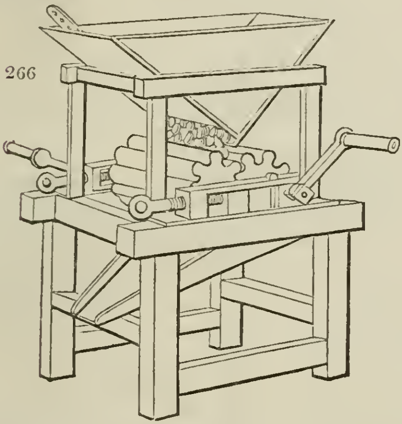

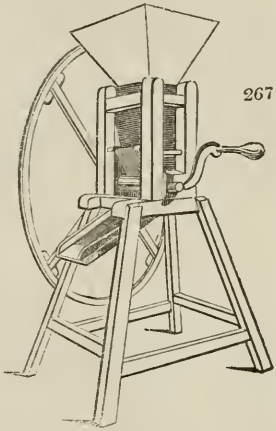

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2558. *The corn-bruising machine* (*fig.* 267.) is contrived for the purpose of bruising or kibbling different sorts of grain, pulse, &c. as well as grinding malt. It is a simple implement, constructed with two iron rollers of different diameters, turned true on their axles or spindles, each roller having a cog or tooth wheel. A roller with grooves is fixed under the hopper, to receive the grain from the hopper, and lay it on the two rollers. To one of the rollers is fixed a fly-wheel. The machine is made to be worked by hand, or any other power. The upper wood frame is made to slide, and is regulated by a screw, according to the size of the grain, and will bruise it more or less as may be required.

2559. *The potato flour-mill* (*fig.* 268.) consists of a cylinder (*a*) covered with tin-plates pierced with holes, so as to leave a rough surface, in the same manner as the graters used for nutmegs, &c., but the holes in this are larger. This cylinder is situate beneath a hopper (*b*), into which the potatoes are thrown, and thence admitted into a kind of trough (*c*), when they are forced against the cylinder, which, as it revolves, grinds the potatoes to a pulp. Motion is given to the machine by a handle fixed upon the end of the axis of the grating cylinder (*a*), and on the opposite extremity of this axis is a fly-wheel (*d*) to regulate and equalise the movement. The potatoes, when put into the hopper, press by their weight upon the top of the cylinder, and, as it revolves, they

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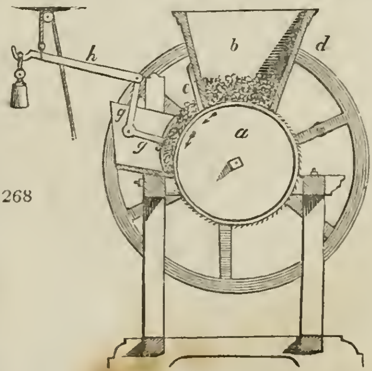

are in part grated away. On one side of the lower part of the hopper is an opening, closed or opened more or less, at pleasure, by a slider (*e*); and the degree of opening which this has, regulates the passage of the potatoes from the hopper into the trough (*c*). This is as wide as the length of the cylinder, and has a concave board (*f*) fitted into it, which slides backwards and forwards by the action of levers (g), fixed to an axis extended across the frame of the machine: a lever (h) is fixed upon this axis, causing a weight which acts upon the board (f) by means of the levers, to force or press forward the potatoes contained in the trough (c) against the cylinder, and complete the grating of them into a pulp. The tin-plate covering the cylinder is of course pierced from the inside outwards, and the bur or rough edge, left round each hole, forms an excellent rasping surface.

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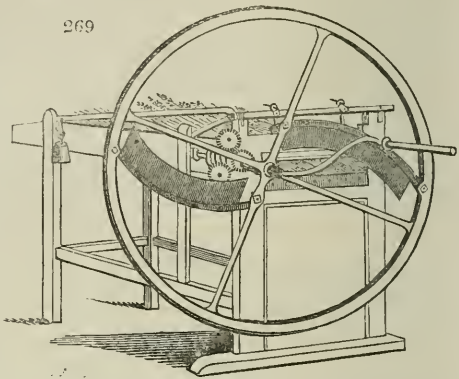

2560. *The chaff-cutter* is used for cutting hay or straw into fragments not larger than chaff, to facilitate its consumption by cattle. There are numerous forms; one of the best is that of Weir (*fig.* 269.), which is so formed, that in case of its being accidentally broken, it may be repaired by any common mechanic. The pressure of the straw is also capable of being regulated with great facility.

2561. *The hay-binding machine* is an invention by Beckway for weighing and binding straw or hay. (*fig.* 272.) It is a very ingenious apparatus, and may be useful to retail farmers in the neighbourhood of large towns. The apparatus, with every implement necessary to be used in cutting, weighing, and binding, may be packed together so as to form a wheel-barrow. (*fig.* 270.) When unpacked (*fig.* 272.), the wheel is taken out, and the bottom of the barrow (a) turned upside down upon the ground as a platform. (*fig.* 271.) The standard (b), is then set up in the sockets of the underside of the barrow. The frame (c) is then unfolded, and the axis of the steelyard or scalebeam (d), placed upon the standard as a fulcrum, supporting the frame (c) at the short end, and at the long end the counterpoising weight is suspended by a chain, and adjusted to the graduations upon the steelyard agreeably to the quantity of hay to be weighed. The bed of the frame (c) is then fastened down to the platform by means of the lever which held the wheel in the barrow. Two haybands are then placed between the hooks (e e), and extended along the bed of the frame (c). The truss of hay is then laid upon the bed of the frame (c), as shown by dotted lines, and the lever or latch underneath withdrawn, so as to allow the scale-beam to oscillate. The proper quantity or weight of hay being adjusted, the truss is bound round with the haybands, which were placed under it. This truss being removed, the same process is followed in weighing and binding every other truss, which is done without the smallest delay or inconvenience; when the whole quantity required is bound up, the apparatus is dismounted and packed together in five minutes, as *fig.* 270. The respective implements, such as the knife, fork, pin, and every part of the machine, fitting together upon the barrow so as to secure the whole, are bound round by the chain and weight, and tightly packed for conveyance. (*Newton's Journal.* vol. i. p. 136.)

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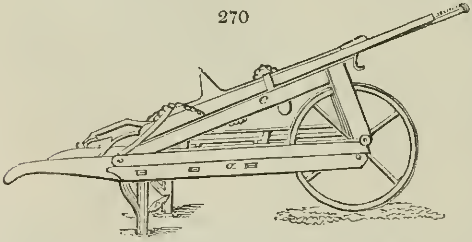

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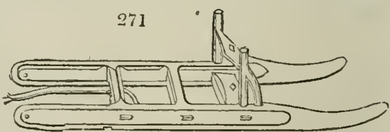

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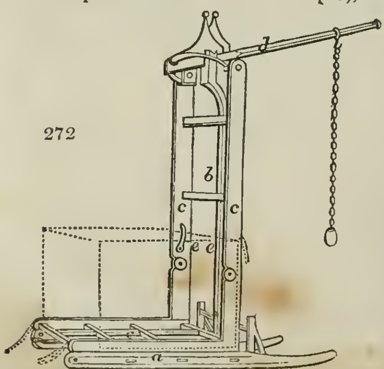

2562. *The rope-twisting machine* (*fig.* 273.), is a small wheel, the prolonged axle or spindle of which terminates in a hook, on which the rope is commenced. It is commonly fixed to a portable stand; but is sometimes attached to a threshing-machine. It is used for twisting ropes of straw, hay, or rushes, for tying on the thatch of ricks, and other similar purposes. It is also used to form very thick ropes for forming straw drains.

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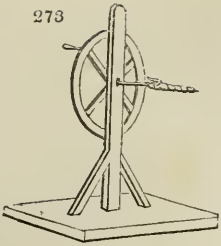

2563. *The draught-machine*, or dynamometer, is a contrivance invented for the purpose of ascertaining the force or power of draught, in drawing ploughs, &c. Finlayson's (*fig.* 274.) is reckoned one of the best varieties for agricultural purposes.

2564. *More's draught-machine* is a spring coiled within a cylindrical case, having a dial-plate marked with numbers like that of a clock, and so contrived that a hand moves with the motion of the spring, and points to the numbers in proportion as the force is exerted: for instance, when the draught equals one cwt. over a pulley, the hand points to figure 1; when the draught is equal to two cwt. it points to figure 2, and so on. Till this very useful machine was invented, it was exceedingly difficult to compare the draught of different ploughs, as there was no rule to judge by, but the exertions of the horses as apparent to the eye; a very undecisive mode of ascertaining their force.

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2565. *Braby's draught-machine* (*fig.* 275.), consists of two strong steel plates, joined at the ends, and forming a spheroidal opening between them. In using it, one end (*a*) is hooked on the muzzle of the plough or other implement, and to the other (*b*) the draught trees are attached. An indicator (*c*) points out the power applied, in cwts. It is evident that Braby's machine and Finlayson's act on the same principle, and that the latter, being more simple in the construction, must be a more accurate indicator, and less liable to go out of order.

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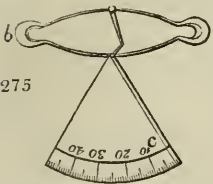

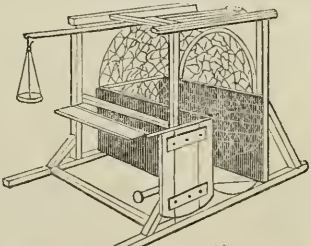

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2566. *The weighing-cage* (*fig.* 276.) is a contrivance made in the form of a sort of open box or cage, by which any small animal, as a pig, sheep, calf, &c. may be very easily and expeditiously weighed, and with sufficient accuracy for the farmer's purpose. It is constructed on the principle of the common steelyard, with a strong wooden frame and steel centres, in which the pivots of the lever are hung; and upon the short side of the lever is suspended a coop, surrounded by strong network, in which the animal intended to be weighed is placed. The point of suspension is connected with the coop by means of two curved iron rods, which at the same time form the head of it; a common scale being hung on the longer side of the lever.

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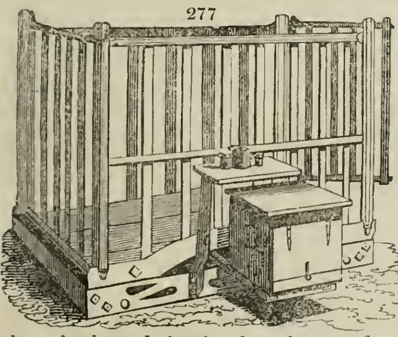
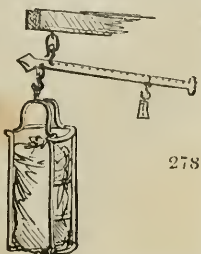


2567. *The cattle-weighing machine* is a contrivance of the steelyard kind, for the purpose of weighing cattle and other animals alive. A machine of this sort is of importance in the grazing and fattening systems, where they are carried to any considerable extent, in ascertaining the progress made by the animals, and showing how they pay for the use of any particular kind of food, or what power it has in promoting the fattening process. Weir's variety (*fig.* 277.) is by far the simplest and most economical of these machines.

2568. *The weighing-machine for sacks* (*fig.* 278.) is a convenient piece of barn-furniture on the steelyard principle, and so common as to require no description.



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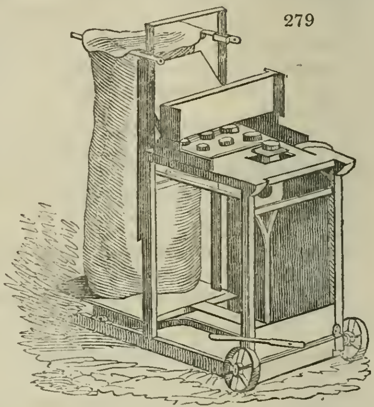
2569. *A potato-weighing machine* (*fig.* 279.), of a very complete description, has been invented by Mr. John Smith, of Edinburgh, and is figured in the *Highland Society's Transactions*, vol. vii. pl. iii. It is on the principle of the steelyard, and chiefly intended for weighing grain, flour, potatoes, or any other commodity usually put into a bag for carriage or keep. The machine is portable, of easy use, and not liable to go out of order.



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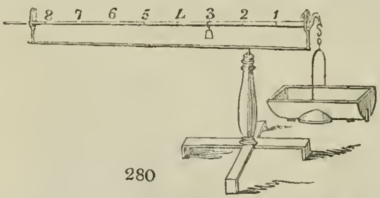
2570. *Ruthven's farmer's steelyard* (*fig.* 280.) is well adapted for weighing and readily discharging bulky commodities. It consists of a longer and shorter beam, with a moveable weight, to be shifted along the former, and a scale suspended to the latter. The longer arm, from its extremity, being confined within a limited range, obviates the inconvenience of jerks and long vibrations, while an index upon it points out the required weight, by a counterpoise being slid backwards and forwards, till the point has been found when it acts as an equivalent. By turning a keeper fixed to the scale, one end of it is opened, turning on a cylindrical hinge at the top, and the contents speedily discharged. These balances may be made of any size required, either to suit the purposes of the farm, or the household. Their simplicity secures them equally against expense of manufacture, and the risk of going wrong when in use. One weight only is required, the value of which, as a counterpoise, depends on its distance from the centre of motion; and it is so confined upon the long arm, that, though it has a perfectly free motion over all its length, it cannot escape at either extremity, and consequently can never be lost, which is a great recommendation to the instrument. The simple manner in which one of the ends of the tin-plate scale opens up round a wire hinge is also very ingenious, and no less calculated to render the steelyard useful when weighing flour, grain, seeds, and such commodities. (*High. S. Trans.*)



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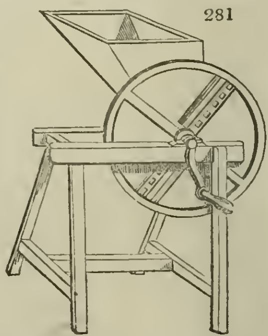
2571. *The turnip-slicer* is of different forms; the old machine works by hand, like a straw-cutter of the original construction; but a better one consists of a hopper and knives, fixed upon a fly wheel. (*fig.* 281.) The turnips press against the knife by their own weight, and a man turning the wheel will cut a bushel in a minute. Gardener's turnip-slicer is a highly improved form of this machine.



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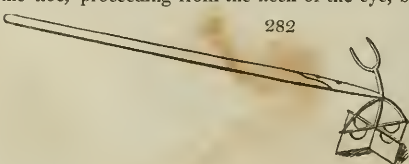
2572. *The turnip-chopper* (*fig.* 282.) is perhaps a more useful implement than the turnip-slicer. It is first made like the common nine-inch garden hoe, forming an oblong square, with an eye to receive the handle, and from the centre of the first hoe, another hoe crosses it at right angles. On the reverse is a two-pronged fork, for the purpose of pulling up the turnips. The turnip being pulled out of the ground by the prongs, or the angles of the hoe, is immediately struck with it about the centre, which divides it into four; and if these four pieces are not small enough, the stroke is repeated upon each of the pieces until they are sufficiently reduced. The two stoutish prongs on the back or reverse part of the hoe, proceeding from the neck of the eye, besides their use in pulling up the turnips with expedition, increase the weight of the hoe, which is in its favour, by lessening the force necessary to split the roots.



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2573. Of *hand-drilling and dibbling machines*, and especially of the former, there are a great many kinds, of various degrees of merit. The sort to be recommended in any particular case will depend on the texture of the soil; one which would answer w ll in a soft soil or sand might not succeed in a stony or loamy soil. As the fashions of drills are continually changing, we advise intending purchasers to describe their soil and kind of culture, as whether raised or flat drilling, &c., to a respectable implement-maker, and try the kind he recommends. In the mean time we submit a few of the established forms.

2574. *The bean or potato dibbling machine* (*fig.* 283.) consists of a single wheel, set with dibber points, which may be placed wider or closer at pleasure. It is pushed along by one man, and succeeds on friable soils, but cannot be depended on when the surface is rough or tenacious. Potato sets to be planted after this machine should be cut with the improved scoop (2494.).

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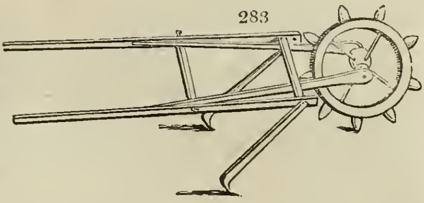

2575. *The common hand drill-barrow* (*fig.* 284.) consists of a frame and wheel somewhat similar to that of a common barrow, with a hopper attached to contain the seed. It is used for the purpose of sowing horse-beans, turnips, and similar seeds, upon small ridges. In using it, the labourer for the most part wheels it before him, the seed being afterwards covered by means of a slight harrow, or sometimes by a shallow furrow.

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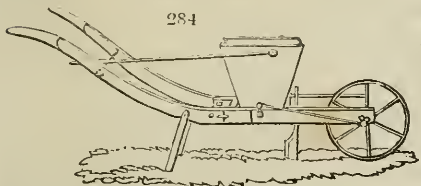

2576. *The broadcast hand-drill* (*fig.* 285.) is chiefly used for sowing clover or other small seeds, with or without grass seeds. The operation, however, is much more frequently performed by hand. Broadcast sowing by machinery drawn by horses or cattle, however, may be advantageously adopted on farms of the largest size, and where the soil is uniform in surface, in moisture, and in richness.

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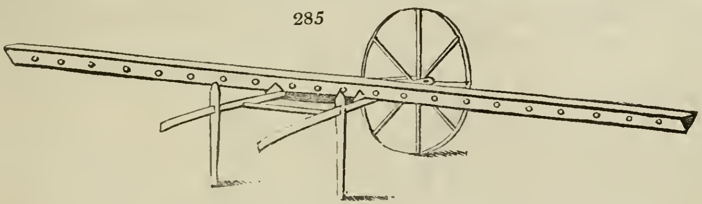

2577. *Coggins's dibbling-machine* (*fig.* 286.) was invented in 1827, and appears very ingeniously contrived. The Mechanism is to be worked by the foot of the operator. The machine runs on wheels, and there are two conical dibbling irons, one larger than the other. These are ranged in a line with the delivering funnel of the drill, and at such distances apart as may be considered proper for discharging the seeds. A hopper (*a*) contains the seed, and such earthy materials as bone dust, or other manure in powder, as may be found necessary to deposit with the seed. There is a funnel (*b*) through which the seeds and manure are passed; and the conical dibbling iron (*c*) is worked by a handle (*d*). This dibbling iron and its handle are connected by two levers, of which the lower (*e*) hangs to the axle of the principal running wheel, and has at its front extremity a small cone (*f*), intended as a marker. There is an upper lever (*g*) which works the axle (*h*) of the cylinder, within

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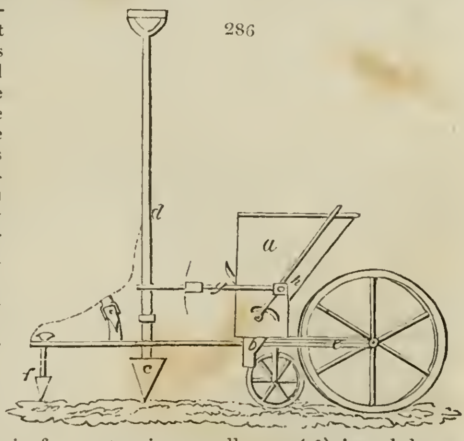

the hopper which delivers the seed. The foot of the operator is strapped to the lever, and by its pressure forces the dibbling iron into the ground. The inventor says that two machines may be used at the same time by the same man, one foot being strapped to each. (*Newton's Journal*, vol. ii. new series, p. 89.)

2578. *The turnip barrow-drill* sows a single row at a time; but is of difficult management on the tops of ridges: for this purpose, it is desirable to have two wheels, one to go on each side of the ridge. An improved variety of this machine (*fig.* 287.) has a barrel of water (*a*) attached, which, by means of a tube, is dropped among the seed in the tract made by the coulter. This very useful appendage may be added to any drill-machine, whether worked by manual or animal labour.

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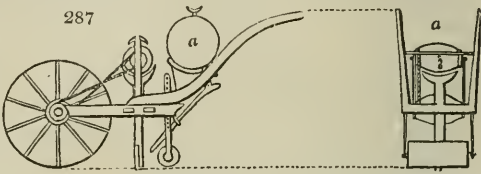

2579. *The hand turnip-roller* (*fig.* 288.) is used for rolling raised drills or ridges previously to and after sowing turnip-seed by a hand-drill. The use of such a roller leaves the ridges in a much better form for receiving the seed than a common cylindrical roller; and after the seed is sown, when this roller is again used, the surface is left in the fittest state for retaining moisture, and for commencing the hoeing and thinning operations.

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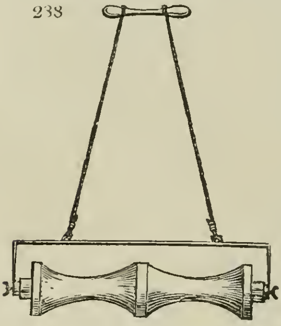

2580. *Doxat's machine for assisting human power* (*fig.* 289.) consists in a certain arrangement of levers and pulleys, by means of which the weight as well as muscular strength of the labourer is intended to be brought into action, and hence to render his necessary exertions less laborious and fatiguing. Supposing the apparatus as applied to a pump; then (*a*) and (*b*) will represent two levers, their fulcrums or pivots being in the standard (*c c*). These levers are connected together by a cord or chain (*d d*) passing over a pulley (*e*). To the lever (*a*) the cord (*f*) is attached, which is also connected to the upper lever (*g*); this upper lever moving upon a fulcrum in the standard (*c*), works the pump rod (*h*). In order to put this apparatus in action, a man is to be seated on a transverse bar or rail (*i*), shown by dots near the end of the lever (*a*). The feet of this man are to rest upon the bottom lever (*b*), and by his alternately sitting upon the lever (*a*), and standing upon the lever (*b*), they are by the chain or cord (*d*) brought into the situation shown by the dotted lines; and hence the lever (*g*) is raised and lowered for the purpose of working the pump. A weight is placed upon the lever (*a*), and made to slide, for the purpose of regulating the machinery and balancing the weight of the water or other matter raised. By these means it is evident, that a man can exert a greater power, in proportion to the fatigue occasioned, than would be effected by the usual methods, such as turning a winch or moving a lever with the arms, &c. (*Newton's Journal*, vol. iii. p. 77.)

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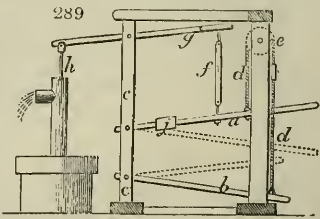

2581. *Other machines for particular departments*, will be noticed in their proper places and some will be wanted which are not peculiar to agriculture, such as rat-traps (*figs.* 290. and 291.), mouse and mole-traps (*fig.* 292.), a fowling piece for shooting birds, scares for deterring birds, and similar contrivances.

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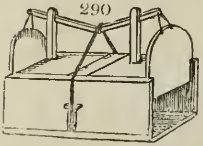

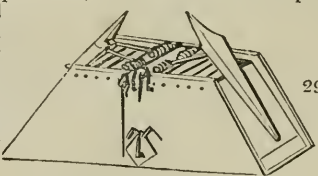

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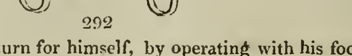

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2582. *The grindstone* (*fig.* 293.) is a hand-machine that cannot be dispensed with in a farmery. The most improved sort has a cast-iron frame, which any person wishing to grind an instrument on may turn for himself, by operating with his foot on a treadle (*a*). This frame can be adjusted to a small or a large grindstone, or altered as the stone wears out, by the construction of the support for the gudgeon (*b*); a loose shield of sheet-iron (*c*) is used to protect the operator from the water thrown off by the wheel when in motion. (*Gard. Mag.* vol. v.)

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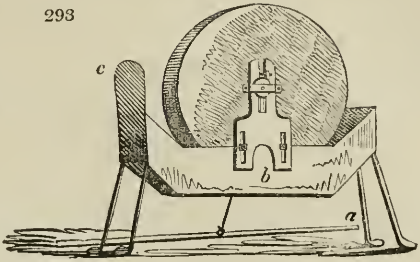

2583. *The essential hand-machines* are the ladder, wheel and hand-barrows, winnowing machine, chaff-cutter, and turnip barrow-drill.

Chap. II.

Of Agricultural Implements and Machines drawn by Beasts of Labour.

2584. *The fundamental implements of agriculture* are the plough, the harrow, and the cart: these are common to every country in the slightest degree civilised; sufficiently rude in construction in most countries, and only very lately brought to a high degree of perfection in Britain. Dr. Anderson (*Recreations in Agriculture, &c.*), writing in 1802, observes, "that there are no sorts of implements that admit of greater improvement than those of husbandry, on the principle of diminishing weight without in any degree abating their strength." Since that very recent period, great improvements have taken place in almost every agricultural implement, from the plough to the threshing-machine; and though these have not yet found their way into general use, especially in England, they may be procured at the public manufactories of the capitals of the three kingdoms with no trouble. It is incredible what benefits would result to agriculture if proper ploughs and threshing-machines were generally adopted; and if the scuffler or cultivator, of which Wilkie's seems to be the most improved form, were applied in suitable soils, and under proper circumstances; not to mention one and two horse carts, improved harrows, and the best winnowing machines. But the ignorance and antipathy to innovation of the majority of farmers in almost every country, the backwardness of labourers to learn new practices, and the expense of the implements, are drawbacks which necessarily require time to overcome. It may also be observed, that, in the progress of improvement, many innovations which have been made have turned out of no account, or even worse than useless; and this being observed by the sagacious countryman confirms him in his rooted aversion from novelty and change. — In our selection, we shall pass over a great variety of forms, the knowledge of which we consider of no use, unless it were to guard against them, and shall chiefly confine ourselves to such as are in use at the present time by the best farmers of the best cultivated districts. These we shall arrange as tillage implements, sowing and planting implements, reaping machines, threshing machines, and machines of deportation.

Sect. I. *Tillage Implements and Machines.*

2585. *The tillage implements* of agriculture comprise ploughs with and without wheels, and pronged implements of various descriptions, as grubbers, cultivators, harrows, rollers, &c. We shall take them in the order of swing ploughs, wheel ploughs, pronged implements, harrows, rollers, &c.

Subsect. 1. *Swing Ploughs, or such as are constructed without Wheels.*

2586. *The plough,* being the fundamental implement of agriculture, is common to all ages and countries, and its primitive form is almost every where the same. The forms used by the Greeks and Romans (see Part I. Book I. Chap. 1 and 2.) seem to have spread over Europe, and undergone no change till probably about the 16th century, when they began to be improved by the Dutch and Flemish. In the 17th century the plough underwent further improvement in England; and it was greatly improved in that following, in Scotland. There are now a great variety of excellent forms, the best of which, for general purposes, is universally allowed to be what is called in England the Scotch plough, and in Scotland the *improved Scotch plough.* In speaking of the implement we shall adopt the latter term, because the *unimproved Scotch plough* differs little from some old forms of the implement common to Europe from the time of the Romans. As the operation of ploughing, like many other operations in practical husbandry, must often vary in the manner of its being performed, it is evident that no one particular sort of plough can be superior to all others, in every season, and under every variety of soil or inclination of surface. The Scotch plough, however, and the variations of which it is susceptible, render it by far the most universal tillage implement hitherto invented or used.

2587. *Ploughs are of two kinds:* those fitted up with wheels, and called *wheel ploughs;* and those without wheels, called *swing ploughs.* The latter are the lightest of draught, but require an experienced and attentive ploughman to use them; the former work with greater steadiness, and require much less skill in the manager: some sorts, indeed, do not require holding at all, excepting at entering in, and turning on and off the work at the ends of the ridges. On the whole, taking ploughmen as they are, and ploughs as they are generally constructed, it will be found, that a district ploughed with wheel ploughs will show greater neatness of work than one ploughed with swing ploughs: but, on the other hand, taking a district where the improved form of swing ploughs is generally adopted, the ploughmen will be found superior workmen, and the work performed in a better manner, and with less expense of labour, than in the case of wheel ploughs. Northumberland in this respect may be compared with Warwickshire.

2588. In *the construction of ploughs,* whatever be the sort used, there are a few general principles that ought invariably to be attended to; such as the giving the throat and breast, or that part which enters, perforates, and breaks up the ground, that sort of long, narrow, clean, tapering, sharpened form that affords the least resistance in passing through the land; and to the mould-board, that kind of hollowed-out and twisted form, which not only tends to lessen friction, but also to contribute greatly to the perfect turning over of the furrow-slice. The beam and muzzle should likewise be so contrived, as that the moving power, or team, may be attached in the most advantageous line of draught. This is particularly necessary where a number of animals are employed together, in order that the draught of the whole may coincide.

2589. *The construction of an improved Scotch swing plough* is thus given mathematically by Bailey of Chillingham, in his *Essay on the Construction of the Plough on Mathematical Principles,* 1795. It had been previously aimed at by Small of Berwickshire, and subsequently by Vetch of Inchbonney, near Jedburgh, (*Highland Soc. Trans.* vol. iv. p. 243.), and more recently and completely in the *Quarterly Journal of Agriculture* for February, 1829. Whoever wishes thoroughly to understand the construction of the plough, and the principles of its operation, are recommended to the last-mentioned very excellent paper, which is too long to be given here, and which would lose half its value by being abridged.

2590. *Land, when properly ploughed,* Bailey observes, must be removed from a horizontal position, and twisted over to a certain angle, so that it may be left in that inclining state, one furrow leaning upon another, till the whole field be completely ploughed. The depth and width of the furrows which is most approved of by farmers, and commonly to be met with in the best-ploughed fields, are in the proportion of two to three; or, if the furrow be two deep, it must be three wide, and left at an angle of 45 to 46 degrees.

2591. *Various forms* have been given to the different parts of the plough, by ingenious persons, according to their different fancies, in order to diminish the weight of the draught, and to turn over the furrow, and leave it in its proper position, without tearing or breaking it.

2592. To have *the line of draught* at right angles to the horses' shoulders is of great importance in the formation of a plough; a circumstance of which the greatest part of the plough-makers are totally ignorant, although it is well known to every one that has the least knowledge of mechanics. If we take the angle that the horses' shoulders make with a perpendicular from the horizon, and continue another line at right angles to it, or parallel to the draught chain; the length of this line from the horse's shoulders to where it meets or crosses the coulter, at half the depth of the furrow, will be thirteen feet two inches for ordinary sized horses.

2593. *Length of beam.* If the plough be properly made, the line of draught should pass through the middle hole of the plough bridle at the point of the beam. This requires the beam to be seven feet long, to give it a proper height at the bridle.

2594. *Left side plane.* That part of the plough next the solid land should be made a perfect plane, and, run parallel to the line of draught; whereas some of the common ploughs are completely twisted in that part, and deviate more than two inches from the line of draught; this throws the plough to the left, and causes the hinder part of the mould-board to press hard against the furrow, and crush and break it, besides increasing the labour of the cattle.

2595. *The position of the coulter* must not deviate much from an angle of 45 degrees:

for, if we make it more oblique, it causes the plough to choke up with stubble and grass roots, by throwing them up against the beam; and, if less oblique, it is apt to drive the stones or other obstacles before it, and make it heavier to draw.

2596. *The mould-board*, for all free soils, and for working fallows, is generally most effective when it has a considerable concavity; but for breaking up clover leys, pasture, or any firm surface, and also for clayey soils, it is found to clean itself better and make neater work when it approaches nearer to a plane, and in very stiff clays, is formed with a concave surface. The lower edge of the mould-board, on the most improved forms, is in a separate piece, which, when it wears, can be taken off and renewed. The technical name of this slip of iron is *the wearing piece*.

2597. *The materials* with which ploughs are constructed is, generally, wood for the beam and handles, cast-iron for the head, side-plates, mould-board, and sole, and wrought iron for the share, coulter, and muzzle. But of late years, in consequence of the dearness of timber, and the cheapness of iron, they have been constructed wholly of the latter material, and with considerable advantage in point of strength and durability, and some also in point of convenience. Among the conveniences may be mentioned, the facility which they afford of bending the left handle to the right of the straight line (see *fig.* 293. *a*), first introduced by Mr. Wilkie of Uddingston, (who, if not the inventor, may certainly be considered the greatest improver of iron ploughs,) by which means the ploughman is permitted to walk with ease in the bottom of the furrow. The stilts or handles may also be joined to the body of the plough, in such a way as to admit of taking off and packing for a foreign country, or raising or lowering the points of the handles according to the size of the ploughman, as in Weatherley's plough.

2598. Of *swing ploughs*, by far the best is the implement known in England as *the Scotch plough*. It is almost the only plough used in Scotland, and throughout a considerable part of England; it is drawn with less power than wheel ploughs, at least, those of the old construction, the friction not being so great; and it probably admits of greater variations in regard to the breadth and depth of the furrow-slice. It is usually drawn by two horses abreast in common tillage; but for ploughing between the rows of the drill culture, a smaller one drawn by one horse is commonly employed. A plough of the swing kind, having a mould-board on each side, is also used both in forming narrow ridges for turnips and potatoes, and in laying up the earth to the roots of the plants, after the intervals have been cleaned and pulverised by the horse and hand-hoe. This plough is sometimes made in such a manner, that the mould-board may be shifted from one side to the other when working on hilly grounds; by which means the furrows are all laid in the same direction. This will be found described as the *turn-wrest* plough.

2599. *Swing ploughs, similar to the Scotch plough*, have been long known in England. In Blythe's *Improver Improved* (edit. 1652), we have engravings of several ploughs; and what he calls the "plain plough" does not seem to differ much in its principal parts from the one now in use. Amos, in an *Essay on Agricultural Machines*, says, that a person named Lummis (whom he is mistaken in calling a Scotchman, see Maxwell's *Practical Husbandman*, p. 191.) "first attempted its construction upon mathematical principles, which he learned in Holland; but having obtained a patent for the making and vending of this plough, he withheld the knowledge of these principles from the public. However, one Pashley, plough-wright to Sir Charles Turner of Kirkleathem, having a knowledge of those principles, constructed upon them a vast number of ploughs. Afterwards his son established a manufactory for the making of them at Rotherham. Hence they obtained the name of the Rotherham plough; but in Scotland they were called the Dutch or patent plough." "At length the Americans, having obtained a knowledge of those principles, either from Britain or Holland, claimed the priority of the invention; in consequence of which, President Jefferson, of the United States, presented the principles for the construction of a mould-board, first to the Institute of France, and next to the Board of Agriculture in England, as a wonderful discovery in mathematics." (*Communications to the Board of Agriculture*, vol. vi. p. 437.) According to another writer, the Rotherham plough was first constructed in Yorkshire, in 1720, about ten years before Lummis's improvements. (*Survey of the West Riding of Yorkshire. Sup. Encyc. Brit.* art. *Agr.*) We have seen it stated somewhere, that one of the first valuable alterations on the swing plough, of the variety formerly used in Scotland, was made by Lady Stewart of Goodtrees, near Edinburgh, grandmother to the Earl of Buchan. She invented what is called the Rutherglen plough, at one time much used in the west of Scotland.

2600. *The Scotch plough* was little known in Scotland till about the year 1764, when Small's method of constructing it began to excite attention. (*Small's Treatise on Ploughs and Wheel Carriages*, 1784; and *Lord Kaimes's Gentleman Farmer*). This ingenious mechanic formed the mould-board upon distinct and intelligible principles, and afterwards made it of cast-iron. His appendage of a chain has been since laid aside. It has been disputed, whether he took the Rotherham, or the old Scotch plough, for the basis of his improvements. The swing plough has been since varied a little, in some parts of Scotland, from Small's form, for the purpose of adapting it more completely to particular situations and circumstances. Since 1810, this plough has been very generally made entirely of iron. In Northumberland the mould-board is made less concave than in Berwickshire, and in Berwickshire it is even less concave than in Small's plough. Different degrees of concavity in the mould-board suit different soils: soft and sandy soil requires most, and a loamy or clayey soil least, concavity. The following are the principal varieties of the improved Scotch plough at present in use in the most improved districts of the north, and among scientific farmers in all countries.

2601. *Small's plough.* The mould-board is more concave than in most other varieties, and this may be considered its characteristic as compared with these varieties. It is sometimes drawn by a chain proceeding from the muzzle to the head, in order to lessen the strain on the draught-beam, and in that case it is called Small's chain plough. It is commonly made of wood and iron (*fig.* 294. *a*, as seen from the right side, *b* from above), but also entirely of iron.

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2602. *The Northumberland plough, and the Berwickshire plough,* are very nearly the same implement; differing from Small's plough in having the mould-board less concave.

2603. *Wilkie's swing plough,* the best iron swing plough in Scotland, (*fig.* 295. *a*, as seen from above, *b* the left side) is formed entirely of iron except the points of the handles. Its characteristic, in point of form, is a longer mould-board with a greater twist in it, the object of which is, to reverse the furrow more completely in light or highly pulverised soils.

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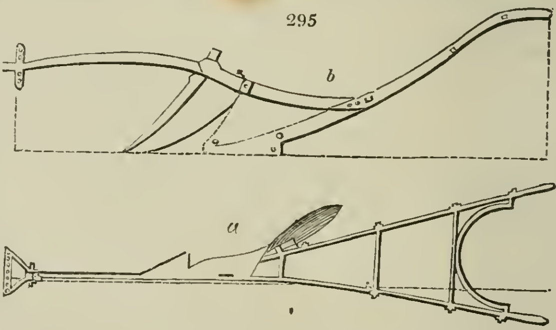

2604. *Finlayson's iron ploughs* (*figs.* 296 to 299.) are, as he informs us (*British Farmer*, p. 9.), constructed in imitation of those of Wilkie, but with improvements and modifications adapted for particular circumstances.

2605. *The heath or self-cleaning plough, or rid plough,* (*figs.* 296, 297.), is formed with the beam so curved vertically (*fig.* 296.), or divided and curved horizontally (*fig.* 297.),

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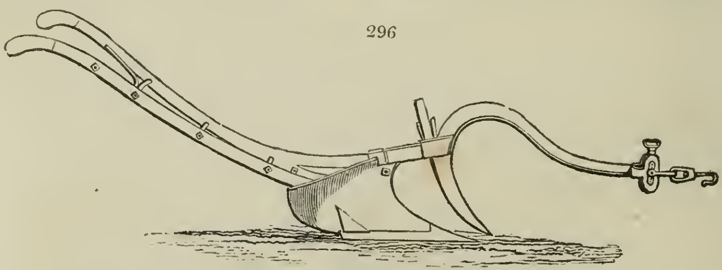

as to leave no resting place for stubble, heath, or other vegetable matter, at the top of the coulter, where in rough grounds, with ploughs of the ordinary construction, it gets entangled and stops the work.

2606. *Finlayson's Kentish skeleton self-cleaning plough* (*fig.* 298.) is intended as a substitute for the common Kentish turn-wrest plough. "The soil, in great part of Kent, is of a peculiarly adhesive clay. When this soil is between the wet and dry, it adheres to the body of the plough like glue, by which the draught is increased probably double or treble." By substituting three or four iron rods for the mould-board, the soil is pre-

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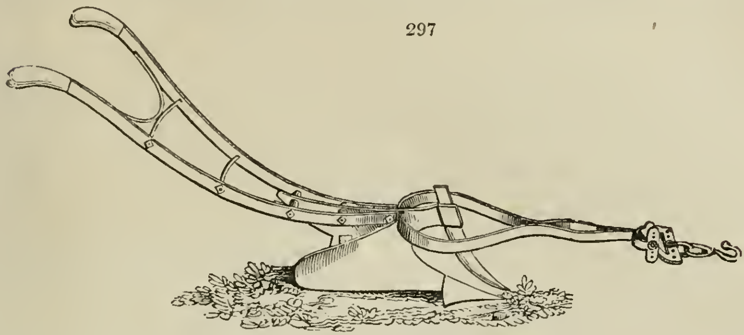

vented from adhering, while the operation of ploughing is at the same time performed in an equally perfect manner with two horses as with four. This is accounted for "by the whole surface of this plough not being more than one third or one fourth the surface of other ploughs." In like manner, when it is necessary to dig or trench very strong clayey soil between the wet and the dry, the operation is performed with much greater

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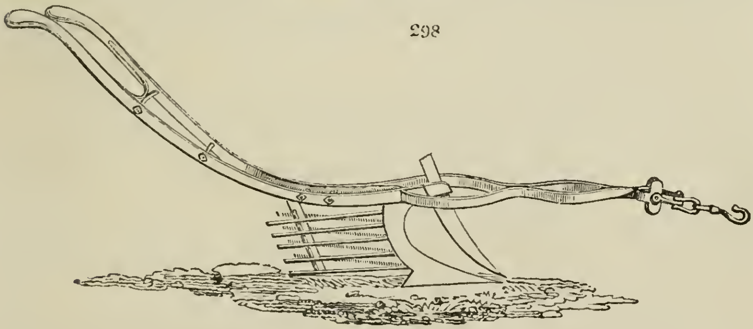

ease by a two-pronged fork. It is important to agriculturists to know the opinion and experience of a man of so much science and extensive practice as the late Mr. Finlayson, who says, "from my own experience I have no hesitation in saying that the most adhesive land may, with ease, be ploughed by the skeleton plough, and one pair of good horses." (*British Farmer*, p. 165.)

2607. *Finlayson's line plough* (*fig.* 299.) is characterised by a rod (*a*), which proceeds

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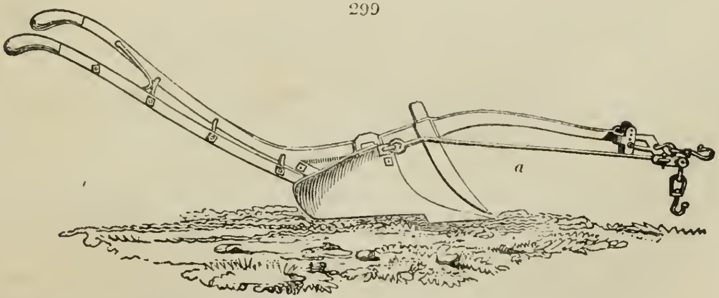

from the sheath of the plough to the muzzle, which is put on when the plough is drawn by horses in a line — a very disadvantageous manner, but yet common in many parts of England.

2608. *The Somerville swing plough* is known by its mould-board, a part of which is rendered moveable by hinges; the advantage of this is, that the furrow can be laid more or less flat at pleasure. "Mould-boards," Lord Somerville observes, "formed to lay furrows in ley, so as to give the most soil to harrows, cannot be of that form best calculated to make good work in stirring earths; more especially the last, which ought to be thrown up in small seams, as it were, that the seed may be duly buried. It has hitherto held necessary to rip off the plate for this purpose, and drive in wedges, by which the mould-plate must be injured. From the trouble attending this operation, it has generally been omitted, and the land, of course, imperfectly worked. But this inconvenience may be remedied, and the mould-board be adjusted with great facility and expedition, by the following means: — When the mould-board is formed, and its plate fitted as usual, let the hind part be cut off, and again connected with the fixed part of mould-board by means of flat hinges, or of thin flexible plates of tempered steel, or of hard hammered iron, so as to admit of that part being set to have different inclinations with the fixed part of the mould-board: by means of a screw passing from the inside through the lower parts of the handle of the plough, opposite the back of this moveable piece, the screw may be made to keep it at any desired degree of inclination, according to the nature of the work to be performed." — This plough, however, has been but little used, and does not seem to meet the approbation of the best cultivators.

2609. *Turn-wrest swing ploughs* are such as admit of removing the mould-board from one side to another at the end of each furrow, for the purpose of throwing the earth removed always to one side. Their principal use is in ploughing across steep declivities, in order that the furrow slice may always be thrown down. Wherever it is practicable, however, it is best to plough obliquely up and down such declivities; because the other practice soon renders the soil too rich and deep at bottom, and too thin and poor at top.

2610. *Gray's turn-wrest swing plough* (*fig.* 300.) is one of the most scientific implements of the kind. The beam, head, and sheath, must always be placed in the direction of a line passing along their middle; and the two handles must be placed equidistant on each side of that line. There are two mould-boards and two coulters, and a mould-board is produced on either side, at pleasure, by moving the lever (*a*) between the plough handles from the one side to the other. The line of draught can be shifted with equal ease and expedition, and at the same time one of the coulters raised up clear of the land, and placed along the side of the beam, whilst the other is put down, and placed in a proper position for cutting off the furrow-slice from the furrow ground. All this is performed at once, without the ploughman's changing his position, by means of two levers (*b*, *c*, and *d*, *a*). We have already noticed (2597.) the mode in which the double-moulding or earthing-up swing plough may be rendered a turn-wrest plough, of a less perfect kind.

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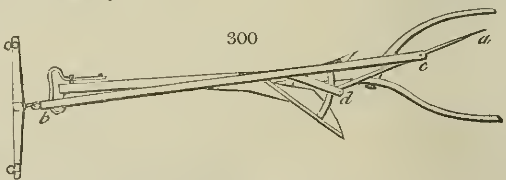

2611. *Weatherley's moveable stilt plough* (*fig.* 301.) is characterised by certain joints in the stilts (*a a*), which admit of raising or lowering the handles at pleasure, so as to suit the height of the ploughman. They also admit of taking off the stilts for the convenience of packing. These joints are the invention of Weatherley, a Northumbrian agriculturist in the service of Prince Esterhazy. The plough is manufactured by Weir of London, who commonly adds to it the improved draught tackle (*b*).

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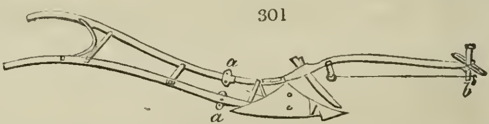

2612. *The ribbing plough* is any of the above implements on a smaller scale, to be used for the operation of ribbing, or laying leys or stubbles in small ridges.

2613. *Ducket's skim-coulter plough* (*fig.* 302.) is said to be a valuable implement, though not much in use. By it the ground may be opened to any depth in separate horizontal portions of earth; and, as the weeds or grassy surface are turned down in the first operation, and covered by fresh earth or mould from beneath, a larger proportion of nourishment is supposed to be provided for the crop, while at the same

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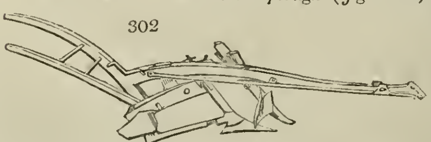

time it is rendered more clean, and the inconvenience of the roots of the grasses or other plants wholly got rid of. It requires a strong team in the heavier sorts of soils, but this is in some degree counterbalanced by the circumstance of one such ploughing being mostly sufficient for the crop. It is, says a late theorist, consequently evident that, considering the number of ploughings generally given in the ordinary way of preparing lands for a crop of barley or turnips, and under the fallowing system for wheat, and the labour and expense in the latter case, in raking, picking, and burning weeds, the advantages of this plough are probably greater than is generally supposed. It has also advantages in another point of view, which is, that the soil is increased in depth, and the parts of it so loosened and broken down that the fibrous roots of the crops strike and extend themselves more readily in it, and of course are better fed and supported. In thin and sandy soils it is more particularly useful, because it cuts off all which is on the surface, at the depth of an inch or an inch and a half, in order to its being laid in a state of decay, for a future crop; by which an increased depth of soil is given to every subsequent course of crops, which often acts as a support, to keep up manures near the surface, as their running through such soils too quickly is a disadvantage. It is also capable of being made use of without a skim-coulter as a common plough.

2614. *A skim-coulter* may be added to any other plough, and may be useful in turning down green crops and long dung, as well as in trench ploughing. But in most instances it is thought a preferable plan, where the soil is to be stirred to an unusual depth, to make two common swing-ploughs follow each other in the same track; the one before taking a shallow furrow, and the other going deeper, and throwing up a new furrow upon the former.

2615. *The double share plough* is distinguished by having one share fixed directly over the other. It is made use of in some of the southern districts, with advantage, in putting in one crop immediately after ploughing down another; as by it a narrow shallow furrow is removed from the surface, and another from below placed upon it, to such depth as may be thought most proper, — it being capable of acting to ten inches or more. In this manner many sorts of crops, such as rye and other green crops that have much height of stem, may be turned down without the inconvenience of any of the parts sticking out through the seams of the furrow slices, by which the farmer has a clean surface of mould for the reception of the grain.

2616. *The mining plough, or trenching plough,* is sometimes employed for the purpose of loosening the soil to a great depth, without bringing it up to the surface; a mode of operation which is particularly useful for various sorts of tap-rooted plants, as well as for extirpating the roots of such weeds as strike deep into the ground. For these purposes it may be employed in the bottom of the furrow after the common plough. It is constructed in a very strong manner, having a share but no mould-board. The share raises the earth in the bottom of the furrow, and, passing on under what it has raised, leaves the soil where it was found, but in a loosened state.

2617. *Somerville's double-furrow plough* (*fig.* 303.) is obviously advantageous in per-

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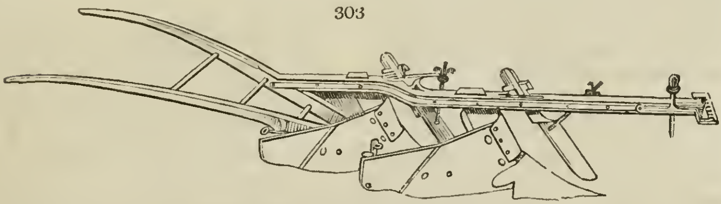

forming more labour in a given time, with a certain strength of team, than other sorts of ploughs, as producing two furrows at a time. It has been found useful on the lighter sorts of land where the ridges are straight and wide, though some think it more confined in its work than those of the single kind. The saving of the labour of one person, and doing nearly double the work with but little more strength in the team, in the same time, recommend it for those districts where four-horse teams are in use. This plough has been brought to its present degree of perfection by Lord Somerville, especially by the introduction of the moveable plates already mentioned (2607.), at the extremities of the mould-board, as in His Lordship's single plough. But, as observed by an excellent authority, " with all the improvements made by Lord Somerville, it can never come into competition, for general purposes, with the present single-furrow ploughs." Lord S. admits, that it would be no object to invade the system already established in well cultivated counties; though, where large teams are employed, with a driver besides the ploughman, it would certainly be a matter of importance to use this plough, at least, on light friable soils. " Their horses," he says, " will not feel the difference between their own single furrow, working one acre, and the well constructed two-furrow plough, with two acres per day; here is no system deranged, and double work done." (*Comm. B. A.* vol. ii.) This plough is also of particular value for ploughing up and down steeps. (See 2627.)

2618. *The Argyleshire plough* differs from Small's, or any single swing plough, in having no coulter fixed in the beam, but, in lieu of this, a fin or knife rising from the left side of the share, which serves the purpose of slicing off the furrow as well as the coulter. This fin or feather must be placed at the same angle as the coulter, and should terminate in a lance-like shape, in order to furnish the least obstruction to stubble, weeds, or stones. This plough is not liable to be choked by stubble, or thrown out by catching small stones between the points of the coulter and sock. It is found particularly useful in taking the earth away from the sides of a drill crop; as its broad upright feather, which operates as a coulter, completely shields the plants from all risk of earth falling on them from the left side of the plough, while, at the same time, the ploughman ascertains to a certainty, that the part of the plough below ground approaches no nearer to the roots of the plants than the upper part does to their leaves; so that he can bring the plough to slice off the earth close in upon their sides, if necessary, In point of draught it is precisely the same as the common plough.

2619. *The double mould-boarded plough* is a kind of plough often used with advantage in clearing out furrows, in setting potatoes, cabbages, and other similar crops, and in earthing up such as are planted in wide rows. Those whose mould-boards move on hinges, and may be set wide or narrow at pleasure, are the most convenient. A variety of this plough, made by Weir of London, admits of removing the mould-boards, and fixing in curved coulters and hoes, for cleaning between drilled turnips and similar crops.

2620. *The binot* is almost the same thing as the double mould-boarded plough, and the one is commonly sold for the other, with no loss to the purchaser. It has two mould-boards, one on each side of the beam. It is used in some soils in forming a ribbed or ridged bed for wheat or other grains; by which means, when the grain is sown over the ribs or ridgelets in the broadcast manner, as it falls for the most part into the furrows, or is harrowed into them, it comes up in rows. It is also used in earthing up crops; and sometimes, in Flanders, but never by the best cultivators in England, in giving the first furrow to stubbles.

2621. *The marking plough* is used in straightening and regulating the distance of ridges where the drill system is practised. Any plough with a rod fixed at right angles to the beam, and a short piece depending from this rod, will trace a line parallel to the furrow drawn by the plough, which line will serve for a guide as to the width of ridges, &c.

2622. *Clymer's plough* (*fig.* 304.) is a recent modification of the implement, formed entirely of iron, and chiefly remarkable for the absence of the coulter, or rather its attachment to the breast, and for the share, mould board, and other parts which move under ground, being composed of distinct pieces of cast-iron. This is considered as cheaper to commence with and easier to repair, because any one part may be renewed of the same material without deranging the rest; whereas renewing or repairing wrought-iron shares, mould-boards, or coulters, is found in many districts both difficult and expensive. It has never come into use.

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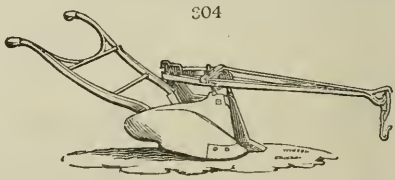

2623. *Stothard's plough* is characterised by a perforated mould-board. The holes may be in any form or dimensions; and their object is to allow the air to pass through, and thereby prevent the adhesion of wet earth, which it is contended adheres in ordinary ploughs with such a degree of tenacity as greatly to increase the friction, and diminish the speed of the horses. (*Newton's Journal*, vol. ii. p. 335.)

2624. *Morton's trenching plough* (*fig.* 305.) has two bodies (*a b*), the one working four

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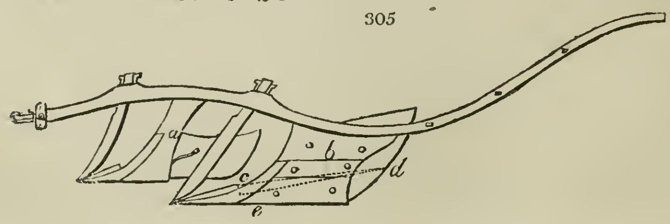
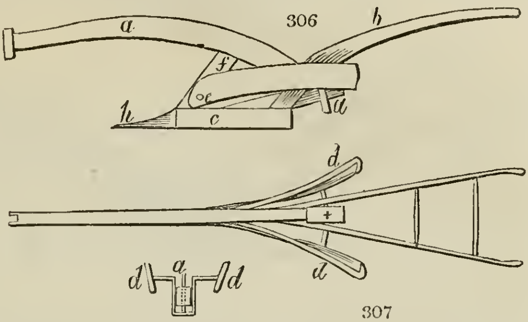


or six inches deeper than the other. The first (*a*) cuts or pares off the surface to the required depth, say five inches, and turns it over into the furrow, ten or twelve inches deep, made by the main body. The second body generally works from ten to twelve inches deep, but might be made to work to the depth of thirteen or fifteen inches; upon its mould-board is formed an inclined plane, extending from the back part of the feather of the sock or share (*c*) to the back part of the mould-board (*d*), where it terminates about six inches above the level of the sole (*e*). This inclined plane raises the soil from the bottom of the furrow, and turns it over on the top of that which has been laid in the bottom of the previous furrow by the body (*a*) going before.



2625. *Gladstone's water-furrowing plough* (*figs.* 306. and 307.) is used for cleaning out the furrows of a new-sown field, when the nature of the soil, or the inclination of the surface, requires extraordinary attention to leading off the rain water. The beam (*a*), handles (*b*), and sole (*c*), of this plough are formed in the usual manner of double mould-board ploughs. The sole is five inches square, for the purpose of forming a square bottom to the furrow. The two mould-boards (*d*) are loose, so as to rise and fall with the depth or shallowness of the furrow, being fastened only by the centre pin (*e*) to the upright (*f*). The mould-boards, or wings, as they are called, are kept extended by a piece of iron (*g*); and this piece of iron has a number of holes in it, so that, by means of a pin (*h*) it may be raised or lowered at pleasure, according to the depth of the water furrow. The mould-boards are made of wood. Any old plough may be converted into one of this description for a few shillings.

2626. *Draining ploughs* are of various kinds, but none of them are of much use; the work can always be done better, and generally cheaper, by manual labour. As most of these ploughs have wheels, we have included the whole of them in next subsection.

Subsect. 2. *Wheel Ploughs.*

2627. *Wheel ploughs* are of two kinds: those, and which are by far the most common, where the wheel or wheels are introduced for the purpose of regulating the depth of the furrow, and rendering the implement more steady to hold; and those where the wheel is introduced for the purpose of lessening the friction of the sole or share. This last description of wheel plough is scarcely known, but it promises great advantages. The former is of unknown antiquity, having been used by the Romans.

2628. *Ploughs with wheels for regulation and steadiness* vary considerably in their construction in different places, according to the nature of soils and other circumstances; but in every form, and in all situations, they probably require less skill in the ploughman. Wheels seem, indeed, to have formed an addition to ploughs, in consequence of the want of experience in ploughmen; and in all sorts of soil, but more particularly in those which are of a stony and stubborn quality, they afford great assistance to such ploughmen, enabling them to perform their work with greater regularity in respect to depth, and with much more neatness in regard to equality of surface. From the friction caused by the wheels, they are generally considered as giving much greater resistance, and consequently demand more strength in the team that is employed; and, besides, are more expensive in their construction, and more liable to be put out of order, as well as more apt to be disturbed in their progress by clods, stones, and other inequalities that may be on the surface of the ground, than those of the swing kind. It is also observed, "that with *wheel* ploughs workmen are apt to set the points of their shares too low, so as by their inclined direction to occasion a heavy pressure on the wheel, which must proceed horizontally:" the effect of this struggle is an increased weight of draught, infinitely beyond what could be supposed: for which reason, the wheel is to be considered as of no importance in setting a plough for work; but passing lightly over the surface, it will be of material aid in breaking up old leys, or ground where flints, rocks, or roots of trees occur, and in correcting the depression of the share from any sudden obstruction, as well as in bringing it quickly into work again, when thrown out towards the surface. (*Communications to the Board of Agriculture*, vol. ii. p. 419.)

2629. *The improved Scotch plough, with one or sometimes two wheels* (*fig.* 308.), fixed near to the end of the beam, without any carriage, goes very light, and is very useful; such alterations as are necessary requiring very little time or trouble. Where two wheels

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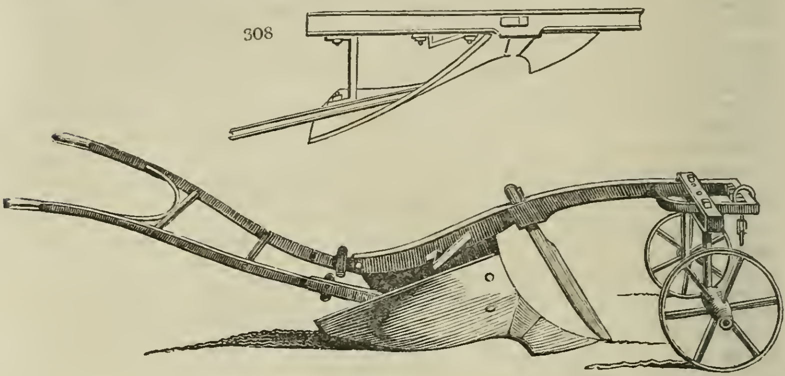
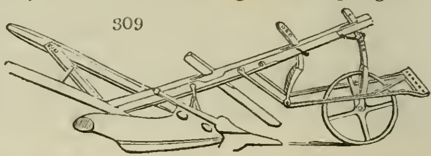


are employed, the plough does very well without a holder on a good tilth or light sward, where there are few stones, except at the setting in and turning out. Wheel ploughs should, however, probably be seldom had recourse to by the experienced ploughman, though they may be more convenient and more manageable for those who are not perfectly informed in that important and useful art.

2630. *The Beverston plough* (*fig.* 309.) was once considered a good wheel plough. It has its principle of draught given it in a very effective manner by an ingenious contrivance of iron work, in which, according to Lord Somerville, " the point of draught is perpendicularly above the point of traction, or the throat or breast where the share fits on."

309



2631. *The Kentish and Herefordshire wheel ploughs* are extraordinary clumsy implements of very heavy draught, and making, especially the former, very indifferent work. They were figured by Blythe in the beginning of the seventeenth century, and seem to have received no improvement since. The Kentish plough is generally made with a turn-wrest, in order always to turn land downwards in ploughing a hill; but this, as Lord Somerville remarks, soon renders the summit of the hill or the upper side of the field, where such a practice is persisted in, destitute of soil. A much better mode is to plough up and down the steep, or diagonally across it. In either case the double mould-board plough, invented by His Lordship, is of singular use, as one furrow only need be taken in going up and two in coming down.

2632. *The Norfolk wheel plough* (*fig.* 310.) has a clumsy appearance, from the great bulk of its wheels and their carriage; but in light friable soils it does its work with neatness, and requires only a small power of draught.

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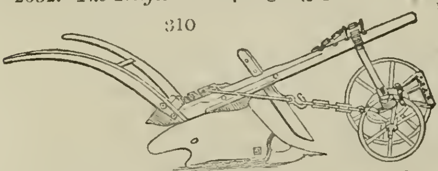

2633. *Ploughs with wheels for diminishing friction* are of comparatively recent date. Morton, of Leith walk, in 1813, conceived the idea of introducing into the body of the plough a wheel about 15 inches in diameter, to act as the sole, and made several exhibitions of a plough so constructed before the Dalkeith Farming Society. (*Gard. Mag.* vol. v.) Wilkie, of Uddingston, brought forward a similar plough in 1814, and Plenty, of London, in 1815. Liston, of Edinburgh, a few years afterwards, brought forward a plough on the same principle; but it never came into use. Plenty's friction wheel plough has been occasionally used in England. It has two wheels under the beam, and one behind the sole; and, while the same plough with two wheels requires a power of 4 cwt., those with a third or friction wheel, as Mr. Plenty informs us, require only a draught of $3\frac{8}{10}$ cwt.

2634. *Wilkie's single horse wheel plough* (*fig.* 311.) was invented by the late Mr. Wilkie, and described by him in the *Farmer's Magazine* for November, 1814. It has the wheel (*d*) placed behind the sole, which, besides considerably reducing the weight of draught, is found to give a degree of steadiness seldom exceeded in the use of the common plough, except when quite new, or recently repaired with a new sock and sole-shoe. At that period, when the back end of the

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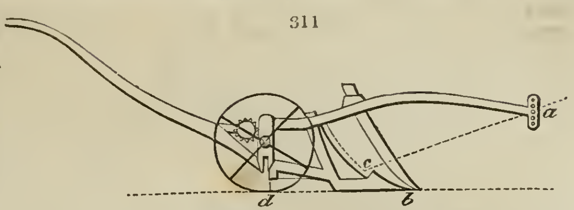


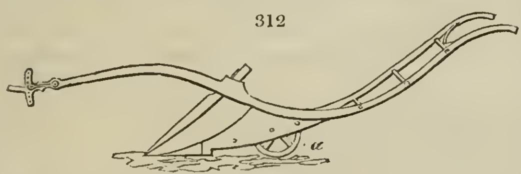
sole is quite full and square, the common plough (when well constructed) goes as well as can be wished for; but, by the great friction of the sole, the back end of it soon becomes convex, and, consequently, the plough loses the steady support of the extremity of the heel; or, in other words, in proportion as the sole becomes more convex, the fulcrum of the lever is extended considerably forward, so as to be too near the centre of gravity. When that is the case, the least obstruction at the point of the share hrows the plough out of the ground. In order to remedy or counteract that tendency, the ploughman is obliged to raise the point of draught at the end of the beam; but this expedient, although it gives the plough more hold by the point of the share, is attended with another inconvenience fully as bad as the former; for, when the point of the share meets with an obstruction as before noticed, the heel of the plough is raised, on account of the point of draught being fixed above the direct line of traction. Thus, the common plough, when the sole becomes convex, is made to go very unsteadily, and often requires the utmost attention and exertions of the ploughman to direct it. What is stated above, however, can only apply to the common plough when out of order by the sole becoming convex.

2635. *Placing the wheel.* In order to understand in what manner the wheel ought to be placed so as to reduce the friction, it may be necessary to remark that one of the first properties of a plough is to be constructed in such a manner as to swim fair on the sole. This depends principally on the form of the sole, and position or inclination of the point of the sock, together with the point of draught at the end of the beam (*a*). If these are properly adjusted, the pressure or friction of the sole will be uniform from the point of the share (*b*) to the back end of the heel (*d*); or, in other words, the friction will be balanced between these two points by means of the beam (*a*) acting as a lever, the heel (*d*) being the fulcrum, and a point over the share (*c*) the centre of gravity.

2636. *The centre of gravity* or of resistance will be extended nearer to the point of the share (*b*), in proportion as the soil has acquired a greater degree of cohesion; as in old pasture ground, or strong clays. But, wherever the point of resistance meets, it is evident that the point of draught at the end of the beam must be placed so as to balance the friction of the sole between its extreme points (*b* and *a*). Viewing the machine, therefore (with regard to the friction of the sole), merely as a sledge carrying a considerable weight, by which it is pressed equally to the bottom of the furrow at the extreme points (*b* and *d*), it is clear that, by substituting a wheel at the one point (*d*), the one half of the friction of the sole will be thrown on the wheel. The draught is reduced by the wheel from forty to sixty-six pounds, or from one seventh to one fifth (two hundred and eighty pounds being the power of one horse.)

2637. *Wilkie's improved friction-wheel plough for two horses* (*fig.* 312.) was invented by the late Mr. Wilkie in 1825, and is manufactured by his son at Uddingston, near Glasgow. We consider this as by far the most perfect implement of the plough kind that has hitherto been produced. The wheel (*a*) is placed so as to incline from the perpendicular, at an angle of about 30 degrees; and, following in the angle of the furrow cut by the coulter and share, it ensures a greater degree of steadiness in the motion of the plough than when rolling only on the bottom of the furrow.

312



The sock or share is of cast-iron, which is a great saving both in first cost and repairs; costing only one shilling, and ploughing at an average upwards of ten acres. Only the coulter requires to be taken to the smithy, the share being renewed by the ploughman at pleasure. The wheel, which is of cast-iron, will last many years. The draught of this plough has been proved at a public ploughing match, in 1829, to be fully 30 per cent less than that of the common scoring plough of the most improved form. The price is also lower than that of any iron plough now in use. Mr. W. has lately made some of these ploughs with a piece of mechanism attached to the wheel, by the revolution of which, the quantity of ground passed over by the plough may be indicated. (*Gard. Mag.* vol. v.)

2638. *The paring wheel plough* is of various forms, though it is an implement seldom required. It is used for paring the surface of old grass lands, or leys on clay soil, where the turf is to be burned. A variety in use in the fen districts (*fig.* 313.), has a wheel (*a*) which cuts the turf, instead of a coulter; a broad flat share which raises it, with a sharp fin or turned-up part at the extremity (*c*), which cuts the turf on that side, thus turning it over in slices about a foot broad and two inches deep. There is a foot (*b*) from the forepart of the beam, which serves to prevent the share from going too deep.

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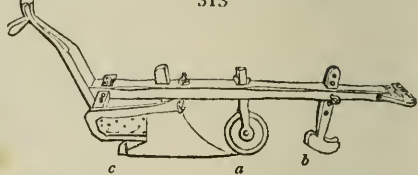
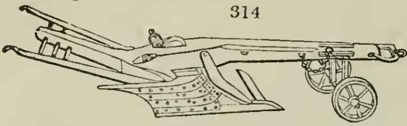


2639. *Clarke's draining plough* (*fig.* 314.) was found to answer well in meadow ground near Belford in Northumberland, but could not be drawn in stiff clay with the force of eight horses.

314



2640. *Gray's draining plough* (*fig.* 315.) seems one of the best. The beam is strongly fortified with iron, and is always kept at a proper distance from the surface of the ground, and also the depth of the drain regulated by two wheels (*a a*) which turn on an iron axle, and roll upon the surface on each side of the drain. The middle coulter is made to cut perpendicularly; consequently, the side coulters will cut the two sides of the drain at an equal slope. When this machine is at work, the earth of the drain is cut in the middle by the foremost coulter, and on each side by the other two coulters. Then the sharp point of the share will cut up that earth from its bed, and, as the machine advances, it must ascend on the surface of the inclined plane; at the same time, the fore-ends of the mould-boards, following in the track of the middle coulter, will divide the slice of earth, as it rises, into two equal parts, turning these parts gradually to each side; and, as the back-ends of the mould-boards extend farther than the breadth of the drain above, the portion of earth so raised will be placed upon the firm ground, leaving the drain quite open. The frame into which the axle is fixed may easily be either raised up or depressed, as the drain is to be cut deep or shallow; and the two outside coulters can easily be placed more or less oblique, so as to cut the sides of the drain at a greater or less slope, as may be found necessary. (*Gray's Implements, &c.* 4to.)

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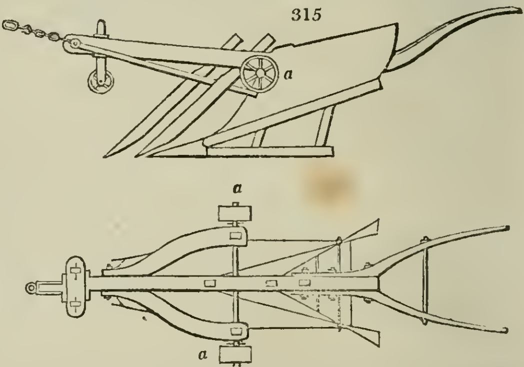
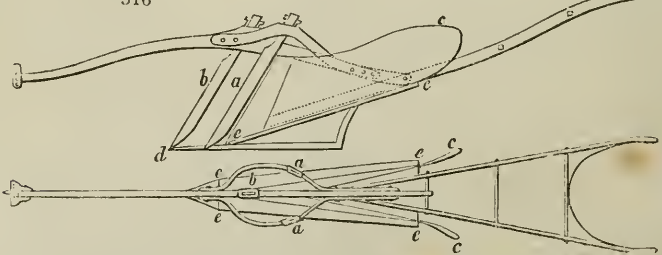


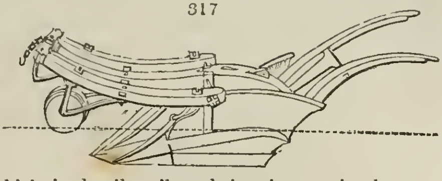
2641. *Morton's draining plough* (*fig.* 316.) has three coulters (*a a b*), two mould-boards (*c c*), and one share (*d*). The mould-boards have an inclined plane, formed upon each (*e e*), which rises from the share backwards to such a height above the level of the sole as the drain is required to be made deep. The middle coulter separates the soil to be lifted into two parts, and each part is raised to the surface by the inclined planes on the mould-boards. The usual dimensions of the drain so formed are 10 or 12 inches deep, 8 or 9 inches wide at bottom, and 14 or 15 inches wide at top; but the construction may be adapted to a smaller or a larger drain, or for cleaning out drains already made.

316



2642. *The gutter plough* (*fig.* 317.) is made use of for forming gutter drains in grass lands, where the soil is of a retentive nature. The power of six horses is required in drawing it for the first time; but four horses are found sufficient for opening the old gutters.

317



2643. *The mole plough* (*fig.* 318.) was invented by Adam Scott, and improved by Lumbert of Gloucestershire. It is said to be an implement which, in ductile soils and situations, as in pleasure-grounds, and where much regard is had to the surface-appearance of the land, may be of considerable benefit in forming temporary drains. It makes a drain without opening the surface any more than merely for the passage of a thin coulter, the mark of which soon disappears: it is chiefly employed in such grass-lands as have a declination of surface, and where there are not many obstructions to contend with; but some think it may be used in other kinds of land, as on turnip-grounds that are too wet for the sheep to feed them off, or where, on account of the wetness, the seed cannot be put into the earth. With this plough the drains should be made at the distance of ten or fifteen feet in straight lines, and also contrived so as to discharge themselves into one large open furrow, or grip, at the bottom of the field. As it requires great strength to draw this implement, it can only be used where a good team is kept.

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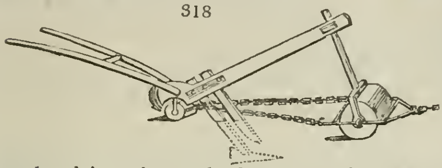

2644. *Lumbert* not only brought this plough to its present shape; but, finding the surface greatly injured by the feet of so many horses as were found necessary to draw it, he invented a piece of machinery (*fig.* 319.), consisting of a windlass, frame, and anchor,

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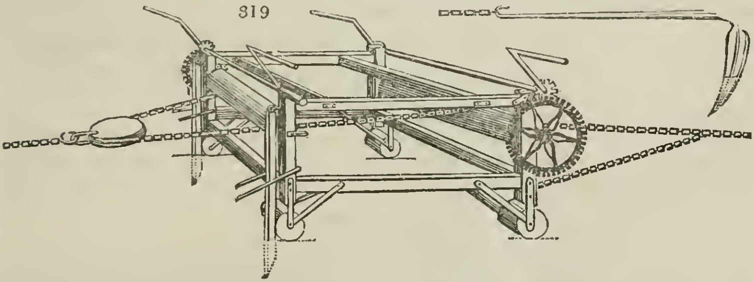

by which it is worked by the labour of four men. Young, and other members of the Board of Agriculture, expressed themselves greatly enamoured of this plan; but it is obviously too complicate and expensive for general use.

2645. *A subsequent improvement*, by Lumbert, consisted in the addition of a gin-wheel and lever, by which the machine was worked by one horse walking round it, as in a common horse-mill; and this last form has again been improved by the late mechanist, Weir, of Oxford-street, London, by the addition of a vertical cylinder, which winds up the chain without any attention from the driver. Weir has also simplified and strengthened this machine in other respects; so that his modification of it (*fig.* 320.) is,

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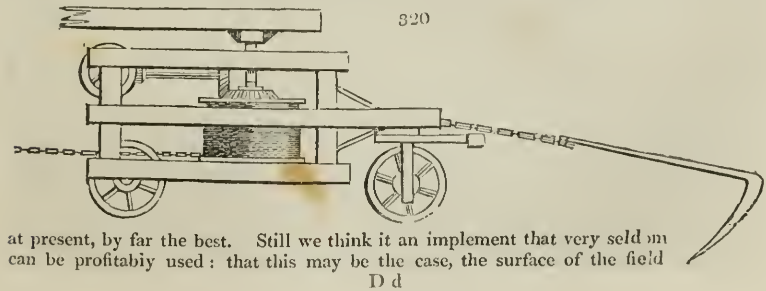

at present, by far the best. Still we think it an implement that very seldom can be profitably used: that this may be the case, the surface of the field must have a natural drainage, by lying in one even slope or slopes; it must be in pasture; and the soil must be of uniform consistency, and free from stones. But even where these favourable circumstances combine, we think two swing ploughs, with finless shares, following in the same track, would effect the same object sufficiently well for all agricultural purposes; and for drains in ornamental grounds, no machine will ever equal manual labour.

2646. *The Duke of Bridgewater's draining plough* (*fig.* 321.) is used for making open drains of a small size (*c*), regular shape, and from five to nine inches deep. The

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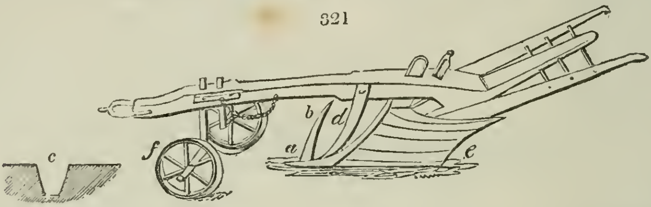


share (*a*) has a coulter (*b*) fixed to it, projecting upwards, to cut one side of the drain, and another coulter (*d*) fixed to the beam and also to the share at its lowest end. The turf which is thus cut out passes between the coulter (*d*) and the mould-board (*e*), and is thus lifted clearly out of the trench. The depth of the drain is regulated by the wheels at the fore end of the beam (*f*). This plough is drawn by four or six horses.

2647. *Various draining ploughs* have been invented and tried by Arbuthnot, Makie, M'Dougal, Green, Pearson, and others. Pearson's will be afterwards figured and described.

2648. *The pressing plough* is properly a roller, and will be found noticed among machines of that class.

2649. *The only essential plough* to be selected from these three sections is the improved Scotch swing plough, with or without one or two wheels, according to circumstances; and with the mould-board, share, and coulter, set to suit different soils, as flinty, chalky, &c.; or soils in different states of culture, as old turf, heath, steep banks, ley, &c.

Subsect. 3. *Tillage Implements, known as Scarifiers, Scufflers, Cultivators, and Grubbers.*

2650. The use of *pronged implements*, as substitutes for the plough, is of comparatively recent date. They differ from the plough in stirring the soil without reversing its surface or altering its form, unless, indeed, they in some cases tend to even or level inequalities; they act both as the plough and harrow at the same time, and on suitable soils, and at proper seasons, much more labour is effected with less expense of men and cattle. Wherever, therefore, lands require to be stirred for any purpose except that of reversing the surface, or laying them into beds or ridges, recourse may be had to pronged tillage implements, such as we are about to describe.

2651. *In estimating the value of pronged tillage implements*, General Beatson (*New System of Cultivation*, 1820) applies the principle of lessening power and employing time. He says, if we apply the principle of petty operations to any stiff land, by taking that depth of furrow which can easily be ploughed with two horses, and repeat the operation (or plough the land a second time), we shall arrive at the end proposed, that is, the same depth of ploughing, with absolutely less exertion of animal strength than if we were to plough the same depth with four horses at one operation.

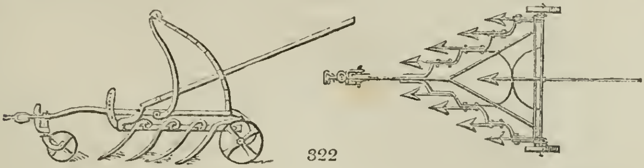
2652 This may be *illustrated* by supposing the resistances to the plough to be in proportion to the squares of the depth of the land. If so, and we are to plough at once with four horses, six inches deep, the resistance at that depth would be $6 \times 6 = 36$: but if with the same four horses, using two at a time, we plough the same depth of six inches at two operations, taking only three inches at each, then the square of the first depth is 9, and the square of the second, 9; making 18 for the total resistance, or the power expended by the two horses, in ploughing six inches deep, at two operations.

2653. *A farther illustration* may be made by supposing the same four horses, which had ploughed at once six inches deep, and had overcome the resistance of $6 \times 6 = 36$, applied, separately, to four light ploughs, or other implements, and to plough only $1\frac{1}{2}$ inch deep at a time, and to go over the same land four times. In this case the sum of all the resistances to be overcome, or the animal force expended, in these repeated ploughings, would be no more than 9 instead of 36; because the square of $1\frac{1}{2} = 2\frac{1}{4}$, which, multiplied by the four ploughings, gives 9, or only one fourth of the power expended in ploughing at once six inches deep. Hence it appears, that in ploughing six inches deep, with four horses, each horse exerts a force $= 9$; whereas in taking only $1\frac{1}{2}$ inch deep, the force he exerts is not more than $2\frac{1}{4}$.

2654. *Farther*, supposing that a horse exerts, in drawing a plough, a force of 160 pounds, it is evident, if four horses are ploughing six inches deep, the total force exerted will be 640 pounds, or 160 pounds by each; but if they be required to plough one inch and a half deep at a time, then the total force expended by the four horses will be only 160 pounds, or 40 pounds by each horse.

2655. *Application*. This leads General B. to the principle on which his small scarifiers are constructed. "They have," he says, "four hoe-tines in the hind bar, and I will suppose that there are four harrow-tines (instead of three) in the front bar, so that each scarifier may be considered as four small ploughs, with four shares and four coulters. If we suppose one horse attached to this implement, and that the force he exerts is 160 pounds, it is obvious that in scarifying to the depth of one inch and a half, he will exert these 160 pounds upon the four pairs of tines, or a force of 40 pounds upon each pair. But, in fact, the force required to draw the scarifier will be considerably less than to draw any form of plough, because the hoe, or share-tines, being much thinner and sharper than a ploughshare and mould-board, will of course meet with much less resistance in stirring the soil." General B. goes on to relate some experiments by which he considers he has "clearly proved that the least expensive method of preparing the land for wheat, after tares, beans, peas, or clover, is simply by using the scarifiers." This we conceive is carrying the use of the scarifier much too far. We think it is a sufficient illustration of its value that it may be used in stirring lands on which potatoes or turnips have grown, or that has been ploughed in autumn or during winter, so that a crop may be sown in spring without farther use of the plough. In working fallows, and preparing for turnips and potatoes, it may save two or three furrows. (*Supp. Ency. Brit.* art. *Agr.* and *Farm. Mag.*)

2656. *Wilkie's parallel adjusting brake, or cultivator* (*fig.* 322.), appears to us decidedly



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the most perfect implement of this description. The prongs of such implements, mechanically considered, are bent levers (*fig.* 323.), of which the fulcrum is at *a*, the power at *b*, and the weight or resistance at *c*. The improvement of Mr. Wilkie consists in adopting a curve (*d b*), for the resisting part of the lever, and thus bringing into action the principle of tension, instead of mere resistance to fracture in the resisting part of the lever. (*Gard. Mag.* vol. v. p. 655.) The parallel movement has the advantage of instantaneously adjusting the implement to any depth that may be required. Besides the ordinary purposes of a cultivator, this brake or harrow may serve the other tillage purposes following: — 1. By attaching tines with triangular feet, it makes a scarifier; or, in place of tines, one large triangular blade suspended from each of its extremities or angles. 2. By substituting cutting wheels in place of tines, it is converted into a sward cutter. 3. From its extreme accuracy of adjustment it will make an excellent drill, or ribbing machine, and may be made to sow at the same time. And 4. and finally, if steam is destined ever to supersede the labour of horses in drawing the plough, this machine, from its peculiar formation and mode of management, will afford the greatest facility for trying the experiment, as it may be made to take a number of furrows at once.

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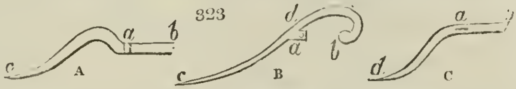

2657. *Finlayson's self-cleaning cultivator, or harrow* (*fig.* 324.), is formed of iron, and,

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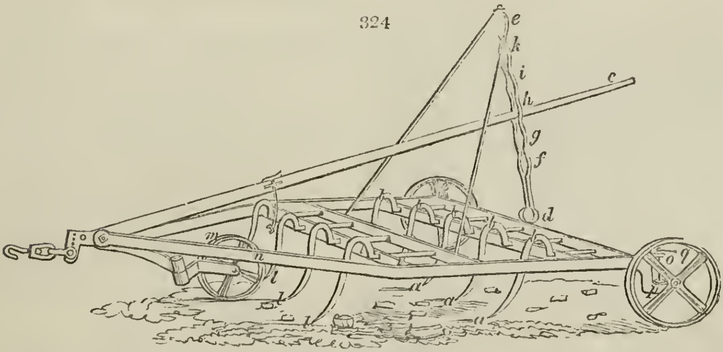

according to the inventor, has the following advantages: — 1. From the position in which the tines are fixed, their points (*a a a a a*) hanging nearly on a parallel to the surface of the land, it follows, that this implement is drawn with the least possible waste of power. 2. From the curved form of the tines, all stubble, couch, &c. that the tines may encounter in their progress through the soil, is brought to the surface, and rolled up to the face of the tines; when it loses its hold, and is thrown off (at *b b b b b*), always relieving itself from being choked, however wet or foul the land. 3. The mode by which this harrow can be so easily adjusted to work at any depth required, renders it of great value; this is done as quick as thought by moving the regulator (*c*) upwards or downwards between the lateral spring (*d e*); and by each movement upwards into the openings (*f g h i k*), the fore tines (*l l l l*) will be allowed to enter the soil about an inch and a half deeper by each movement into the different spaces, until the regulator is thrown up to (*e*), when the harrow is given its greatest power, and will then be working at the depth of eight or nine inches. Also the axletree of the hind wheels is moved betwixt *o* and *p*, a space of seven or eight inches, by a screw through the axletree, which is turned by a small handle (*g*), so that the hind part of the harrow, by this simple mode, is also regulated to the depth at which it is found necessary to work. 4. When the harrow is drawn to the head or foot lands, the regulator is pressed down to *d*, and the fore wheel (*m*) is then allowed to pass under the fore bar (*n*), by which the nose of the harrow is lifted, and the points of the fore tines (*l l l l*) will then be taken two or three inches out of the soil, which affords the means of turning the harrow with the greatest facility. 5. Being made of malleable iron, its durability may be said to be endless; whereas, if made of wood, the prime cost would be entirely lost at the end of every five or six years. Lastly, the mode of working is so easy, that any boy of ten or twelve years of age is perfectly qualified to manage it. Next to Wilkie's brake, we consider this the most valuable of pronged implements, and think that, like Wilkie's implement, it might be substituted for the plough, after drilled green or root crops, on light soils generally. Some account of the astonishing powers of the implement, as exemplified in breaking up Hyde Park, London, in 1826, will be found in the *Gardener's Magazine*, vol. ii. p. 250.

2658. *Weir's improved cultivator* (*fig.* 325.) is a very effective implement of this kind,

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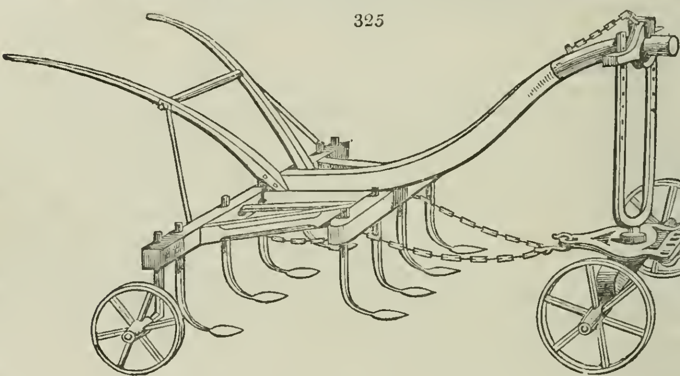

with nine coulters or prongs. It may be set to go more or less deep by raising or lowering both the fore and hind wheels.

2659. *The Scotch cultivator or grubber* (*fig.* 326.) was formerly considered one of the best implements of this kind, as a substitute for the plough; but it has since been superseded by Finlayson's self-cleaning harrow. It consists of two strong rectangular frames, the one including the other, and nine bars mortised into the inner one, with eleven coulters or prongs with triangular, sharp-edged, dipping feet, four cast-iron wheels, and two handles. All the cutters are fixed in these bars, except two which are placed in the side beams of the outer frame, and may be set to go more or less deep by means of pins and wedges. It works as deep as the plough has gone; and by the reclined position of the coulters, brings to the surface all the weed roots that lurk in the soil. Beans and peas have been sown in spring on the winter furrow, after beng stirred by the grubber; and barley also after turnips, without any ploughing at all. This implement is made of different sizes, and may be worked either by four or by two horses, and one man.

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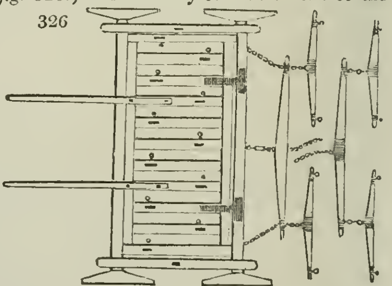

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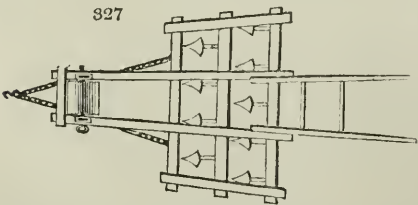

2660. *Parkinson's cultivator* (*fig.* 327.) has been found a very useful implement, both for stirring and cleaning land. Its inventor recommends that where the land is foul from couch, sods, or any other cause, the number of teeth or hoes should be reduced to five or seven; two or three being placed in the fore bull, and four in the hindermost; increasing them to nine as the land becomes in a fine condition.

2661. *The chain by which this cultivator or scarifier is drawn*, enables the person that holds it to work it better, than if it were drawn by a beam like a plough, and occasions also less draught by the power being nearer to the claws; the machine goes more freely than it would if some of the claws were in the fore bull, the sole use of that bull being to draw by. When the scarifier was made in a triangular form, and with the same number of claws, it was apt to go on its head, or by raising the hindmost claws out of the ground to work frequently at one corner only. The claws are formed at the bottom with a point, so as to push a stone out of the way before the broad part can meet with any obstruction, which makes the machine cut with much greater ease. As to their width at the foot, they may be made to cut all the land more clearly than a plough if required, where thistles, fern, &c. grow, and the claw is so formed by its crooked direction as to raise every obstruction to the top, rock excepted

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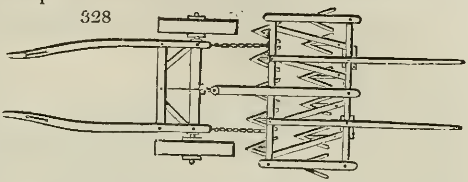

2662. *Hayward's cultivator* (*fig.* 328.) or, as it is called, extirpator, or scalp plough, is used on land already ploughed. Its hoes or scalps are intended to pierce about two inches at each operation; so that by repeatedly passing it over the surface, the land will be stirred as deep as the plough has gone.

2663. *Beatson's cultivator* (*fig.* 329.) is recommended by the inventor for its lightness: it is intended, as before observed (2650.), to effect by reiterated application what is done by the large Scotch cultivator at once; by which means a saving of power is obtained, but with a loss of time, as is usual in all similar cases.

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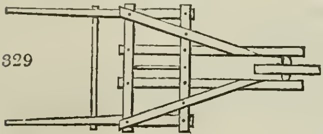

2664. *The only essential tillage implement of the prong kind* is Wilkie's brake, which, taking it altogether, we consider to be one of the most perfect implements ever invented. The next is Finlayson's harrow, also a most excellent implement. The other cultivators and brakes are so far inferior, that they may be considered as reduced to historical merit; and we have therefore retained them chiefly for the purpose of showing the progress which has been made in this department of agricultural mechanism.

Subsect. 4. *Tillage Implements of the Hoe Kind.*

2665. Of *horse hoes* there is a great variety, almost every implement-maker having his favourite form. They are useful for stirring the soil in the intervals between rowed crops, especially turnips, potatoes, and beans. Respecting the construction of horse hoes it may be observed that soils of different textures will require to be hoed with shares of different forms, according to their hardness, or mixture of stones, flints, or gravel. The number of hoes also in hard soils requires to be diminished; in the case of a stony clay, one hoe or flat share, with or without one or two coulters or prongs, will often be all that can be made to enter the ground. In using these implements, the operator should always consider whether he will produce most benefit by merely cutting over or rooting up the weeds, or by stirring the soil; because the hoe suited for the one purpose is by no means well adapted for the other. In the former case flat shares are to be preferred, but pointed, that they may enter the soil easily; in the latter, coulters or prongs, as in the cultivators, are much more effective, as they will enter the soil and stir it to a considerable depth, thus greatly benefiting the plants by the admission of air, heat, dews, and rain, and by rendering it more permeable by the roots.

2666. *Wilkie's horse hoe and drill harrow* (*fig.* 330.), is a very superior implement, intended to be introduced between the drills as soon as the plants appear above ground,

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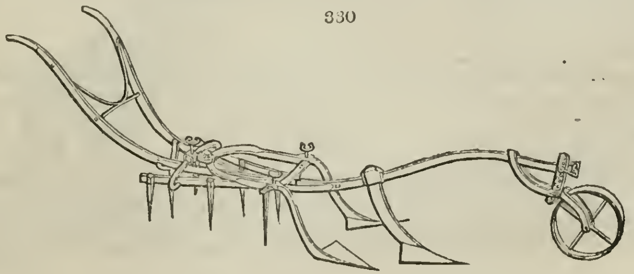

and the operation is repeated at intervals till the crop is thoroughly cleaned. The centre hoe is stationary, and the right and left expand and contract in the same manner as in the horse hoe. The depth is regulated by the wheel at the point of the beam, and may be varied from one to six inches. The hoes cut the bottom of the space between the drills completely, while the harrow following, pulverises the soil, and rakes out the weeds. Should circumstances require, the wings of the harrow may be taken off, and the hoes only used; or the hoes displaced, and the harrow only employed. This implement was invented by the late Mr. Wilkie of Uddingston, near Glasgow, in 1820, and is the first instance of the cycloid form being adopted in hoes or prongs. Afterwards Mr. Finlayson applied this form to his harrow; and subsequently Mr. Wilkie, junior, of Uddingston, to his admirable brake (2655.)

2667. *Finlayson's self-cleaning horse hoe and drill harrow* (*fig.* 331.) is an excellent

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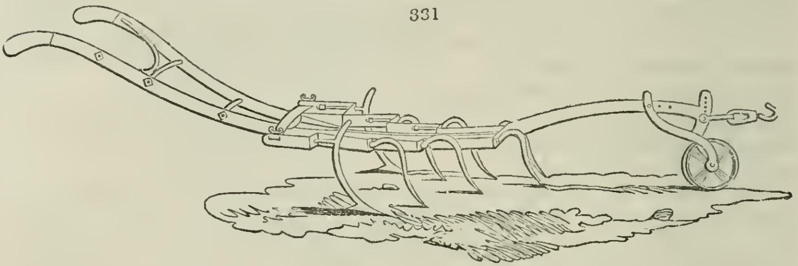

implement, and as a harrow is preferable to that of Wilkie (2665.), from whose implement it differs chiefly in being more a harrow than a hoe, and in every prong being calculated for cleaning itself.

2668. *Wilkie's horse hoe and drill plough* is considered an effective implement. The mould-boards are taken off when used as a horse hoe, and the hoes taken off and the mould-boards replaced when earthing up the crops; thus combining, in one implement, a complete horse hoe and double mould-board plough. A good horse hoe being the principal object in the construction of this implement, the method of fixing the hoes claimed particular attention, in order to combine lightness with strength and firmness, and admit, at the same time, of being set at different degrees of width and depth, all of which are accomplished on an improved principle. The wheel at the point of the beam regulates the depth; the right and left hoes are hinged, at the back end, to the handles of the plough, while by moving on the circular cross bar, on which they are fastened with wedges, they may be set to any width, from about twelve to nearly twenty-four inches.

2669. *Weir's expanding horse hoe* bears a considerable resemblance to Wilkie's implement. It has circular coulters, hoe-tines, and a double mould-board. When used for earthing up potatoes, the mould-boards and coulter are put on; when used as a hoe, the curved coulters are put in the expanding bar according to the width between the rows.

2670. *Blakie's inverted horse hoe* (*fig.* 332.) consists of a line of coulters set in a beam, and this beam attached to the axle of a pair of common wheels. It hoes several rows at once, and instead of being straight the coulters are all curved or kneed, and set back to back so as to include a row between each pair. The advantage of the kneed or bent form of the lower part of the coulter is, that the soil is pared off in a sloping direction from the plants, which are thus not so liable to be choked up with earth, as by a broad hoe or share; or to have their roots so much exposed to the air as by cutting perpendicularly down close to the row, by a common coulter. It is chiefly adapted for drilled corn, and then it works several rows: in turnips it may work one or two according to the soil; in all cases where the width between the rows admits, the agricultor should be more anxious

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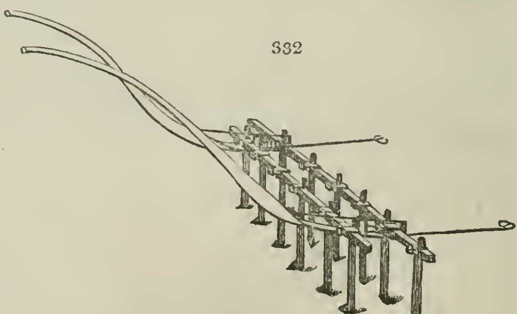

to stir the soil to a good depth than to skim over a great extent of surface, merely cutting over the weeds.

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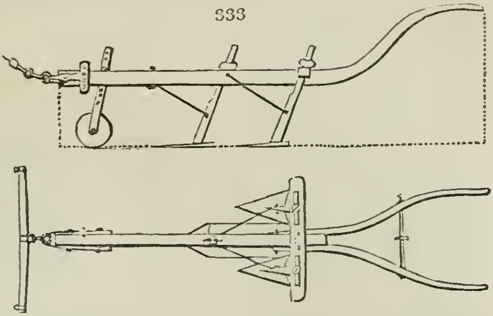

2671. *The Scotch horse hoe* (*fig.* 333.) has three hoes or shares, and is drawn by a single horse. By means of the wheel it can be set to go to any depth; and in hard surfaces, one share or more can be taken out, and coulters or bent prongs, as in the cultivator (*fig.* 325.), substituted.

2672. *The Northumberland horse hoe* (see *Report, &c.* p. 43.) is of a triangular form, and contains three coulters and three hoes, or six hoes, according to the state of the soil. In hoeing between drills of turnips, the two side coulters are used of a curved form. A hoe of the same kind is sometimes attached to a small roller, and employed between rows of wheat and barley, from nine to twelve inches distant; it is also used in place of a cultivator, in preparing bean-stubbles for wheat in autumn, and in pulverising lands for barley in spring.

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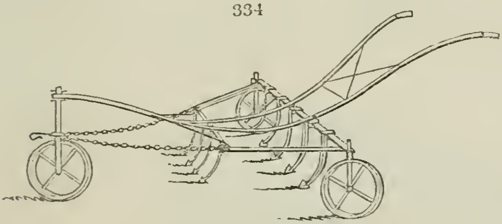

2673. *Henry's improved scarifier* (*fig.* 334.) is a strong light implement, which may be set to any width, and in foot soils will be found effective.

2674. *Amos's expanding horse hoe and harrow* (*fig.* 335.) is said to be much used in Lincolnshire. The hoe is constructed with expanding shares (*a a*), which can be

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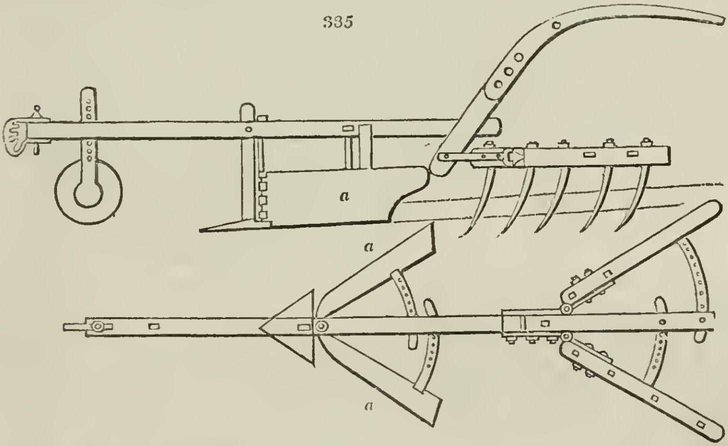

set to different distances, as it may be required, within the limits of twelve and thirty inches. The harrow which is attached to it is found advantageous in clearing lands from successive crops of weeds, as well as in bringing them to a proper state for the purpose of cropping; serving in this respect as a cultivator.

2675. *The hoe and castor wheel* (*fig.* 336.) is said to enable the holder to guide the shares more correctly between narrow rows of corn drilled on a flat surface. It is not often required, and must be unnecessary if the rows have been correctly sown.

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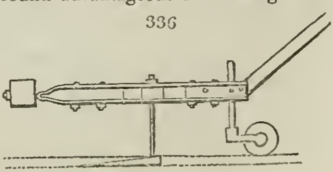

2676. *The thistle hoe or hoe scythe* (*fig.* 337.) is an invention by Amos. "It is used," he says, "for the purpose of cutting over thistles, and other injurious weeds in pasture lands. In the execution of the work it not only greatly reduces the expense, but executes it in a much closer manner than the common scythe. One man and a horse are said to be capable of cutting over twenty acres in a day. The leading share (*a*) is made of cast steel, in the form of an isosceles triangle, whose equal sides are fourteen inches long, and its base twelve inches; it is about one eighth of an inch thick in the middle, tapering to a very fine edge on the outsides; and the scythes (*b b b*) are fixed to four pieces of ash wood, three inches square, and two feet four inches long. These scythes are three feet long from point to point, four inches broad at the widest part, and made of cast steel. The agriculture, where such a machine as this is wanted, must surely be of a very rude and imperfect kind; for even supposing the machine to cut over the thistles, that operation cannot be so effectual as cutting them under the collar by hand with the spade or spud.

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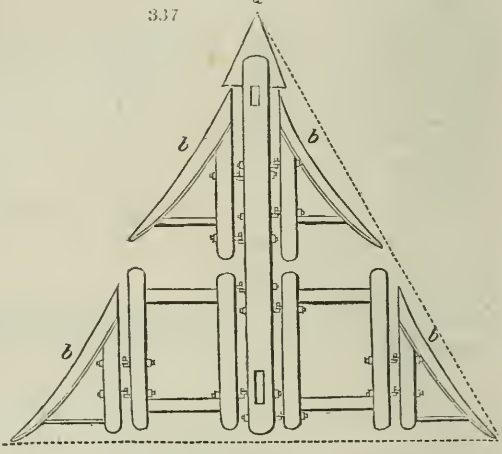

2677. *The only essential implements* of this class are those of Wilkie and Finlayson.

Sect. II. *Machines for Sowing and Planting.*

2678. *Machines for sowing or planting in rows* are very various, and often too complicated. Harte says, the first drill machine was invented by a German, and presented to the court of Spain in 1647; but it appears, from a communication to the Board of Agriculture, that a sort of rude drill or drill plough has been in use in India from time immemorial. Their use is to deposit the seed in equidistant rows, on a flat surface; on the top of a narrow ridge; in the interval between two ridges; or in the bottom of a common furrow. Corn, when drilled, is usually sown in the first of these ways; turnips in the second; and peas and beans in the third and fourth. The practice of drilling corn does not, however, seem to be gaining ground; and even where it is found of advantage to have the plants rise in parallel rows, this is sometimes done by means of what is called ribbing, a process more convenient in many cases than sowing with a drilling machine.

2679. Of *corn drills*, Cooke's improved drill and horse hoe (*fig.* 338.), though not the most fashionable, is one of the most useful implements of this kind on light dry soils, on even surfaces, and in dry climates. It has been much used in Norfolk and Suffolk, and many other parts of England. The advantages of this machine are said to consist, — 1. In the wheels being so large that the machine can travel on any road without trouble or danger of breaking; also from the farm to the field, &c. without taking to pieces. 2. In the coulter-beam (*a*), with all the coulters moving with great ease, on the principle of the pentagraph, to the right or left, so as to counteract the irregularity of the horses' draught, by which means the drills may be made straight; and, where lands or ridges are made four and a half, or nine and a half feet wide, the horse may always go in the furrow, without setting a foot on the land, either in drilling or horse hoeing. 3. In the seed supplying itself regularly, without any attention, from the upper to the lower boxes, as it is distributed. 4. In lifting the pin on the coulter-beam to a hook on the axis of the wheels, by which means the coulters are kept out of the ground, at the end of the land, without the least labour or fatigue to the person who attends the machine. 5. In going up or down steep hills, in the seed-box being elevated or depressed accordingly, so as to render the distribution of the seed regular; and the seed being

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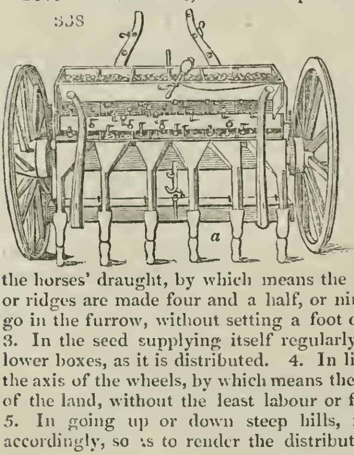

covered by a lid, and thus screened from wind or rain. The same machine is easily transformed into a cultivator, horse hoe (*fig.* 339.), scarifier, or grubber, all which

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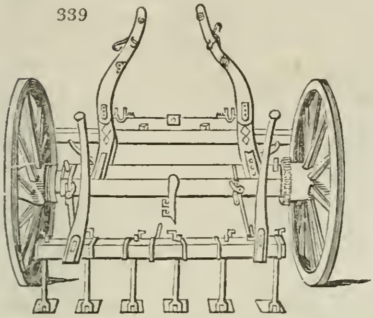

operations it performs exceedingly well; and by substituting a corn-rake, stubble-rake, or quitch-rake, for the beam of coulters, or hoes (*a*), it will rake corn-stubbles, or clean lands of root weeds. When corn is to be sown in rows, and the intervals hoed or stirred, we scarcely know a machine superior to this one; and from being long in a course of manufacture, few can be made so cheap. But these advantages, though considerable in the process of drilling, are nothing, when compared with those which arise from the use of the horse hoe; with which from eight to ten acres of land may be hoed in one day, with one man, a boy, and one horse, at a trifling expense, in a style far superior to, and more effectual than, any hand-hoeing whatever; also at times and seasons when it is impossible for the hand-hoe to be used at all.

2680. *The Norfolk drill*, or improved lever drill (*fig.* 340.), is a corn drill on a larger scale than Cooke's, as it sows a breadth of nine feet at once: it is chiefly used in the light soils of Norfolk and Suffolk as being more expeditious than Cooke's, but it also costs about double the sum.

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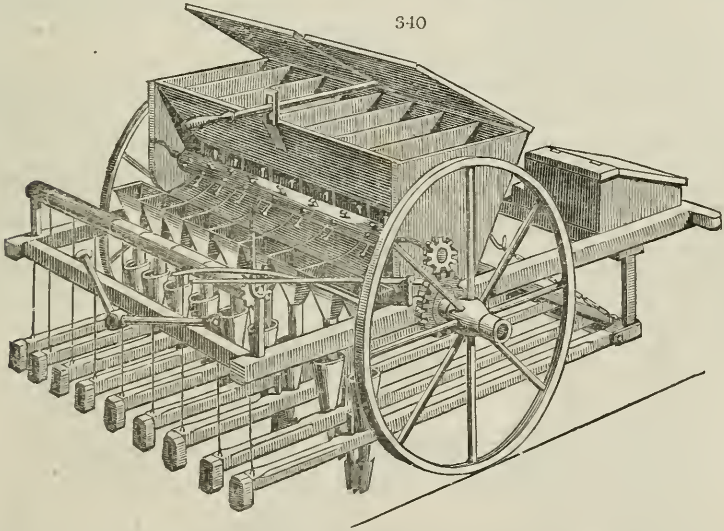

2681. *Cooke's three-row corn drill* is the large machine in a diminutive form, and is exceedingly convenient for small demesne farms where great neatness is attended to. It can be used as a cultivator, hoe, rake, &c., like the other.

2682. *Morton's improved grain drill-machine* (*fig.* 341.) is decidedly the simplest and

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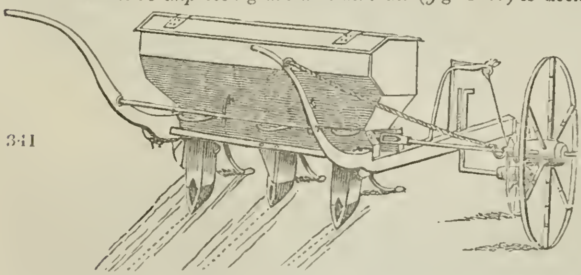

best of corn drills. In this machine three hoppers are included in one box, the seed escaping out of all the three by the revolution of three seed cylinders upon one axle; and drills of different breadths are produced simply by the shifting of a nut, that fixes a screw moving in a groove in the under-frame, by which the distance between the two outside conductors and the central one (which is fixed) can be varied from nine to ten or eleven inches; and that the two small wheels may always be at the same distances respectively as the conductors, there are two washers (hollow cylinders), an inch in breadth, on the axle-arms of each, which may be transferred either to the outside or inside of the wheels, so as to make their distances from the outside conductors nine, ten, or eleven inches respectively also. The small wheels may be raised or depressed, so as to alter the depth at which the seed shall be deposited, by the action of a wedge, which retains the upright part of the axle in any one of a number of notches, which are made similarly in both, and which are caught by an iron plate on the upper side of the arms which carry the axles. This machine may be still farther improved by increasing the number of conductors to five instead of three; the latter number giving too light work to the horses. (*Highland Soc. Trans.* vol. vii.)

2683. *Of bean drills* there are three kinds, all equally good: one for sowing in prepared drills or after the plough, which is pushed by manual labour, and has been already described (2574.): one attached to a light plough, which draws a furrow in prepared soil, and sows a row at the same time (*fig.* 342.); and one which can be fixed between the handles of any common plough for the same purpose. The former has a wheel (*a*) to regulate the depth of the furrow, and a lever (*b* to throw the drill out of gear on turning at the ends of the ridges. It is a useful and very effective implement; though a skilful ploughman will effect the same object by a drill placed between the handles of a common swing plough.

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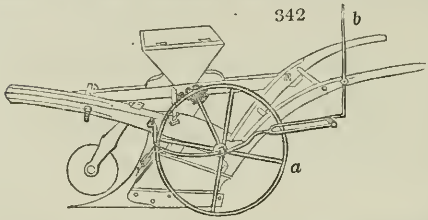

2684. *Weir's expanding bean drill to sow four rows* is affixed to a pair of wheels and axle, in the manner of Cooke's drill. The axle which passes through the drill boxes has four movable brushes and cylinders, by which means any widths, within that of the axle, can be given. Where ground is prepared and ribbed, and where there is not a Cooke's drill on the premises, this machine may be resorted to with convenience.

2685. *The block-plough drill* is an equiangular triangular block, 30 inches to a side, with cast-iron scuffler teeth and wooden blocks slipped over them. A field being ribbed or laid up in ridgelets with this implement, is next sown broadcast with wheat and bush-harrowed, by which the grain rises in rows, as accurately as if sown with the drill. (*Farm. Mag.* vol. xxiii. p. 406.)

2686. *Machines for dibbling beans,* impelled by manual l bour, have been already noticed (2574.). A horse dibbling machine (*fig.* 343.) has been invented, though very little used,

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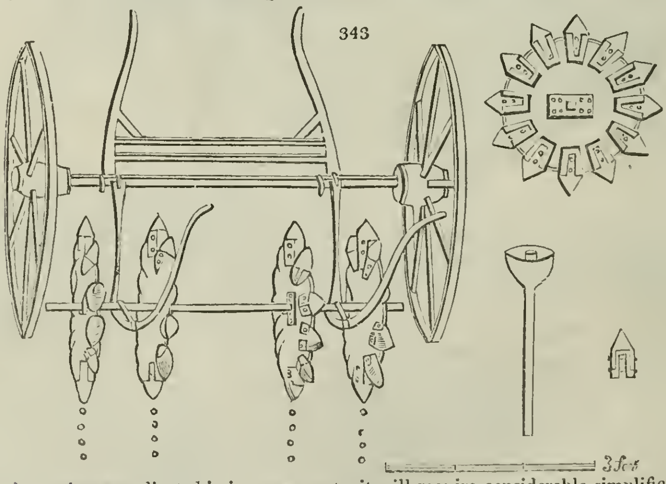

and being rather complicated in its movements, it will require considerable simplification before it can be recommended. A heavy cast-iron roller, with protruding angular rings, might form drills for the beans, and, probably, some machine of this sort might distribute them singly or nearly so, and at regular distances: but the best cultivators prefer sowing in drills, more thickly than in dibbling, in order to admit of a wide interval for culture, so as not only to clean the surface as between dibbled rows, but to stir and work the soil, and produce a sort of semi-fallow.

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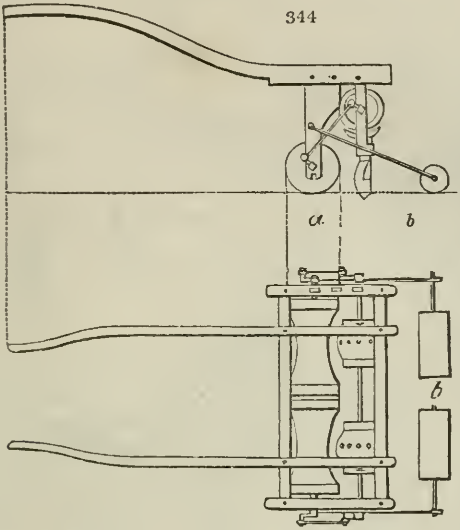

2687. Of *turnip drills*, the best, when this root is cultivated on a large scale, is the improved Northumberland drill. (*fig.* 344.) The roller (*a*) which goes before the seed has two concavities, and thus leaves the two ridgelets in the very best form for the seed; after these are sown, two light rollers (*b b*) follow and cover them. It is drawn by one horse, sows two rows at once, and seldom goes out of repair.

2688. *Common's (sometimes French's) turnip drill* (*fig.* 345.) is generally considered one of the best. Common was a cartwright at Denwick, near Alnwick, and received a medal from the Society of Arts, and twenty guineas from the Highland Society, for his invention, in 1818. He made the machine of wood; but iron being found so much more suitable and durable, the manufacture of Common's drills fell into the hands of blacksmiths, and chiefly of French of Alnwick, from which circumstance it is frequently known by that maker's name. The machine is easily put in and out of gear by means of a lever (*a*); and since it has become the fashion to sow pulverised manure with turnip seed, two hoppers (*b b*) have been added for that purpose. The seed and manure, when deposited in the gutter traced by the coulters (*c c*) are covered by two small flat rollers, as in the common Northumberland drill. Common's machine is not yet perfect; the seed is not measured out with sufficient accuracy, and it stands too high from the ground, gets top heavy, and on hill sides does not sow the seed in the middle of the drill furrow: it is best made with two wheels, which steadies it in all situations; the funnels, being still attached to the guards of the concave shifting rollers, deposit the seed with much more neatness and accuracy. (*J. C. R. near Alnwick.*)

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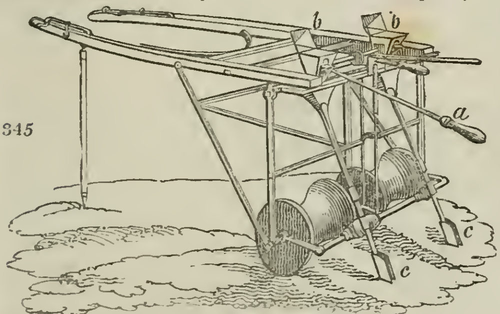

2689. *The Northumberland one-row turnip drill* (*fig.* 346.) has two wheels which run in the hollows on each side of the drill or ridgelet to be sown; by which means the sower is enabled to keep the row exactly in the centre of the drill. The ridgelets are previously rolled, either by a common or concave roller; the latter being preferable: and as the horse goes in the furrow at one side of the drill to be sown, of course he draws from one side of the draught-bar of the barrow. A small roller follows, and covers and presses in the seed. A recent improvement in this machine is the addition of a hopper (*a*) for pulverised manure, over which a barrel of water might easily be suspended, if deemed requisite.

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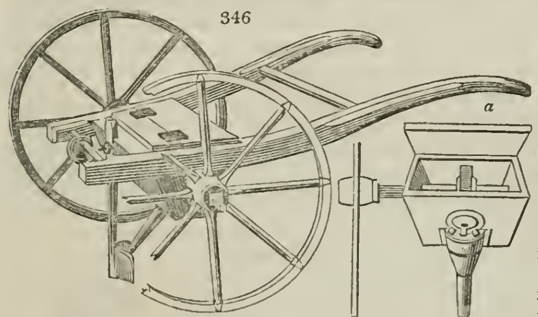

2690. *Weir's manuring one-row turnip drill* (*fig.* 347.) is a remarkable improvement on the Northumberland implement. It has a manure hopper (*a*) and a seed hopper (*b*), the same as the other; but the manure, in place of being dropped along with the seed, is deposited in a deep gutter made by a coulter (*c*) which goes before; this manure is covered by a pronged coulter (*d*) which follows the other; next comes the coulter

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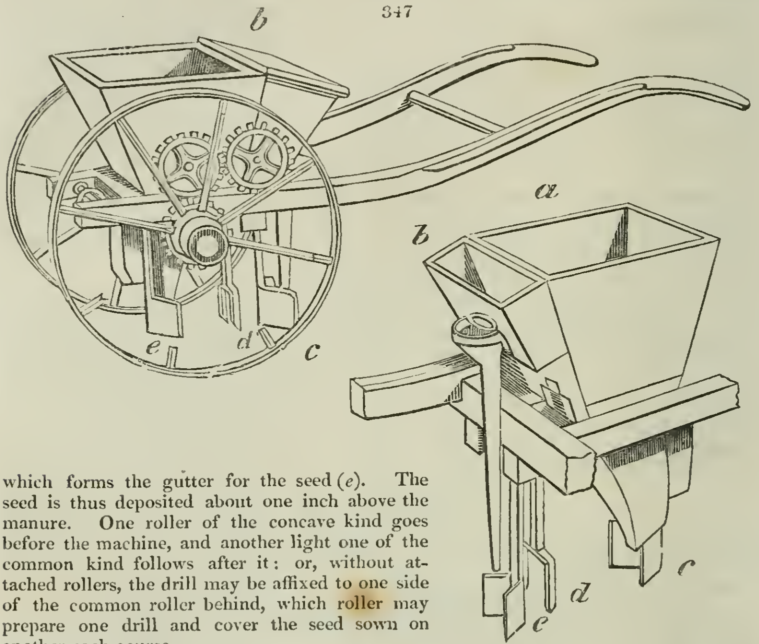

which forms the gutter for the seed (*e*). The seed is thus deposited about one inch above the manure. One roller of the concave kind goes before the machine, and another light one of the common kind follows after it: or, without attached rollers, the drill may be affixed to one side of the common roller behind, which roller may prepare one drill and cover the seed sown on another each course.

2691. *The drill roller* is so contrived as to form regular small incisions or drills in the ground, at proper depths for the seed. It is merely a common roller, mostly of iron, about seven feet long, about which are put cutting-wheels of cast iron, that turn round the common cylinder, each independently of the others, which cylinder generally weighs about a ton. It is drawn by three or four horses abreast, and driven by a man elevated behind them; the cutting-wheels, being movable, may be fixed at any distance, by means of washers; but the most common and favourite distance is four to six inches. It is said to have been found effectually productive of the principal benefits which have been derived from the operation of drill ploughs, or the practice of dibbling and setting the corn by hand, with the great advantage of saving both time and expense; as by the use of this simple machine, one man may sow and cover five or six acres of corn in one day, using for the purpose three horses, on account of its weight. It was at first chiefly used on clover or other grass leys on the first ploughing, but may be as properly employed on land which has been three or four times ploughed. The mode of working it is this: — " A clover ley or other ground being ploughed, which the cultivator intends for setting or dibbling with wheat, the roller is drawn across the furrows, and cuts the whole field into little drills, four inches asunder; the seed is then sown broadcast in the common quantity, and the land bush-harrowed; by which means the seed is deposited at one equal depth, as in drilling, and that depth a better one than in setting, and the crop rises free from the furrow-seams, which are the ill effects of common broadcast sowing, at least on a ley ploughed once." To us this machine, so much praised by some writers, seems merely an ingenious mode of increasing the expenses of culture. By the use of a plough, such as Small's, that will cut a square furrow, no machine of this sort can possibly become necessary. The land when ploughed will be left in little drills, and being sown broadcast, the seed will come up as if it had been drill-rolled or ribbed. It is admitted, however, that the pressure of the roller may be useful in soft lands, and may, possibly, keep down the wire-worm. For this purpose we have the pressing plough. (2715.)

2692. *The drill-watering machine* (*fig.* 348.) is an implement of recent invention by John Young, a surgeon, in Edinburgh. It is used for watering turnips and other drill crops in dry seasons; and promises to be a valuable assistant to the amateur agriculturist, in dry seasons or situations, or where it is an important object to secure a crop. It has been much approved of by the Highland Society of Scotland and the Dalkeith

Farmers' Society. (See *Farm. Mag.* vol. xxi. p. 1.) The machine consists of a barrel, which is mounted upon a cart frame, and discharges water from a ball stop-cock having

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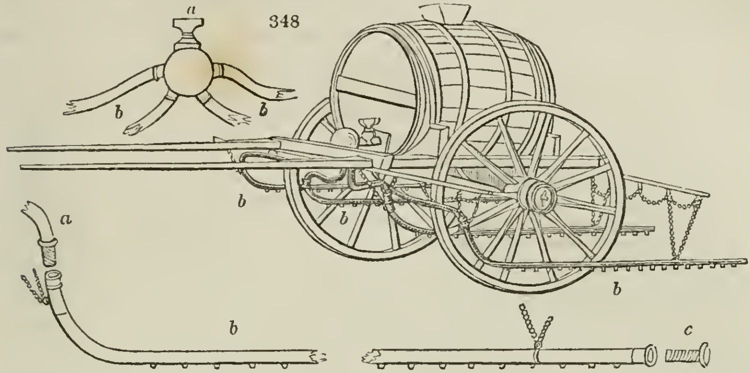

four mouths (*a*) communicating by means of a leathern hose with four horizontal tubes (*b b b b*), shut up at the end by a screw (*c*), which admits of the tube being cleaned. The tubes are placed parallel with the drills, two between the wheels of the cart, and one on the outside of each wheel; the distance of the tubes, and their height from the surface, are regulated by hooks and chains; and the water is discharged in small streams, through twenty projecting apertures in the under part of the tubes. The tubes are suspended by chains to the hooks in an iron rod secured to the fore and back part of the frame of the cart. The mouth of the funnel on the top of the barrel is covered with a wire-cloth, to prevent any thing getting in to clog the apertures. The quantity of water let out by the apertures being less than what is received into the tubes, the tubes are always full; by which a regular discharge is kept up from all the apertures at the same time. As the machine advances, the stream which falls from the first aperture upon the plants is followed up by successive streams from all the apertures in the tube; therefore each plant must receive the discharge from twenty apertures.

2693. *Estimate of its operation.* — Supposing the barrel to contain 200 gallons, and the tubes to be five feet long, the diameter of the tubes three eighths of an inch, and the diameter of the apertures in the tubes one sixteenth of an inch, 200 gallons will be discharged from 80 such apertures in two hours one third. The diameter of the mouths of the stop-cock must be equal to the diameter of the tubes. The horse, going at the rate of 2⅓ miles in one hour, in two hours and twenty minutes will go 5 miles five-sixths. The distance between four drills is 6 feet 9 inches; therefore, if we suppose a parallelogram to be 6 feet 9 inches broad, and 5 miles five sixths long, the area of this parallelogram will be 4 acres 3 roods 1·6 perches, which will be watered by 200 gallons in two hours and twenty minutes: and in one hour will be watered 2 acres 7·27 perches, supposing the water to flow uniformly; but the quantity given out upon the drills must be regulated by the progressive movement of the machine.

2694. *In construction* it is neither complicated nor expensive: it may be erected upon the frame of a cart used for other purposes in husbandry; and the barrel and apparatus may be furnished for about six pounds sterling, supposing the stop-cock and connecting-screws to be made of brass, and the tubes of copper or tin. This machine may be used for other purposes; such as the application of urine as a manure, or of a solution of muriate of soda, which has been proposed for some crops.

2695. *The best drill machines* are French's and Weir's for turnips, Morton's for corn, and the drill attached to a plough (2686.) for beans.

Sect. III. *Harrows or Pronged Implements for scratching the Surface Soil, for covering the Seed, and for other purposes.*

2696. *The harrow is an implement of equal antiquity with the plough*, and has of late years undergone so much improvement as to have originated that class of pronged implements known as cultivators, grubbers, &c. The original uses of the harrow seem to have been chiefly three: that of reducing or comminuting soil already stirred or ploughed; tearing root weeds out of such soil; and covering sown seeds. We shall confine ourselves in this section to these three uses. For the purpose of stirring the soil to the depth of eight or ten inches and tearing up weeds, no harrow is preferable to that of Finlayson, or Wilkie, in which the tines or prongs are of the cycloidal form. For the purpose of breaking and pulverising the surface of soils, straight prongs, and such as present by breadth or position greater resistance when drawn through the soil, are preferred. It is generally considered that prongs whose horizontal section, a few inches above the point, is a square or a parallelogram (*fig.* 349.) are best adapted for the attrition to which they are subject in being moved forward in a direction parallel to their

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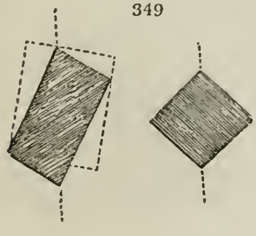

diagonals, and for resisting the lateral or shaking motion occasioned by encountering obstacles. (*Quart. Jour. Agr.* vol. ii. p. 555.) The principal parts of harrows are generally made of wood; but they are frequently also constructed entirely of iron.

2697. *The Berwickshire harrow* (*fig.* 350.) is the most perfect implement of the kind in general use. It consists of two parts joined together by iron rods, having hasps and hooks. Each part consists of four bars of wood technically termed bulls, and connected together by an equal number of cross bars of smaller dimensions mortised through them. The former of these bars may be $2\frac{1}{2}$ inches in width by 3 inches in depth, and the latter 2 inches in width by 1 inch in depth. The longer bars are inclined at a certain angle to the smaller, so as to form the figure of a rhomboid, and they have inserted into them the teeth at equal distances from each other. This inclination of the longer bars is made to be such, that perpendiculars from each of the teeth, falling upon a line drawn at right angles to the line of the harrow's motion, shall divide the space between each bar into equal parts; so that the various teeth, when the instrument is moved forward, shall equally indent the surface of the ground over which they pass. (*Quart. Jour. Agr.*)

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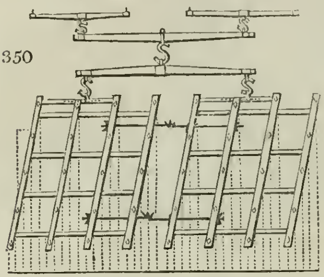

2698. *The angular-sided hinged harrow* (*fig.* 351.) is one of the best implements of the kind, as it both operates on the ground with great regularity, and is less liable to ride or be deranged in turning, than the common, or the rhomboidal harrow.

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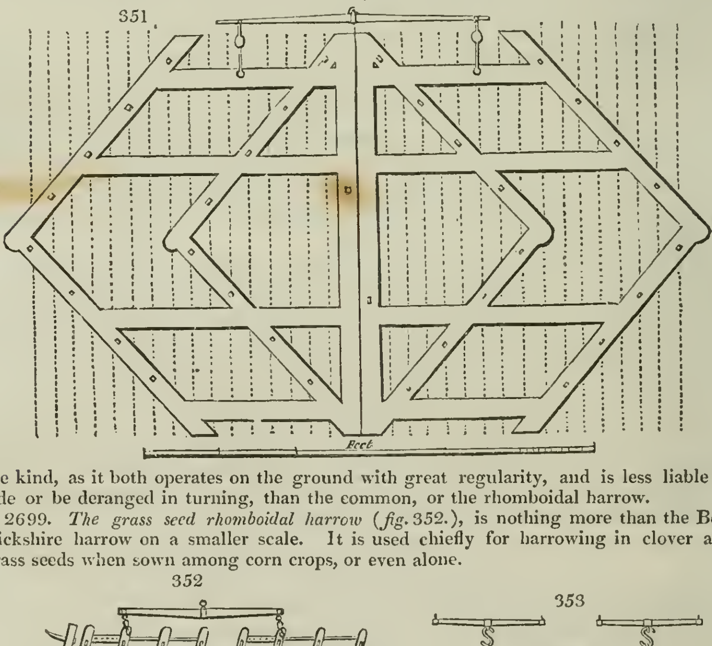

2699. *The grass seed rhomboidal harrow* (*fig.* 352.), is nothing more than the Berwickshire harrow on a smaller scale. It is used chiefly for harrowing in clover and grass seeds when sown among corn crops, or even alone.

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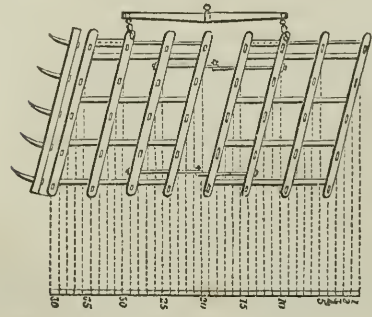

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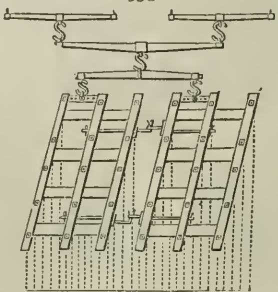
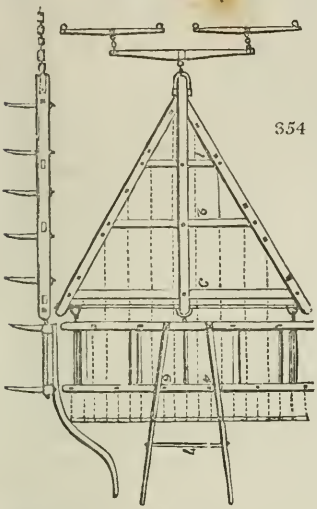


2700. *The common brake* (*fig.* 353.) is merely a harrow of the common kind, of greater weight and dimensions than necessary for ordinary soils. Its use is to reduce the stronger clays, at a time when they are too obdurate to be impressed with the teeth of the common harrow. The levelling brake, or grubber, is generally considered the preferable implement for this purpose.



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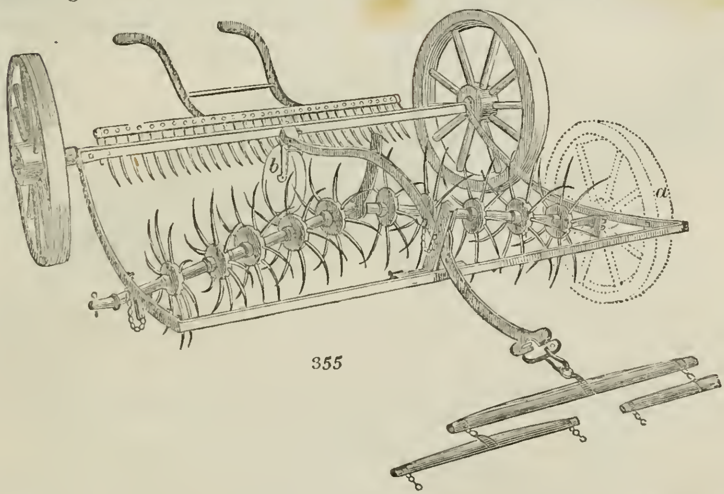
2701. *The brake, grubber, or levelling harrow* (*fig.* 354.), is a valuable implement on strong clayey soils. It consists of two frames, the one triangular and the other oblong. By means of the handles, the oblong part of this brake can either be raised up or depressed; so that when the ground is cut in small pieces by the teeth of the triangular harrow, then the oblong harrow following, its teeth, being pressed down into the high parts, carry or drag part of the soil off from the heights; and, when they are raised up by the handles, leave that soil in the hollow or low parts. By this means, the ground is brought nearly to one plain surface, whether that surface be horizontal or sloping. Sometimes it may be found necessary to place a greater number of teeth in the oblong part of the brake, so that they may be nearer to one another, and perform the operation more effectually. The teeth are made sharp or thin on the fore edge, for cutting; broad and thick on the back, for strength; and tapering, from a little below the bulls to their joints.

2702. *Morton's revolving brake harrow* (*fig.* 355.) is a very powerful implement in strong clayey soils infested with couch. When the implement is to be moved from one field to another, the large wheels may be brought forward (*a*), to support the tines from the ground, while the hind axle and the rake are supported by a castor or truck-wheel (*b*). In most soils, four horses and a driver and holder are necessary to work this instrument; which, however, no good farmer will ever require the aid of, unless it be when entering upon land which has been allowed to run wild, or clay of an extraordinary degree of tenacity. We have seen it extensively and advantageously used, on the latter description of soil, by Mr. Dickson of Kidbrook farm, Blackheath, Surrey. (*Gard. Mag.* vol. iv. p. 186.)



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2703. As *substitutes* for the last two implements, may be mentioned Finlayson's harrow (2657.), Wilkie's brake (2656.), and Kirkwood's improved grubber, which will be afterwards figured and described, the invention being only made public while the present sheet is passing through the press (February 15.). Bartlett's cultivator, Brown's cross-cutting machine, the Sythney scarifier, and the spiky roller, noticed in next section, are used for a part of the purposes of the last two implements.

2704. *Gray's seed-harrow for wet weather* (*fig.* 356.) promises to be useful in certain situations, as in a tenacious retentive soil and moist climate. The sowing of wheat, under existing circumstances, is one of the most important branches of the corn farmer's labour. In some backward seasons, it is almost impossible to get wheat land harrowed according to the common method, especially land that has been reduced by summer fallow, without subjecting it to poaching from the horses, which is not only unfavourable to the soil, but also occasions a great waste of seed. Hence it often happens, that a less quantity of grain is got sown than was intended, or is requisite for the supply of the market. The beam (*a*) to which the harrows are attached admits of being made shorter or longer as the width of the ridge requires; the shafts have freedom to turn round either to the right hand or to the left, and the teeth of the harrows are placed square in the bulls, so that they can be drawn from either end at pleasure. The wheels (*fig.* 357.) may be from three to four feet in diameter if made on purpose; but for the professional farmer it will be sufficient to borrow a pair from a one-horse cart.

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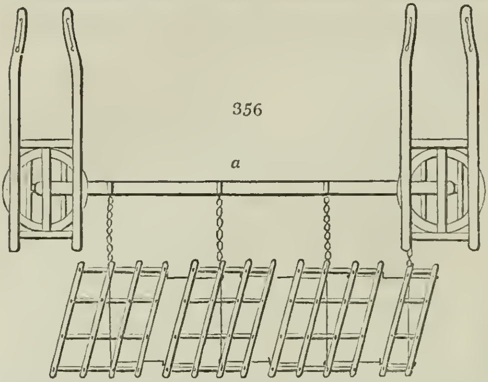

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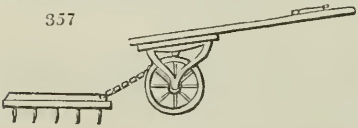

2705. *The bush harrow* (*fig.* 358.) is used for harrowing grass lands to disperse roughnesses and decaying matter; and it is also sometimes used for covering grass or clover seeds. Small rigid branches of spray are interwoven in a frame, consisting of three or more cross bars, fixed into two end-pieces in such a manner as to be very rough and bushy underneath. To the extremities of the frame before are sometimes attached two wheels, about twelve inches in diameter, upon which it moves; sometimes, however, wheels are not employed, but the whole rough surface is applied to, and dragged on, the ground.

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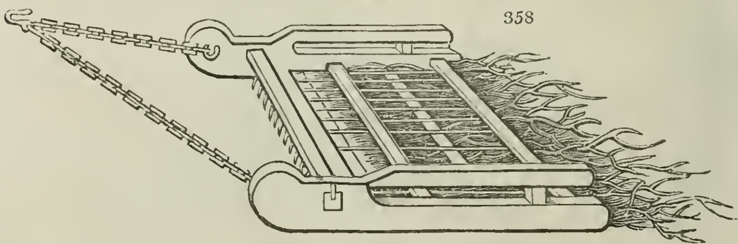

2706. *The only essential implement of the harrow kind* is the Berwickshire harrow. (*fig.* 350.)

Sect. IV. *Rollers.*

2707. *The roller* is constructed of wood, stone, or cast iron, according to convenience or the purposes for which it is to be used. For tillage lands, the roller is used to break the lumps of earth, and in some cases to press in and firm the ground about newly sown seed; on grass lands it is used to compress and smooth the surface, and render it better adapted for mowing. It has been matter of dispute whether rollers with large or small diameters have the advantage in point of effect upon the land. In constructing heavy rollers, they should not have too great a diameter, whatever the material be of which they are formed, as the pressure is diminished where the implement is of very large size, by its resting on too much surface at once, except an addition of weight in proportion be made. By having the roller made small, when loaded to the same weight, a much greater effect will be produced, and a considerable saving of expense be made in the construction of the implement. The common length of rollers is five or six feet, and the ordinary diameter from fifteen to thirty inches; but those employed for flattening one-bout ridges, in order to prepare them for drilling turnips upon, are commonly shorter, and of much less diameter. Large rollers should have double shafts, in order that they may be drawn by two horses abreast; and such as are employed for arable lands should have a scraper attached to them. Strong frames are also necessary for rollers, so that proper weights may be put upon them; and open boxes or carts (*fig.* 359.) placed upon them may sometimes be requisite, in order to contain any additional weight that may be thought proper, as well as to receive stones or other matters that may be picked up from the ground. Pieces of wood or stone, as heavy as a man can lift, are the most suitable substances for loading these implements with, where they have not the advantage of boxes for receiving loads.

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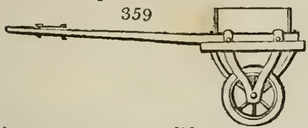

2708. *The parted cast-iron roller* was invented to remedy the inconvenience experienced in the use of the common implement, in turning at the ends of ridges or other places, where, from the roller not moving upon its axis, but being drawn along the surface of the ground, it is liable to bear it up, and make depressions before the cylinder comes again into the direct line of draught; and at the same time it is not brought round without great exertion in the teams. The cylinder, in two pieces (*fig.* 362. *a a*), obviates this inconvenience, by enabling the two parts to turn round on their own axis, the one forward, and the other in a retrograde direction.

2709. *The spiky or compound roller* is occasionally employed in working fallows, or preparing stiff bean-land for wheat. In stiff clay-ground, when ploughed dry, or which has been much trod upon, the furrow-slice will rise in large lumps, or hard clods, which the harrow cannot break so as to cover the seed in a proper manner. In this state of the ground, the rollers commonly used have little effect in breaking these hard clods. Indeed, the seed is often buried in the ground, by the clods being pressed down upon it by the weight of the roller. To remedy this, the spike-roller has been employed, and found very useful; but a roller can be made, which, perhaps, may answer the purpose better than the spike one. This roller is formed from a piece of hard wood, of a cylindrical form, on which are placed several rows of sharp-pointed darts, made either of forged iron, or cast metal. These darts, by striking the hard clods in a sloping direction, cut or split them into small pieces; and, by this means, they must be more easily pulverised by the harrow.

2710. *Bartlett's cultivator* (*figs.* 360. and 361.) is an implement of the roller kind,

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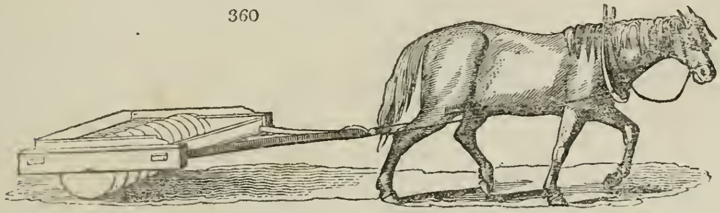
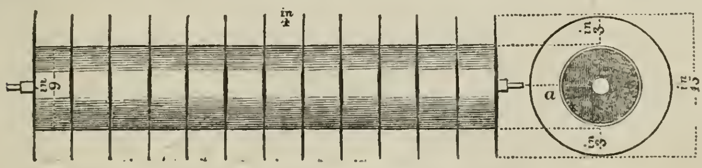


said to be useful in preparing wet land for tillage in Cornwall. It consists of a roller composed of 13 thin iron plates, each fastened to a circular block of wood of four



inches in thickness, and nine inches in diameter, and bound round with iron. Both blocks (*a*) and plates (*b*) are movable on an iron axle; and though Mr. Bartlet, the inventor, has adopted a diameter of nine inches for the blocks, and fifteen inches for the plates, yet these dimensions may be increased or diminished at pleasure. The frame in which the roller is inserted has a bar, on which are fixed scrapers of iron, which keep the roller continually clean. (*Gard. Mag.* vol. v.)

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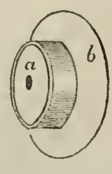

2711. *The roller and water box* (*fig.* 362.) is sometimes used for watering spring crops, or clovers, with liquid manure, previously rolling them. It has the advantage of

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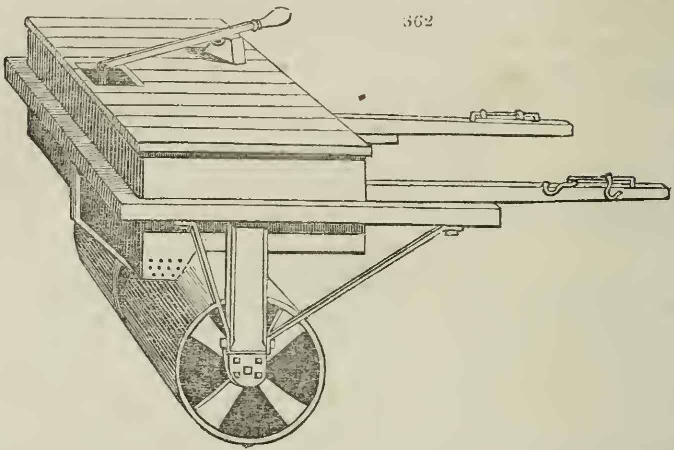

a more perfect machine, in the holes being easily cleaned when choked up with the thickened water.

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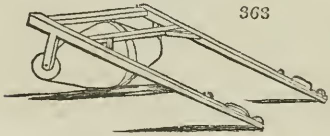

2712. *The furrow-roller* (*fig.* 363.) is contrived for the purpose of rolling the furrows in steep hilly situations, and other places where the common roller cannot be employed.

2713. *The Norfolk drill-roller*, and the ridge and furrow concave or scalloped roller attached to certain turnip-drills, have already been depicted. (2680. and 2688.)

2714. *The pressing plough* is a term erroneously applied to a machine of the roller kind (*fig.* 364.) It generally consists of two cast-iron wheels, for the purpose of impressing two small seed gutters or drills on the furrow slices turned over by the common plough, and a third wheel for running in the bottom of the furrow for the purpose of keeping the machine steady. The wheels are kept clean by scrapers. (*fig.* 365.) This implement is used in breaking up clover leys for wheat. two ploughs follow each other; and after them one horse, walking in the furrow, drags the pressing plough. The advantages are said to be a firm bed for the seed, by which it is not liable to be thrown out in the winter season, and not so liable to be attacked by the grub and wire worm; and the rising of the plants in rows, by which means they may be hoed or harrowed between.

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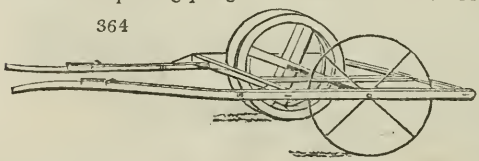

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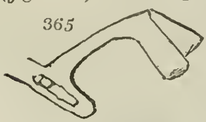

2715. *Brown's cross-cutting machine* (*fig.* 366.) is used for cross-cutting the furrows of rough, mossy, and heathy land, in order to reduce the soil to a state fit for receiving the seed. It consists of a series of parallel iron plates, or blades as they may be termed, fixed in a frame-work of wood, by the weight of which, and the pressure on the shafts by the driver, they are forced into the ground. The frame consists of oak; and the main beams are 4 feet long, 6 inches deep, and 5 inches broad, with cross bars of proportional strength. The handles are $6\frac{1}{2}$ feet long. The blades are of good foreign iron, 4 feet 3 inches

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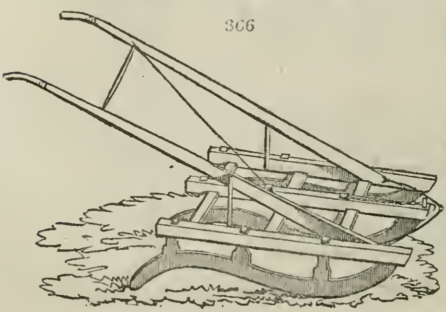

long, $3\frac{1}{2}$ inches broad, and five eighths of an inch thick at the back. The curves of the blades are formed to a circle of 40 inches diameter. (*High. Soc. Trans.* vol. vii.)

2716. *The Sithney scarifier, or hash,* consists of a cylinder with many circular cutters, or a number of circular cutters connected together upon one axis, which is intended to pass over the ground, for the purpose of scarifying or cutting the surface of grass land, perpendicularly, to the depth of a few inches, and to any required degree of fineness. By means of this scarifier, or hash, the roots of old grass may be effectually destroyed, without the labour of ploughing, which is calculated to enable the farmer to graze the land much longer, previously to breaking it up for wheat or turnip tillage. The apparatus is proposed to be connected to the hinder part of an ordinary cart; or the axis of the cylinder, or circular cutters, may be supported by two iron arms, attached to the axletree with a pair of common carriage wheels. When this machine is used for renewing lawns or grass land, it will then be necessary to fix above the cutters a box containing grass seed; which box must be perforated with small holes, one hole being exactly over every cutter, so that the seed may fall immediately into the furrow produced by the cutter. (*Newton's Journal,* vol. i. p. 250.)

2717. *The only essential roller* for general purposes is the parted cast-iron roller, with a scraper and box over (*fig.* 359.).

Sect. V. *Machines for laying Land even, and other occasional or anomalous Tillage Machines.*

2718. *Various machines* for agricultural purposes are occasionally brought into notice by amateur cultivators, and some even by the professional farmer. It forms, indeed, the privilege and the characteristic of wealth and intelligence, to procure to be made whatever particular circumstances may require, in every department of the mechanical agents of culture. We shall only notice a few, and that chiefly for the purpose of showing the resources of the present age.

2719. *Of machines for laying land level* two may be noticed: in the first and best (*fig.* 367.), the horses are harnessed to a pole (*a*), which is joined to an axle having a pair of low wheels (*b c*). Into this axletree are mortised two long side-pieces (*d*), terminating in handles (*e e*). Somewhat inclined to these long or upper side pieces, shorter lower ones are joined by cross pieces, and connected by strong side-boards. The machine has no bottom; its back part (*f*) is strongly attached to an axle (*fig.* 368. *g*), and to the bottom of this the scraper part (*h*) is firmly screwed. The front ends of the slide irons (*fig.* 367. *m*), turning up, pass easily through mortises in the upper side-pieces (*d*), where, by means of pins, the inclination of the slide irons and of the back board can be adjusted within narrow limits, according to the nature of the soil to be levelled and the mass of earth previously loosened by ploughing. This earth the back board is intended to collect and force before it, until the machine arrives at the place where it is intended to be deposited. Here, by lifting up the hinder part of the machine by its handles (*e e*), the contents are left on the ground, and the machine proceeds to a fresh hillock. (*Supp. Encycl. Brit.* i. 25.)

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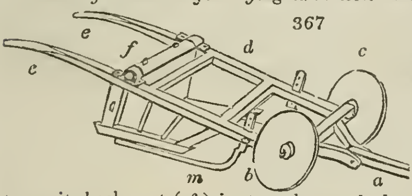

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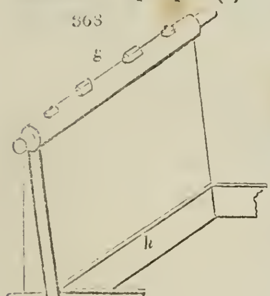

2720. *The Flemish levelling machine* (*fig.* 369.) may be considered as a shovel, on a large scale, to be drawn by a pair of horses; it collects earth at the pleasure of the holder, who contrives to make the horses turn over the shovel and empty the contents by merely letting go the handle (*a*), and recovering it by means of a cord (*b*), when emptied, as already described. (508.)

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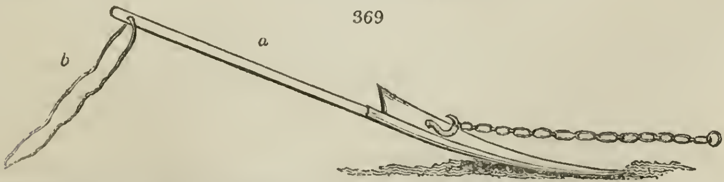

2721. *The levelling harrow* (2701.) is adequate to all ordinary purposes.

Sect. VI. *Machines for reaping and gathering the Crop.*

2722. *The horse machines* of haytime and harvest are chiefly the horse rakes, the hay tedder, and the reaping machine.

Subsect. 1. *Horse Rakes and Haymaking Machines.*

2723. *Raking machines* are not in very general use; but, where corn is mown, they are successfully employed in drawing together the scattered stalks, and are also of great use in haymaking. The saving in both cases consists in the substitution of animal for manual labour.

2724. *The common or Norfolk horse rake* (*fig.* 370.) is employed for barley and oat crops, and also for hay. One man, and a horse driven by means of a line or rein, are capable of clearing from twenty to thirty acres in a moderate day's work; the grain being deposited in regular rows or lines across the field, by simply lifting up the tool and dropping it from the teeth, without the horse being stopped.

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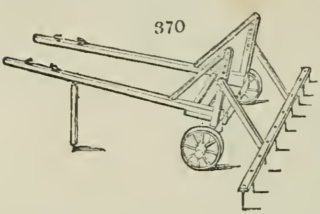

2725. *The horse stubble-rake* is a large heavy kind of horse rake, having strong iron teeth, fourteen or fifteen inches in length, placed at five or six inches from each other, and a beam four inches square, and eight or ten feet in length. In drawing it two horses are sometimes made use of, by which it is capable of clearing a considerable quantity of stubble in a short time. In general, however, it is much better economy to cut the stubble as a part of the straw.

2726. *The couch-grass rake* differs little from the last, and is employed in fallowing very foul lands, to collect the couch-grass or other root weeds. It may be observed, however, that where a good system of cultivation is followed, no root weeds will ever obtain such an ascendency in the soil as to render an implement of this kind requisite.

2727. *Weir's improved hay or corn rake* (*fig.* 371.) is adjusted by wheels, and is readily put in and out of gear by means of the handles (*a a*) and bent iron stays (*b b*). It is drawn by one horse in shafts (*c*), and is a very effective implement.

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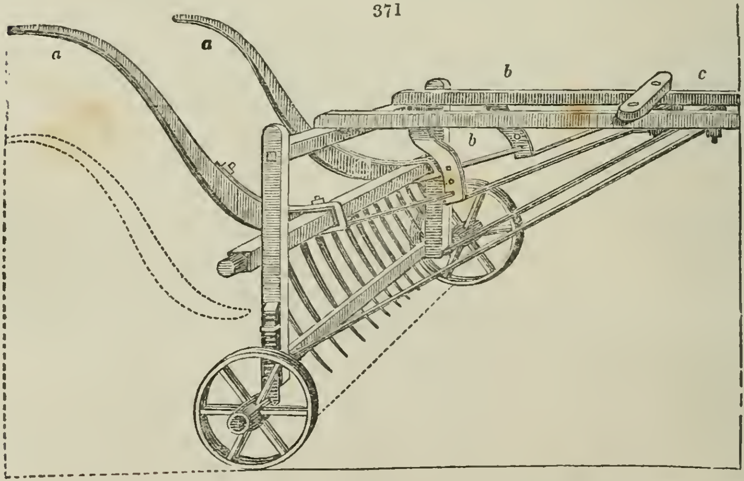

2728. *The hay-tedding machine* (*fig.* 372.), invented about 1800, by Salmon of Woburn, has been found a very useful implement, especially in making natural or meadow hay, which requires to be much more frequently turned, and more thinly spread out, than hay from clover and rye grass. It consists of an axle and pair of wheels, the axle forming the shaft of an open cylindrical frame, formed by arms proceeding from it, from the extremities of which bars are stretched, set with iron prongs, pointing outwards, and about six inches long, and curved. There is a crank by which this cylinder of prongs is raised from the ground, when the machine is going to, and returning from, the field;

or when it is not wanted to operate. It is drawn by one horse, and, on the whole, answers as a tedding machine perfectly. In the neighbourhood of London, where

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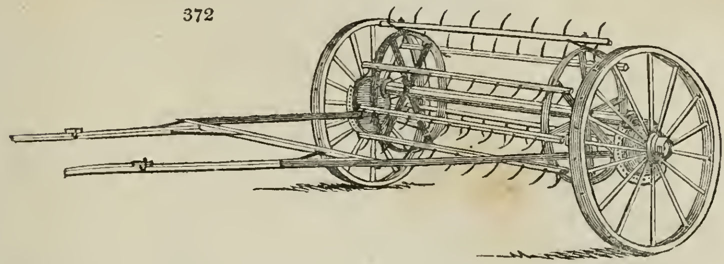

meadow hay is so extensively made, it is found to produce a great saving of labour, and is now coming into very general use.

2729. *The hay swoop or sweep* (*fig.* 373.) is an implement for drawing or sweeping accumulations of hay to the cart or rick, or to any larger accumulations. Sometimes a rope is merely put round the heap, especially if it has been a few days in the cock, or piled up; but the most general hay swoop consists of two curved pieces of wood, six or eight feet long, joined by upright pieces, so as to form something like the back of a chair. To the four corners of this, ropes are attached, which meet in the hook of a one-horse whipple-tree (*a*).

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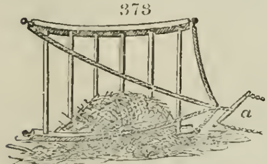

2730. *Snowden's leaf-collecting machine* is for the purpose of collecting dead leaves from lawns, parks, and pleasure-grounds, and has been employed in the King's grounds at Hampton Court. The apparatus consists of a large cylindrical tub, about five feet in diameter, and seven feet long, which swings upon an axle, and is open at top, in order to receive the leaves as they are collected. The collectors are hollow iron scoops, or scrapers, attached to bars, extending across the machine from two iron hoops, which work round the cylindrical receiver, and, as they revolve, scrape the ground, collect the leaves together, lift them up, and turn them over into the tub. The collectors or scoops (*fig.* 374.) are made of many distinct pieces, set in rows, with springs behind each, by which any part of the scraper is enabled to give way, should it come in contact with a stone, in a manner similar to the rake bars of a haymaking machine. The hoops carrying the scrapers are lowered and adjusted to meet the ground, by having their pivots supported in a lever attached to the carriage, upon which it is adjusted by means of a circular rack and pinion. The scrapers are carried round as the carriage moves forward, by means of a spur-wheel, upon the nave of one of the carriage wheels, which works into a cog wheel upon the axis of the scraper-frame. This apparatus is designed, beside cleaning parks and lawns of dead leaves, to remove snow from the walks, to scrape and clean roads, and for several other useful purposes. (*Newton's Journal*, vol. i. p. 203.)

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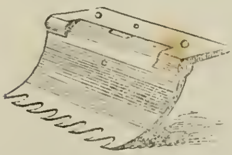

Subsect. 2. *Reaping Machines.*

2731. *Though reaping machines*, as we have seen (133.), are as old as the time of the Romans, one of an effective description is yet a desideratum in agriculture; unless the recent invention of the Rev. Patrick Bell can be considered as supplying that desideratum. The high price of manual labour during harvest, and the universal desire in civilised society of abridging every description of labour, will doubtless call forth such a reaping machine as may be employed in all ordinary situations; and this is, perhaps, all that can be desired or expected. Corn laid down, or twisted and matted by wind and rain, or growing among trees, or on very irregular surfaces, or steep sides of hills, will probably ever require to be reaped by hand. But independently of the high price of labour, despatch, as an able author observes (*Supp. Encyc. Brit.* i. 118.), is a matter of great importance in such a climate as that of Britain. In reaping corn at the precise period of its maturity, the advantages of despatch are incalculable, especially in those districts where the difficulty of procuring hands, even at enormous wages, aggravates the danger from the instability of the season. It cannot, therefore, fail to be interesting, and we hope it may be also useful, to record some of the more remarkable attempts that have been made towards an invention so eminently calculated to forward this most important operation.

2732. *The first attempt at a reaping machine*, so far as we have learned, was made by Boyce, who obtained a patent for a reaping machine early in the present century. This machine was placed in a two-wheeled carriage, somewhat resembling a common cart, but the wheels were fixed upon the axle, so that it revolved along with them. A cog-wheel, within the carriage, turned a smaller one at the upper end of an inclined axis, and at the lower end of this was a larger wheel, which gave a rapid motion to a pinion fixed upon a vertical axis in the forepart of the carriage, and rather on one side, so that it went before one of the wheels of the carriage. The vertical spindle descended to within a few inches of the surface of the ground, and had there a number of scythes fixed upon it horizontally. This machine, when wheeled along, would, by the rapid revolution of its scythes, cut down a portion of the corn growing upon the ground over which it passed; but having no provision for gathering up the corn in parcels and laying it in proper heaps, it was wholly unsuited to the purpose.

2733. *An improvement on this attempt* was made by Plucknet, an agricultural implement-maker of London, some years afterwards. The principal alteration he made was in substituting for the scythes a circular steel plate, made very sharp at the edge, and notched at the upper side like a sickle. This plate acted in the same manner as a very fine toothed saw, and was found to cut the corn much better than the scythes of the original machine.

2734. *A machine, invented by Gladstone of Castle Douglas*, in the stewartry of Kircudbright, operated upon nearly the same principles with Plucknet's; but Gladstone made his work much better by introducing a circular table, with strong wooden teeth notched below, all around, which was fixed immediately over the cutter and parallel to it. The use of these teeth was to collect the corn, and retain it till it was operated on by the circular cutter. The corn, when cut, was received upon this table; and, when a sufficient quantity was collected, taken away by a rake or sweeper, and laid upon the ground beneath the machine, in separate parcels. To this machine was added a small circular wheel of wood, covered with emery, which, being always kept in contact with the great cutter at the back part, or opposite side to that where the cutting was performed, kept it constantly ground to a sharp edge.

2735. *Salmon of Woburn made the next attempt;* and his invention, it is said, promised better than those we have mentioned. It was constructed upon a totally different principle, as it cut the corn by means of shears; and it was provided with a very complete apparatus for laying it down in parcels as it was cut.

2736. *The next machine* (*fig.* 375.), and one of great ingenuity and promise, is that constructed by

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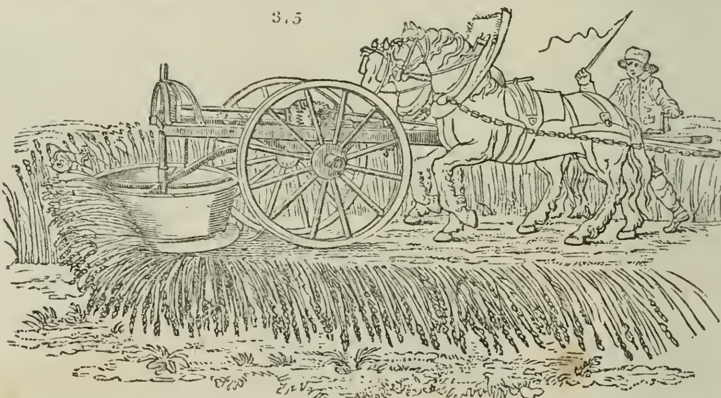

Smith, of the Deanston Cotton Works, Perthshire. Smith's perseverance, his successive improvements, and ingenious yet simple contrivances for remedying defects, afforded strong grounds to hope that he would ultimately succeed in rendering his machine a most valuable acquisition to agriculturists; but various circumstances have prevented Mr. Smith from perfecting his invention. He made the first trial of his machine upon a small scale, during the harvest of 1811. It was then wrought by two men. In 1812 he constructed one upon a larger scale, to be wrought by a horse; but, though he cut down several acres of oats and barley with considerable ease, it was found that when met by an acclivity the horse could not move the machine with proper effect. In 1813 he made a more successful attempt, with an improved machine, worked by one man and two horses; and (1814) it was still farther improved by an additional apparatus, tending to regulate the application of the cutter when working on an uneven surface. This ingenious machine has been again tried, in September 1815, and with much success. A Scotch acre ($1\frac{1}{4}$ acre English) of beans was cut down with ease in an hour and a quarter. The trials made with it on wheat, though not extensive, were satisfactory; and in reaping oats, the corn was laid down in the most regular manner. The cutter of this machine is circular, and operates horizontally; it is appended to a drum connected with the forepart of the machine, its blade projecting some inches beyond the periphery of the lower end of the drum; and the machine is so constructed as to communicate, in moving forward, a rapid rotatory motion to this drum and cutter, by which the stalks are cut, and, falling upon the drum, are carried round and thrown off in regular rows. This most ingenious piece of machinery will cut about an English acre per hour, during which time the cutter requires to be four times sharpened with a common scythe stone. The expense of this machine is estimated at from thirty to thirty-five pounds. If properly managed it may last for many years; only requiring a new cutter every two or three years, a repair which cannot cost much. This promising invention, which attracted a good deal of notice a few years ago, remains, it is believed, as it was then, in a state not calculated for extensive use. Mr. Smith's large concerns in the cotton manufacture may have prevented him from continuing his experiments; and it is understood that the time he has already devoted to it has been without sufficient remuneration or encouragement.

2737. *Bell's reaping machine* (*figs* 376. and 377.) is the most recent as well as the most perfect invention of this description. The frame-work of this machine (A A) may be made lighter or stronger according to circumstances; B B and C C are four wheels upon which it is mounted, of whatever form it is made; B B have their spokes at right angles to their naves, and are $3\frac{1}{2}$ feet diameter. For neatness' sake the naves are made of cast-iron; the wheels are from five to six inches broad at the rims, and are surrounded with a slight hoop of iron. Were they made narrower in the rims, when the ground was soft they would both cut it, and drag, without giving motion to the connected parts of the machinery. The small wheels (C C), which support the front of the frame, are (like the large ones B B) made of wood: they are fourteen inches in diameter, and six inches broad at the rims, with a very slight hoop of iron round them. Their axles, which are of iron, are screwed to the frame, and are about $1\frac{1}{4}$

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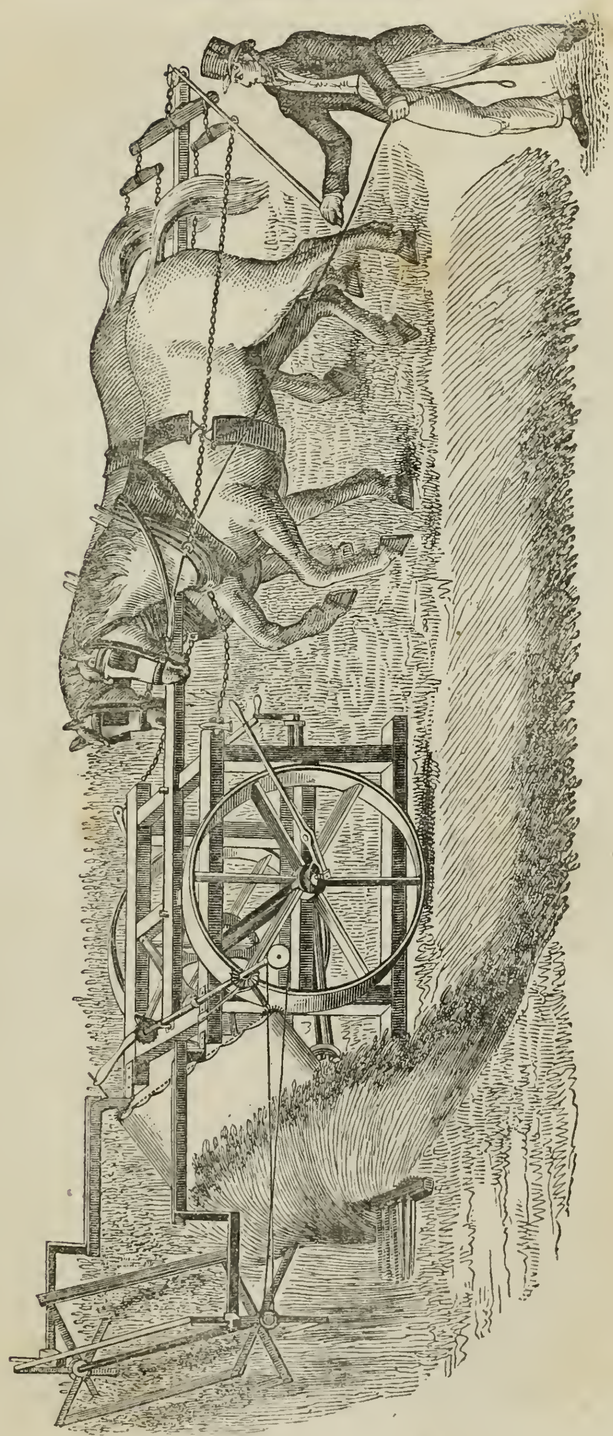

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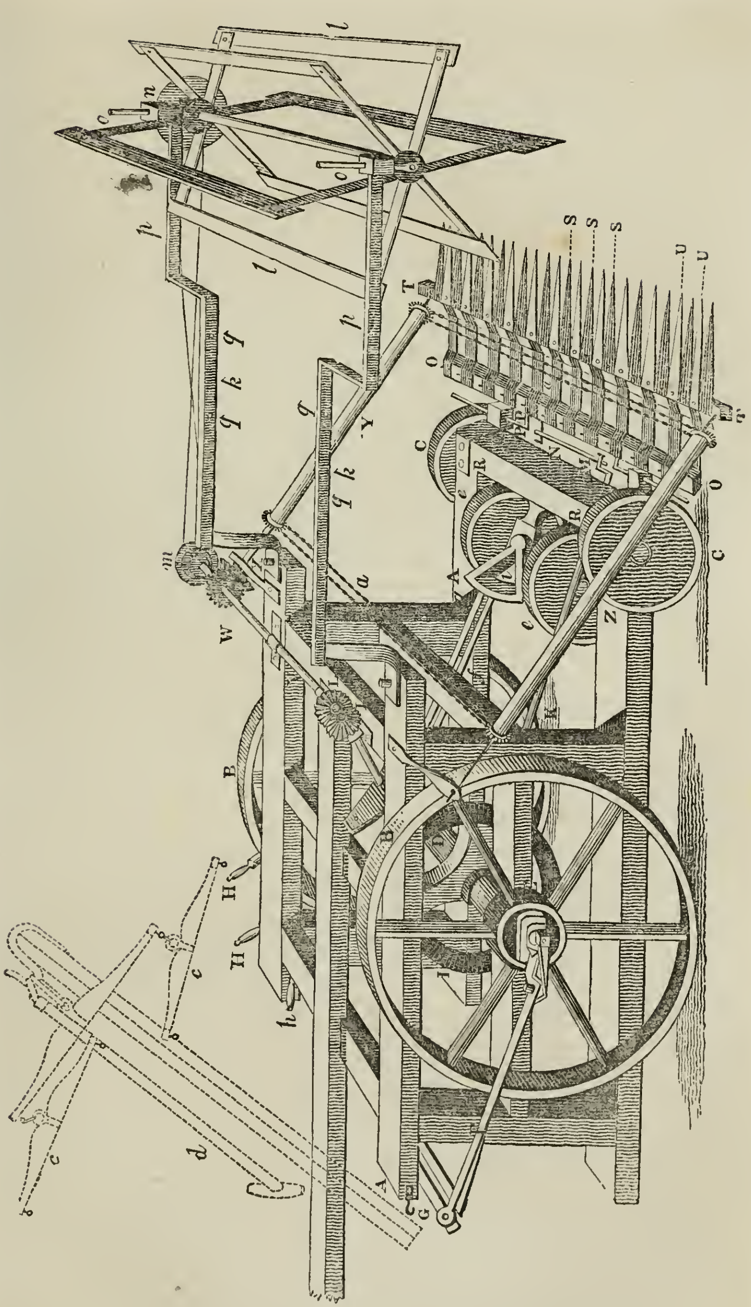
inches in diameter. The wheels are placed as near the front of the frame as possible, the reason for which will appear when the general description of the machine is given. The wheels B B are connected with the main axle (D), in such a manner as that they may turn upon it, similarly to a carriage-wheel, without moving the axle with them; or they can be fixed to it at pleasure, so as to turn it round with them as occasion requires. For this purpose, the holes in the naves are circular; and of course so much of the axle as passes through them is round. There are cross flenges, cast upon the nave, which catch hold of the coupling box E when the machinery is to be moved, and are disengaged from it by the handle F, when the machine is going, without moving the machinery. In the engraving, this part of the apparatus is entirely concealed at one of the wheels, except a small portion of the handle at H. The other coupling box is but faintly represented at E. The handle F has a joint in it, which is fixed to the other half of it, which passes through the frame of the machine, and terminates with the handle H; so that both coupling boxes can be managed by the driver, standing at H, although they are on opposite sides of the frame. The main axle (D) is $3\frac{1}{2}$ feet long between the shoulders, and eight inches from the shoulders to the coupling box: the frame of the machine is four feet broad, by seven feet long. Fixed upon the main axle (D) is the beveled wheel (I) of sixty teeth, part of which is seen in the engraving. This beveled wheel moves two pinions of ten teeth each. These pinions are concealed in the plate by the frame of the machine: one of them turns the crank-rod (K), and the other gives motion to the coupling wheels (L L) upon the top of the frame. The crank-rod (K) being thus put in motion as the machine moves forward, the crank M, which gives motion to the cutters, revolves with a uniform and steady motion. N is a coupling strap of iron, which connects the crank (M) and the movable bar (O O) together, which is kept in its place by means of the sliding hooks (P P) working in the brass sockets (Q Q) which are screwed upon the strong iron supports (R R.) It is obvious that as the crank (M) revolves, it will, by pulling the connecting rod (N), give a perpetual motion backwards and forwards to the movable bar (O O). In order that there may be as little friction as possible to the movable bar (O O) there are two friction pulleys fixed to the iron supports (R R), upon which the movable bar (O O) rests. These are not seen in the plate, as they are placed immediately below the bar; but to any person who considers the thing attentively, they must be readily understood. They are of the greatest consequence, as the back parts of the cutters wholly rest upon the movable bar (O O); and from the spring which each cutter must necessarily have, the pressure upon it is very considerable. With respect to the cutters, it may here be remarked that the greater body of them is made of iron, edged with the best steel, hardened as much as they will bear, without breaking out into chips when the machine is in operation. The cutter-bar (that is, the bar upon which the cutters are screwed) is strongly screwed upon the extremities of the supports (R R), and is six feet long, by three inches broad, and three fourths of an inch thick. The lower or fixed cutters (S S S) are made triangular, of solid iron, edged with steel, as before mentioned: they are fifteen inches long from the point to the extremity, four inches broad at the base, and nearly one fourth of an inch thick; they are steeled only to the front of the bar, thus leaving a steeled edge of about one foot. In the middle of the base of the cutter there is a hole pierced, half an inch in diameter, and a corresponding one in the bar where it is to be placed. The hole in the bar is screwed; and, in fixing a cutter, a bolt is passed through the hole in the base, and screwed tightly down into the bar. To prevent a cutter from shifting its place, there are other two small holes pierced, one on each side of the half-inch hole in the base, and corresponding ones in the centre of the bar: these holes are one fourth of an inch in diameter. Into he holes in the bar there are two iron pins firmly riveted below, and left one eighth of an inch above the bar, made to fit neatly into the holes in the cutters, although with a sufficiency of looseness to allow the cutter to be taken easily off when the bolt in the middle is screwed out. By this means, when the bolt in the middle is screwed down, a firm and unalterable position is insured to the under cutter. The upper cutters (U U,) &c., like the under ones, are made of good iron, edged with steel as far back as the hole where the bolts upon which they turn pass through. They are three inches broad where the hole is pierced; and, behind the cutter-bar, as is seen in the plate, they are bent down about two inches, to allow the rollers and canvass to operate, as shall be afterwards described. After being continued horizontally about three inches, they are again bent up, and their extremities placed above the movable bar. They are made about $13\frac{1}{2}$ inches long from the point to the hole, and about $7\frac{1}{2}$ inches from the hole to the extremity backwards. Both upper and under cutters are sharpened on both sides, similarly to a pair of scissors; the under ones, of course, upon the upper side, and the upper ones upon the lower side; thus forming, when the cutters are screwed to their places, a perpetual cutter upon that principle. The bolts upon which the upper or movable cutters work are half an inch in diameter, and are screwed to the bar through a hole of corresponding breadth: they are made to go through the bar about half an inch, upon which a nut is screwed, to prevent the bolts from unscrewing, which they would otherwise do, from the moving of the cutters; which would allow the edges of the cutters to separate, and of course the machine would get deranged, and would not operate. The points of the under or fixed cutters are six inches separate; of course the holes in the bar, by which they are fixed, are six inches apart. The bolts of the upper or movable cutters are intermediate, that is, three inches from the others; so that the cutter-bar is bored from end to end with holes half an inch in diameter, and three inches distant. The small holes, with the pins which prevent the fixed cutters from shifting their places, are each $1\frac{1}{2}$ inch from the large holes; so that the bar, before the cutters are screwed upon it, is pierced first with a small hole, then a large one, then two small ones, then a large one, then two small ones, &c., as may be understood from the plate; each hole $1\frac{1}{2}$ inch apart. The back parts of the movable cutters, as was already mentioned, rest upon the movable bar; and on each side of every cutter there is an iron pin, of one fourth of an inch in diameter, riveted into the movable bar. By means of these pins, it is easily seen, from the consideration of the plate, that, as the movable bar is pushed backwards and forwards by the crank (M) upon the friction pulleys below it, the movable cutters will have a perpetual motion backwards and forwards. Under the heads of the bolts, which fasten the movable cutters, and the cutters themselves, there is placed a washer of brass, to diminish the friction as much as possible; and, for the admission of oil, there are two small holes pierced in the head of each bolt. There are twelve movable cutters, and thirteen fixed ones, with intervals of six inches between the points of the latter; so that the breadth of the machine is exactly six feet: but this breadth, from the principle of the machine, may be either increased or diminished, according to the nature of the farm upon which the machine is intended to operate. Upon a perfectly level farm the machine might be made broader; but upon a farm of sloping or uneven surface, one of six feet in breadth will be found to be work enough for two horses. As it was before stated, the beveled wheel (I) gives motion to the coupling wheels (L,) of 18 teeth each; these move the horizontal shaft V, and the wheel W, which is fixed to the end of it. The whee W has 36 teeth; and pinion X, which it turns, and which is fixed upon the gudgeon of the roller Y, has 18 teeth. This part, however, is misrepresented in the drawing, which was taken from a model which had the rollers turned by coupling wheels, as shown in the plate. The one roller (Y) turns the other (Z), by the pitch-chains (*a a*), the chief use of which is to keep the sheet of canvass from changing its place by the revolution of the rollers. The canvass, from its gravity, would slip down upon the rollers as the machine moved forward; and it would twist upon them, by the unequal pressure to which it is exposed by the cut corn pressing unequally upon it: to prevent these derangements, there are loops fixed to the canvass, which are made fast to the links of the chain, about six inches apart; and there being an equal number of links in both the upper and lower chains, and an equal number of teeth in the four pulleys upon which they work, the canvass revolves uniformly, without being in the least deranged by the many casualties to which it is exposed. *b* is the pole to which the horses are yoked: it is made of wood, and is firmly fixed to the cross rails upon the top of the frame: its length is ten feet from its extremity to the frame of the machine. *c c* are the swingletrees by which the horses are yoked: they are yoked similarly to horses in a carriage, so as both to draw forward, or push backward, at pleasure. Their heads, of course, are towards



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the machine; and, in appearance, they push the machine before them, but, in reality, they are drawing the same as in the plough. *d* is a small rod of wood, or *helm*, which the driver holds in his right hand, by the pulling of which to him, or pushing it from him, he conducts the machine straight forward. The dotted lines in the plate are a continuation of the pole with the swingletrees and helm attached. The machine is turned, at the end of the ridge, by the following contrivance: — The two wheels *e e*, in the body of the machine, are joined to the lever *f* by an upright movable axle. These wheels are similar to the two (c c) on the front of the frame: they have a strong iron axle, which is made so long as to let the wheels conveniently turn between the crank-rod (K) and the frame of the machine. In order that this piece of the apparatus may be used with advantage, the beveled wheel I is not placed upon the middle of the main axle (D), but about one foot from the end of it, as is seen in the engraving. This throws the crank-rod (K) nearer the side of the machine, thus leaving plenty of space for the turning apparatus. In the middle of the horizontal axle of the wheels *e e* there is an upright standard of iron, sufficiently strong, and firmly joined to the horizontal axle. This upright standard or axle passes through the middle of the lever *f* (which is of wood, and, at this part, about five inches square), about twenty inches from the end of it. Upon the top of the upright standard there is placed a segment of a wheel (*i*), with the teeth on the lower side, which is worked by a small pinion of six teeth upon the end of the rod *g*. This pinion is not seen in the engraving, as it is completely concealed by the segment *i*. The rod *g*, and the small pinion upon it, are turned round by the handle *h*; the pinion moves the segment *i*, which, being firmly fixed to the upright standard, turns the small wheels *e e* either way. When the machine is cutting, the wheels *e e* are put parallel to the cutters; and in this position they assist the machine in passing a furrow, without allowing the cutters to come in contact with the opposite side of it. But when the machine is to be turned round, they are turned, with an angle to the path of the machine, by the handle *h*; and the rod *g* being fixed in that position by a screw near the handle, the lever is then pressed down, and fixed with a *catch* to the frame of the machine. In pressing down the lever *f*, the small wheels *ee*, which before were about two inches from the ground, are pressed to the earth, about two or three inches below the natural level of the machine. Of course, the two front wheels (c c) are lifted two or three inches from the ground, and the cutters considerably more, thus insuring them from accident while turning round. The machine now rests upon the two large wheels B B, and the two small ones *ee* of the lever; and the two front wheels (c c) go for nothing, as they do not touch the ground. But the axle of the small wheels *e e* being placed with an angle to the main axle (D) of the large wheels B B, the machine will naturally turn round upon the horses being moved slowly forward: of course, the greater the angle formed by the two axles, the less space will the machine require to turn upon. In turning the machine, however, attention must always be given to disengage the large wheels B B from the main axle (D): this is done by shifting the coupling boxes E E by means of the handles H H. The apparatus *l l*, or collector, is placed exactly above the cutters: it is $2\frac{1}{2}$ feet in diameter, made of wood, as slight as may be. The supports *k k*, in the original machine, were made of iron; but now the two side-beams of the machine are made of a piece of wood, with a natural cast upon it, similar to the beam of a plough, but rising with a much greater angle, as near the form of the iron supports in the plate as possible, and continued horizontally till their points are exactly above the movable bar *o o*. The points *p p* are made of iron, bent as in the plate, to allow the collector (*l l*) to turn round. At *q q q q* are strong iron screws, working in nuts placed in the wooden part of the supports, which serve the double purpose of uniting the iron part to the wood, and allowing it to be drawn forward, or pushed backward, as occasion may be, by either shifting to another hole, or, which is better, by long slips in the middle of the bar. Long corn requires the collector to be placed forward, and short corn requires it to be taken back. At *o o* are two perpendicular rods, which slip in holes in the points of the supports; by the moving of which, upwards or downwards, the collector (*l l*,) which turns in sockets in the lower ends of these rods, is lowered, or heightened, according to the length of the corn to be cut. The rods are fixed in their places by screws in the end of the supports. The collector is turned by a cross belt, or chain, passing over the two pulleys *m n*. A piece of slight canvass is put round the rollers Y Z, fixed to the chains *a a*, as before described. The lower ends of the rollers have a shield of plate iron round their gudgeons, to prevent the cut corn from warping, which it does effectually. The bushes of the roller Z are made to shift by screws, to tighten the chains a little, to prevent them from slipping the pulleys, as they lengthen a little by using, especially when new. *Fig.* 376. is a representation of the machine in full operation. About six or eight yards of the field require to be cut at the ends to allow the machine to turn without injuring the corn, which may be done by the machine itself. If the corn is standing nearly upright, a convenient number of ridges may be taken in and cut by going round them; but if the corn is standing, and the field free from deep furrows, it may be cut by going round and round it till it is finished in the middle. One man, as seen in the plate, is sufficient to manage the whole operation. The cutting, collecting, and laying are the three principal parts of this machine, which have been all, more or less, explained in the general description given above. But as they are particular, a few words on each of these heads may still be necessary, that the machine may be completely understood in all its bearings. First, then, with regard to the cutting: it is desirable that the machine should do her work, and nothing more. If the motion of the cutters were too slow, she would not clear the ground; and if it were too quick, there would be a useless expenditure of power and machinery. Let it be remembered that the large outer wheels B B are $3\frac{1}{2}$ feet in diameter; that the beveled wheel I has sixty teeth; and that the crank-rod pinion has ten; and that the cutters have twelve inches of a cutting edge. The diameter of the wheels B B being $3\frac{1}{2}$ feet or forty-two inches, their circumferences are 131·94678 inches; every revolution of them will pass over nearly 132 inches of the ground's surface; but there being ten teeth in the crank-rod pinion, and sixty in the beveled wheel I, every revolution of the wheels B B will turn the crank-pinion six times, and, of course, the crank as often. But every turn of the crank-pinion gives two cuts, and each stroke of the cutters clears twelve inches of the ground, because they have twelve inches of a cutting edge: therefore, one revolution of the wheels B B gives twelve strokes of the cutters, and clears twelve times twelve, or 144 inches of the surface of the ground. But one revolution of B B passes only over 132 inches of surface; therefore, the cutters are calculated to cut, in one revolution of B B, twelve inches more than enough, that is, one inch each stroke. This, however, is perhaps nothing more than is advisable to calculate upon, making allowances for the operation of the machinery, the partial dragging of the wheels, &c. &c. Secondly, the collector (*l l*) must not move too slowly, lest it should retard the corn from falling upon the canvass; and it must not move too quickly, lest it should shake ripe grain. As before stated, it is $2\frac{1}{2}$ feet in diameter, that is, 94·2477 inches in circumference. But one revolution of B B passes over 132 inches of surface; therefore, that the collector (*l l*) may just touch the corn, without bringing it back, or retarding it from naturally falling back, it must make 1·4 revolution for every one that B B makes. Since there are six arms in *l l*, every arm will touch the standing corn at equal distances of 15·7 inches. The pulley *m* makes six revolutions for one that B B makes: it is six inches in diameter, and the pulley *n*, upon the axle of *l l*, is nine inches; therefore *m* revolves 1·5 times for once that *n* turns round, and the collector (*l l*) revolves four times for once that the large wheels B B revolve. But $4 \times 94{\cdot}2477 = 376{\cdot}99$ inches, the space passed through by the circumference of the collector, while the machine moves forward only 132; the difference of which is 244·99, the space that the collector passes over more than the machine, during one revolution of B B. Therefore, every inch of the corn is brought back 1·54 inch nearly, by the collector, which is sufficient to insure its falling backwards upon the canvass; and yet it touches the corn so gently, that it is impossible that it can injure it in the smallest degree. A quicker and a slower motion, however, is advisable; which is easily given, by having two or three sheaves upon the pulleys *m* and *n*; and then, by shifting the belt, a different motion is produced. With regard to the canvass, it is necessary that it should revolve as much as the ground passed over by the machine; that is, while the wheels B B make one revolution, or pass over 132 inches of the surface, 132 inches at least of canvass should pass over the rollers. W, as before stated, has thirty-six teeth, and X eighteen, so that the roller Y will give two revolutions for one of W. But W revolves six times for one revolution of the wheels B B: hence the roller Y will revolve twelve times for every revolution of B B. The diameter of the rollers is four inches; their circumferences, therefore, are nearly 12·56 inches, twelve revolutions of which will give 150·72 inches. As before stated, one revolution of B B gives only 132 inches, wherefore there is a preponderance of motion, on the side of the canvass, of 18·72 inches for every revolution of B B. This velocity is necessary to insure the canvass of clearing itself in all cases; and, with a smart velocity, the cut corn is laid down with a greater angle to the path of the machine. It may here be observed, that it is often found convenient to have the canvass to lay down the corn on either side of the machine, according to the direction from which the wind is blowing. This may be done with a double wheel at X, with a handle in the usual method employed for reversing the motion of the rollers of the threshing machine. It were desirable, too, if possible, to have the canvass besmeared with a drying oil or gum, or some other substance which would prevent it from contracting with moisture; as the slightest shower, or dew of a morning, contracts it so much, as to render the implement useless until the corn is perfectly dry.

2738. *An estimate of the probable value of Bell's reaping machine* may be formed from the reports signed by numerous practical farmers, who were spectators to different trials made in 1828 and 1829. In September, 1828, the machine was tried at Powrie, in the county of Forfar, before between forty and fifty landed proprietors and practical agriculturists, who signed a declaration, stating "that the machine cut down a breadth of five feet at once, was moved by a single horse, and attended by from six to eight persons to tie up the corn; and that the field was reaped by this force at the rate of an imperial acre per hour." (*Gard. Mag.* vol. v. p. 600.) In September, 1829, the machine was tried at Monckie in Forfarshire, in the presence of a still greater number of persons, who attest that it cut, in half an hour, nearly half an English acre of a very heavy crop of oats, which were lodged, thrown about by the wind, and exceedingly difficult to harvest. It was tried in a number of other places in Forfarshire, Perthshire, and Fifeshire, and the general conviction appears to be, that it will soon come into as general use among farmers as the threshing machine. (*Gard. Mag.* vol. vi.) The price is, at present, between 30*l.* and 35*l.*; but if it were once in general use, probably the cost might be lowered; but even that price would be saved out of the usual sum paid for manual labour, during only one harvest, by an extensive farmer. Few men deserve better of his country, and indeed, of every civilised country where agriculture is practised, than Mr. Bell; for surely that invention must ultimately be of great benefit to men and women, which enables them to do by horses, oxen, or steam, that which they have hitherto done by a most severe description of manual labour, rendered doubly oppressive by the season of the year in which it must necessarily be performed.

2739. *A machine for reaping, and at the same time sheaving corn,* was invented in the year 1822, by Mr. Henry Ogle, school-master at Rennington, near Alnwick, Northumberland. In 1823, Messrs. Brown, iron founders in Alnwick, advertised that they would furnish machines of this sort complete for sheaving corn at the beginning of harvest. No farmer however could be found who would go to the expense. The operation of the machine was satisfactory, and it was estimated to cut fourteen acres per day. An engraving and description of it will be found in the *Mechanic's Magazine*, vol. v. p. 50. In the same work (vol. i. p. 145.) will be found an engraving of a mowing machine invented by Jeremiah Baily, of Chester County, United States, about 1821, and said to answer well, and to have been extensively used. Whoever contemplates further improvements in this description of machinery, would do well to begin by making himself master of all the foregoing inventions.

2740. *Gladstone's machine for reaping beans* (*fig.* 378.) has been used in several parts of Scotland with complete success. The framework of this machine is the same as that of a common plough. To this is added the knife (*a*), which is a plate of steel, screwed to a piece of wood, to keep it from bending up and down; this wood being screwed to the framework. There is a wheel (*b*) to keep the knife when in motion in a horizontal position. The cutting edge of the knife (*c*) has teeth, or serratures, on the upper side (*d*); the under side (*e*) is flat. One horse and a man will cut with this machine from four to fi[ve] acres a day, with ease, and perform the work as perfectly as by manual labour.

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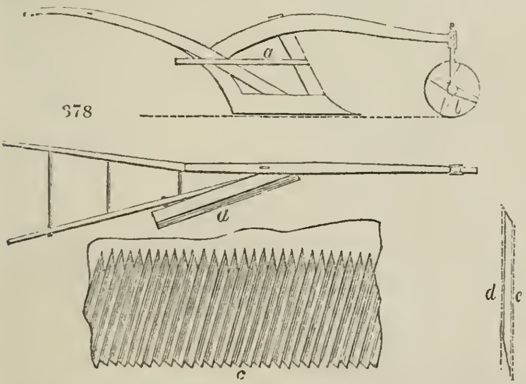

2741. *A machine for reaping the heads or seed-pods of clover* (*fig.* 379.), where the second growth of that crop is left to stand for seed, has been used in some parts of Norfolk and Suffolk. It consists of a comb, the teeth of which are lance-shaped, very sharp, and set close. This comb is affixed horizontally to the fore part of the bottom of an open box or barrow, which is drawn by one horse and guided by a man, who empties the barrow in regular lines across the field by means of an implement (*a*), which serves also to clean the teeth.

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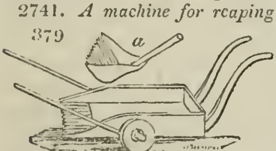

2742. *A machine for mowing clover hay* has frequently been attempted, but not yet perfected. One by Plucknet, of the Blackfriars Road, London, succeeded tolerably, but never came into use: it consisted of circular knives put into rapid motion, and the cut stalks guided to one side by a revolving cradle, like that attached to corn scythes. (2480.) It never came into use.

Sect. VII. *Machines of Deportation.*

2743. *The carriage or conveyance machines of agriculture* are chiefly carts and waggons, and their several varieties.

Subsect. 1. *Carts.*

2744. *Carts,* like other implements, vary in their forms and modes of construction, according to the nature and situation of the roads, and many other local circumstances; but, for the purposes of farming, those of the single-horse kind are in general the most advantageous and useful. The advantages of single-horse carts, Lord R. Seymour observes (*Ann. Ag.* xxvii.), are universally admitted, wherever they have been attentively compared with carriages of any other description. A horse, when he acts singly, will do half as much more work as when he acts in conjunction with another; that is to say, that two horses will, separately, do as much work as three conjunctively: this arises, in the first place, from the single horse being so near the load he draws; and, in the next place, from the point or line of draught being so much below his breast, it being usual to make the wheels of single-horse carts low. A horse harnessed singly has nothing but his load to contend with; whereas, when he draws in conjunction with another, he is generally embarrassed by some difference of rate, the horse behind or before him moving quicker or slower than himself; he is likewise frequently inconvenienced by the greater or less height of his neighbour: these considerations give a decided advantage to the single-horse cart. The very great ease with which a low cart is filled may be added; as a man may load it, with the help of a long-handled shovel or fork, by means of his hands only; whereas, in order to fill a higher cart, not only the man's back, but his arms and whole person must be exerted. To the use of single horses in draught there can be no objection, unless it be the supposed necessity of additional drivers created by it: the fact however is, that it has no such effect; for horses once in the habit of going singly, will follow each other as uniformly and as steadily as they do when harnessed together; and accordingly we see, on the most frequented roads in Ireland, men conducting three, four, or five, single-horse carts each, without any inconvenience to the passengers: such, likewise, is the case where lime and coal are generally carried upon pack-horses. In some of the northern counties of Britain also, one man manages two or three, and sometimes more, one-horse carts.

2745. *Carts drawn by one horse, or by two horses,* says a writer whose authority is unquestionable (*Supp. Ency. Brit.*), are the only farm carriages of some of the best cultivated counties, and no other are ever used in Scotland. Their load depends upon the strength of the horses, and nature of the roads; but, in every case, it is asserted that a given number of horses will draw a great deal more, according to some one third more, in single-horse carts than in waggons. Two-horse carts are still the most common among farmers in Scotland; but those drawn by one horse, two of which are always driven by one man, are unquestionably preferable for most purposes. The carriers of the west of Scotland usually load from a ton to a ton and a half, on a single-horse cart, and no where does it carry less than 12 cwt. if the roads are tolerable.

2746. *Wheels,* such as are broad, with conical or convex rims, are common in England; in Scotland the wheels are generally narrow, though broader ones are beginning to be introduced. Those used for the common, or two-horse, carts, are usually about $4\frac{1}{2}$ feet high, and mounted on iron axles. The advantages of broad cylindrical wheels have been illustrated with much force and ingenuity in several late publications. (*Communications to the Board of Agriculture*, vol. ii. and vol. vii. part i.)

2747. *Large wheels to carts, drays, &c.* will, besides greatly increasing the facility of draught, tend to lessen the number of accidents to which all two-wheeled carriages are liable, from the shaft-horse falling down. To render this more evident, let us first examine *fig.* 380., which is a rude sketch of a cart constructed in the usual manner, and supposed to be loaded with bricks, stone, sand, or other heavy material. While thus loaded, and the horse is in an erect position, the centre of gravity (g) is almost directly over the axletree, in which state the body of the cart is nearly balanced, or only pressed upon the back of the horse with a force equal to a few pounds' weight. But the horse is supposed to have fallen: the consequence is, that the centre of gravity is thrown much more forward; the body of the cart and its load becomes divided by the line a b, perpendicular to the axletree, into two very unequal parts, c and d; the whole of the increased portion (c) in front of the line acting as a weight upon the horse, and only partly counterbalanced by the diminished portion (d) behind the line. It frequently happens that this increased weight, so suddenly thrown upon the shafts, snaps them short off; and, at all times, tends to prevent the horse from rising until part of the load is removed. By adopting the larger wheels, and the bent

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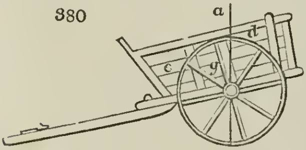

axle (*fig.* 381.) the cart, &c. becomes much less liable to such accidents, because the centre of gravity (g) and the centre of suspension (the axle) are brought much nearer together; the former being placed nearly over the latter, at a small distance only from it. A horse falling with a loaded cart so constructed, will experience but little increase of weight upon him while down: the cart will be divided as before, by the line $a\ b$, into two parts; but it will be observed, these portions differ but little in their respective magnitudes. The centre of gravity (g) will be thrown forward, but in a very trifling degree. In carts, &c. it will almost always happen that the centre of gravity will be *above* the point of suspension (the axle); but in gigs, &c. the body may be placed so low that the centre of gravity may fall *below* that point, when the body will always maintain an erect (*i. e.* a horizontal) position, and, should the horse fall down, will operate to lift him up again. A gig so constructed would be almost beyond the possibility of those serious, and frequently fatal, accidents, which occur from the falling of the horse. (*W. Baddeley, jun.* in *Mech. Mag.* vol. xii. p. 204.)

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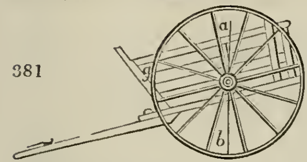

2748. *The power of wheels* has no dependence on the height of the wheels, or the length of their spokes, but depends wholly on the power of draught that is joined to their axles, and to the forward motion, or the progress of the carriage. If the carriage were placed upon skates completely polished, and upon smooth ice, it would be drawn by as little power as if it were placed upon wheels. The use of wheels is to lessen the resistance to the carriage by friction, or rubbing upon the ground, or upon the floor upon which the carriage is to be moved; that resistance is least of all when the ground is hard and smooth, such as a rail-road of iron; it increases upon soft and upon rough ground; and it increases still more when the carriage must be drawn up an ascent, according to the steepness of the ascent, because the power of draught must be able to lift the carriage, it may be said, step by step, up the ascent; and when the ascent is soft or rough, more power of draught is necessary. When the wheels are dished they plough the soft ground, and grind the rough ground, and thereby they increase the power of resistance, and require more power of draught to overcome the absurdity of their own form; and thus they cause the continual shaking of the joints of the carriage, and the wearing of the iron and of the wood of which it has been made. Narrow wheels are drawn rather more easily through small loose stones; but, upon every other kind of ground, broad wheels that are rollers are drawn more easily, or with less power, and the benefit of them to the roads is greater according to their greater breadth. High broad wheels do not sink so deep into soft ground as low wheels do; but, if the low wheels be made broader, the benefit obtained will be in proportion to the additional breadth. The axles of high wheels turn seldomer round, or the wheels turn seldomer round the axles, which is an advantage; but high wheels must be weightier than low wheels, which is a disadvantage. High wheels are useful to carry great stones, or great trees, under the axles; and loads of every kind, alive as well as dead, ought to be hung as low as possible. And every load ought to be hung, or to be placed, upon springs, which will allow the carriage to be lighter; and the lower it is hung, or placed, it will be so much safer from overturns, there will be less shaking, and less power of draught will be required. (*Sir Alex. Gordon*, in *Farm. Mag.* vol. xx. p. 150.)

2749. *The construction of wheels* has been much improved by the introduction of cast-iron naves or stocks. These stocks are found particularly suitable for warm climates, and scarcely any others are exported. Messrs. Morton, of Leith Walk, have renewed the spokes in them after they have been in use twenty years, and found the stocks as good as when new. (*Gard. Mag.* vol. vi.) In England wrought-iron spokes have been employed, which are found to succeed perfectly, and, from their durability, will, in the end, be found cheaper than wood.

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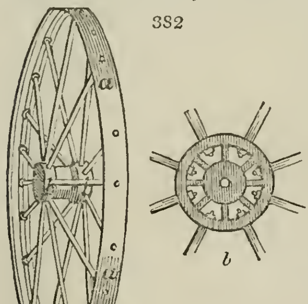

2750. *Jones's improved iron wheels* (*fig.* 382.) are formed wholly of cast and wrought iron. The felly, or periphery of the wheel (a), is made of cast iron, with conical holes on the outside, contracting towards the centre, through which the spokes, made of iron rods, are to be passed, and secured in the box, or nave (b), near the centre of the wheel, by nuts screwed on to the reverse end of the rods, by which means they are drawn tight. (*Newton's Journal*, vol. i. 2d Series, p. 154.)

2751. *A great improvement in the construction of axles* for carriages, carts, and waggons, has been made by George Burges, Esq. M.A. of Cambridge. Instead of one circle moving within another, as in all common axles; or one circle moving within another, this other having grooves for retaining oil in the manner of the patent axles; Mr. Burges's axle is a circle (*fig.* 383. a) moving within six points, formed by six equal convex segments, which hold oil in their angles (b): the friction is thus reduced to a minimum in theory; and with case-hardened iron, and abundance of oil, we should think it could not be otherwise in practice. Mr. Burges has had the axles of his own carriage constructed in this way for some years. (*Gard. Mag.* vol. v.)

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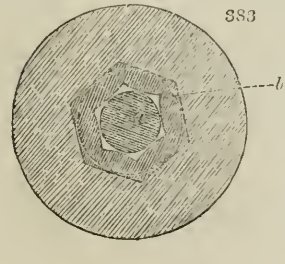

2752. *The Scotch one-horse coup cart* is used either without or with (*fig.* 384.) a frame for the purpose of building on a greater load of hay, straw, or corn in the sheaf. This frame is held on by no fastening, but remains in its place from being fitted to the exact width of the body of

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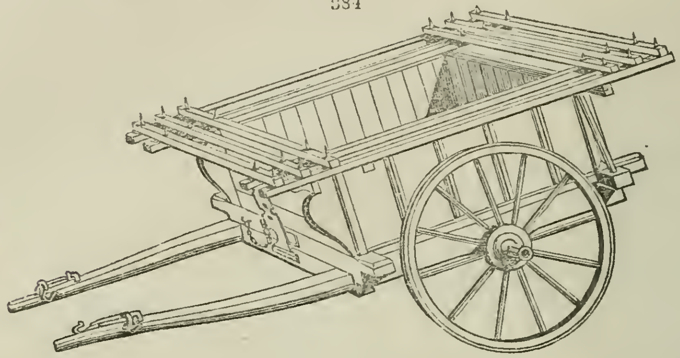

the cart. On drawing out an iron pin, the fore part of the body rises up from the shafts, while the other end sinks, and allows the load, whether of dung, earth, or stones in the close cart, or of hay, or sheaves of corn, on the cart and frame, to fall to the ground.

2753. *The Scotch corn cart* (*fig.* 385.) consists of open framework, with a boarded bottom, and is used solely for the purpose of carting hay, corn in the sheaf, or similar materials. It is light, cheap in construction, and contains a bulky load, which, being lower and more extended than a load on a coup cart with a frame, is less likely to be overturned.

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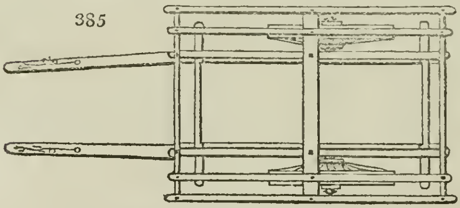

2754. *The Scotch two-horse cart* differs little from the one-horse cart, except in being larger. To prove the inferiority of double to single horse carts, Gray observes, " that whatever greater part of the load is placed before the centre of gravity, which is always in the axle, must rest constantly on the horse that is in the shafts. In going down hill this burden must be considerably increased, especially if the load be high above the centre of the axle, or the descent steep; and the additional burden upon the shaft-horse is always in proportion to these two causes united. But there is another disadvantage; for, unless the line of the draught of the foremost horse be exactly in the line from the hook of his collar to the centre of the axle (which is hardly possible), he will perpetually be pulling down the hindmost horse, or, in other words, will be giving him more weight to carry. For, as the traces of the foremost horse are generally fixed upon the shafts, this throws his line of draught at a considerable angle above the centre of the axle; from which it is evident, that although the road be ever so level, yet in every double or two-horse cart, the foremost horse must either not draw at all, or must bring additional weight upon the horse in the shafts, which weight will always be in proportion to the force with which the trace-horse draws, and the largeness of the angle which the line of his draught makes with the line from the hook of his collar to the centre of the axle. Besides, unless the driver be more careful than ordinary, and keep the trace-horse to his duty, the other one has not only this great weight to carry, but also the whole load to draw. The angle is increased considerably when the trace-horse is of a lower size than the one in the shafts, which may frequently happen; and, by this means, a still greater burden is laid upon the back of the horse employed in the shafts.

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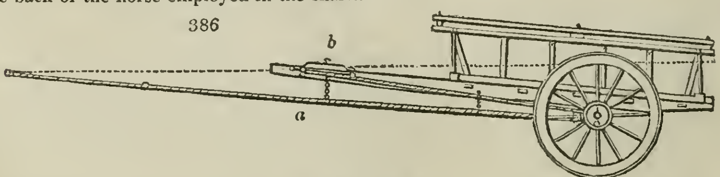

2755. *Improved two-horse carts.* (*fig.* 386.) It may be suggested to those who are fond of employing two-horse carts, that, in order to adjust the traces of the fore-horse with as little injury as possible to the one behind, and by this means make both their powers coincide, two iron frames are fixed into the axle, in each of which is placed a sheeve or whorl. Upon these sheeves pass a rope or chain (*a*). In the outside of each shaft is fixed a long iron staple; and on each staple is placed an iron slider (*b*), having liberty to shift either forward or backward; the chain from the collar of the shaft-horse is hooked into the eye of the slider; and the chain or rope, by which the foremost horse draws, passing from his collar (*c*), round on the sheeve at the axle, is hooked into the other eye of the slider. By this means the two horses are so connected, that, if the one shall relax, immediately the exertion of the other horse presses the collar hard upon his shoulders, so that he must either exert himself or be pulled backwards. Thus the exertions of the two horses are united, so as to form one power applied to the cart, in place of two powers working generally against one another, which must be the case in the common way of attaching two horses to a cart. But, by this way of yoking, the shaft-horse receives no additional burden from the exertion of the trace-horse, as they both draw from one point, which is the centre of the axle, to the hooks of their respective collars, by which their powers must nearly coincide. If this coincidence does not take place, it is evident that the two horses will, to a certain degree, be pulling against one another, which must be extremely distressing to each in his turn, especially to the one in the shafts. The same principle, as will afterwards appear, has been employed in yoking horses to threshing machines.

2756. *The corn cart* has a longer body than the close cart, and the sides and ends are open, and support two rails along each. It is made to fit the axle and wheels of the close cart, and is chiefly used in haytime and harvest, when it is supposed to admit of laying on a larger load of sheaves or hay than the cart and frame.

2757. *Lord Somerville's drag-cart* (*fig.* 387.) is constructed with a contrivance for

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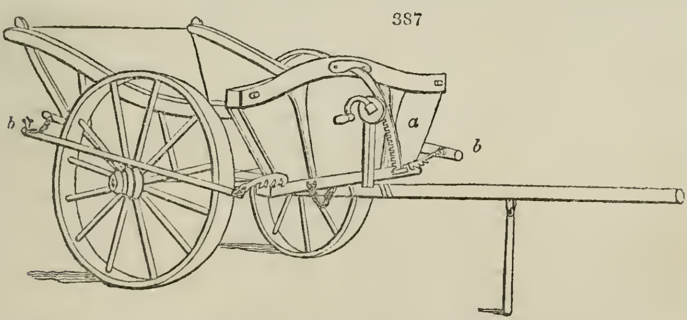

checking or regulating the rapidity of its motion in going down hills or other declivities. The method for adjusting the position of the centre of gravity of the load, and to prevent its pressing too much on the cattle in going down hill, is by a toothed rack, screwed to the front of the cart, and worked by a pinion and handle (*a*) immediately connected with the pole. By means of this pinion and rack the front of the carriage is elevated more or less, in proportion to the declivity of the hill, by which means the weight of the load is made to bear more on the axis, and less on the necks of the oxen. A friction drag (*b*) is made to press more or less on the side of the wheel, according to the steepness of the descent; the one end of it is connected with the tail of the cart by a small chain, and the other end to the front, by means of a toothed rack, which catches on a staple in the front of the cart, by which the pressure of the friction-bar may be regulated at the discretion of the driver: the notches or teeth in this rack, it is observed, should be as close to each other as circumstances will permit.

2758. *The advantages of the friction-drag*, and other contrivances, are said to be, 1st, The method, which is equally simple and expeditious, of adjusting the centre of gravity of the load, so as to have a proper bearing on the horses or cattle, in going down hill. 2dly, The method of applying friction to the side of the wheel, to regulate the motion of the carriage in going down hill (instead of locking the wheels), the advantages of which method appear to be as follow: namely, first, the pressure and degree of friction may, with great expedition, be adjusted to the steepness of the declivity, so that the carriage will neither press forward, nor require much exertion to make it follow the cattle; secondly, the friction is so applied to the wheel, that a given pressure will have twice the effect in retarding the progress that it would have if immediately applied to the body of the carriage, or to the axis: and, by applying the friction on both sides of the wheel, the risk of heating and destroying the friction-bar is much less than if the same degree of friction were applied in one place. 3dly, This apparatus is so conveniently placed, that it can be instantly applied or adjusted, without stopping the carriage, or exposing the driver to the same danger as in locking a wheel. And, 4thly, This contrivance will assume yet a greater importance when applied to both the hind wheels of waggons, by which means the resistance may always be proportioned to the steepness of the descent, the tearing up of the road prevented, the unnecessary exertion of the cattle in drawing the locked carriage down hill avoided, the danger to which the driver is sometimes exposed in locking the waggon-wheel totally evaded, and the time now lost in locking and unlocking the wheel saved to the proprietor.

2759. *Rapson's stop drag for carriages going down hill* (*figs.* 383, 389, and 390.) consists of five or more pieces of wood, "united on the outside by a strong jointed iron hoop; the wood pressing upon the nave of the wheel. The first, a fixed pivot (*a*), from the hoop, is fixed to the under side of the frame of the cart; from the other extremity of the hoop of the brake proceeds a bar (*b*), which slides through the plate or socket (*c*) fixed to the side of the cart frame; a vertical perforation is made through the bar (*b*), just behind the plate, to receive the pin (*d*), which is likewise chained to the shaft: this pin, so placed, prevents any force applied to the chain from tightening the brake on the nave of the wheel. *Fig.* 389. represents the interior of a wheel on level ground, the nave surrounded by the brake, which, by its own gravity, is hanging loose, leaving the wheel perfectly free. *Fig.* 390. shows a wheel on a declivity, the chain drawn tight by the pressure of the breeching on the horse; the brake, of course, closely surrounding the nave, and forming an effectual drag. *Fig.* 391. is a bird's-eye view of the whole apparatus, exhibiting the framing of the cart, the shafts, wheels, and brakes; the chains also are shown, passing from the bars on each side, each round a horizontal pulley on the shaft, and attached to the ends of the breeching. Thus it is evident that, when a cart, furnished with this drag, is going down hill, the load, pressing the breeching against the horses, draws the brake tight by means of the chain, and produces a friction on the nave proportioned, in some measure, to the declivity. When backing upon level ground, by inserting the pin (*fig.* 388. *d*) through the bars of the brakes, the wheels will be kept free. This drag is to be applied to the naves of the carriage wheels, with a chain attached, fastened to the breeching of the horse, and a small pin on each side of the shaft is to go into the hole of the bar of the drag. If one of the pins be taken out, one wheel will be dragged and the other not. By leaving out both pins, the two wheels are dragged in going down hill, by the breeching bearing against the horse. The wheels will revolve round on a level road, and in going up hill undrag themselves. When the wheels are braced, two or three tons' weight have very little pressure on the horse in going down hill. If two loaded carts should meet on a narrow hill, by unhooking the drag-chain from the breeching, and hooking it to the tub-chain (back chain), the horse can be put back with the greatest ease and safety. When the horse is put back against the hill, the two pins must be put in the bars of the drags. The drag consists of a wooden brake, applied round the nave of each wheel, in pieces which are encircled and connected by a jointed iron plate. The small bar attached to one end of this brake slides freely through a corresponding hole in a plate fixed at right angles to the shaft: a hole is drilled through this sliding bar, for the purpose of admitting a pin or forelock, chained to the shaft. To each end of the breeching is attached a chain, which, passing through a horizontal sheeve, or pulley, on the upper surface of each shaft, is ultimately fixed to the bar of the drag. While the bolts or forelocks remain in the holes behind the perforated plate before mentioned, it is evident the brake cannot tighten upon or drag the wheel; but, on either of those pins being removed, the wheels become immovable." (*Smith's Mechanic*, vol. ii. p. 322.)

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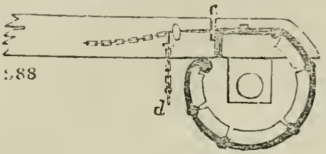

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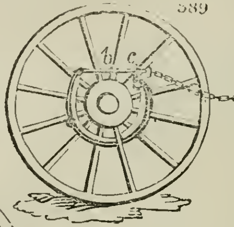

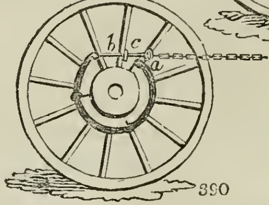

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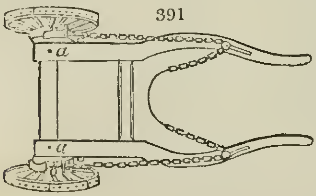

2760. *Kneebone's drag for two-wheeled carriages* (*fig.* 392.) is composed of a piece of wrought iron, curved to the exact form of the circumference of the wheel, with a chain, to be fastened to the near shaft, to keep the drag properly under the wheel. When the drag is out of use it may be hung on hooks, at the under part of the tail of the cart. The weight of this drag is usually from sixty to eighty pounds. "This simple contrivance has never failed to be effectual in retarding carts, or any two-wheeled carriages, while descending hills, taking off the great burden from the shaft horse, and permitting the carriage to descend with the greatest ease and safety in the most mountainous country. It may be applied to any kind of road, and is not subject to the inconvenience of locking poles, which, on rough roads, among loose stones or deep ruts, are very apt to overturn carts by the sudden resistance they meet with. Deep ruts, or loose stones, have not been found to lessen the advantages of this drag." (*Smith's Compend. of Practical Inventions*, p. 322.)

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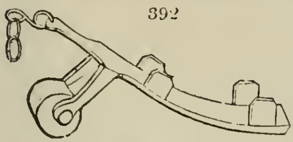

2761. *The improved quarry cart* has a bend in its iron axle, which brings it within fourteen inches of the ground, although moving on wheels more than five feet high. In the ease with which it is drawn, loaded, and unloaded, it is superior to the common cart in the proportion of seven to three.

2762. *The three-wheeled cart* is a low machine, on wheels about two feet in diameter, the third wheel placed in the middle before, and generally of smaller size than the two others. It is used for conveying earth or gravel to short distances, as in canal and road making; and for these purposes it is a most valuable machine, and in very general use.

Subsect. 2. *Waggons.*

2763. *Waggons* constructed in different forms, and of various dimensions, are made use of in different districts of the kingdom; and for the most part without much attention to the nature of the roads, or of the articles which are to be conveyed by them; being, in general, heavy, clumsy, and inconvenient. Waggons require much more power in the draught than carts, and are far from being so handy and convenient, which is certainly an objection to them, though they carry a much greater load. There can be no doubt that more work may be done in any particular time, with the same number of horses, by carts than by waggons, in the general run of husbandry business, especially where the distance is small between loading and unloading. Waggons may perhaps be the most proper sort of conveyances for different sorts of heavy loads to a considerable distance; but for home business, especially harvest, and other field work which requires to be speedily performed, carts seem decidedly preferable.

2764. *Waggons, though they may possess some advantages over carts* in long journeys, and when fully loaded, the editor of *The Farmer's Magazine* observes, are now admitted to be much less convenient for the general purposes of a farm, and particularly on occasions which require great despatch, as in harvesting the crop.

2765. *On the loading of waggons* much of the value depends. "A waggon or other carriage, on four wheels of equal diameter, is of lighter draught than those in common use, having the fore pair of wheels of less diameter than the hind; but if the load be placed on the fore and hind wheels in the same proportion that their diameters bear to one another, nearly all the advantages of having wheels of equal diameter will be obtained. This proportioning of the load cannot at all times be effected in carriages of the ordinary description, even if wished; because the body of the vehicle must be equally filled with the goods to be removed, or a great loss of room would occur." (*W. Baddeley*, in *Mech. Mag.* vol. xii. p. 173.)

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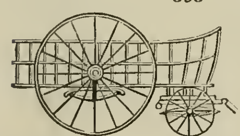

2766. *The distribution of the load between the wheels*, so as to render the difference in their size a matter of no importance, may be effected by adopting a plan recommended by Baddeley, before quoted. In a sketch of a waggon, which this engineer has given in the *Mechanics' Magazine* (*fig.* 393.), the hinder wheels are unusually large, and are so situated as to carry four fifths of the weight when the body is fully loaded; with less than a full load they may be made to carry the whole weight, by placing it over them. To admit of such large wheels being used the axle is bent, as will be better seen by referring to *fig.* 394., which is a section of the hinder portion of the carriage; it will also be seen that this part of the carriage is supported by three springs, two only being used in the fore part. Simple as this arrangement may at first sight appear, it will be found to possess a great superiority over waggons of the usual construction. The ease with which great roofs may be transported upon wheels of large dimensions has been a long and well established fact; but, at the same time, it is one of which the builders of carriages have never so fully availed themselves as they should have done. In passing over a rough or unevenly paved road (such as yet abound in many parts of our metropolis), a small wheel sinks into every little hollow, and the axle, if noticed, would be found to describe a line almost as curved and irregular as the surface of the road. A large wheel on the same road would partake but slightly of its inequalities, and the line described by the axle would be found to deviate but little from a straight line; indeed, with a wheel sufficiently large, the axle would describe a perfectly straight line. In the latter case the friction, and consequently the draught, would be little more than if the carriage ran upon a rail-road; the larger, therefore, we use the wheels, the nearer we approach this favourable point of effect. By the application of the bent axle (*fig.* 394.), large wheels, so highly necessary in these cases, might be employed without raising the body of the carriage. (*W. Baddeley, jun.* in *Mech. Mag.* vol. xii. p. 174.)

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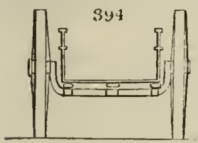

2767. *The Gloucestershire waggon*, according to Marshal, is the best in England. By means of a crooked side-rail, bending archwise over the hind wheel, the bodies or frames of them are kept low, without the diameter of the wheels being much lessened. The bodies are likewise made wide in proportion to their shallowness, and the wheels run six inches wider than those of most other waggons, whereby advantages in carrying top-loads are evidently obtained. Rudge, in his survey of the above district, says, that in many districts, waggons are the principal carriages employed in getting in the hay, and are either full-bedded, or with three-quarter beds. The former have the advantage of a greater length of bed, but are not so convenient for turning; the latter, though diminished in size, have the convenience of locking the fore wheels, and turning in almost as narrow a compass as a chaise, in consequence of the bed being hollowed out on each side near the middle, to admit the exterior part or felloes of the fore wheels. Both waggons are capable of carrying nearly the same weight; though the former, being deeper in the bed, is somewhat better adapted for the carriage of heavy articles, such as bags of corn, &c. For the purpose of harvesting, or carrying hay and straw, their length and width are increased by light ladders before and behind, and of similar contrivances called "rathes," the whole length of the sides. The ladders are put on and taken off at pleasure, in both kinds, but the side additions are generally fixed, except in the strait-headed, which are in use on the western side of the Severn; in these they are made removable, so as to leave the bed quite naked.

2768. *The Berkshire waggon* (*fig.* 395.) is constructed on a simple and convenient principle, not having the usual height or weight of other waggons, while it possesses sufficient strength, and is easy in the draught. An improvement suggested is, that of leaving the space sufficiently deep in the body or bed for the fore wheels to lock round in the shortest curve; as, in the present manner of its construction, a great deal of time is lost in turning at the ends of the swarths, in carrying hay, and on many other occasions. In this way the inconvenience may be removed, without doing the smallest injury to the symmetry or strength of the carriage.

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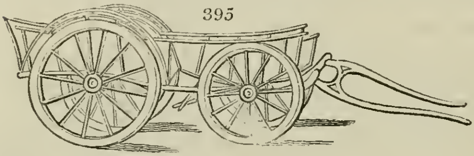

2769. *The Norfolk cart and waggon* is formed by adding a pair of fore wheels and shafts to a common cart, connected by a pole from axle to axle. It is said to be light, cheap, and convenient, and capable of carrying nearly as much hay or straw as the Berkshire waggon.

2770. *Rood's patent waggon* (*fig.* 396.) is a contrivance whereby the same carriage may, in a few minutes, be changed by the driver into two complete tip-carts of the common

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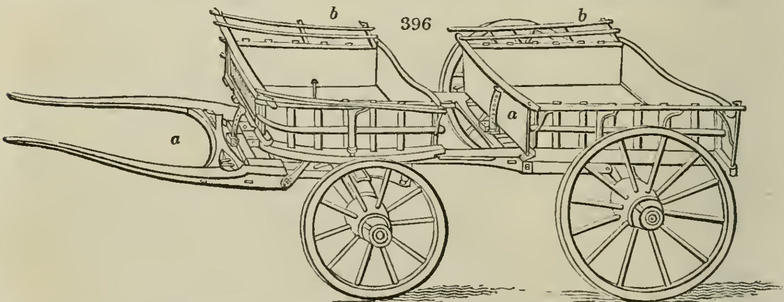

dimensions, and applicable to all the uses of carts in general, or into one waggon, so complete, that a narrow inspection is necessary to distinguish it from a common waggon. The carts have a contrivance (*a a*) to render them more safe and easy to the horse in going down a hill, and have movable side-ladders (*b b*), which will be found of great use in carrying corn, bark, &c. It may be constructed with perfect facility by the wheelwrights of any county; its shape and particular dimensions can be suited to the wishes of the owner, or to the local fashion of his neighbourhood. The result of considerable experience and enquiries enables its inventor to state, that it may, in any county, be completed for about five pounds more than the cost of two common carts. It must, however, be admitted to be somewhat more clumsy than a common waggon.

2771. *Gordon's one-horse waggon* (*fig.* 397.) is a very scientifically designed machine. The wheels are cylindrical, and of the breadth of six inches. The draught is by what is called a draught spring. (*fig.* 398.) "By these draught springs," the inventor says, "a carriage will be put into motion by little more than half of the power that would be necessary without them, and the benefit will continue during all the time that the carriage may be continued in motion; but the benefit will be lessened as the speed of the carriage may be increased, the projectile or forward force being increased in aid

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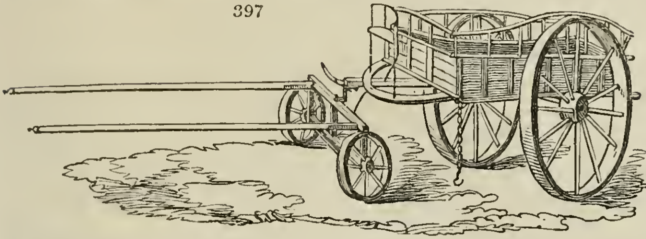

of it. Tugs, which are the greatest cause of the restiveness of horses, are prevented by these springs, and jolts are very much lessened; and carriages and horses will not be so soon worn out; and the motion of carriages will be much easier." When several beasts are employed to draw any carriage, each should be attached by one

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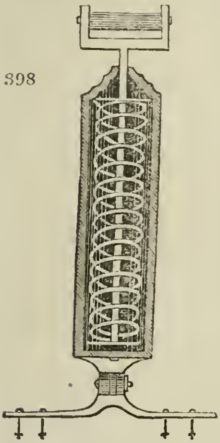

of these springs. The advantage is said to be obtained by the spring being squeezed together, in some degree, before the carriage can be set in motion; and the exertion of the spring to expand itself pulls the carriage with so much force, which is added to the force exerted by the beast. Sir Alexander Gordon, the inventor, is said to have employed carriages of this sort himself, but they have never come into general use. Messrs. Morton of Leith Walk perfectly understand their construction, and their details are recorded in the *Farmer's Magazine*, vols. xvii. and xx.

2772. *Light waggons drawn by one horse* are recommended for general use where roads are hard and smooth, and not hilly. Mr. Stuart Menteath uses them at Closeburn in Dumfriesshire, and frequently draws from a ton and a half to two tons in a waggon weighing not more than nine cwt. drawn by one horse.

Sect. VIII. *Machines for threshing and otherwise preparing Corn for Market.*

2773. *Threshing and preparatory machines* include threshing and winnowing machines, and awn and smut machines. Threshing machines are common in every part of Scotland, on farms where the extent of tillage-land requires two or more ploughs; and they are every year spreading more extensively in England and Ireland. They are worked by horses, water, wind, and, of late, by steam; and their powers and dimensions are adapted to the various sizes of farms. Water is by far the best power; but, as a supply cannot be obtained in many situations, and as wind and steam require too much expense for most farms, horses are employed more generally than any other. Where windmills are erected, it is found necessary to add such machinery as may allow them to be worked by horses, occasionally, in very calm weather; and the use of steam must be confined, for the most part, to the coal districts.

2774. *The operation of separating the grain from the straw* was long performed by the flail, to the manifest injury of both the farmer and the community; for though in some cases the work was tolerably well performed, yet in a great majority of instances it was otherwise. A quantity, perhaps equal to the average of the seed sown, was lost even in the best cases: but, where the allowance to the thresher was either a proportion of the produce, known by the name of lot, generally a twenty-fifth part; or, when he was paid in money, at so much per boll; the temptation to do the work in a slovenly manner was so great, that a quantity, perhaps double what was required for seed, was lost upon many farms; — an evil that did not escape the notice of intelligent men, by several of whom attempts were made to invent something that would do the work more perfectly; this, therefore, seems to have led to the construction and use of this valuable machine.

2775. *The first threshing-machine*, as before observed (795.), was invented by Menzies, brother to the then sheriff-depute of East Lothian; the machinery was driven by a water-wheel, which put in motion a number of flails, of the same kind with those used in threshing by the hand. Trials made with these machines were so far satisfactory, that a great deal of work was done in a given time; but, owing to the velocity required to do the work perfectly, they soon broke, and the invention fell into disgrace.

2776. *Another attempt*, some time in the year 1758, was made by a farmer in the parish of Dumblane in Perthshire. His machine was constructed upon principles similar to the flax-mill, having an upright shaft with four arms enclosed in a cylinder, three and a half feet in height and eight in diameter, within which the shaft and its arms were turned with considerable velocity by a water-wheel. The sheaves, being presented by the hand, were let down from the top upon the arms, by which the grain was beat out, and, together with the straw, descended through an opening in the floor, where they were separated by riddles and fanners, also turned by the water-wheel.

2777. *A third attempt*, about twenty years after, was made by Elderton, near Alnwick, and Smart, at Wark, both nearly about the same time. Their machine was so constructed as to act by rubbing, in place of beating out the grain. The sheaves were carried between an indented drum, about six feet in diameter, and a number of rollers of the same description ranged around it, towards which they were pressed by springs, in such a way as to rub out the grain when the drum was turned round. Upon trial, this machine was also found ineffectual, as along with its doing very little work in a given time, it bruised the grain, and so materially hurt its appearance as to lessen its value considerably in the market.

2778. *The machine, in its then imperfect state,* was seen by the late Sir Francis Kinloch, Bart. of Gilmerton, a gentleman well acquainted with mechanics, and who had paid much attention to country affairs: it occurred to him that the machine might be rendered more perfect by enclosing the drum in a fluted cover, and fixing on the outside of it four fluted pieces of wood, capable of being raised a little from the circumference by springs, in such a way as to press against the fluted cover, and to rub out the grain as the sheaves passed between them; but, after repeated trials, it was found to bruise the grain nearly as much as the model from which it was copied. In that state it remained for some time, and was afterwards sent by Sir Francis to a very worthy and ingenious character, Meikle of Know Mill, in his neighbourhood, a millwright by profession, who had for a very considerable time employed his thoughts upon the same subject. After much consideration, and several trials, it appeared to Meikle that the purpose of separating the grain from the straw might be accomplished upon a principle different from any that had hitherto been attempted, namely, by skutches acting upon the sheeves by their velocity, and beating out the grain, in place of pressing or rubbing it out; accordingly a model was constructed at Know Mill, in which the grain was beat out by the drum, to which it was presented through two plain feeding-rollers, which were afterwards altered for fluted ones. The first machine on a large scale, executed upon this principle, was done by a son of Meikle's, for Stein of Kilbagie, in the year 1786, which, when finished, performed the work to the satisfaction of all parties, and established Meikle's principle of beating out the corn as superior to all others. This superiority it still maintains, and is likely ever to do so.

2779. *Many improvements have been made on these machines* since their introduction. One of the most useful of these, perhaps, is the method of delivering the straw, after it has been separated from the corn by the circular rake, to what is called a *travelling-shaker*, which carries it to the straw-barn. This shaker, which revolves like the endless web used in cotton and other machinery, is composed of small rods, placed so near as to prevent the straw from falling through, while any thrashed corn that may not have been formerly separated, drops from it in its progress, instead of falling along with it, where it would be trodden down and lost.

2780. *Improved mode of yoking the horses.* It is well known that the work of horses in threshing-mills is unusually severe, if continued for any length of time; that they sometimes draw unequally; that they, as well as the machine itself, are much injured by sudden jerks and strains, which are almost unavoidable; and that, from this irregularity in the impelling power, it requires much care in the man who presents the corn to the rollers, to prevent bad threshing. It is therefore highly desirable that the labour should be equalised among the horses, and the movements of the machine rendered as steady as possible. A method of yoking the horses in such a manner as compels each of them to take his proper share of the labour has accordingly been lately introduced, and the necessary apparatus, which is neither complicated nor expensive, can be added to any machine worked by animal power. (*Farmer's Magazine*, vol. xiii. p. 279.; § 2754. and 2786. and *figs.* 386. 399. and 400.)

2781. *Winnowing machines added.* All well constructed threshing mills have one winnowing machine, which separates the chaff from the corn before it reaches the ground; and a second sometimes receives it from the first, and gives it out ready for market, or nearly so. If the height of the building does not admit of this last addition, a separate winnowing machine, when the mill is of great power, is driven by a belt from it. In either of these ways there is a considerable saving of manual labour.

2782. *Advantages of threshing machines.* With a powerful water-mill, the editor of *The Farmer's Magazine* observes, it cannot be doubted, that corn is threshed and dressed at no more expense than must be incurred for dressing alone, when threshed with the flail. Besides, the corn is more completely detached from the straw; and, by being threshed expeditiously, a good deal of it may be preserved in a bad season which would have spoiled in a stack. The great advantage of transferring forty or fifty quarters of grain in a few hours, and under the eye of the owner, from the yard to the granary or market, is of itself sufficient to recommend this invaluable machine, even though there were no saving of expense.

2783. *The specific advantages resulting from the use of the threshing machine* are thus stated in *The Code of Agriculture*: 1. From the superiority of this mode, one twentieth part more corn is gained from the same quantity of straw than by the old-fashioned method. 2. The work is done more expeditiously. 3. Pilfering is avoided. 4. The grain is less subject to injury. 5. Seed corn can be procured without difficulty from the new crops, for those to be sown. 6. The market may be supplied with grain more quickly in times of scarcity. 7. The straw, softened by the mill, is more useful for feeding cattle. 8. If a stack of corn be heated it may be threshed in a day, and the grain, if kiln-dried, will be preserved, and rendered fit for use. 9. The threshing-mill lessens the injury from smutty grain, the balls of smut not being broken, as when beaten by the flail; and, 10. By the same machine the grain may be separated from the chaff and small seeds, as well as from the straw. Before the invention of threshing-mills farm-servants and labourers endured much drudgery; the large corn farmer sustained much damage from bad threshing; and had much trouble, vexation, and loss, from careless and wicked servants; but now, since the introduction of this valuable machine, all his difficulties, in these respects, are obviated.

2784. *The advantage that might be derived by the public, were threshing mills used in every case,* for separating corn from the straw, is thus estimated by Brown of Markle:—

The number of acres producing grain in Great Britain, at - - - - - - - - -	8,000,000
The average produce in quarters, at 3 qrs. per acre, at - - - - - - - - - - -	24,000,000
The increased quantity of grain produced by threshing-mills, instead of using the flail, at one twentieth part of the produce, or in quarters, at - - - - - - - - - - -	1,200,000
The value of that increased quantity, at 40*s.* per quarter - - - - - - - - - -	L2,400,000
The saving in the expense of labour, at 1*s.* per quarter - - - - - - -	L1,200,000

2785. *A variety of threshing machines* have been made in England, both on the rubbing and beating, or scutching, principle, and some combining both modes; but none have been found to answer the purpose of separating the grain from the straw so well as those of Meikle, which is the kind exclusively used in Scotland and the north of England.

2786. *Meikle's two-horse threshing machine, with the new-invented yoking apparatus* (*fig.* 399. and 400.), is the smallest size of horse engine which is made. From the limbers, or hanging pieces (*a*), by which the cattle draw when working this machine, proceed the chains or ropes to which the horses are yoked, these chains or ropes being united by an iron frame, placed upon a lever, having liberty to turn on a bolt; one end of each of two single ropes is fixed to this iron frame, and upon their other ends are fixed small blocks; in each of which is placed a running sheeve, and over these sheeves pass double ropes or chains. One horse is yoked to these chains at the one arm, and one at the other arm, so that the chains or ropes by which they draw, being connected by the blocks, and the sheeves having liberty to move either way, if one of the horses relaxes, immediately the other presses the collar to his shoulders. For instance, if the horse yoked to the chains at one arm (*fig.* 400. *a*) were to relax, then the one yoked at the other (*b*) would instantly take up his rope, and pull the collar hard to his shoulders.

so that the lazy horse must either exert himself or be drawn backward, until the hooks, to which he is yoked, rest on the limbers. Thus each horse spurs up his fellow, they being

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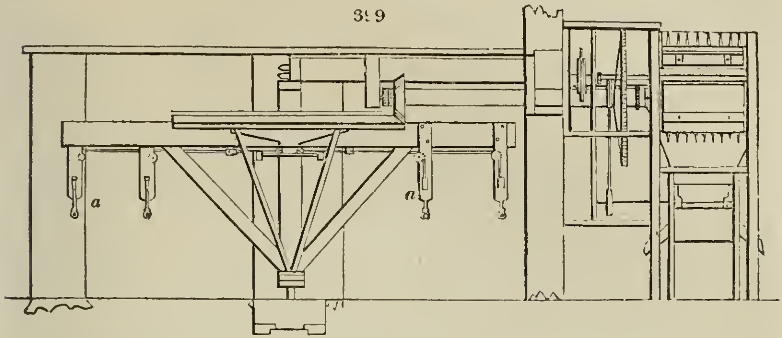

both connected by the ropes and sheeves; their exertions are united, so as to form one power applied to the machine, instead of two powers, independent of one another. By this

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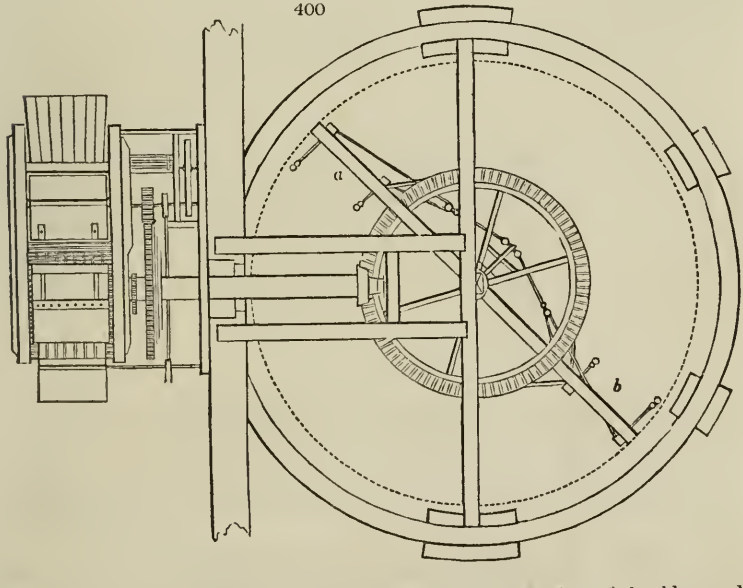

means the draught will always press the collars equally upon the horses' shoulders, and, though they are working in a circle, yet the strains of the draught must press fairly, or equally, on their shoulders, without twisting their bodies to either side. This advantage cannot be obtained in the common way of yoking horses in a threshing machine, unless the draught-chains on each side of the horse be made in exact proportion in length to the diameter of the circle in which he walks, or the chain next to the centre of the walk be made a little shorter than the one farthest from it, which is often neglected; but in this way of yoking the horses, the strain of the draught will naturally press equally on his shoulders when pulling, which of course must be less severe on the animal when walking in a circle.

2787. *The advantages of this method of yoking horses* to a threshing machine, which was invented by Walter Samuel, blacksmith at Niddry, in the county of Linlithgow, have been fully ascertained by experience, and acknowledged by the most intelligent farmers in Scotland. They are as follows:—

1st, The very great comparative ease obtained for the cattle, in this the heaviest part of their work. This, without doubt, is a real saving of labour; for it is no exaggeration to affirm, that five horses, yoked by this apparatus to a threshing machine, will perform with equal ease the labour of six horses, of equal strength and weight, yoked in the common way, each horse being independent of the rest.

2dly, A very great saving results in the tear and wear of the machine, from the regularity and uniformity of the movement. This will be acknowledged by any judge of the subject who witnesses the performance. The sudden jerks and strains that generally take place in the usual way, are found to be quite removed; the machinery moving with the same kind of uniformity as if driven by water. In consequence of which the work is better performed, and that in a very perceptible degree.

2788. *Meikle's water threshing-machine* (*fig.* 401.) is the preferable engine, when a supply of water can be obtained. The main axle or shaft (*a*), upon which is fixed the water-wheel (*b*), has placed upon its circumferencecast-metal segments (*c*), the teeth of which turn the pinion which is fastened on the axle of the threshing-drum; the platform, on which the unthreshed corn is spread, joins the feeding rollers, that conduct the corn forward to the threshers; next the threshing-drum is the straw-shaker, driven by a leathern belt, passing over a sheeve, fixed on an iron spindle connected with the axle of the water-wheel and the sheeve on the axle of the shaker.

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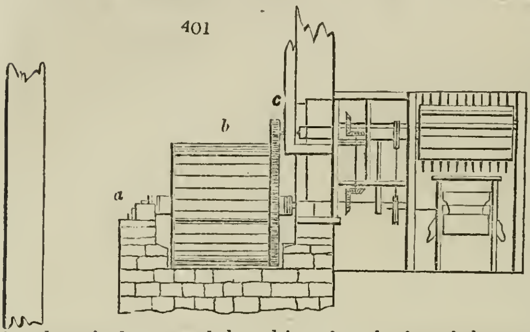

2789. *Meikle's threshing machine to be driven by water or by four horses* (*fig.* 402.), is a powerful and convenient engine, as advantage may be taken of water when it is

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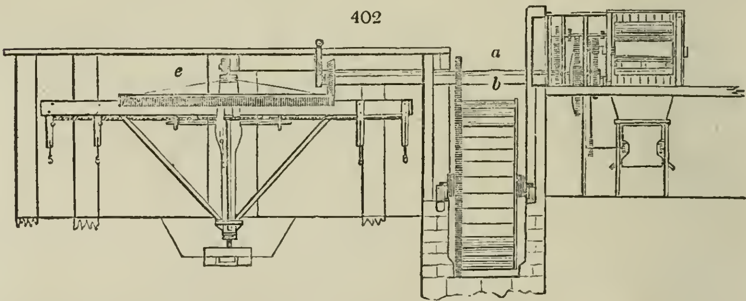

abundant, and in dry seasons horses can be applied. To this machine the improved apparatus for yoking the horses is appended, and by the simple operation of varying the positions of the pinions on the common shaft (*a*), which communicates with the water and horse-wheel (*b*, *c*), threshing may be carried on without interruption, either with the water or the horses separately; or a small quantity of water may be applied to assist the horses at any time, when a sufficient supply of water cannot be obtained to impel the machine alone.

2790. *Meikle's threshing machine to be driven either by wind or six horses* (*Gray*, Pl. XII.) is a powerful but costly erection. On large corn farms, however, it will answer to erect such machines; and there are frequent instances in Berwickshire and Northumberland, of farmers incurring that expense on the security of twenty-one years' leases. The machinery of the wind power of this machine is fitted up with a small van to turn the large ones to face the wind, and with the machinery necessary to roll on or off the sails according to its increase or diminution; by which means the naturally unsteady power of wind is rendered as regular as that of horses or water. The threshing part of this machine contains the usual apparatus, and also a complete set of fanners and screens for cleaning the corn. To the board upon which the unthreshed grain is spread, and introduced between the feeding rollers, succeeds the drum, with the threshers, or beaters, fixed upon the extremity of its arms; then the shaker, that receives the straw from the threshing drum, and conveys it to the second shaker, by which it is thrown down a sloping searce, either on the low floor, or upon a sparred rack, which moves on rollers, turned by the machine, and by this means is conveyed into the straw-shed, or else into the barn yard. One searce is placed below the threshing-drum; and, while the drum's circular motion throws out the straw into the straw-shaker which conveys it to the second shaker, the chaff and grain pass at the same time down through a searce or sparred rack into the hopper, which conveys it into the fanners. By the fanners the corn is separated from the chaff, the clean grain running out at the opening, and the chaff or any light refuse blowing out at the end by the rapid motion of the fans, which are driven by a band or rope from a sheeve placed upon the axle of the threshing-drum, and passing over the sheeve fixed upon the pivot of the fans.

2791. *Meikle's threshing machine to be impelled by steam* is the same arrangement of interior machinery, with a steam engine outside of the barn connected by a shaft in the manner of the wind and water machines.

2792. *Portable threshing-machines,* to be fixed in any barn, or in the open field, for threshing the crops of small farms, or for other purposes of convenience, are differently contrived. Except the hand machine, already described (§ 2546.), all of them work by horses, and generally by one, or at most two. The most complete have a large frame of separating beams, into which the gudgeons of the larger wheels work, and which retains the whole of the machinery in place. In general there are no fanners; but sometimes a winnowing machine is driven by a rope from the threshing machinery. Such machines are considerably more expensive, in proportion to their power, than fixed machines; they are, therefore, not much used, and indeed their place might often be profitably supplied by the hand machine. Portable threshing machines are very common in Suffolk. It is not unusual in that county, for an industrious labourer who may have saved 30*l.* or 40*l.* to own one, which is moved from place to place on two wheels, and worked, when fixed, by three or four horses. The horses and other labourers are supplied by the farmer; and the owner of the machine acts as feeder. The quantity threshed is from fifteen to twenty quarters a day. Reaping machines, and steam ploughing-machines, will probably in a few years be owned, and let out for hire in a similar manner.

2793. *Weir's portable two-horse power threshing machine* is one of the best in England. The corn is threshed on Meikle's skutching principle, and is sometimes supplied by fluted rollers, and sometimes introduced through a hopper directly over the drum; a mode which is found not to break the straw so much as the common mode.

2794. *Lester's portable threshing-machine* received the straw without the intervention of rollers, and separated the corn entirely by rubbing. It was an ingenious, but very imperfect, machine, and never came into use.

2795. *Forrest of Shifnal's portable threshing machines* have been employed in several parts of Warwickshire, Shropshire, and the adjoining counties. It combines the rubbing and skutching methods, but does not perform either perfectly. Meikle's machines, in fact, can alone be depended on, for completely separating the grain from the straw; though some others may render the straw less ineligible for thatch, or for gratifying the present taste in litter of the London grooms.

2796. *The smut machine* (*fig.* 403.) is the invention of Hall, late of Ewel in Surrey, now of the Prairie in the United States. It resembles that used for dressing flour, and consists of a cylinder perforated with small holes, in the inside of which are a number of brushes, which are driven round with great rapidity. The wheat infected with smut is put into the cylinder by a hopper (*a*), and the constant friction occasioned by the rapid motion of the brushes (*b*) effectually separates the smutty grain, which is driven out by the holes of the cylinder. Hall finds that it requires much more power to clean wheat by this machine, than to dress flour. A machine on this construction might be a very useful appendage to every threshing machine, for the purpose of effectually cleaning all wheat intended for seed, or such wheat, meant for the market, as had a great proportion of smut in it. (*Stevenson's Surrey*, p. 141.)

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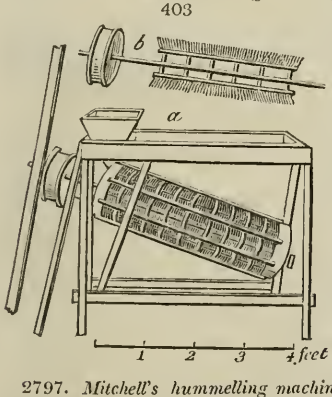

2797. *Mitchell's hummelling machine* (*fig.* 404.) is the invention of a millwright of that name in the neighbourhood of Elgin, and it has been very generally added to threshing machines, in the barley districts of Scotland, for the purpose of separating the awns from the grains of barley. It operates on the scutching principle, and is composed of a scutcher consisting of a spindle, at the top of which is fixed a wheel for putting it in motion, and between this wheel and its lower extremity three tier of scutching arms (*a*); each scutcher is composed of two pieces forming a cross (*b*), and bevelled at the edges to prevent them from cutting the barley in the operation of hummelling (*c*). The scutcher revolves in a cylinder (*d*), into which the barley passes through a spout (*e e*) from a hopper placed over the machine. The cylinder may either be of wood or cast iron, and the framework which supports it (*f*) may be of either, or of both of these metals. (*Farm. Mag.* vol. xiii.)

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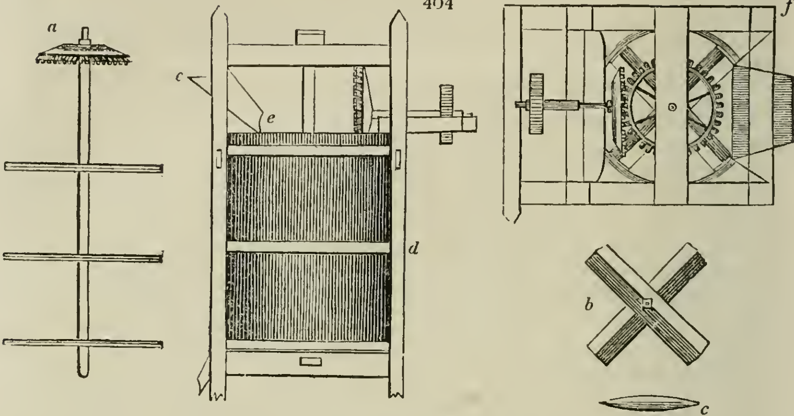

2798. *To take the awns from barley where a threshing machine is used*, a notched spar, lined on one side with plate iron, and just the length of the rollers, is fixed by a screw bolt at each end of the inside of the cover of the drum, about the middle of it, so that the edge of the notched stick is about one eighth of an inch from the arms of the drum as it goes round. Two minutes are sufficient to put it on, when its operation is wanted, which is, when putting through the barley the second time; and it is as easily taken off. It rubs off the awns completely.

2799. *A cheap method of hummelling barley*, where a threshing machine is in use, consists in having a second cover for the drum lined with tin, having small holes perforated in it in the manner of a grater, and the rough side externally. The grain being separated from the straw in the ordinary way, the grated cover is to be substituted for the common one, and the grain passed through a second time. This mode is said to succeed as well as any other. (*Farm. Mag.* vol. xiii. p. 443.)

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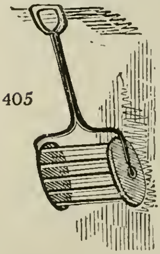

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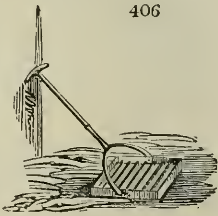

2800. *Hand hummelling machines* (*figs.* 405. and 406.) are in use in Lincolnshire and other parts of England, where barley is much cultivated, and where threshing machines are little in use. (*Gard. Mag.* vol. v.)

Sect. IX. *Mechanical and other fixed Apparatus, for the Preparation of Food for Cattle, and for grinding Manure.*

2801. *The principal food-preparing contrivances* are, the steamer, boiler, roaster, breaker or bruiser, and grinder.

2802. *An apparatus for steaming food for cattle*, the editor of *The Farmer's Magazine* observes, should be considered a necessary appendage to every arable and dairy farm of a moderate size. The advantage of preparing different sorts of roots, as well as even grain, chaff, and hay, by means of steaming apparatus, for the nourishment of cattle, begins now to be generally understood. It has been long known that many sorts of roots, and particularly the potato, become much more valuable by undergoing this sort of preparation; and it is equally well known that when thus prepared they have been employed alone as a substitute for hay, and with cut chaff, both for hay and corn, in the feeding of horses, as well as of other animals. To a farmer who keeps many horses or cattle, or even swine or poultry, the practice of boiling their food in steam is so great a saving and advantage, that it deserves the most particular attention. Though potatoes have often been given raw to both horses and cattle, they are found to be infinitely preferable when cooked by steam, as they are rendered thereby much drier and more nutritive, and better than when boiled in water; this has been long since shown by the experiments of Wakefield of Liverpool, who, in order to ascertain it, fed some of his horses on steamed and some on raw potatoes, and soon found the horses fed on the steamed potatoes had greatly the advantage in every respect. Those on the steamed potatoes looked perfectly smooth and sleek, while the others were quite rough. Ecclestọn also found them useful instead of corn; and the extensive and accurate trials of Curwen have placed the utility and advantage of them in this way beyond all dispute. Curwen has found that in their preparation in this way the waste of the potato is about one eighteenth part, and that straw when given along with them answers as well as hay, as the horses keep their condition and do their work equally well.

2803. *A steaming apparatus on a grand scale* has been erected at Workington, by Curwen, of which an accurate ground plan and section, with a copious description, are given in *The Complete Farmer*. One erected by the Duke of Portland, chiefly for steaming hay, will be afterwards described.

2804. *An economical steaming and washing machine* has been described by Grey, in his *Implements of Husbandry, &c.* The parts of this machine are few and simple: the potatoes are washed, and emptied into a large chest to drip; and when a sufficient quantity is washed, this chest, by a motion of the crane, empties itself into a steaming-box, placed almost immediately over the boiler; by which means a large quantity of potatoes or other materials are steamed at once. The chief advantage attending the use of this simple steaming apparatus, he says, consists in saving manual labour in lifting on and off the tubs for holding the potatoes, or other materials to be steamed; also in lessening the expense of erection, and repairs of leaden or copper pipes, turn-cocks, &c. Its superiority over one with a number of steaming-tubs, especially in a large operation, will be at once perceived by those who have paid attention to the subject. The steaming boiler may be made of any approved form, and of a size proportioned to the steaming-box, with a furnace of that construction which affords the greatest quantity of heat to the boiler with the smallest waste of fuel. The steaming-box may be made either of cast-metal plates, enclosed in a wooden frame, or of stout planks, well joined, and firmly fixed together. It has been found by experience, that a box, eight feet in length, five feet wide, and three feet deep, will serve for cooking, in the space of one hour, with the attendance of one person, a sufficient quantity of potatoes to feed fifty ordinary horses, allowing each horse thirty-two pounds weight per day. The boiler and steaming-box, however, ought to be made of a size in proportion to the number of cattle to be fed, or the quantity of materials to be steamed; both boiler and steaming-box may be made of any form and proportion that will best answer the intended purpose, with the least expense.

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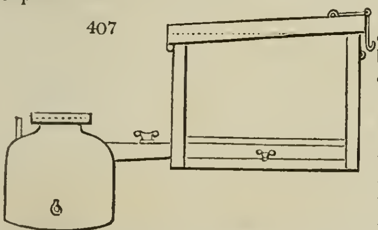

2805. *A steaming-machine, on a simple and economical plan* (*fig.* 407.), consists of a boiler, and wooden chest or box placed over or near it. The box may be of any size, and so placed as to be supplied and emptied by means of wheel or hand barrows in the easiest manner, either by the end or top, or both, being made to open. If the box is made eight feet by five, and three deep, it will hold as many potatoes as will feed fifty cows for twenty-four hours, and these may be steamed in an hour. (*F. Mag.* vol. xviii. p. 74.)

2806. *Boilers or boiling machines* are only had recourse to in the case of very small establishments. By means of fixed boilers, or boilers suspended by cranes, on the Lodi dairy principles (270.), roots may be boiled, and chaff, weak corn, and other barn refuse, rendered more palatable and nutritive to cattle. Hay tea also may be made, which is a salutary and nutritive drink for horses or cattle when unwell, or for calving cows. Food for swine and poultry may also be prepared in this way: or water boiled and salted to half prepare chaff and culmiferous plants for animals.

2807. *A baking or roasting oven* has been recommended for preparing the potato by Pierrepoint (*Comm. Board of Agr.* vol. iv.), which he states to be attended with superior advantages; but as, independently of other considerations, the use of such an oven must be limited to potatoes, a steaming-machine, which will prepare any sort of food, is undoubtedly preferable for general purposes. Many speculative plans of this sort, however ingenious, chiefly deserve notice as beacons to be avoided, or to prevent their being invented and described a second time.

2808. *A machine for pounding limestone* (*fig.* 408.) is in use in some parts of the country where unburnt chalk, limestone, or limestone gravel, is used as a manure. This machine may be worked by steam, wind, water, or the power of horses. It consists of a beam (*a*) working on a wheel (*b*), and raising and lowering a cone of cast iron (*c*). The base of this cone, which may be a circle of from two to six feet in diameter, according to the power of the machinery, and the size and hardness of the material to be broken, should be studded with knobs or protuberances about two inches long, of a diamond shape, terminating in a blunt point, and about five inches in circumference at the bottom. The stones to be broken are laid on a circular basement, founded at some depth below the surface, the foundation of which is prepared in the following manner : — " A stratum is formed of clay, well tempered, and mixed with a proportion of burnt limestone, powdered without being slacked, and forge ashes beat very small. When this is properly dried, a bed of sand, about eighteen inches in thickness, should be laid above it, and paved with common paving stones of the kind used for streets : this, after being well beat down, should be covered with another bed of sand of the same thickness, which should be paved in the same manner, and afterwards well beat down. The foundation of the building should be, at least, six feet below the common surface ; which will allow eighteen inches for the clay, thirty-six inches for the two beds of sand, and eighteen inches for the two courses of pavement. The circumference should consist entirely of hewn stone, at least the uppermost three feet of it ; the stones of which should be strongly batted together with iron, and secured on the outside with numerous wooden posts driven into the earth, and different courses of pavement, extending at least six feet all round, carefully laid, and well beat down. A floor prepared in this manner, if it is not used too soon, will resist any force that can be let fall upon it. The limestone laid into it should not be too small, and should have a light bedding of sand in the soil to give it stability." (*Farm. Mag.* vol. iii.)

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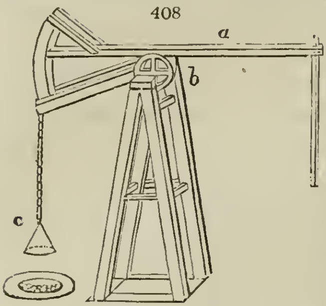

2809. *A stone-hewing machine* to be impelled by steam has lately been invented by Mr. James Milne of Edinburgh. It is said to save an immensity of manual labour, and to be competent to the execution of the finest mouldings. (*Scotsman*, Oct. 28. 1829.)

2810. *Low's Machine for raising large stones* (*fig.* 409.) is a powerful engine. An iron plug is driven into the stone, and retained there by its elasticity. The machine " is placed over the stone to be raised, by extending the posts on each side, and then the windlass is attached. Of the stone to be thus raised, however large it be, it is enough to see the smallest part appear above the surface of the ground. At this part, let a workman, with a mallet, and the common steel-boring chisel of masons, make a small circular hole, about two inches deep, and as perpendicular as possible. This chisel should be of such a size as to make the hole about a sixteenth part of an inch less in diameter than the plug itself, so that a stroke or two of a hammer may be necessary to drive the iron home. When the latter is thus driven an inch, more or less, into the stone, it is attached to the block, and the ropes are tightened by turning the winch. Nothing more is now requisite than to set as many persons as may be required to work the windlass ; and, strange as it will seem, with no other fastening than this simple plug, the heaviest mass will be torn up through every opposing obstacle." (*Quar. Jour. Agr.* vol. i. p. 208.)

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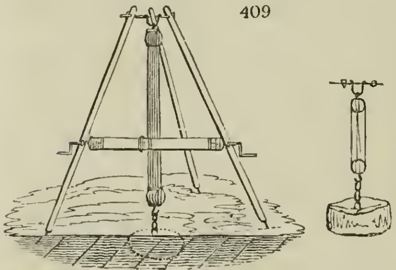


Chap. III.

Edifices in use in Agriculture.

2811. *A variety of buildings are necessary* for carrying on the business of field culture ; the nature and construction of which must obviously be different, according to the kind of farm for which they are intended. Suitable buildings, the editor of *The Farmer's Magazine* observes, are scarcely less necessary to the husbandman than implements and machinery ; and might, without much impropriety, be classed along with them, and considered as one great stationary machine, operating more or less on every branch of labour and produce. There is nothing which marks more decidedly the state of agriculture in any district, than the plan and execution of these buildings.

2812. *In erecting a farmery,* the first thing that deserves notice is its situation, both in regard to the other parts of the farm, and the convenience of the buildings themselves. In general, it must be of importance on arable farms, that the buildings should be set down at nearly an equal distance from the extremities; or so situate, that the access from all the different fields should be easy, and the distance from those most remote, no greater than the size of the farm renders unavoidable. The advantages of such a position in saving labour are too obvious to require illustration; and yet this matter is not near so much attended to as its importance deserves. In some cases, however, it is advisable to depart from this general rule; of which one of the most obvious is, where the command of water for a threshing-mill, or other purposes, can be better secured in another quarter of the farm.

2813. *The form most generally approved for a set of offices* is a square, or rather a rectangular parallelogram; the houses being arranged on the north, east, and west sides, and the south side fenced by a stone wall, to which low buildings, for calves, pigs, poultry, &c. are sometimes attached. The space thus enclosed is usually allotted to young cattle: these have access to the sheds on one or two sides, and are kept separate, according to their size or age, by one partition-wall or more. The farmer's dwelling-house stands at a short distance from the offices, and frequently commands a view of the inside of the square; and cottages for servants and labourers are placed on some convenient spot, not far from the other buildings.

2814. *The different buildings required for the occupation of land* are chiefly those devoted to live stock, as the stable, cow-house, cattle sheds, &c.; those used as repositories or for conducting operations, as the cart-shed, barn, &c.; and human habitations, or cottages and farm-houses. After noticing the separate construction of these edifices, we shall exemplify their combination in different descriptions of farmeries.

Sect. I. *Buildings for Live Stock.*

2815. *Buildings for agricultural live stock* are the stable, cow-house, cattle-houses and cattle-sheds, sheep-houses, pigsties, poultry-houses, rabbitry, pigeonry, and bee-house.

2816. *The stable* is an important building in most farmeries; it is in general placed in the west side of the square, with its doors and windows opening to the east. Nothing conduces more to the health of horses than good and wholesome air. The situation of the stable should always be on firm, dry, and hard ground, that in winter the horse may go out and come in clean; and, where possible, be built rather on an ascent, that the urine and other liquid matters may be easily conveyed away by means of drains for the purpose. As there is no animal that delights more in cleanliness than the horse, or that more dislikes bad smells, care should be taken that there be no hen-roost, hogstics, or necessary houses near the place where the stable is to built. The swallowing of feathers, which is very apt to happen, when hen-roosts are near, often proves injurious to horses. The walls of a stable ought to be of brick rather than stone, and should be made of a moderate thickness, two bricks or a brick and a half at least, or the walls may be built hollow, not only for economy, but for the sake of warmth in the winter, and to keep out the heat in the summer. The windows should be proportioned in number to the extent, and made on the east or north side of the building, that the north wind may be let in to cool the stables in the summer, and the rising sun all the year round, especially in winter. They should either be sashed or have large casements for the sake of letting in air enough; and there should always be close wooden shutters, turning on bolts, that the light may be shut out at pleasure. Many pave the whole stable with stone, but that part which the horse is to lie on is often boarded with oak planks, which should be laid as even as possible, and cross-wise rather than length-wise; and there should be several holes bored through them to receive the urine and carry it off underneath the floor by gutters into one common receptacle. The ground behind should be raised to a level with the planks, and be paved with small pebbles. There are mostly two rings placed on each side of the manger, or stall, for the reins of the horse's halter to run through, and a logger is to be fixed to the ends of these, sufficient to poise them perpendicularly, but not so heavy as to tire the horse, or to hinder him from eating; the best place for him to eat his corn in, is a drawer or locker, which need not be large, so that it may be taken out at pleasure to clean it, by which means the common dirtiness of a fixed manger may be avoided. Many people are against having a rack in their stables; they give the horse his hay in a trough bin, formed of boards with an open bottom.

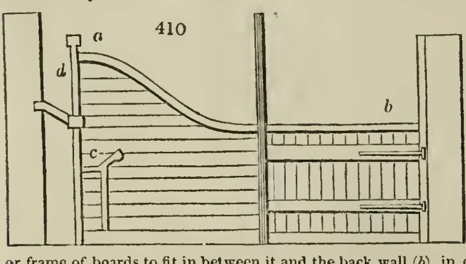
2817. *A lofty stable* is recommended by White (*Treatise on Veter. Med.* p. 1.), fifteen or twenty but never less than twelve feet high, with an opening in the ceiling for ventilation. The floor he prefers is brick or limestone, inclining not more from the manger to the gutter than an inch in a yard. Some litter, he says, should always be allowed for a horse to stale upon, which should be swept away as often as is necessary. This, with a pail or two of water thrown upon the floor, and swept off while the horse is at exercise, will keep the stable perfectly clean, and free from offensive smells.

2818. *The depth of a stable* should never be less than twenty feet, nor the height less than twelve. The width of a stall should not be less than six feet clear. But when there is sufficient room, it is a much better plan to allow each horse a space of ten or twelve feet, where he may be loose and exercise himself a little. This will be an effectual means of preventing swollen heels, and a great relief to horses that are worked hard. With respect to the rack and manger, White prefers the former on the ground, rising three feet high, eighteen inches deep from front to back, and four feet long. The manger, eighteen inches deep, eighteen inches from front to back, and five feet in length. The rack he prefers being closed in front, though some farmers prefer it open, alleging that horses when lying down will thus be enabled to eat if they choose. A close-fronted rack, however, is better adapted for saving hay. The back part of the rack should be an inclined plane made of wood; should be gradually sloped towards the front; and should terminate about two feet down. Such a rack will hold more hay than ever ought to be put before one horse. The advantages of this rack are numerous: in the first place, the hay is easily put into it, and it renders a hay loft over the stable unnecessary; which ought to be an inducement to the builder to make the stable as lofty as it ought to be, to obtain proper ventilation. All the hay that is put into this manger will be eaten; but in the common rack it is well known that a large portion of the hay is often pulled down upon the litter, and trodden upon, whereby a considerable quantity is often wasted. It prevents the hay-seeds or dust from falling upon the horse, or into his eyes; and what is of considerable importance, though seldom attended to, there will be an inducement to the horse-keeper to give the horse hay in small quantities at a time, and frequently, from the little trouble which attends putting it into the rack. The saving in hay that may be effected by the use of this rack is so apparent, that it need not be dwelt upon. A great saving also may be made in oats, by so fastening the horse's head during the time of feeding, that he cannot throw any of them out of the manger. This kind of rack and manger, from being boarded up in front, will effectually prevent the litter from being kept constantly under the horse's head and eyes, by which he is compelled to breathe the vapours which arise from it. It will also prevent him from getting his head under the manger, as sometimes happens, by which means, not unfrequently, the poll evil is produced. The length of the halter should be only four feet from the head-stall to the ring through which it passes: this will admit of his lying down with ease, and that is all which is required. The ring should be placed close to that side where the manger is, and not in the centre of the stall. The side of the stall should be sufficiently high and deep to prevent horses from biting and kicking each other. When the common rack and manger are preferred, the rack-staves should be perpendicular, and brought nearly down to the manger, and this may easily be done without the necessity of a hay-loft, and the manger may be made deep and wide as described.

2819. *The window of the stable* should be at the south-east end, and the door at the opposite end. The window should be as high as the ceiling will admit of, and in size proportioned to that of the stable. In one of twelve feet high, it need not come down more than four feet, and it will then be eight feet from the ground, and out of the way of being broken. The frame of the window should be moveable upon a pivot in the centre, and opened by means of a cord running over a pulley in the ceiling, and fastened by means of another cord. With a window of this kind, in a stable of three or four horses, no other ventilation will be required: a person never need be solicitous about finding openings for the air to enter, where there is sufficient room above, and means for it to escape. A stable thus constructed will be found conducive to the health and comfort of horses, and will afford an inducement to the horse-keeper to attend to every little circumstance which may contribute to cleanliness. He will not allow the smallest bit of dung to remain swept up at one end of the stable, as it commonly is. The pails should be kept outside, and not standing about the stable as they usually are. If it is necessary to take off the chill from water, it is much better, and more easily done, by the addition of a little hot water, than by suffering it to stand in the stable; and while the horses are at exercise, the litter should be all turned out to dry, and the brick floor well washed or swept out. A little fresh straw may then be placed for the horses to stale upon. Litter thus dried during the day will serve again as well as fresh straw for the bottom of the bed, and be perfectly free from smell. The litter necessary to be kept under a horse that he may stale with comfort, and without splashing himself, is not considerable, and may be changed once a day. A great saving may be made in litter by turning it out, and drying it as described; and a shed built adjoining a stable would afford a place for doing this at all times, and might serve also to exercise and clean a horse in during wet weather.

2820. *Neither dogs, fowls, nor goats, should ever be permitted to enter a stable;* and dung should be kept at a distance from it. A good contrivance in cleaning horses is, to have two straps, one on each side of the stall, about one yard from the head of it. By these the horse may be fastened during the time he is cleaned, by which he will be effectually prevented from biting the manger or the horse-keeper; and being kept back in the stall, the man will be better able to clean the front of his fore legs, chest, and neck, and be able to move round him. This is better than strapping him to the rack.

2821. *Farm stables in Scotland*, the editor of *The Farmer's Magazine* observes, are constructed in such a manner, that all the horses stand in a line with their heads towards the same side-wall, instead of standing in two lines, fronting opposite walls, as formerly. Those lately erected are at least sixteen feet wide within walls, and sometimes eighteen, and the width of each stall upon the length of the stable is commonly five feet. To save a little room, stalls of nine feet are sometimes made to hold two horses; and in that case, the manger and the width of the stall are divided into equal parts by what is called a half trevice, or a partition about half the depth of that which separates one stall from another. By this contrivance, each horse indeed eats his food by himself; but the expense of single stalls is more than compensated by the greater ease, security, and comfort of the horses. The trevices or partitions which divide the stalls, are of deals two inches thick, and about five feet high; but, at the heads of the horses, the partition rises to the height of seven feet (*fig.* 410. *a*), and the length of the stall is usually from seven to eight feet. In many cases the end stall has a door or frame of boards to fit in between it and the back wall (*b*), in order to enclose food of any kind, a sick horse, a foal, or mare and foal, &c.



2822. *The manger* (*c*) is generally continued the whole length of the stable. It is about nine inches deep, twelve inches wide at the top, and nine at the bottom, all inside measure, and is placed about two feet four inches from the ground. Staples or rings are fixed on the breast of the manger, to which the horses are tied.

2823. *The rack* for holding their hay or straw, is also commonly continued the whole length of the stable. It is formed of upright spars (*d*), connected by cross-rails at each end, and from two to two and a half feet in height. The rack is placed on the wall, about one foot and a half above the manger, the bottom almost close to the wall, and the top projecting outwards, but the best plan is to place it upright (*c*, *d*, *a*,). The spars are sometimes made round, and sunk into the cross-rails, and sometimes square. In a few stables lately built, the round spars turn on a pivot, which facilitates the horse's access to the hay, without requiring the interstices to be so wide as to permit him to draw it out in too large quantities.

2824. *Immediately above the racks* is an opening in the hay-loft, through which the racks are filled. When it is thought necessary, this may be closed by boards moving on hinges.

2825. *The racks in some of the best stables* occupy one of the angles between the wall and trevices, and form the quadrant of a circle. The spars are perpendicular, and wider placed than in the hanging racks. The hay-seed falls into a box below, instead of being dropped on the ground, or incommoding the eyes and ears of the horses.

2826. *Behind the horses*, and about nine feet from the front wall, is a gutter, having a gentle declivity to the straw-yard or urine-pit. Allowing about a foot for this, there will remain a width of eight feet to the back wall, if the stable be eighteen feet wide; a part of which, close to the wall, is occupied with corn-chests and places for harness.

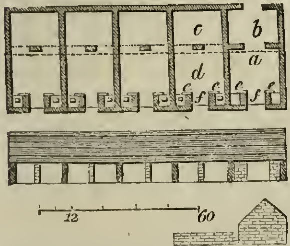
2827. *With a view to save both the hay and the seed*, it is an advantage to have the haystacks so near the stable as to admit of the hay being thrown at once upon the loft. In some stables there is no loft, and the hay is stored in a separate apartment.

2828. *The stable floor* is, for the most part, paved with undressed stones; but in some instances, the space from the gutter to the back is laid with flags of freestone.

2829. *Horse-hammels*, or small sheds, with yards to each, have been used as stables in a few instances, and with great success in Berwickshire. Each shed holds two horses, with a niche for their harness: to each shed there is an open straw-yard, of small size, with a water trough, and a gate large enough to admit a cart to take out the dung. John Herriot, of Ladykirk, has long used these buildings for his horses with great success. He has lost none by death for a number of years, and they seldom have colds or any other disease. His horses lie in these open hammels in winter; and it is remarked, that in frosty weather, when snow is falling, and lying on the ground, the animals do not go under cover, but prefer to lie out, with their backs and sides covered with snow. It is well known, that if a horse is kept out in winter, he will have no grease, nor swelled legs, and perhaps few other diseases. These hammels seem to have all these advantages, at the same time that they protect the animal from damp, and prevent his back from being kept wet by heavy or long continued rains. Every farmer who keeps a large stock of horses, occasionally loses one by inflammation, brought on by coughs and colds; but the horses of the farmer alluded to become aged, and he has not had occasion to purchase a young horse for several years. (*Husb. of Scot.* i. 26.) Suffolk cart horses lie out during night throughout the whole year; they are not exempt from grease, but they are probably more healthy than horses in general are.

2830. *Cattle-sheds* are used either for lodging milch cows, or for feeding cattle for the butcher. The principal requisites in buildings of this description are, to be capable of being well aired; to be so constructed as to require the least possible labour in feeding the cattle and clearing away the dung; and the stalls to be so formed as to keep the cattle as dry and clean as possible, with sufficient drains to carry away, and reservoirs to collect, the urine and dung. There are three ways in which the cattle are placed: first, in a row towards one of the side walls; secondly, in two rows, either fronting each other, with a passage between, or with their heads towards both side walls; and, thirdly, across, or upon the width of the house, in successive rows, with intervening passages for feeding and removing the dung. In the first mode, it is usual to have openings in the walls, through which the cattle are supplied with turnips; otherwise they must necessarily be served from behind, with much inconvenience both to the cattle-feeder and the cattle themselves. The plan that is most approved, and now becoming general when new buildings are erected, is to fix the stakes to which the cattle are tied about two and a half or three feet from the wall, which allows the cattle-man, without going among them, to fill their troughs successively from his wheelbarrow or basket, with much ease and expedition. It is also a considerable improvement to keep the cattle separate, by partitions between every two. This will, in a great measure, prevent accidents, and secure the quiet animals from being injured by the vicious; for in these double stalls, each may be tied up to a stake placed near the partition, so as to be at some distance from his neighbours; and it is easy to lodge together such as are alike in size and in temper. The width of such stalls should not be less than seven feet and a half, and the depth must be regulated by the size of the cattle.

2831. *Cattle-hammels* (*fig.* 411.) The practice of feeding cattle in small sheds and straw-yards, or what are called *hammels* in Berwickshire, deserves to be noticed with approbation, when saving of expense is not a paramount object. Two cows are usually kept together, and go loose; in which way they are thought by some to thrive better than when tied to a stake, and, at the same time, feed more at their ease than when a number are kept together as in the common straw-yards. All that is necessary is, to run partition walls across the sheds and yards of the farmers; or if these are allotted to rearing stock, one side of the square, separated by a cart-way from the straw-yards, may be appropriated to these hammels. In the usual management of a row of cattle hammels in Berwickshire, there is one hammel (*a b*) at one end used as a temporary repository for roots and straw for the cattle; then each hammel consists of the open yard (*d a*), and the covered part (*c*): the entrance door, of which there is only one to each hammel, is in the wall of the yard (*f*), and on each side of it are two troughs (*e, e*) for food, and a crib for hay or straw, and for cut clover or other herbage in summer.



2832. *Harley's cow-house* at Glasgow contained one hundred cows. It stood upon a vaulted cellar, which was divided into three apartments: the middle one for the manure; that at one end for potatoes, and other roots to be used as food; and in the other, cows not giving milk were kept. The dung was dropped into the centre division through apertures in the gutters (*fig.* 412. *a, a*), eighteen inches in diameter, covered with cast-iron plates. Sometimes a cart was brought into the cellar, and the dung at once dropped into it, and carted away. The covers had finger-holes for lifting them up, and the dung was drawn along the grooves into them by a broad hoe or scraper fitted to the groove. It was often found necessary to mix ashes with the dung, to render it of a fit consistence for being carted away. The second division of the vaults was fitted up for the process of fattening; darkness and quiet being considered favourable circumstances. In the third division, roots were effectually preserved from frost. At one end of the cow-house a tank was formed, fifty feet long, sixteen feet wide, and six deep, with its surface on a level with the bottom of the cellar; it was arched over, and had a man-hole for cleaning out the sediment,

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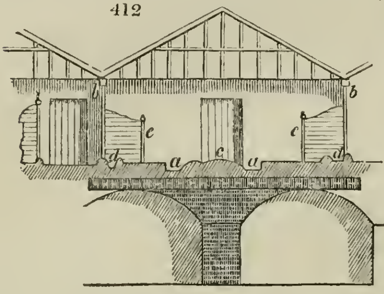

four feet in diameter: into this tank the whole of the urine was conducted, after being filtered through the urine gutters into spouts beneath it reaching the whole length of the house. Each filter consisted of a vessel covered with a plate of cast iron, pierced with small holes, the surface of the plate being on a level with the surface of the gutter: the use of the vessel under it is to receive the sediment, for which purpose it is made four inches wider than the cover, and in this extra width the water runs over into the cast-iron spout by which it is conducted to the ank: it enters the tank by a division surrounded by boards pierced with holes, so as to filter it a second time, in order that the water may be pumped up with greater ease. This water was sold to the gardeners and others, at from 1*s.* to 1*s.* 6*d.* per hundred gallons. The roof was supported in the middle by cast iron pillars (*b*); there were no ceilings, but the slates were hung to the quarterings of the rafters on pins, with a good lap; this being found warm enough in the coldest weather, and favourable for ventilation in the hottest: there were also windows in the roof, both for light and ventilation. The heat was generally kept to 60° or 64°. The passages (*c*) were paved, and five feet wide, and two inches and a half higher in the middle than at the side.

2833. *The floor on which the cows stood in Harley's cow-house* "was raised six inches above the passages; this not only *showed the cows to greater advantage*, but kept them dry and clean: and two and a half feet of the floor next to the trough were made of composition, similar to what is commonly used in making barn floors; because the principal weight of the cows being upon their fore feet, and as in lying down the whole weight is upon their knees, it was obviously desirable to have that part of the stall as smooth and soft as possible; indeed, it is conceived that joints and flooring would be the best for that purpose, were it not for the expense. The back part of the stall was of hewn stone, and for about eighteen inches towards the groove there was an inclination of about half an inch, to let the water go off; and these eighteen inches were of stript ashlar transversed, the strips being about an inch separate; this prevented the feet of the cows from slipping. In all cow-houses, perhaps, the front part of the stall should be rather lower than the back part, since it would enable the cattle to lie easier; and, besides this, they would not be apt to slip their calf. Cows which put out their calf bed, or have a tendency to slip their calf, should have a straw mat laid below their hind quarters. The bottom of the feeding troughs was on a level with the floor of the stalls; both edges were of hewn stone, the outer one next the passage was three inches above the bottom of the trough, and the other six inches higher; they were four inches and a half thick, and rounded to a semicircle; the trough was one foot three inches wide, and six feet four inches long." (*Harleian Dairy System*, p. 24.)

2834. *The standing room for the cows in the Harleian dairy*, that is, the space between the feeding trough (*d*) and gutter (*a*), was from six to seven feet; the latter dimension being for the larger cows. The breadth allowed for a cow was from three feet to three feet six inches; two cows standing together between wooden partitions as in stables (*e*). Each cow is fixed to a stake nine inches from the partitions, and six inches from the feeding trough; the stakes are two and inches a half in diameter, and the cows are fixed to them by chains and swivels fixed to rings. "The chains were three feet seven inches long, consisting of twenty-one links, viz., three on one side of the swivel, and eighteen on the other; the short end of the chain had a hook for joining the chain, with a broad point of an oval shape, which was more easily hooked and unhooked, and answered the purpose better than the common mode used in dogs' chains." The hecks, or racks for the hay, are three feet two inches long, by one foot ten inches deep, framed with deal, and filled up with one horizontal and ten perpendicular iron rods a quarter of an inch in diameter. These hecks are hung with window cord, which passes over pulleys, so that they can be raised by a wheel and pinion at pleasure, so as to be above the heads of the cows, when they are eating green food from the feeding gutter. Mr. Harley considers it of importance that each cow should not only be kept clean by combing and brushing, but, by the chain system of fastening, should have the liberty of licking its own skin and that of its fellow. (*Harleian Dairy System*, p. 28.)

2835. *Calf-pens, or calf-stages*, are common additions to cow-houses, where the feeding of calves for the butcher is an object of pursuit. The principal thing to be observed in

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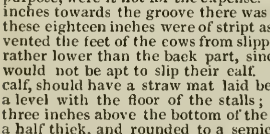

the construction of calf-pens is the laying of the floor, which should be made of laths or spars about two inches broad, laid at the distance of an inch from each other, upon joists, so as to make the floor about ten or twelve inches from the ground, as the situation will admit (*fig.* 413.) This not only keeps them quite dry, by allowing all the moisture to pass immediately away, but has the advantage of admitting fresh air below the bedding, and thereby preventing that unwholesome disagreeable smell too often found among calves; for it is to be understood, that this place below the floor (*a*) should frequently be cleaned, as well as the floor itself whenever it becomes wet or dirty; but it is not right to allow the litter to increase to a great thickness, otherwise the moisture will not so easily pass through. Calf-pens are, however, too often made without this sparred floor, and the fresh litter always laid on the old till the calves are removed, which is a slovenly practice, and not by any means to be recommended. Stalls, or divisions, are too often neglected in calf-pens. Partitions, about three feet high, of thin deal nailed on small posts, might be so contrived as to be movable at pleasure, to increase or diminish the stall, if necessary, according to the age and size of the calf. If it be thought unnecessary to make the partitions movable, there might be a small round trough, in a circular frame, fixed in the corner of each pen, for holding the milk, and a door in the next adjoining corner. A small slight rack for holding a little hay, placed at the upper part of the pen, might also be useful. The troughs should be round, that the calves may not hurt themselves upon them, which they might probably do on the angles if they were square. The advantages of this kind of calf-pens are, that the calves are all kept separate in a small compass, and cannot hurt each other, as the stronger ones sometimes do the weaker when confined promiscuously, and their food may be much more easily and equally distributed.

2836. *The calf-pens in Gloucestershire*, Marshal observes, are of an admirable construction; extremely simple, yet singularly well adapted to the object. Young calves, fattening calves more especially, require to be kept narrowly confined: quietness is, in a degree, essential to their thriving. A loose pen, or a long halter, gives freedom to their natural fears, and a loose to their playfulness. Cleanliness, and a due degree of warmth, are likewise requisite in the right management of calves. A pen which holds seven, or occasionally eight, calves, is of the following description:—The house, or roomstead, in which it is placed, measures twelve feet by eight: four feet of its width are occupied by the stage, and one foot by a trough placed on its front; leaving three feet as a gangway, into the middle of which the door opens. The floor of the stage is formed of laths, about two inches square, lying the long way of the stage, and one inch asunder. The front fence is of staves, an inch and a half in diameter, nine inches from middle to middle, and three feet high; entered at the bottom into the front bearer of the floor (from which cross-joists pass into the back wall), and steadied at the top by a rail; which, as well as the bottom piece, is entered at each end into the end wall. The holes in the upper rail are wide enough to permit the staves to be lifted up and taken out, to give admission to the calves; one of which is fastened to every second stave, by means of two rings of iron joined by a swivel; one ring playing upon the stave, the other receiving a broad leathern collar buckled round the neck of the calf. The trough is for barley-meal, chalk, &c. and to rest the pails on. Two calves drink out of one pail, putting their heads through between the staves. The height of the floor of the stage from the floor of the room is about one foot. It is thought to be wrong to hang it higher, lest, by the wind drawing under it, the calves should be too cold in severe weather: this, however, might be easily prevented by litter or long strawy dung thrust beneath it. It is observable, that these stages are fit only for calves which are fed with the pail, not for calves which suck the cow.

2837. *Hogsties*, for the breeding or fattening of swine, are mostly built in a simple manner, requiring only warm dry places for the swine to lie in, with small areas before, and troughs to hold their food. They are generally constructed with shed-roofs, and seldom above six or seven feet wide, with height in proportion. In order that they may be convenient, they should be at no great distance from the house; and the less they are connected with the other farm-buildings the better. In some cases, it might be of utility to have them connected with the scullery, in such a way as that all sorts of refuse articles might be readily conveyed to them by pipes or other contrivances. When at a distance, they should be so placed as that the servants need not enter the farm-yard in feeding them. It is a circumstance of vast advantage in the economy of labour, as well as of food, to have them conveniently situated and built. Though swine are generally, perhaps from a too partial view of their habits, considered as filthy animals, there are no animals which delight more in a clean and comfortable place to lie down in, and none that cleanliness has a better effect upon with respect to their thriving and feeding. In order to keep them dry, a sufficient slope must be given, not only to the inside places where they are to lie, but to the outside areas, with proper drains to carry off all moisture. The outsides should also be a little elevated, and have steps up from the areas of at least five or six inches in height. Hogsties should likewise have several divisions, to keep the different sorts of swine separate; nor should a great many ever be allowed to go together; for it is found that they feed better in small numbers and of equal size, than when many of unequal sizes are put together. Proper divisions must, therefore, be made: some for swine when with the boar; others for brood swine, and for them to farrow in; for weaning the pigs, for keeping the store pigs, for fattening, &c. When convenient, the areas should be pretty large; and where it can be had, it is of great use to have water conveyed to them, as it serves many useful purposes.

2838. *Every sty should have a rubbing-post.* "Having occasion," says Marshal, "to shift two hogs out of a sty without one, into another with a post, accidentally put up to support the roof, he had a full opportunity of observing its use. The animals, when they went in, were dirty, with broken ragged coats, and with dull heavy countenances. In a few days, they cleared away their coats, cleaned their skins, and became sleeky haired; the enjoyments of the post were discernible even in their looks, in their liveliness, and apparent contentment. It is not probable, that any animal should thrive while afflicted with pain or uneasiness. Graziers suffer single trees to grow, or put up dead posts in the ground, for their cattle to rub themselves against; yet it is probable that a rubbing-post has never been placed intentionally in a sty; though, perhaps, for a two-fold reason, rubbing is most requisite to swine." In farm-yards the piggeries and poultry-houses generally occupy the south side of the area, in low buildings, which may be overlooked from the farmer's dwelling-house. They should open behind into the straw-yards or dung-heap, to allow the hogs and fowls to pick up the corn left on the straw, or what turnips, clover, or other matters are refused by the cattle. They should have openings outwards, that the pigs may be let out to range round the farmery at convenient times; and that the poultry may have ingress and egress from that side as well as the other.

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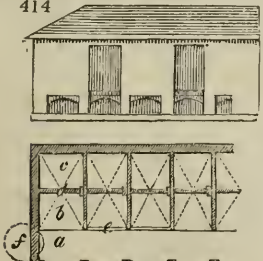


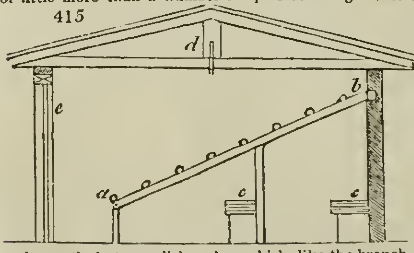
2839. *The pig-house at Harley's dairy establishment* (*fig.* 414.) consisted of a number of sties separated from each other by a nine-inch wall: each sty consisted of two apartments; one for exercise, which was open above (*a*), and the other for feeding in, which was covered (*b*); and a third, also covered, for sleeping in (*c*). The threshold of the opening to the sleeping apartment was formed by a cast-iron trough kept full of water (*d*), through which the pigs being obliged to pass when they went to sleep, it is said their feet were washed, and their litter kept clean. The water in these troughs was supplied by a pipe at one end, and each separate tank had a waste pipe. The floor of the sleeping place was a few inches higher than that of the feeding apartment; and the floor of the latter, and also of the open area, were inclined towards the middle (*e*), under which was a sewer with filtering plates for the urine to pass through; and at the end of the sewer a tank (*f*) received the whole." (*Harleian Dairy System*, p. 122.)

2840. *Poultry-houses* are generally slight structures for rearing and feeding domestic fowls. Beatson (*Com. to the Board of Agr.* vol. i.) is of opinion, that poultry ought always to be confined, but not in a close, dark, diminutive hovel, as is often the case; they should have a spacious airy place, properly constructed for them. Some people are of opinion, that each sort of poultry should be kept by itself. This, however, is not, he says, absolutely necessary; for all sorts may be kept promiscuously together, provided they have a place sufficiently large to accommodate them conveniently, and proper divisions and nests for each kind to retire to separately, which they will naturally do of themselves. Wakefield of Liverpool keeps a large stock of turkeys, geese, hens, and ducks, all in the same place: and although young turkeys are in general considered so difficult to bring up, he rears great numbers of them in this manner every season, with little or no trouble. For this purpose he has about three quarters, or nearly a whole acre, enclosed with a fence only six or seven feet high, formed of slabs set on end, or any thinnings of fir or other trees split and put close together. They are fastened by a rail near the top and another near the bottom, and are pointed sharp, which he supposes prevents the poultry flying over; for they never attempt it, although so low. Within this fence are places slightly constructed (but well secured from wet) for each sort of poultry; also a pond or stream of water running through it. These poultry are fed almost entirely with steamed potatoes, and thrive astonishingly well. The quantity of dung made in this poultry-place is also an object worth attention: and when it is cleaned out, a thin paring of the surface is at the same time taken off, which makes a valuable compost for the purpose of manure. But for keeping poultry upon a small scale, it is only necessary to have a small shed or slight building, formed in some warm, sheltered, sunny situation (if near the kitchen or other place where a constant fire is kept so much the better), with proper divisions, boxes, baskets, or other contrivances, for the different sorts of birds, and for their laying and incubation.

2841. *Where a few poultry*, taking their chance at the barn-door, are kept by the farmer for the convenience of eggs, and to supply the table when a fowl is wanted, no particular attention is requisite; but as, in some situations, they may pay well for more food and closer attention, other circumstances may be noticed. "The poultry-house should," Young says, "contain an apartment for the general stock to roost in, another for setting, a third for fattening, and a fourth for food. If the scale is large, there should be a fifth, for plucking and keeping feathers. If a woman is kept purposely to attend them, she should have her cottage contiguous, that the smoke of her chimney may play into the roosting and setting rooms; poultry never thriving so well as in warmth and smoke; an observation as old as Columella, and strongly confirmed by the quantity bred in the smoky cabins of Ireland. For setting both turkeys and hens, nests should be made in lockers that have lids with hinges, to confine them if necessary, or two or three will," he says, "in sitting, crowd into the same nest. All must have access to a gravelled yard, and to grass for range, and the building should be near the farm-yard, and have clear water near. Great attention should be paid to cleanliness and whitewashing, not for appearance, but to destroy vermin."

2842. *The interior arrangement of a poultry-house* for a farm-yard is generally very simple, and consists of little more than a number of spars reaching across the building at different heights, or at the same height, with a gangway or ladder attached, for the fowls to ascend: but where comfort and cleanliness are studied, a preferable mode is to form a sloping stage of spars (*fig.* 415. *a*, *b*) for the poultry to sit on; beneath this stage may be two ranges of boxes for nests (*c*, *c*); the roof (*d*) should have a ceiling to keep the whole warm in winter, and the door (*e*) should be nearly as high as the ceiling for ventilation, and should have a small opening with a shutter at bottom, which, where there is no danger from dogs or foxes, may be left open at all times to admit of the poultry going in and out at pleasure, and especially for their early egress during summer. The spars on which the clawed birds are to roost should not be round and smooth, but roundish and roughish, like the branch of a tree. The floor must be dry, and kept clean for the web-footed kinds.

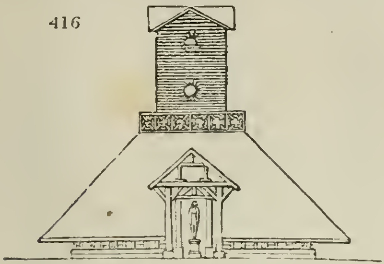
415



2843. *The rabbitry* is a building of rare occurrence in agriculture, and where it is required differs little from the piggery; consisting of a yard for exercise and receiving food, and a covered close apartment, connected, for repose, sleep, and the mothers and young. In the latter are generally boxes a foot or more high and wide, and divided into compartments of two or more cubic feet for the rabbits to retire into, and bring forth their young. Where young rabbits are fed for the market, the mother and offspring are generally confined to hutches, which are boxes a little larger than the common breeding boxes, and kept in a separate apartment. In treating of the rabbit (Part III.), these and other contrivances for the culture of this animal will be brought into notice.

2844. *The pigeonry* is a structure not more frequent than the rabbitry, being scarcely admissible in professional agriculture, except in grazing districts, where the birds have not so direct an opportunity of injuring corn. Sometimes they are made an ornamental appendage to a proprietor's farmery, or to a sheep-house in a park (*fig.* 416.), or other detached building; and sometimes a wooden structure, raised from the ground on one post or more, is formed on purpose for their abode. Whatever may be the external form, the interior arrangement consists of a series of boxes or cavities, formed in or against the wall, generally about a foot high and deep, and two feet or less long: one half of the front is left open as an entrance, and the other is closed to protect the female during incubation. (See *Pigeon*, Part III.)

416



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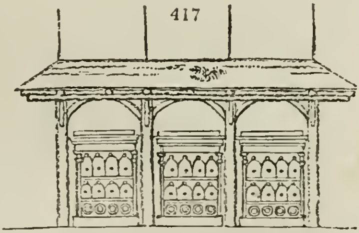


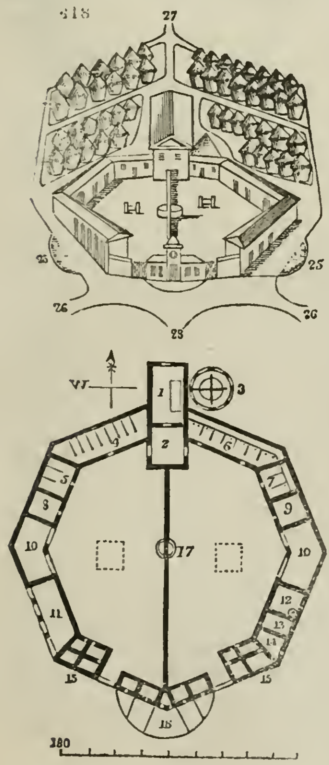
2845. *The apiary* is a building or structure seldom wanted, except to protect hives from thieves; then a niche or recess in a wall, to be secured in front by two or more iron bars, is a simple and effectual mode. Sometimes apiaries are made ornamental (*fig.* 417.), but the best bee-masters set little value on such structures, and prefer keeping their bees detached in single hives, for sufficient reasons. These hives may be chained to fixed stools in Huish's manner. (See *Bee*, Part IV.)

Sect. II. *Buildings as Repositories, and for performing in-door Operations.*

2846. *Buildings for dead stock and crop* occupy a considerable portion of the farmery, and include the barn, granary, straw and root-houses, cart-sheds, tool-house, harness-room, and, when farming is conducted on a very extensive scale, the smiths' and carpenters' work-rooms.

2847. *The corn-barn*, or building in which corn is contained, threshed, and cleaned, has undergone considerable change in form and dimensions in modern times. Formerly it was in many cases made so large as to contain at once all the corn grown on a farm; and in most cases it was so ample as to contain a great portion of it. But since the mode of forming small corn stacks became more general, and also the introduction of threshing machines, this description of building is made much smaller. The barn, especially where the corn is to be threshed by a machine, is best placed on the north side of the farmery, as being most central for the supply of the straw-yards, as well as the stables and cattle-sheds. In this situation it has also the best effect in an architectural and picturesque point of view. (*fig.* 418.) Suppose an octagonal form chosen for a farmery, with the barn (1), straw-room and granary over (2), and mill-shed (3), to the north; then on the left of the barn may be the stable for work-horses (4), and riding-horse stable (5), cattle-house (6), cow-house (7), sick horse (8), sick cow (9), cattle-sheds (10), cart-shed (11), boiling and steaming house (12), root-house (13), chaff and other stores for steaming, or mechanics' work-shop (14), piggeries (15), poultry-house and rabbitry (16). The yard may be divided in two by a wall running north and south, with a pump, well, or other supply of water in the centre (17). The rick-yard (27) should be to the north of such a farmery, for easy conveyance to the barn: the main entrance (28) should be from the south, opposite the dwelling-house; side entrances (26) should lead to different parts of the farm and to the main roads of the country, and there should be ponds (25) for washing the horses' feet and for the poultry. The same accommodation may be arranged in a square or circular outline. (*fig.* 419. and 420.)

418



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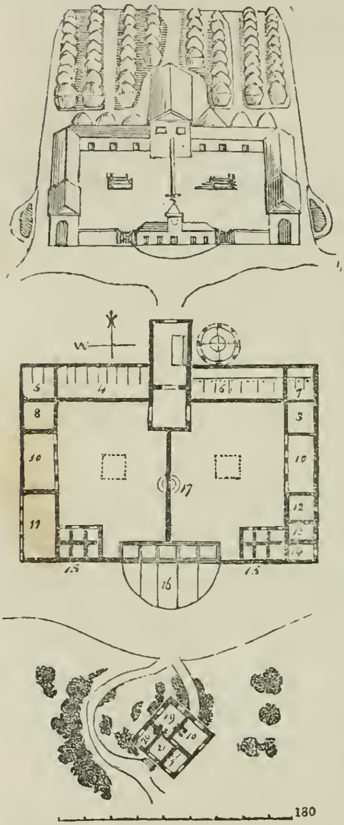
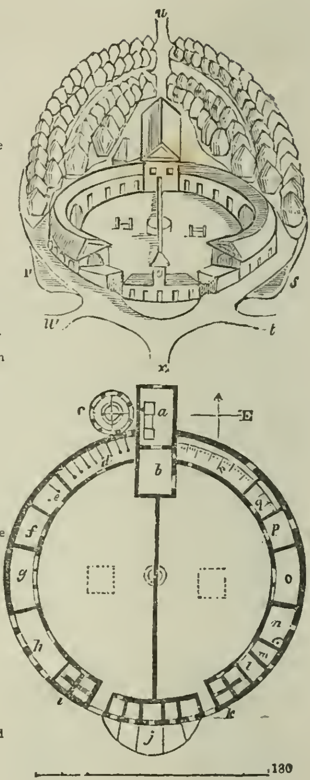


1. Barn
2. Show-room
3. Mill-shed
4. Common stable
5. Riding-horse stable
6. Ox-feeding house
7. Cow-house
8. Hospital stable
9. Root and steaming house
10. Cattle-sheds
11. Cart-shed
12. Carpenter's shed
13. Smith's forge
14. Tool-house
15. Piggeries
16. Poultry
17. Well and cistern
18. Farmer's kitchen
19. Common parlour
20. Business room
21. Entrance.

420



a. Corn-barn
b. Straw end
c. Mill-shed
d. Common stable
e. Riding-horse stable
f. Hospital
g. Cattle-shed
h. Cart-shed
i. Piggeries
j. Poultry
k. Piggeries
l. Tool-house
m. Carpenter
n. Smith
o. Cattle-sheds
p. Root-house
q. Cow-house
r. Ox-feeding house
s. Washing-pond
t. Side-road
u. Entrance to rick-yard
v. Pond
w. Side road
x. Main entrance.

2848. *The English corn-barn*, in which a large quantity of corn in the straw is to be contained, and threshed out with flails, may either be constructed on wooden frames covered with planks of oak, or be built of brick or stone, whichever the country affords in the greatest plenty; and in either case there should be such vent-holes, or openings in their sides or walls, as to afford free admittance to the air, in order to prevent the mouldiness that would otherwise, from the least dampness, lodge in the grain. The gable-ends are probably best of brick or stone, on account of greater solidity; the whole may be roofed with thatch or tiles, as either can be more conveniently procured. It should have two large folding-doors facing each other, one in each side of the building, for the convenience of carrying in or out a large load of corn in sheaves; and these doors should be of the same breadth with the threshing-floor, to afford the more light and air; the former for the threshers, and the latter for winnowing. Over the threshing-floor, and a little above the reach of the flail, poles are often laid across from one beam to another, to form a kind of upper-floor, upon which the thresher may throw the straw or haulm, to make an immediate clearing, till he has time to stow it properly elsewhere: and on the outside, over the great doors, it is sometimes convenient to have a large pent-house, made to project sufficiently to cover a load of corn or hay, in case a sudden storm should come on before it can be housed; and also to shelter the poultry in the farm-yard in great heat or bad weather. It was formerly the custom in countries that abounded in corn to have separate barns for wheat; for spring-corn, such as barley and oats; and for peas, tares, lintels, clover, saintfoin, &c.; but where the grain can be stacked, the heavy expense of so many buildings of this kind may be avoided. On no description of farm buildings has so much needless expense been incurred as on barns. The most ostentatious in England are those on Coke's estate in Norfolk; they are built of fine white brick, so large and unscientifically constructed that they cannot be filled with corn from the fear of bursting the side walls.

2849. *The threshing-floor*, or space on which the grain is threshed out by the flail, is an important object in the English barn. It is for the most part made in the middle of the building; but may be laid down in any other part, if more convenient, and should always be so formed as to be perfectly close, firm, and strong. In constructing these kinds of floors, various sorts of materials are employed, such as compositions of different earthy kinds, stones, lumps, bricks, and wood. The last substance, when properly laid and put together, is probably the best and most secure from damp. When made of wood, they are sometimes so contrived as to be movable at pleasure, which is a great convenience in many cases: they are made of different dimensions, but from twelve to fourteen by eighteen or twenty feet are in general proper sizes for most purposes.

2850. *Threshing-floors in Gloucestershire*, Marshal observes, are of a good size, when from 12 to 14 by 18 to 20 feet. The best are of oak, some of stone; but a species of earthen floor, which is made there, is thought to be superior to floors of stone, or any other material, except sound oak-plank. The superior excellency of these floors is owing in part to the materials of which they are formed, and in part to the method of making them. In order to this, in some places, the surface of the intended threshing-place is dug away to the depth of about six inches, and the earth thus taken out, when of a proper kind, after being well cleared of stones, is mixed with the strongest clay that can be procured, and with the dung of cattle. This mixture is then worked together with water, till it is of the consistence of stiff mortar, and the compost thus made is spread as smooth as possible with a trowel, upon the spot from which the earth was taken. As it cracks in drying, it must be frequently beaten down with great force; or rolled with a heavy roller until all the crevices are filled up: and this must be continued till it is quite solid, hard, dry, smooth, and firm.

2851. *Boarded threshing-floors*, made of sound, thick, well-seasoned planks of oak, are excellent for service, will last a long time, and may be converted into good floorings for rooms, by planing them down, after they are become too uneven for the purpose originally intended.

2852. *Earthen threshing-floors* should not be advised, except where good materials can be procured, and the making of them be performed in the most perfect manner, which, as we have noticed (2850.) is only the case in particular instances and districts.

2853. *Brick floors*, when well laid down, may, in some cases, make a tolerable floor for many purposes, but on account of their not only attracting, but retaining, moisture, they are not to be recommended where grain of any kind is to continue much upon them.

2854. *In constructing wooden floors* the most usual mode is that of nailing the planks, or boards of which they are composed, after their edges have been shot true, and well fitted and jointed, close down to wooden joists or sleepers, firmly placed and secured upon the ground, or other place for the purpose. But in the midland districts, instead of the planks being nailed down to sleepers in the ordinary way, the floor is first laid with bricks, and the planks spread over these, with no other confinement than that of being "dowled" together, that is, ploughed and tongued, and their ends let into sills or walls, placed in the usual way, on each side of the floor. By this method of putting down the planks, provided the brick-work is left truly level, vermin cannot have a hiding-place beneath them; and a communication of damp air being effectually prevented, floors thus laid are found to wear better than those laid upon sleepers. It is observable that the planks, for this method of laying, ought to be thoroughly seasoned. It is evident, however, that where barn-floors can be made hollow, they must be much better for the purpose of threshing upon, than such as are either placed on brick-work, or the ground. From their greater pliability and elasticity in threshing upon, the grain is of course threshed out with more ease, certainty, and despatch.

2855. *The threshing-mill barn* is not restricted to any size; but it answers best when the ground-plan is a parallelogram, the width from twenty to thirty feet, according to the size of the machinery, and the height from fifteen to twenty feet, in order to allow one winnowing machine, or even two, to be placed under the threshing part of the machinery. The barn in this case is in three distinct divisions: the first, for the unthreshed corn, should be of such a size as to contain an ordinary stack, and, if possible, it should be so contrived as to be entered by a loaded cart; which, whether the corn be threshed as carried in, or be laid up for future operations, is a great saving of labour. The second division contains the machinery and the corn floor, and should be enclosed with boards so as to be locked up when not in use. The third division is the straw-barn, which should be so large as to admit of keeping separately a considerable quantity of different kinds of straw, accessible for fodder and for litter.

2856. *The hay-barn* is commonly constructed of timber, and sometimes is open on the south or east, or even on all sides. In Middlesex, there are many hay-barns capable of holding from thirty to fifty, and some even one hundred, loads of hay. They are found to be extremely useful and convenient during a catching and unsettled hay-harvest, and also at other seasons of the year. In wet and windy weather, they afford an opportunity of cutting, weighing, and binding hay; none of which operations could, at such a time, be performed out of doors. Most farmers agree that hay may be put together earlier, even by a day, in a barn, than it would be safe to do in a stack. They advise, however, that the sides of the mow should be raked or pulled clear of the quartering of the barn; and, when thus managed, they are of opinion that the hay will be as good in the barn as in the stack. In the driest seasons, barns are a saving; and, in wet seasons, the ready assistance which they afford, in speedily securing the hay, has been known to make a difference in price of twenty shillings per load. Many persons, on the other hand, think hay is more apt to heat in a barn than in the open air; and that they present no advantages which may not be obtained by the canvass stack-cover. If they do not possess considerable advantages, then the loss must be great, as the erection of such barns is a heavy expense.

2857. *The granary*, in barns with threshing machines, is sometimes formed immediately above the floor on which the machine works; which, among other advantages, admits of raising the corn to it directly from the ground-floor, either by the threshing-mill itself, or a common windlass easily worked by one man. When it is to be taken out and carried to market, it may be lowered down upon carts, with the utmost facility and despatch. There is evidently no greater expense incurred by this arrangement: for the same floor and height of side walls that must be added to the barn, are required in whatever situation the granary may be; and it possesses several advantages. Owing to its being higher than the adjacent buildings, there is a freer circulation of air, and less danger of pilfering, or of destruction by vermin; the corn may be deposited in it as it is dressed, without being exposed to the weather, while the saving of labour is in most cases considerable.

2858. *The construction of the agricultural granary* has in it nothing particular; being, in fact, only a well ventilated room, where corn is seldom kept more than a month or two, and generally in sacks.

2859. *A detached granary* often forms a part of farmeries on a small scale: they should be built with firmness, and well secured from the entrance of vermin. In order to effect the latter purpose, they should be raised, by means of stone pillars, about eighteen inches or two feet, and have a frame of some durable wood, with quarterings of timber, so placed as that they may be filled up closely with brickbats, and the inside made secure by being lined with thin boards nailed firmly to the different pieces of quartering. The floors must be made firm, close, and even: the outside may also be covered with boarding, if it be thought necessary, and the roof well tiled. There may be different floors or stories, according to the room required.

2860. *Of commercial corn granaries*, some of the most extensive are in Dantzic. They are seven, eight, or nine stories high, having a funnel in the midst of every floor, to let down the corn from one to another. They are built so securely, that, though every way surrounded with water, the corn contracts no damp, and the vessels have the convenience of coming up to the walls for their lading. The Russians in the interior of the empire preserve their corn in subterranean granaries, of the figure of a sugar-loaf, wide below, and narrow at top; the sides are well plastered, and the top covered with stones. They are very careful to have the corn well dried before it is laid into these store-houses, and often dry it by means of ovens, their autumn being too short to effect it sufficiently.

2861. *A granary to preserve corn for many years* should be a dry cellar, deeply covered with earth; and, after the corn is put in, hermetically sealed to exclude heat, air, and moisture, and preclude the possibility of the grain vegetating, or of the existence of insects or vermin, or the hatching of their eggs. (See 1834.)

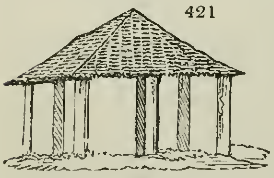
2862. *The root-house* is used for storing up or depositing potatoes, turnips, carrots, cabbages, or other roots or tops for the winter feed of cattle. It should always join the cattle-sheds, and communicate with them by an inner door that opens into the feeder's walk by the heads of the cattle. The entrance door ought to be so large as to admit a loaded cart. These houses are essentially necessary wherever there are a number of cows, or other sorts of cattle, to be supported on roots of the carrot, parsnep, turnip, and potato kinds, as well as for cabbages; as without them it would not only be inconvenient, but in many cases in severe weather impossible, to provide them for the daily supply of such stock. Cabbages should not, however, be kept long in houses, as they are very apt to take on the putrid fermentation, and become useless. The master should be careful that the yard man constantly keeps such places perfectly clean and sweet, in order that the roots may contract no bad smell, as cattle are in many cases extremely nice in their feeding, and when once disgusted with any sort of food, seldom take to it again in a proper manner.

2863. *The steaming-house* should be placed next the root-houses, for obvious reasons; and have an inner floor communicating with it in a line with the door of the feeder's walk.

2864. *The straw-house* or *straw-shed*, when there is one distinct from the barn, should be placed at the end of the cattle-sheds, opposite to the root-house, and like it should have a cart entrance, and an inner door communicating with the feeder's walk. Straw, however, is often stacked, in preference to placing it in a straw-house, especially when large quantities of corn are threshed at one time.

2865. *Cart-sheds*, or lodges for the shelter and protection of carts or waggons, and other large implements, are generally built close on three sides, with the fourth open, and the roof supported with posts or pillars. Sometimes they are open on all sides (*fig.* 421.); but this admits too much wind, which carries moisture with it in the cold seasons of the year, and dries up and shrinks wooden articles in summer. Their situation in the square should be apart from the buildings for live stock, and also from the barn, straw, and root houses: generally the first part of the east or west side on entering is devoted to the purpose of cart-sheds and tool-houses.

421



2866. *The tool-house* is used for keeping the smaller implements used in manual labour in the fields, as spades, rakes, forks, &c. It is essential that this apartment be dry and free from damps; and, when convenient, it should have a loft for the better preservation of sacks, cordage, sowing sheets, baskets, spare harness, &c.

2867. Some *other buildings*, besides those of this and the preceding section, will be wanted in most farm-yards of any extent, as stables for young horses, riding-horses, an hospital stable, &c. Particular descriptions of farms also require appropriate buildings, as dairies, cheese-rooms, hop-kilns, and wood-lofts, which will be considered in treating of dairy farms, hop culture, the management of sheep, &c.

2868. *Sleeping-rooms* for single men should be made over the stable, and for the feeder or cow-keeper over the cattle-sheds, that they may hear any accident which takes place among the horses or cattle during the night, and be at hand to remedy it.

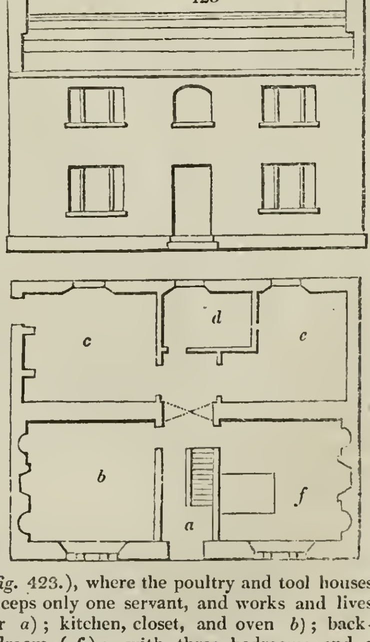
2869. *A smithy, and carpenter's work-room*, sometimes form part of the buildings on a large farm. Instead of going to a distance to the residence of these necessary mechanics, arrangements are made with them to attend at stated periods, or when sent for, by which a saving both of time and money is effected. Sometimes these buildings are set down at a little distance from the square, to prevent danger from fire, and lessen the expense of insurance. The fixtures, as the anvil, bellows, bench, vice, lathe, &c. and some of the larger tools, belong to the farmer, but the others the mechanics bring with them. A small stock of iron, steel, and timber is kept, to be in readiness; and also the cast-iron work of ploughs, carts, &c., and sometimes the smaller pinions, and other parts of the threshing machines.

Sect. III. *The Farmer's Dwelling-house.*

2870. *The dwelling-house of the farmer* is generally detached from the farmery on the south side, and separated from it by a road, grass-plat, garden, or pond, or all of these, according to circumstances. In size and accommodations it ought to be proportioned to the capital requisite for the farm; that is, it ought to be on a par with the houses of other members of society of similar property and income. In design it ought to be simple and unostentatious, utility and convenience being its recommendatory beauties. At the same time, as observed in the *Code of Agriculture*, "every landlord of taste, in fixing on the site and plan of a new farm-house and offices, ought certainly not to overlook the embellishment of the country." How much of the beauty of a country, and of the ideas of the comfort and happiness of its inhabitants, depends on the appearance of its farm-houses and cottages, every traveller is aware; and every agriculturist who has travelled through the British Isles can recognise at once a well cultivated district by the forms of the farm-yards, and the position of the farmer's dwelling-house. The difference between the best and worst cultivated English counties in this respect is sufficiently striking; and the ideas of wealth, comfort, order, and scientific agriculture, which the farmeries and cottages of Northumberland and Berwickshire excite in the mind, are totally unfelt in passing through even Hertfordshire and Essex; where the scattered straggling hovels of all sizes and shapes, the monstrous barns, and ricketty shapeless farm-houses, indicate a low state of culture, and an ignorant tasteless set of occupiers. Even in Norfolk and Suffolk the want of symmetry in the farmeries of opulent farmers is every where conspicuous; and the want of taste and decorum in setting the dwelling-houses among dung heaps and urine ponds no less so.

2871. In selecting a few *examples of farm-houses*, the first we shall notice is that of the smallest size, where the farmer keeps no servant and cultivates only a few acres. The ground plan of such a house (*fig.* 422.) should contain an entry (*a*); kitchen (*b*); dairy and pantry (*c*); parlour (*d*); light closet off the parlour as a store-room, or for a bed (*e*); tool-house (*f*); stair, and cellar under (*g*); water-closet, and poultry-house over (*h*); there are three bed-rooms in the roof, and one garret. The dimensions may be varied at pleasure; but twelve feet square is the least dimension that can be given to the kitchen and parlours.

423



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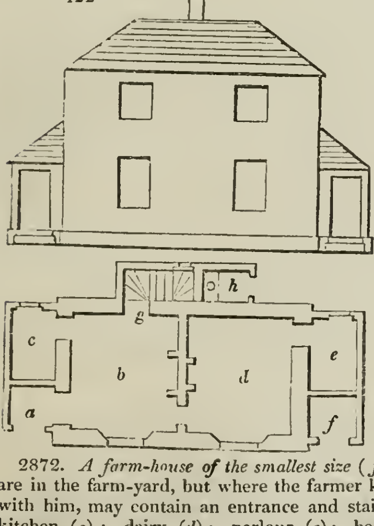

2872. *A farm-house of the smallest size* (*fig.* 423.), where the poultry and tool houses are in the farm-yard, but where the farmer keeps only one servant, and works and lives with him, may contain an entrance and stair *a*); kitchen, closet, and oven *b*); back-kitchen (*c*); dairy (*d*); parlour (*e*); bedroom (*f*); with three bedrooms and a garret up-stairs, and a cellar under. The arrangement of this ground plan is excellent, with the single exception of the situation of the fireplaces, which in no cottage or small dwelling-house ought to be in the outside wall. A few of such farm-houses and tenants should be found in all parts of the country, if for no other reason than to preserve the gradation from the labourer to the professional farmer, and from the cottage to the farm-house.

2873. *A farm-house larger* than the preceding (*fig.* 424.), and for a farmer and his family rather in a better style, may contain a principal entrance and lobby (*a*); parlour (*b*); closets (*c*); store-room for meal, cheese, &c. (*d*); lumber room for small implements (*e*); beer cellar (*f*); pantry (*g*); dairy (*h*); staircase (*i*); kitchen, with an oven under the stairs, and a boiler on the other side of the fireplace (*k*); coals or wood, and back entry (*l*); pigsty, with a small opening towards the kitchen for throwing in dish-water, offal, &c. (*m*); and poultry-house (*n*); with two garret bedrooms over the wings; two good bedrooms and a closet up stairs, and a garret in the roof.

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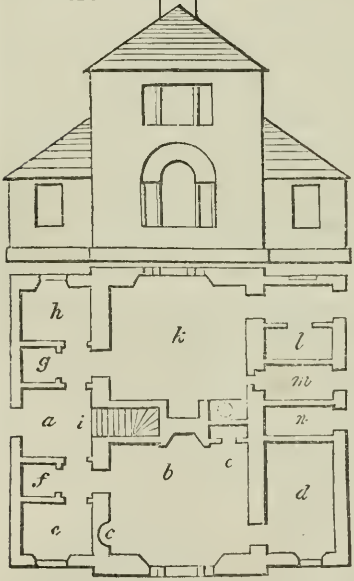

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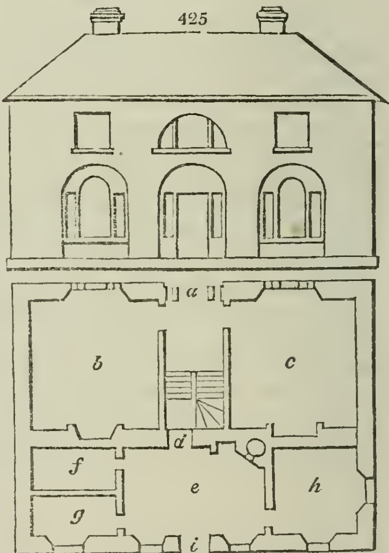

2874. *A farm-house of the second lower scale* (*fig.* 425.), executed at Burleigh in Rutlandshire, contains a principal entry (*a*); parlour (*b*); kitchen (*c*); stair (*d*); dairy (*e*); pantry (*f*); cellar (*g*); and cheese-room (*h*). The three latter are attached to the back part of the house by a continuation downwards of the same roof. By making their ceilings only seven and a half or eight feet high, some small bedrooms may be got above them, having a few steps down from the floor of the front rooms, or a few steps up from the first landing-place. The back door of the kitchen enters into a brewhouse and washhouse, the fireplace and copper being behind the kitchen vent. Beyond this brewhouse is a place for holding fire-wood, &c., in the back wall of which are openings to feed the swine. In the kitchen is an oven; and below the grate a very good contrivance for baking occasionally, but principally used for keeping the servants' meat warm; it consists of a cast-iron plate, and door like an oven. The chamber-floor is divided into two rooms forwards, and two small ones backwards.

2875. *Farmer's dwelling-houses, containing more accommodation and comfort,* and displaying appropriate taste and expression of design, will be found in a succeeding section, where farmeries are treated of, and also where we treat of laying out farms. (Part III.)

SECT. IV. *Cottages for Farm Servants.*

2876. *Cottages for labourers* are necessary appendages to every farm or landed estate, and no improvement is found to answer the purpose better than building these on a comfortable and commodious plan. In the southern counties of the island, where the farmer's labourer is supposed to change his master once a year, or oftener, the whole business of cottages is commonly left to accident; but in the north a certain number of married servants are kept on every farm, and a fixed place near the farmery is appointed for their situation. These habitations are in the tenure of the farmer, in common with the other buildings of the farm; and whenever a married servant changes his master he changes his habitation.

2877. *The accommodation formerly considered suitable for farm labourers* consisted of two rooms. That on the ground floor not being less than twelve feet square, with a sleeping-room of the same size over, and sometimes on the same floor. But this is justly deemed too small for an ordinary labourer's family. "Humanity," Beatson observes, "shudders at the idea of an industrious labourer, with a wife and perhaps five or six children, being obliged to live, or rather exist, in a wretched, damp, gloomy room, of ten or twelve feet square, and that room without a floor; but common decency must revolt at considering, that over this wretched apartment there is only one chamber to hold all the miserable beds of this miserable family. And yet instances of this kind, to our shame be it spoken, occur in every country village. How can we expect our labourers or their families to be healthy; or that their daughters, from whom we are to take our future female domestics, should be cleanly, modest, or even decent, in such wretched habitations?"

2878. *The accommodation which the smallest cottage ought to have*, according to Waistell, is a kitchen, washhouse, and closet, or pantry, with two bed-rooms. A parlour is almost useless. The kitchen, being freed from the business of washing and baking, may always be kept decent for the family to live in; and a decent kitchen is greatly preferable to a disorderly parlour; and a parlour that is not used oftener, perhaps, than two or three times a year, will seldom be kept in order. Every cottager who has a family of children at home, ought, for decency's sake, to have two bedrooms; and if the children are of both sexes he ought to have three. For the purpose of thoroughly airing and sweetening the bedrooms there ought to be windows to all the rooms. (*Waistell's Designs*, &c. p. 81.) "If the rooms of a cottage be built too low, or in any other respect upon a bad plan, the inconveniences arising from these circumstances will, in all probability, have to be endured by its successive occupants as long as the materials of which it is composed will last. If, therefore, the welfare of the inhabitants of such dwellings be considered, it is highly important that any circumstances which would thus entail the want of comfort should be avoided; and it must be gratifying to those who erect durable and efficient cottages, in healthy situations, with gardens attached, to contemplate on what industry, what cleanliness, what happiness, and, in short, what great and lasting improvement in the condition and habits of this class of their fellow-beings, they may, as they have it in their power, by a little attention, so easily and so beneficially to themselves effect." (*Ib.* p. 84.)

2879. *Cottages for farm servants*, it is observed by the able author of the article *Agriculture*, in the *Supplement to the Encyc. Britannica*, "are usually set down in a line, at not an inconvenient distance from the farm-yard. Each of them contains two apartments with fireplaces, and garret sleeping-rooms over. Adjoining is commonly a cow-house, hogsty, shed for fuel, necessary, a small garden, and sometimes other appendages of comfort and enjoyment. As an example of the minimum of modern accommodation, we may refer to two cottages on a farm in Berwickshire, as described in the report of that county. They contain each a kitchen (*fig.* 426. *a*), small parlour and store-room (*b*), with two good bedrooms over, and a dairy under the staircase. — There is a garden behind (*c*), a place for a calf or pigs, or for fuel (*d*), water-closet (*e*), and dung-heap (*f*). The labourer's cows, in this case, are kept at the farmery, along with those of the farmer.

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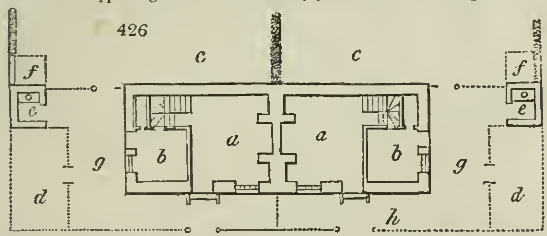

It is proper to observe, however, that this is more the *beau idéal* of the cottage of a farm servant in Scotland than the reality. With the exception of some cottages that have been recently built by Englishmen who have become possessed of property in Scotland, such as the Marquess of Stafford, Earl Gwydir, &c. the dwellings of the labouring classes are a disgrace to the country. It is any thing but creditable, both to the landed proprietors and the farmers, that while the houses of both have been greatly improved in comfort and appearance within the last thirty years, scarcely any improvement has taken place in the dwellings of their servants. Even in East Lothian, Berwickshire, and other counties, generally considered the most improved in Scotland, scarcely any alteration has taken place for the better within our remembrance. One cause, no doubt, of this want of comfort, and the appearance of enjoyment in Scottish cottages, is owing to the ignorance of the cottager of many of the comforts which are enjoyed by the same class in other countries, and more particularly in England, Holland, and the South of Germany. This applies particularly to tradesmen cottagers, or what may be called independent occupiers; but with respect to all those cottagers who are the hired servants of owners or occupiers of land, the blame belongs wholly to the owners and occupiers, and may be traced to their want of sympathy for their fellow-men, as well as a want of an enlightened view of their own interests. "Could the rich," Waistell remarks, "but consider themselves interested in the appearance of their tenants and labourers, and hold the improvement of the cottage and cottage garden, and its inhabitants, as an essential part of the improvement of their grounds; they would thus make their seats appear the growth of plenty diffused, and not the solitary instance of wealth in the midst of wretchedness, at once its neighbour and its reproach." (*Waistell's Designs*, &c. p. 9.)

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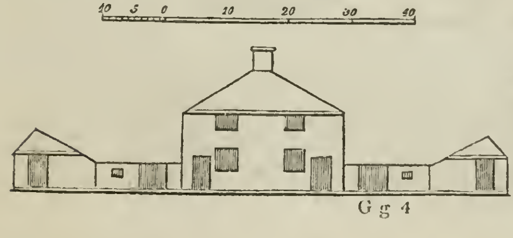

2880. *A double ploughman's cottage and cow-house* (*fig.* 427.) may be thus arranged. Both may contain a kitchen (*a*) with an oven, and there may be a small parlour or store-room (*b*), a dairy and pantry (*c*), with two bedrooms over. Detached may be a pigsty (*d*), water-closet (*e*), place for fuel (*f*), and cow-house (*g*), with gardens adjoining, dung-heap, porch, step-up, &c. as in the other place.

2881. *Waistell's double cottage for labourers* (*fig.* 428.) contains, for each cottage, a kitchen twelve feet square (*a*), and a washhouse (*b*), pantry (*c*), and place for fuel under the stairs (*d*), covered with a lean-to or penthouse roof, six feet wide in the clear. The entrance is made immediately into the kitchen; but in exposed or cold situations, and especially where fuel is dear, a porch should be either taken off the inside of the kitchen or added to the outside; or a temporary screen or curtain might be used in cold weather. On one side of the kitchen fire there is a cupboard. The washhouse and pantry floor may be made two steps lower than the kitchen, and the floor over them about two feet lower than the floor over the kitchen; thus there will be room for small beds within the lean-to. The kitchens are seven feet six inches high, and the bedrooms over may be made eight feet high by putting the ceiling joists two feet above the wall-plate. The ceiling-joists may be so many collar-beams to the rafters, which will greatly strengthen the roof. The fireplaces and flues are in the division-walls. In this position the greatest advantage is derived from the heat, and thus, in small cottages, the chambers would not require, except in sicknesses, any fires. Two cottages, having the same accommodations, cannot, perhaps, be built at less expense upon any other plan.

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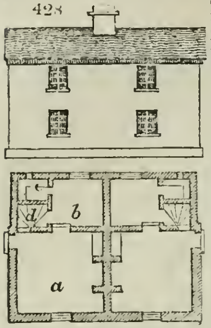

2882. *Waistell's design for a double cottage with offices* (*fig.* 429.) contains "porches (*a a*), kitchens (*b b*) twelve feet by thirteen feet; and the back kitchen, or washhouse (*c*), which may be on the same level, is six feet by seven feet. The pantry (*d*), which may be sunk one step, is partly under the stairs (*e*). In the porch is a cupboard to contain the labourer's tools, and beyond the porch is a small room for fuel (*f*). At each end of the building are three doors: the first opens into the vault (*g*), the second into the place for ashes, or dust (*h*), and the third into the hogsty (*i*), over which is a roost for poultry. The hollow or cavity in the wall between the stairs, &c. and pigsty (*k*) is to prevent any soakings or disagreeable smell being perceptible in the house. The chamber-floors being of equal dimensions with the ground-floors, each cottager will have two bedrooms. One room may be made somewhat larger than the other; the larger for the parents and the smaller for the children. The bedrooms being partly within the roof, a higher elevation would improve the appearance, and render it more wholesome, and will be preferred by those with whom the additional expense is of less consideration than the health and improvement of their cottagers. Lofty bedrooms are highly conducive to health." (*Waistell's Designs*, &c. p. 82.)

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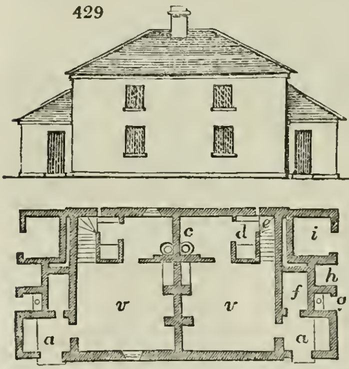

2883. *Waistell's double cottage with cow-house* (*fig.* 430.) contains "kitchens (*a*) fourteen feet by twelve feet; the back kitchens (*b*) are eleven feet by seven feet; and at one end there may be a closet under the stairs for a pantry (*c*). There are also boilers and ovens, projecting from the back of the house; but where the cottagers do not make their own bread, or where they eat oat-bread, ovens will not be required. The entrances are through porches (*d*) in the low buildings, beyond which, as in the last example, is a place for fuel (*e*), and at the back of this last is the dairy (*f*), with the door from the kitchen. The situation of some conveniences on a plan may sometimes appear too conspicuous; but, as at least a garden, however small, is supposed to be attached to every labourer's cottage, the judicious planting of a few evergreen shrubs will give all the privacy required. The doors to the cow-house (*g*) are at the back; and convenient places for collecting manure (*h*) may be made in the corners against the sides of the hogsties (*i*). Every thing convertible into manure ought to be gathered into these yards. By collecting manures, and preparing them with judgment, ground of an inferior quality may be continued in a profitable and progressive state of improvement, until it has acquired a high degree of fertility. Small tenants should not only be provided with convenient yards for compost dunghills, but should also have pointed out to them, by the proprietors or agents of estates, the various fertilising substances which lie within their reach; and also be informed which of them will make the most valuable dressings for grounds of the nature of those which they respectively occupy; and such attention to their interests must be gratifying to them. The chamber-floor over the kitchens may be divided: small rooms, about six feet wide, with windows above the low buildings, would serve for bedrooms for daughters; the larger rooms for the parents, and the rooms over the back-kitchens for the sons. Should these conveniences not be sufficient, small bedrooms may be added at each end, over the entrance, dairy, &c.; or, with a little addition in the elevation of the walls above the ceiling of the chambers, tolerable rooms may be formed in the roof. Cottages for manufacturers will require larger rooms, as for looms, &c. If the occupiers of adjoining tenements keep horses, they may unite their teams when a stronger draught than two horses is required for ploughing, or any other work." (*Waistell's Designs*, &c. p. 83.)

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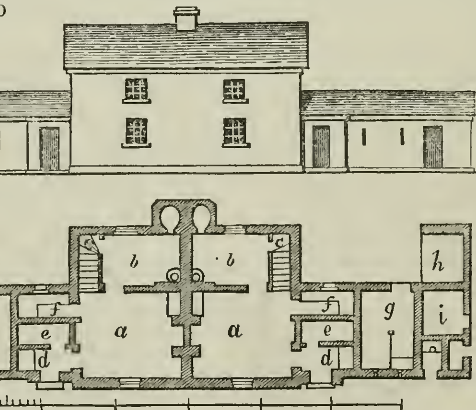

2884. In regard to the *construction of cottages* much information may be obtained from a work entitled *A Series of Plans for Cottages*, by J. Wood of Bath. This author lays down the following seven principles as the means of obviating the inconveniences to which cottages, as usually built, are liable.

2885. *The cottage should be dry and healthy.* This is effected by keeping the floor sixteen or eighteen inches above the natural ground; by building it clear of banks, on an open spot of ground, that has a declivity or fall from the building; by having the rooms not less than eight feet high, — a height that will keep them airy and healthy; and by avoiding having chambers in the roof.

2886. *They should be warm, cheerful, and comfortable.* In order to attain these points, the walls should be of a sufficient thickness (if of stone, not less than sixteen inches; if of brick, at least a brick and a half) to keep out the cold of the winter, or the excessive heat of the summer. The entrance should be screened, that the room, on opening the door, may not be exposed to the open air. The rooms should receive their light from the east, or the south, or from any point betwixt the east and the south: for, if they receive their light from the north, they will be cold and cheerless; if from the west, they will be so heated by the summer's afternoon sun, as to become comfortless to the poor labourer, after a hard day's work; whereas, on the contrary, receiving the light from the east or the south, they will be always warm and cheerful. So like the feelings of men in a higher sphere are those of the poor cottager, that if his habitation be warm, cheerful, and comfortable, he will return to it with gladness, and abide in it with pleasure.

2887. *They should be rendered convenient*, by having a porch or shed, to screen the entrance, and to hold the labourer's tools; by having a shed to serve as a pantry, and store-place for fuel; by having a privy for cleanliness and decency's sake; by a proper disposition of the windows, doors, and chimneys; by having the stairs, where there is an upper floor, not less than three feet wide, the rise or height not more than eight inches, and the tread or breadth not less than nine inches; and, lastly, by proportioning the size of the cottage to the family that is to inhabit it: there should be one lodging-room for the parents, another for the female, and a third for the male children. It is melancholy, he says, to see a man and his wife, and sometimes half a dozen children, crowded together in the same room, nay, often in the same bed; the horror is still heightened, and the inconveniency increased, at the time the woman is in child-bed, or in case of illness, or of death; indeed, whilst the children are young, under nine years of age, there is not that offence to decency if they sleep in the same room with their parents, or if the boys and girls sleep together, but after that age they should be kept apart.

2888. *Cottages should not be more than twelve feet wide in the clear*, that being the greatest width that it would be prudent to venture the rafters of the roof, with the collar-pieces only, without danger of spreading the walls; and, by using collar-pieces, there can be fifteen inches in height of the roof thrown into the upper chambers, which will render dormar-windows useless.

2889. *Cottages should be always built in pairs*, either at a little distance from one another, or close adjoining, so as to appear one building, that the inhabitants may be of assistance to each other, in case of sickness, or any other accident.

2890. *For economy, cottages should be built strong*, and with the best of materials, and these materials well put together; the mortar must be well tempered and mixed, and lime not spared; hollow walls bring on decay, and harbour vermin; and bad sappy timber soon reduces the cottage to a ruinous state. Although cottages need not be fine, yet they should be regular; regularity will render them ornaments to the country, intead of their being, as at present, disagreeable objects.

2891. *A piece of ground should be allotted to every cottage*, proportionable to its size; the cottage should be built in the vicinity of a spring of water — a circumstance to be attended to; and if there be no spring, let there be a well.

2892. *On the foregoing seven principles* he recommends all cottages to be built. They may be divided into four classes or degrees: first, cottages with one room; secondly, cottages with two rooms; thirdly, cottages with three rooms; and, fourthly, cottages with four rooms: plans of each of which, having great merit in their distribution, may be seen in his very able work.

2893. *An economical mode of constructing the walls of brick-built cottages* is described by Dearn, in a *Tract on Hollow Walls* (London, 1821). These walls are only nine inches wide, and built hollow, by laying the courses alternately lengthwise on edge, and crosswise on the broad face. Another description of hollow walls has been invented by Silverlock of Chichester, and used by him in building garden walls (See *Encyc. of Gardening*), in which all the bricks are laid on edge, but alternately along and across the wall; or, in bricklayers' language, header and stretcher. Either of these modes suits very well for cottages of one story; and if well plastered inside the house, they will be warmer and drier than solid walls even of fourteen inches' thickness. Hollow walls of any height may be built by laying the bricks flatwise, and joining the outer and inner four-inch, or single brick, walls, by cross bricks at moderate distances.

2894. *Mud walls*, built in the French manner, or *en pisé*, are recommended by Beatson, Crocker, and others, and also "walls composed of soft mire and straw;" but these last we consider, with Wood, as the reverse of economical in the end, and totally unfit for our climate and degree of civilisation.

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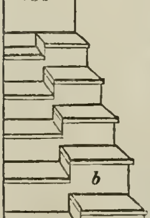

2895. *An economical mode of forming staircases to cottages*, is described by Beatson, and has been adopted in a few places. Its merit consists in occupying exactly half the room which is required for stairs on the ordinary plan. This is effected by dividing every step into two parts (*fig.* 431 *a* and *b*), and making one part double the height of another. In ascending such a stair the left foot is set on the left step (*a*), and the right foot on the right step (*b*), alternately to the top of the stair. It is therefore clear, that as the steps for the right and for the left foot are in the same line, and although neither foot rises each time higher than seven inches and a half above the other, yet every time that one foot is moved, it rises fifteen inches higher than it was before. Suppose in a stair of this kind, that each tread or breadth for the foot is nine inches, and that each rise of the one foot above the other is seven inches and a half; consequently, as each foot rises the height of two steps, or fifteen inches, every time it is moved, it is plain that six steps of this kind will rise as high as twelve in the common way, and will require only one half the size of a hatch or opening in the floor above, that would be required for those twelve steps as usually constructed. This will be of considerable advantage, where much is required to be made of little room, and will of course give more space to the chambers above; but it has the disadvantage of being disagreeable, and even dangerous to descend, especially for pregnant women and young children.

2896. Of what are called *ornamental cottages for labourers,* we shall say little. Utility is a beauty of itself, but there are higher degrees of that sentiment excited by the appearance of convenience and abundance; by the evidence of design or intelligence in the contriver as displayed in the elevation and general effect, and by classical, imitative, or picturesque forms in the masses and details. The great evil, however, is, that these ornamental cottages, as generally constructed, are felt by the occupiers to be very uncomfortable habitations; every thing being sacrificed by the designer to external appearance. This is in the very worst taste, and has, in most parts of the country, brought ornamental cottages into ridicule. Utility, therefore, is the main consideration, and nothing ought to be considered as ornamental that is at all at variance with this property.

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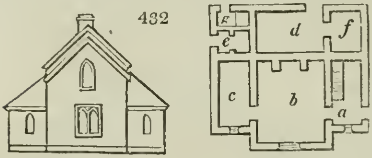

2897. *As an example of a cottage ornamented in the least degree* (*fig.* 432.) we submit a specimen in the gothic style, by Holland. It contains an entrance lobby, and stair (*a*), kitchen (*b*), small parlour and store-room (*c*), cowhouse (*d*), pigsty (*e*), poultry-house (*f*), and water-closet (*g*). Over the kitchen is a bedroom with a fireplace, and another communicating with it over the cowhouse.

2898. *A cottage ornamented in the second degree* (*fig.* 433.) contains an entrance and lobby (*a*), kitchen (*b*), stair (*c*), parlour, or store-room (*d*), back kitchen (*e*), cowhouse (*f*), and water-closet (*g*), with two good bedrooms over the centre of the building, and two garrets over the wings.

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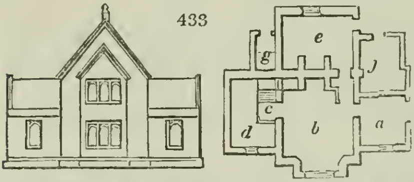

2899. *A double ornamental cottage,* erected by Lord Penrhyn, in Wales (*fig.* 434.), contains a porch, lobby, and stair (*a*), kitchen and living room (*b*), parlour (*c*), with cellars and pantry under, and to each house two bedrooms over. It must be confessed, however, that this cottage is more ornamental than convenient.

2900. *A double ornamental cottage, with latticed windows* (*fig.* 435.), built in Hertfordshire, on a very dry soil, contains, on the ground floor, the kitchen and living room (*a*), pantry (*b*), and small light closets (*c*), with a stair up to two good bedrooms

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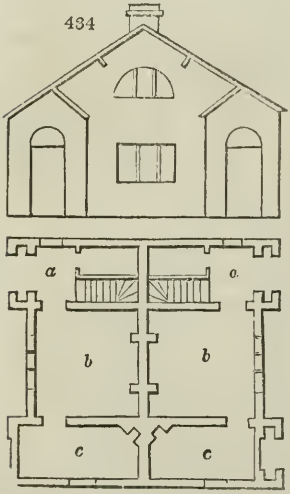

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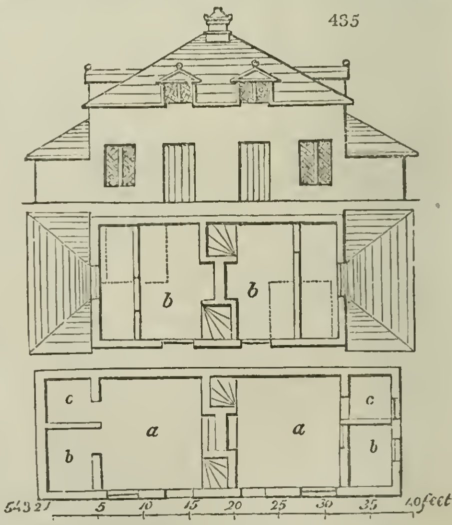

above, and down to a dairy, cellar, fuel-room, and other conveniences beneath. It is placed in a neat garden, with piggery, bee-house, poultry, dung-pit, water-closet, covered seat or bower, pump-well, and other appendages to each cottage.

2901. *A variety of other plans of cottages* will be found connected with the plans of farmeries, and in our *Topography of Agriculture.* (Part IV.)

Sect. V. *Stack-yard, Dung-yard, and other Enclosures immediately connected with Farm Buildings.*

2902. *The different appendages which are common to farm buildings* are the dung-yards, pits and reservoirs, the rick-yard, the straw-yard, the poultry-yard, drying-yard, garden, orchard, and cottage-yards. These necessarily vary much, according to situation and other circumstances, but all of them are more or less essential to a complete farmery.

2903. *The dung-yard and pit* is placed in almost every case in the centre of the main yard. A pavement, or causeway, ought to be carried round the yard, next to the houses, of nine or fifteen feet in width, according to the scale of the whole: the remaining part of the yard should either be enclosed with a wall with various doors to admit cattle, carts, and wheel-barrows, or, on a small scale, it may be entirely open. From this space the earth should be excavated so as to form a hollow deepest at the centre, or at the lower end if the original surface was not level; and from the lowest part of this hollow should be conducted a drain to a reservoir for liquid manure. The bottom of this excavation, or dung basin, ought to be rendered hard, to resist the impression of cart wheels in removing the dung, and impervious to moisture, to prevent absorption.

2904. *For these purposes*, it may be either paved, the stones being set on a layer of clay; or what will generally answer equally well, it may be covered with a thick coat of gravel or chalk, if it can be got, and then well rolled; mixing some loam with the gravel, if it is found not to consolidate readily. To prevent, as much as possible, a superfluity of rain-water from mixing with the dung and diluting its drainings, all external surface-water should be prevented from entering the farm-yard by means of drains, open or covered; and that which collects on the inner slopes of the roofs, should, in every case, be carried off by gutters. Such is the opinion of most agriculturists as to the situation of the farm-yard, dung-hill, and reservoir; but, in addition to these requisites, it is now very properly considered as equally important that there be urine-pits, either open or covered.

2905. *The urinarium, or urine-pit,* is constructed in or near to the stables and cattle-sheds, for the immediate reception of the drainage of these buildings unmixed with rain-water. It is found from experience that a very considerable addition of the richest kind of manure is thus obtained on every arable farm. At the same time it is proper to observe, that no benefit, but a loss, will arise, if the urine is so completely drained from the straw as to leave it too dry for fermentation. Where there are no stall-fed cattle, an able author (*Supp. Enc. Brit.* i. 121.) is of opinion there will be no more urine than what will be required for converting the straw into manure. Where cattle are fed at the stake, however, he considers a reservoir as essential. Allan, of Craigcrook near Edinburgh, recommends that there should be two, in order that as soon as one is full, it should remain in that state till the urine becomes putrid before it is taken away. The urine is either applied to the land in its liquid state, or mixed with peat, earth, &c. The reservoirs may be either vaults of masonry, or wells: in either case, the hole for the pump should be sufficiently large to admit a man to clean out the sediment when it accumulates. A very desirable plan seems to be, to have these vaults, or wells, chiefly within the cattle-house, as in Flanders, but partly also without, to admit room for the pump-hole, close by the wall on the inside of the surrounding paved road. It is needless to add, that such constructions ought to be made water-tight by the use of some cement, or by puddling with clay outside of the masonry.

2906. *The stack-yard*, or enclosure within which corn, hay, &c., are stacked, is placed exterior to that side of the building which contains the barn. Stack-yards should always be sufficiently spacious and airy, having a firm dry bottom; and some advise them to be ridged up, to prevent the accumulation of surface-water; as by raising the ridges pretty well in the middle, and covering the places where the stacks are to be built, either with rough stones, with a mixture of gravel, or with pavement in the same manner as streets, much advantage would be gained at little expense: but a much better method is to have them raised considerably above the surface, and placed upon pillars of wood or stone, with a covering of wood round the circumference, and beams laid across. The enclosing of stack-yards should be well performed, either by means of walls or palings, or better with a sunk fence; as in this way the stacks will have the full benefit of the air from top to bottom, — a circumstance of no small moment, since it is often found, especially in wet seasons, where the fence of the stack-yards is only a low wall, that the whole of the stacks are damaged or spoiled as high up as the wall reaches, while the upper part is perfectly safe. Should any addition be required to the sunk fence, a railing upon the top may be quite sufficient. This fully shows the vast advantage of having stack-yards sufficiently airy. The proper arrangement of the stands, for their being removed to the threshing-mill, is also a matter of much consequence, in the economy of the work that is to be performed in them.

2907. *A stack-yard, arranged on principles peculiarly well planned and judicious*, has been formed by Mitchell, of Balquharn near Alloa. His stacks are divided into regular rows, and there is a road on each side of every double row, besides a road round the whole yard. This plan is attended with the following advantages: 1st, by these parallel roads, there is a greater degree of ventilation; 2dly, he can remove any stack he pleases, as necessity or markets may require; 3dly, in the hurry of harvest there is no confusion or loss of time, whatever may be the number of men or horses employed; and 4thly, by having the rows and the stacks regularly numbered, there is no difficulty in ascertaining what each field of the farm produces.

2908. *Corn-stands* are requisite fixtures of the stack-yard: they are basements of timber or masonry, or sometimes of iron, on which to build the stack, and their object is to keep the lower part of the stack dry, and exclude vermin. The usual mode of constructing stands is to place a stout frame of timber on upright stones, two feet high, and having projecting caps of flat stones. They are also constructed wholly of stone, with circular or polygonal walls (*fig.* 436 *a*, *b*), built to the same height as in the former case, in a rather slanting manner outwards, and covered on the tops with copings of oak-planking or flat stones, which project over the edges several inches, and in that way prevent the ascent of rats and mice to the stacks. In both these modes, pieces of timber are placed as a frame in the middle to support the grain upon, and generally a cone of spars in the centre, to form a column of air in the heart of the corn. Some suppose the first of these sorts of corn-stands to be the best for general purposes, as being more easily as well as more cheaply constructed, and at the same time permitting the air to enter and circulate with more freedom underneath, in the bottom of the stand, which is of much advantage. It is obvious that the form of these stands or basements must vary according to that in which the stacks are to be made, which is different in different districts. But wherever the threshing machine is introduced, the circular base, as producing a stack of a moderate size, with other advantages, is generally preferred. But cast-iron stands (*fig.* 437.) with or without funnels, are now found preferable in point of economy, and admit of stacking the corn somewhat earlier. The pillars of these stands are three feet high, and weigh half a cwt. each. A stack requires seven pillars, besides the framing, which may either be made of poles or young trees. In the wet climate of Clackmannanshire, wheat has been stacked in five days, beans in eight, and barley and oats in ten days, and sometimes earlier. No vermin can find their way into these stacks to consume the grain, and the straw is better preserved. The cone or triangle keeps up a circulation of air, and prevents heating or other damage. (*Gen. Rep. of Scotland*, vol. iv. *App.* p. 379.)

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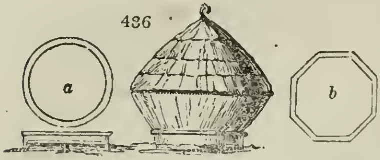

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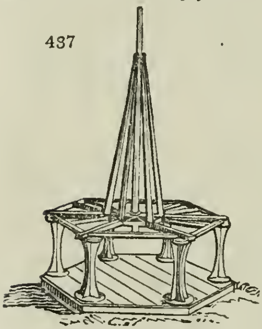
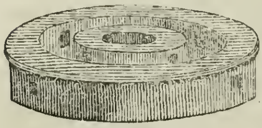


2909. *Waistell's circular rick-stand* (*fig.* 428.) is twelve feet eight inches in diameter. It consists of two concentric circular walls, the outer twenty and the inner eighteen inches thick; the outer wall covered with flagstones, which project four inches over it, to prevent rats and mice from getting up into the rick. The space between the two walls is twenty inches wide; across this space are laid hedgestakes, which are sufficiently long to support the rick, so that no large bearers are wanted, nor other strong and expensive bearers of any kind. The outer wall is twenty inches high, to the top of the projecting flags; at about half its height, four grates of cast iron, about six inches square and half an inch thick, are placed in openings left through the external walls, at equal distances from each other to admit air. The bars of the grates are a quarter of an inch broad, and a quarter of an inch distant from each other, which is sufficiently close to prevent the entrance of mice. Stands thus constructed are considered, by those who have tried them, to be less expensive and more effective than on any other plan that has been yet invented. The air that passes through these four grates, and through the openings in the internal walls, will circulate freely under the rick; and if a chimney be carried up the middle of the rick to its top, the current of air that will pass up through it will carry off the heat and moisture, which might otherwise injure, and even spoil, such corn as was rather too moist when carried. (*Waistell's Designs*, &c. p. 101.)



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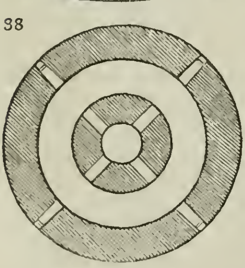
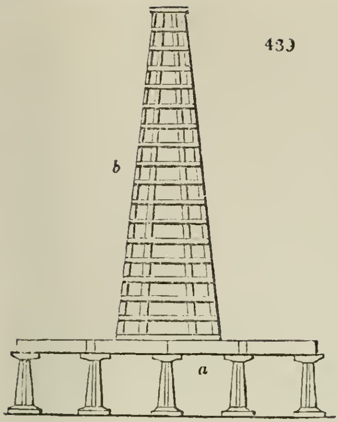


2910. *Hay-stands*, according to some, may be formed in the same manner as those for corn, only it is seldom necessary to have them made of such expensive materials. A simple frame of wood is mostly sufficient, with proper bearers laid across for the support of the stack; and these stands are much better than loose pieces of wood laid across at the bottom, and filled in with brush or faggot wood, on which ricks are commonly built. Earthy floors or foundations should never be thought of for this purpose, as the dampness must injure a considerable part of the hay at the bottom; but where faggots are not scarce, and the ground on which the hay-stack is built is rather elevated, no stand can ever become necessary.

2911. *The stack-funnel* fausse or boss (*fig.* 439. *a.*) as it is called in the north, whether the stand be of wood, iron, or stone, may be formed of a few poles placed on a



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circular, square, or angular base, having a few short spars nailed across, or a straw rope wrapped round.

2912. *The stack-cover* is a cloth or canvass covering, for suspending over stacks during the time of their being built to protect them from rain. A simple implement of this sort has long been in use in Kent; but it has been improved on by Sir Joseph Banks, so as to become more manageable, though somewhat more costly. It consists of two long upright poles fixed into two cart wheels: a rope, managed by blocks and tackle, connects the poles at top, and supports, raises, or lowers the canvass roof in the usual manner of managing tents and sails. Its construction and use will be afterwards more particularly described.

2913. *The straw-yard* is a term applied to enclosures in or about the farmyard, in which cattle are turned in loose to eat straw. In most cases this enclosure occupies the centre of the farm-yard, and includes the dung-basin, or it is a subdivision of the yard; but in some cases enclosures and sheds are erected exterior to the farmyard, and near the straw and root house. The great object in arranging straw-yards of this description, is to provide a sufficient extent of sheds open to the south for cover to the cattle in severe weather, and high fences or sheds on the east or west sides, according to their position with relation to the main yard, for shelter.

2914. *The poultry-yard* in most cases may be a very small enclosure, as the poultry of common farmeries should be allowed to range over the straw-yards and most parts of the premises, to pick up what cannot be got at by swine.

2915. *A tradesman's yard* or small enclosure is often appended to the smith's and carpenter's shops, as well to contain timber as implements in want of repair, &c.

2916. *A kitchen-garden* is an essential appendage to the dwelling-house. Its situation should be apart from the farmery, so as not to interfere with it, or be injured by the blowing in of straws, &c. The size of the garden will, of course, depend somewhat on that of the house and farm; but as a small farmer with a large family will require as many or more vegetables than one of a higher class, there can be no impropriety in the garden being large. As potatoes and turnips, and sometimes other vegetables, may be had of better quality from the field, some abatement of size may be allowed on this account. In general, the garden need not be under a fourth of an acre, nor exceed twice that quantity. The best fence is a wall, and next a close oak paling; but if neither of these can be had, a thorn hedge will answer, though it harbours vermin, and its roots always rob a portion of the accompanying border. The best form is a parallelogram, lying east and west, which may be intersected by walks, so as to divide it into four or six other parallelograms, with a surrounding border as broad as the enclosure fence is high.

2917. *An orchard* may either be regularly formed on an allotted space; or fruit trees may be scattered over a lawn or piece of grass ground which may surround the house. In a convenient part of this orchard, posts should be fixed to form a drying ground, unless the drying is performed by heated air or steam in the house.

2918. *The gardens appended to the labourers' cottages* may contain from one eighth to one sixth of an acre. Their situation should always adjoin the house; but whether they should surround it or enclose it on one or more of its sides, must depend on the position of the cowhouse belonging to each cottage. In some cases, and perhaps it is the best plan, these cowhouses form a range by themselves, in a small field devoted to their use, and situate behind the row of cottages.

Sect. VI. *Union of the different Farm Buildings and Enclosures in a Farmery.*

2919. *In fixing the arrangement of a set of farm buildings,* the first things, according to Beatson, to be taken into consideration, after choosing the situation, are the nature and produce of the farm. From these may be judged the different kinds of accommodation that will be necessary. For example, every farm must have, first, a dwelling-house; secondly, a barn suitable to the extent of arable land in the farm, either with or without a threshing-mill, but always with one, if possible, and so placed as to go by water, if a supply can be had; thirdly, stables, the dimensions of which must be determined according to the number of horses necessary for the farm; fourthly, cowhouses, or feeding-houses, or both, according to the number of cows and cattle; and so on, till the whole accommodations, and their dimensions, are fixed upon. Having ascertained these, and the situation for building on being also settled, the ground must be carefully and attentively viewed; and if not very even, the different levels must be observed, and the best way of conducting all the necessary drains, and carrying off all superfluous moisture; and also the best situations for dung and urine-pits, or reservoirs, which will, in a great degree, ascertain at once where the cattle-houses and stables should be. These being fixed on, the barn should be as near them as possible, for the convenience of carrying straw to the cattle; and the barn-yard should be contiguous to the barn. These main points being determined on, the others will easily be found; always observing this rule, to consider what is the nature of the work to be done about each office, and then the easiest and least laborious way to perform that work, so far as it is connected with other offices. In case this should not be sufficiently explicit, suppose, by way of illustration, the situation of a feeding-house is to be considered of. The nature of the work to be performed here is, bringing food and litter to the cattle, and taking away their dung. The place from which the greatest part perhaps of their food and all their litter comes, is the barn; therefore the feeding-house should be as near the barn as possible. If turnips or other roots, or cabbages, make a part of their food, the most commodious way of giving these must be determined on; whether by having a root-house adjoining the cattle-house, and that filled occasionally, or by having a place to lay them down in, near the head of the stall, from which they are thrown in at holes left in the walls for that purpose. The easiest method of clearing away the dung must also be considered, and the distance from the main dung-pit and urine reservoir. The same general rule being observed in determining on the site of all the other offices or accommodations, together with a careful examination of the ground to be occupied (upon which the arrangement of the offices in a great measure should depend), any person conversant in rural affairs, who attends to these particulars, and can lay down his ideas in a drawing, may easily direct the planning and building of a very commodious set of offices. With respect to the site of the dwelling-house, it may be remarked, that, although the middle of a regular front is in some points of view the most pleasing, and in many situations perhaps the best, yet, unless the ground and other circumstances in every respect favour such a disposition, it should not invariably be adhered to; for it may often happen that a much better situation for the dwelling-house may be obtained at a little distance from the offices, a pleasing uniformity be observed in them at the same time, and the house be more healthy and agreeable. In some cases, and for some kinds of farms, it may be particularly necessary to have the house so placed, in respect to the offices and farm-yard, as to admit of their being constantly inspected, and the labour that is to be performed in them attended to and overlooked.

2920. *Farm buildings in the colder latitudes* of Europe and America are most advantageously combined together under one roof, and on a square or parallelogram ground plan. The saving in the first erection, and in all future repairs, is very considerable; and not less so the saving of heat during the severe weather of winter. In such countries open straw-yards for cattle are not wanted; for in summer these are either in the fields, or stall-fed, and in winter both cattle and sheep are kept almost always in the house. In Britain, however, where the winters are mild, and where it is the custom to keep cattle loose in the straw-yards, it is found desirable to distribute the buildings around such yards, for the sake of shelter to the cattle: but in the case of sheep farms, or where all the cattle kept are stall-fed, there seems no reason why the greater part of the buildings of a farmery might not be included in a cube with a single roof.

2921. *Waistelt* considers a "parallelogram, the most ample and least expensive form for the arrangement of farm buildings; if any other form be adopted, more of both materials and labour will be required." Much the best publication on the subject of farm buildings is that of Mr. Waistell, entitled *Designs for Agricultural Buildings*. London. 4to. 1827. It ought to be consulted by every proprietor intending to erect or alter farm buildings. According to this author, a farmery ought neither to be situated on a hill nor on a dead flat, but, if possible, on gently waving grounds on a southern declivity. At all events the spot should be dry, and of easy access; — dry, that it may be warm and easily kept clean; easy of access and central, to facilitate carrying home the crops, and out the manure, and for general despatch of business. It should not be far removed from a public road, and should, if possible, command a view of the greatest part of the farm. The site to be built on should be level, or made so, or nearly so, declining in preference to the south. Drainage must be got, or a deep cesspool formed for the house; and a urine pit for the farm-yard. A gravelly soil, on the banks of a quick-running stream, is one of the healthiest of situations; while a rich and marshy soil is the reverse, and peculiarly unwholesome. Plenty of good water is desirable; and if that cannot be got otherwise, it must be obtained by a mode which never fails — "by putting spouts round all the buildings, to collect the rain-water which falls upon them into one, two, or more tanks: by this last means a sufficient supply of water has been collected from the roof of a cottage to answer every purpose of the family during the driest season, while other cottagers in the neighbourhood, having only ponds, had to travel miles for water. Ponds having a large surface exposed to the sun and air, soon lose a great proportion of water by evaporation; the water in a covered tank is not liable to this loss, and will keep quite clean, and, if properly ventilated, will always be sweet. The quantity of water that falls annually upon every hundred superficial feet or square of building, is about 1,400 imperial gallons. Besides the water collected from the buildings being useful, the buildings themselves will be benefited by the spouts, as the walls and their foundations will be kept much drier, and will last longer than they would do if all the water from the roofs were suffered to fall upon them." The manner of constructing tanks will be found in Part III. Book III.

Chap. III. Sec. III. The aspect, or principal front of the house, and that side of the farm-yard which is least sheltered by buildings, should generally face the south. "As the wind rarely blows from the south-east, and as our most constant and most violent winds are from the south-west, it would seem that one point to the east of south will generally be the best aspect." The north-east corner being the coldest, is the best for the dairy. Open cattle-sheds should face the sun. The farmhouse should be at a little distance southward from the middle of the south side of the farm-yard. The living room and the master's bedroom should look into the farm-yard for the sake of looking after the servants, and seeing that no accident happens to the live stock. The rule for the distance of the dwelling-house from the south wall of the farm-yard, is the length of the house's shadow at noon on the shortest day. "In the latitude of London, the length of shadows on a horizontal plane when the sun is in the meridian, on the shortest day, is about equal to 3⅗ times the height of objects. On the 23d of November and 19th of January, they are equal to three times the height. The back of a farmhouse in front of the yard ought not, therefore, to be placed much nearer to the north side of the farm-yard, than four times the height of the house." It is essentially necessary for the health of the inhabitants, that the house should be separated from the farm-yard, which is generally covered with dung, by an open, naked, and dry court-yard; since nothing is more injurious to health than putrid effluvia of every kind: besides, bad smells, it is well known, "lessen the products of butter dairies, by preventing a complete separation of the cream from the milk." Hog and poultry houses should be near the kitchen and the brewhouse, but not so near as to offend by their smell. The barn and threshing-machine should in general be placed on the north side of the yard; the granary over the straw-room; the stables, cowhouses, and cart-sheds, on the east and west; and the open sheds on the north side, so as to face the south.

2922. *The form and proportion of farm buildings* are ably treated of by the same author. The more a building deviates from a square, the more will it require to enclose a given area. The area of a building twenty feet square, is four times as large as that of one ten feet square, and it only requires twice the length of wall to surround it. Hence large-roomed houses cost less proportional expense than small-roomed ones. "Utility, durability, and economy, are best obtained by adhering strictly to simplicity of form, and building with good materials. Let the buildings be quadrangular, as nearly square as other circumstances will allow, and roofed at one span. Avoid lead gutters, and such projections as bow windows, dormar windows, &c. These are not only expensive to construct and keep in repair, but are often the cause of much damage to other parts by the overflowing of water, particularly after snow. The increase of the size of farm-houses is not required to be in the same ratio as the extent of the farms; that is, the dwelling-house for a small farm must be proportionably larger, and consequently will cost more, in proportion, than one for a large farm. The cost of cattle-sheds, cow-houses, and stables, will be nearly in the same ratio as the sizes of the farms, provided the lands be of the same quality, and in like situations." One window will generally be found sufficient for every room in a farm-house; unless where two would admit of looking over a greater part of the farm: every window ought to be made to open at top and bottom, for the purpose of ventilation; and the top ought to be as near the ceiling as possible for that purpose, and because the upper half of a window always admits most light. All rooms should be high, because the floor and ceiling cost the same, whether the walls are high or low. In all new buildings, bedrooms, in addition to the chimney for the fire, should have a small flue, say six inches square, carried up from the top of the room in any convenient situation, for the purpose of ventilation; cellars, and even stables and cowhouses, should be ventilated in this way. This has been done by many gentlemen in their stables, because, as our author remarks, "the health of servants is often less attended to than the health of cattle." Farmers and their families frequently suffer in their health, without knowing the reason, from the pernicious effluvia of the following articles: — "Oil, oil colours, impure wool, sweaty saddles, soap, tallow, fat, fresh meat whether raw or dressed, wet clothes, and other wet articles; by foul linen, washing, drying, and ironing; by the fumes from charcoal fires, which are extremely pernicious, and frequently fatal; by green plants and flowers, however fragrant; and by saffron and hops; which last articles, Dr. Wallich says, have also sometimes proved fatal." The floors of all dwelling-houses ought to be raised above the surface, not less than eighteen inches on a damp soil, nor nine inches on the driest. No external walls to dwelling-houses should be less than a brick and a half in thickness, unless cemented on the outside, or built with Roman cement.

2923. *The conveniences of farmhouses and detached offices* are arranged by Waistell under seven classes as follows:—

2924. 1st Class. *Back kitchen, bacon-room, bakehouse, brewhouse, cider-house, kitchen, and washhouse.* Two rooms generally serve for all these purposes in farmhouses of the smallest size; but the bakehouse and the brewhouse should always be in attached buildings, as the vapour arising from both baking and brewing is very injurious to health. Bacon is best kept in a closet with a draft through it.

2925. 2d Class. *Cellar, potato-place, carrot-store,* &c. When under the kitchen they should be arched over; when sunk only a few steps, the walls should be built hollow, and a bank of earth raised against them.

2926. 3d Class. *Chambers or bedrooms.* Such as are in the roof should be lighted from the gables, dormars being expensive. The men-servants' bedroom ought not to be up the same stairs as the bedrooms for the family.

2927. 4th Class. *Cheese-press house, cheese-room, dairy, dairy-scullery, and shed.* These ought all to be connected. "A milk-room, sunk three feet within the ground, and a sloping bank raised against its walls externally, to the height of three feet, with the earth dug out of it, will be found nearly as cool in summer and warm in winter as a cellar, but more convenient to occupy, as four or five steps to descend into it will be sufficient." The milk-house should never be used as a pantry, because the smells incident to the latter prevents the cream from rising. A rill of water through a dairy carries heat to it in winter, and from it in summer.

2928. 5th Class. *Parlour, counting-house, pantry, and store-room.* If the two latter apartments are attached, instead of being within the house, so much the better, on account of the pernicious effluvia which proceed from them.

2929. 6th Class. *Court-yard, chaise-house, privy, ash-pit, and tool-house.* A tank may be built in the court-yard for the hogwash, and it ought to have oak covers, like the water-tank. The cesspool of the privy ought to be lined with Roman cement, and its walls ought either to be hollow, or of double thickness. "When a drain is required, it should have a trap; from the underside of the seat, a trunk or flue should be constructed to carry off, above the roof, any smell that may arise: if, however, the cesspool be airtight, so that no air may be admitted below the seat, which always ought to have a cover, the air would then be stagnant, and the smell not likely to ascend. The tool-house may also, in some cases, serve for the cheese-press house, and also for dry pigs' food."

2930. 7th Class. *Coal-house, fuel-house, wood-house, and wood or coal yard.* In some places the wood is stacked and thatched.

2931. *The out-offices of farm buildings* are arranged by the same author in eleven classes, as follows: —

2932. 1st Class. *Barn, straw-room, and threshing-machine.* A comparatively small barn will suffice where there is a threshing-machine. Parallelogram barns (*fig.* 440.), and barns with porches (*fig.* 441.), are much more expensive in proportion to their capacity than square barns (*fig.* 442.) On the same principle, as we have already mentioned, if all the buildings of the farmery were arranged under one roof, the same accommodations would be obtained at much less expense; but among other disadvantages there would be no sheltered yards for cattle, unless walls were built on purpose, which would materially lessen the saving by combination.

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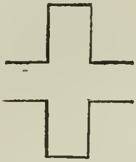

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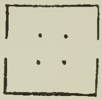

2933. 2d Class. *Granary.* Ventilation, dryness, and security from vermin, are essential objects.

2934. 3d Class. *Fold-yards, cattle-sheds, cattle-troughs, hogs'-troughs, hogs'-court,* &c. The openings in front of sheds should be at least seven feet high. Horses and cows ought to be kept separate, and the different kinds, strength, and ages, by themselves. In many situations the warmth of cattle-yards might be increased by surrounding plantations. The middle of fold-yards should be hollowed out, and the moisture should either be conveyed away to a proper tank, or there may be a tank built immediately under the hollow. "In some cases, a stream of water may be conveyed through the farm-yard; when this is the case, below the place where the cattle drink, it may have conveyed into it the over-flowings and drainings of the yards and offices, after they have been filtered through the earth and peat, and, thus enriched, be conducted to adjoining meadows, and as much ground watered with it as it is capable of flooding."

2935. 4th Class. *Cow-house, feeding-house or shed, foddering-bay, bull-house, calf-house, hay-room, store or turnip room, turnip-cistern, and place for sick cattle.* No cow or feeding house should be built without a passage or foddering-bay at the heads of the cattle; if that be wanting, it not only takes more time to feed the cattle and clean their troughs, but also their food, when passing behind them, is liable to be soiled by their dung; this renders it highly disgusting to them, which is the cause of much waste." When the cattle stand in rows across the building, one foddering-bay may serve two rows; it should have a gate at each end, and if a stream of water is at hand, it may have a sunk cistern for washing the turnips. Stalls for containing two cattle of the largest size should be seven feet wide and twelve feet long. By double foddering-bays and the rows of cattle across the house, more room is got under the same roof, and the cattle are fed with greater facility.

2936. 5th Class. *Stable, stable-court, hay and chaff room, loose box or house, and harness-room.* The width of each stall should be from five to six feet; short partitions between stalls from three feet six inches to four feet; long partitions eight feet. Boxes for single horses should be eight feet wide and twelve feet long. Recesses may often be made in the walls to contain forks and other stable implements, harness, and to lessen the projection of corn-bins. The height from the floor to the ceiling should in no case be less than eight feet. Lofts over stables are bad places for both hay and corn, from the breath of the animals and the effluvia of the dung. For draught horses a stable open to the roof is best; for saddle horses one ceiled over at nine feet, if properly ventilated, is preferable, as they require to be kept warmer. Small openings should be made at the bottoms of the doors, and at the tops of the walls, with shutters, so as to admit of ventilation when the larger windows cannot be opened. Stables should be exceedingly well paved, because when the urine does not run off, it generates a variety of diseases.

2937. 6th Class. *The cart-shed or waggon-hovel, plough and harrow place, and wool-room.* The height should be at least seven feet, and the granary may frequently be built over.

2938. 7th Class. *Hogsties, hen-roosts, boiling-house, duck-house, goose-house, hogs' food-house, hogs' food-tank, pigeon-house, poultry-yard, and turkey-house.* The hogsties should be so placed as to be of easy access from the kitchen, and at the same time not to prove offensive to either the house or the stables by their smell. The height may be three or four feet, and the hen-roosts may be placed over them; the boiler for preparing their food, the food-tank, the duck-house, and the goose-house near them. The pigeon-house may be placed over any building; but if the water collected from the roofs be used for culinary purposes, pigeons ought not to be kept.

2939. 8th Class. *Brining-room for wheat, and slaughter-house.* One building will serve both these purposes, and it should be paved with flat paving-stones.

2940. 9th Class. *Sheep-house.* A square of twenty feet on the side will contain thirty sheep; the walls should be ten feet high; this gives $13\frac{1}{3}$ feet surface to each sheep. The doors ought to be always open, and there ought to be a fold-yard, so that the sheep may go out and in at pleasure.

2941. 10th Class. *Forge, tool-house, workshop, privy,* &c. The forge ought to be apart on account of the danger of fire; the carpenter's workshop ought to have folding doors to admit a cart or waggon. In large farmeries there ought to be a small yard distinct and apart from the fold-yards and rick-yards, for the purpose of the forge, workshop, implements requiring repair, and stock of timber and other materials. In all farmeries there ought to be two privies; one for the women-servants near the house, and one for the men near the stables: there ought also to be two water-closets, one in the dwelling-house for the mistress and her female children and friends; and the other within the house, or adjoining it, for the master and his friends.

2942. 11th Class. *Men's lodge, meal-chest, and potato-house.* Where single men are kept, they are sometimes lodged in the farmery, and supplied with meal, milk, and potatoes. They should have a large, light, and well ventilated room for cooking and living in, with bedchambers over, and iron bedsteads. The practice of sleeping in lofts over horses is highly injurious to health.

2943. *The materials and construction of agricultural buildings* are next treated of by Waistell, in a manner at once highly scientific and practical.

2944. *Mortar.* Bad mortar is the main cause of the decay of all our modern buildings, from the cottage to the palace. Roman cement should be used in foundations, in exterior jointing, and frequently even in plastering in the interior, in different proportions, according to circumstances which it is unnecessary to suggest to the builder. Avoid salt or brackish water and sea sand; slack the lime while it is yet hot from the kiln, make it into mortar immediately, and use it if possible the same day. This applies to all kinds of lime to be used in building. All lime or mortar to be mixed with Roman cement, ought to be used instantly afterwards; if not used in five minutes it will set and become useless. Mortar to be used with hair as plaster may be kept some time; but no advantage is gained from this in point of strength, but the contrary.

2945. *Walls* Foundations should vary in thickness according to the compressibility of the ground, the height to which they are to be built, and the weight they may have to support. Under wide doors or windows, inverted arches springing from the adjoining piers are found useful, by equalising compression. Walls should diminish in thickness as they rise. Windows and door frames in external walls should always be placed in reveals, and every window should have a sill. Where anything is to be fixed to walls, a piece of wood in size and shape like a brick or stone should be built in, having the end even with the surface of the wall. In walls built of brick or small stones, templets, or plates of timber, stone, or cast iron, should be laid under the ends of all timber bearings on the walls to spread the load. In topping all walls exposed to the weather, set the last course in Roman cement.

2946. *Timber.* Stiff woods, as the oak and fir, are better for floors than stronger and more elastic timbers, like the ash, which bends with less weight than these woods. The strength and stiffness of a joist depend more on its depth than its breadth; a fact too little attended to by many country carpenters.

2947. *Roofs.* High roofs are necessary for tempestuous climates, the better to shoot off the rains and snows; but a high roof, having a larger surface than a smaller one, requires timber of a greater scantling, to make it equally able to resist high winds; roofs, therefore, should be made sufficiently high for the climate and kind of covering, and no higher. "A roof whose height is one half the span, will have one fourth more surface than if it were made one fourth the span. In general one third of the span or width of a roof, is the lowest extremity that is advisable where tiles, either plain or pan-tiles, are to be used. Plain tiles should be laid dry, and afterwards plastered wholly over, tiles and laths together, with coarse hair mortar. This is considered a great improvement over the commoner modes, of laying tiles in plaster or in straw. Roofs for pan-tiles in exposed situations should be somewhat higher in pitch than in sheltered places. Roofs for gray or stone slates should be strong in proportion to the great weight of these materials. Roofs for straw, ling, chips, reeds, &c. should rise half their width. Roofs of these materials have many disadvantages, and among others, that of rendering the water which falls on them unfit for culinary purposes." (*Waistell's Designs for Agricultural Buildings*, p. 78.)

2948. *For a grazing farm in a mountainous country*, the following plan (*fig.* 443.) is given by Waistell. "The interior consists of a fold-yard for the cattle, and a court-yard, to keep the cattle, pigs, &c. from the

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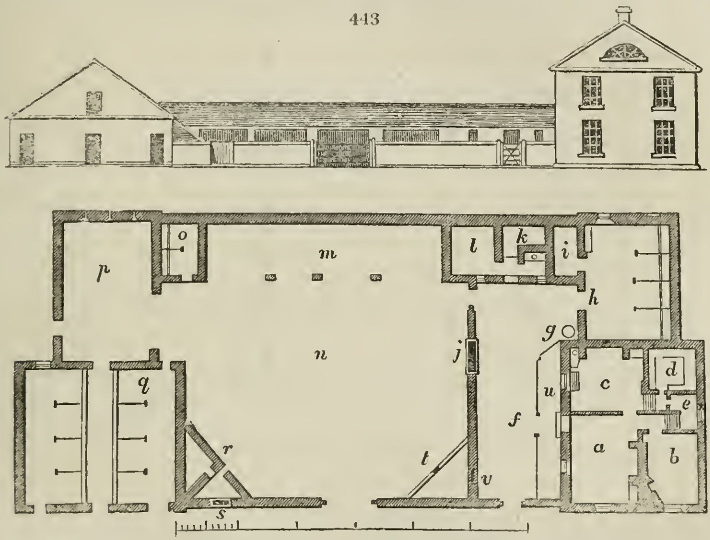

house, which is placed on the east side. On the ground plan of the house are the kitchen, back kitchen, parlour, dairy, and pantry. Both the kitchen and back kitchen overlook the yards, &c. The other window to the kitchen, and also the parlour window, are supposed to overlook the farm. In the back kitchen are shown the situation of the copper or boiler, pump, and sink. The dairy is sunk five steps, for the sake of coolness in summer, and warmth in winter; and the way the benches or shelves may be placed, is shown. The pantry, which is down the same steps leading from the back kitchen to the dairy, is under the stairs to the chamber-floor. Under the parlour is the cellar. A part of the cellar may be partitioned off for a store-room for potatoes, &c. There are, on the first floor, four chambers, and over them two garrets in the roof, lighted from the ends of the house. The chamber over the dairy may be used for the men-servants' bedroom; or, should that not be required, as it will be lofty, it may be used as a store-room. Next the house, on the north, is a stable for four horses. A saddle closet might be conveniently formed in the corner of the stable, at the back of the kitchen fire-place, where the saddles, &c., would always be kept dry. At the other end of the stable, a recess is formed for the corn-bin, near the window. The horses, in passing to and from the stable, through the court-yard, do not mix with or disturb the cattle in the fold-yard. The gate to the court-yard is placed as far as possible from the house; and posts and rails, or chains, may be placed, as shown by the single line, to keep the horses from, and to protect children at, the door. A tank for the hogwash may be made in the corner formed by the house and stable. The situation for it is shown by the dotted circle. Arranged along the north sides of the yards are the chaff-room next the stable, various offices, open shed, and calf-house. The shed is open to the south, and may be used for cattle, and a part of it for a cart. The space within the roof of either the shed or stable, may be appropriated as repositories for such tools and implements as are only occasionally in use, as hay-rakes, ladders, &c. To a part of the space in the roof of the shed (which may be enclosed), an opening, or door, may be left from the place for fuel. The hen-roost may be in the roof, over the place for ashes, &c. On the west side of the fold-yard are the barn and cow-house; and, as on the farm for which this design is proposed, little corn is grown, the barn may occasionally be used as a store-room for turnips; for this reason, there is a door from it to the foddering-bay. The cow-house contains standings for sixteen head of cattle, eight on each side of the gangway; a feeding-house for the like number of cattle arranged in a single row, with a foddering-bay at their heads, would require one sixth more area, and one fourth more wall. Over the cow-house is a straw-room, which may occasionally be filled with unthreshed grain. The ridges of the roofs of the barn and cow-house are of the same height, but the side walls of the cow-house are about three feet lower than the side walls of the barn. On the wall, between the fold-yard and court-yard, is placed a large water-trough for the cattle in the yard, and for the stable horses. The hogsty is in the corner next the cow-house; and in the opposite corner, a court for the store pigs is formed by the post and rail to keep off the cattle; and there the trough for the pigs is placed. The wide door to the barn is made next the fold-yard; but, in some situations, it may be more convenient on the outside; for, when the fold-yard is filled with manure, access with a loaded cart to the barn, that way, may be difficult." (*Waistell's Designs*, &c. p. 86.) The following is a recapitulation: *a*, kitchen; *b*, parlour; *c*, back kitchen; *d*, dairy; *e*, pantry; *f*, court-yard; *g*, tank for the hogwash; *h*, four-horse stable; *i*, chaff-room; *k*, ashes; *l*, fuel; *m*, shed; *n*, fold-yard; *o*, calf-house; *p*, barn; *q*, house for 16 cattle; *r*, hogsty and hog-yard; *s*, water-cistern; *t*, hogs'-court; *u*, enclosed area in front of the house; *v*, hog-troughs.

2949. *For a small arable and grazing farm,* Waistell's farm-house and outbuildings (*fig.* 444.) are as follows: — The house is on the west side, with a porch in front.

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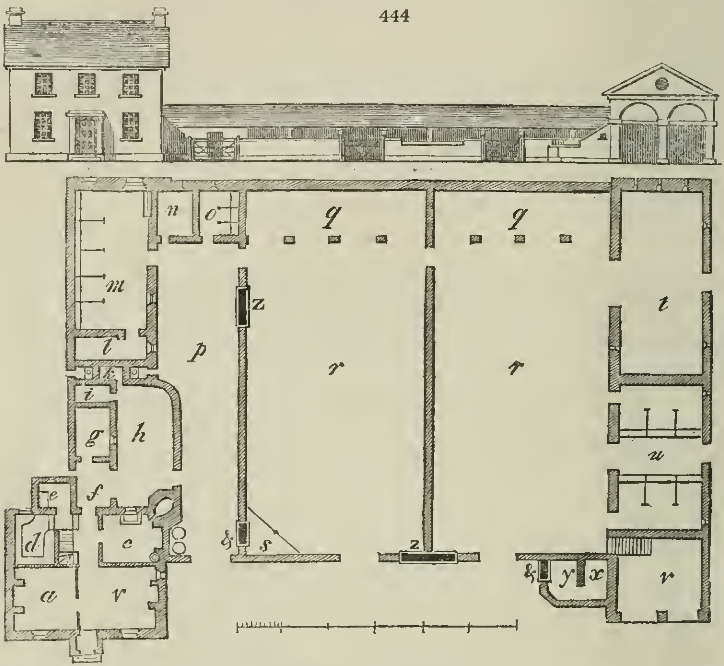

Over the pantry may be a convenient store-room. "The barn is forty feet long and eighteen feet wide. The cow-house will contain twelve cattle, and there is a loft over it, which may be used for a store of straw, or unthreshed grain. The approach is supposed to be from the east, and the cart-lodge, which is additional, is so placed that it must always be passed as the horses go to the stable; and the granary over it is conveniently near the barn. A roost for hens may be made over the pigsty adjoining the cart-lodge; and under the steps to the granary, and at the inner part behind the carts, the ploughs and harrows may be placed." The following is an enumeration of the details: *a*, parlour; *b*, kitchen; *c*, back kitchen; *d*, dairy; *e*, pantry; *f*, open shed; *g*, coals; *h*, kitchen-court; *i*, tools; *k*, ashes; *l*, harness room; *m*, five-horse stable; *n*, hay and chaff house; *o*, calf-house; *p*, stable-court; *q*, cattle-sheds; *r*, fold-yards; *s*, hogs'-court; *t*, barn; *u*, stalls for twelve cattle or cows, with foddering-bay in the centre; *v*, cart-lodge with granary over; *x*, hogsty; *y*, hog-yard; *z*, cisterns and hogs' troughs.

2950. *The particular requisites of a farm-stead,* Marshall observes, "are as various as the intentions of farms. A sheep-farm, a grazing-farm, a hay-farm, a dairy-farm, and one under mixed cultivation, may require different situations, and different arrangements of yards and buildings. On a farm of the last species, which may be considered as the ordinary farm of this kingdom, the principal requisites are, shelter, water, an area or site sufficiently flat for yards and buildings; with meadow land below it, to receive the washings of the yards; as well as sound pasturage grounds above it for a grass-yard and paddocks; with private roads nearly on a level, to the principal arable lands; and with suitable outlets to the nearest or best markets." The first of which, when wanting in the desired situation, may in time be supplied by plantations and mound-fences; and where there is not a natural supply of water, a well, water-cellar, or artificial rill may, he says, furnish it.

2951. *For a farm under mixed husbandry,* the particulars to be arranged, according to Marshall, may be thus enumerated: — 1. A suite of buildings, adapted to the intended plan of management, as a dwelling-house, barns, stables, cattle-sheds, cart-shed. 2 A spacious yard, common to the buildings, and containing a receptacle or stall-manure, whether arising from stables, cattle-sheds, hogsties, or other buildings; together with separate folds, or straw-yards, furnished with appropriate sheds, for particular stock, in places where such are required. 3. A reservoir, or catchpool, situated on the lower side of the buildings and yards, to receive their washings, and collect them in a body for the purpose of irrigating the lands below them. 4. A corn-yard, convenient to the barns; and a hay-yard contiguous to the cow or fatting-sheds. 5. A garden and fruit-ground near the house. 6. A spacious grass-yard or green, embracing the whole or principal part of the conveniences; as an occasional receptacle for stock of every kind; as a common pasture for swine, and a range for poultry; as a security to the fields from stock straying out of the inner yards; and as an ante-field or lobby, out of which the home-grounds and driftways may be conveniently entered. In respect to the distribution or management of these different objects, he remarks, that in order to make it with good effect, great caution, study, and patience are required, that the most may be made of given circumstances. " An accurate delineation of the site which is fixed on, requires," says he, " to be drawn out on a scale; the plannist studying the subject alternately upon the paper and on the ground to be laid out; continuing to sketch and correct his plan, until he has not a doubt left upon his mind; and then to mark out the whole upon the ground, in a conspicuous and permanent manner, before the foundation of any particular building be attempted to be laid. It may," he thinks, " be naturally conceived by a per-on who has not turned his attention to this subject, that there must be some simple, obvious, and fixed plan to proceed upon. But seeing the endless variety in the mere dwelling-places of men, it is not to be wondered at, if a still greater variety of plans should take place where so many appurtenances are required, and these on sites so infinitely various; nor that men's opinions and practices should differ so much on the subject, that on a given site, no two practical men, it is more than probable, would make the same arrangement." There are, however, he says, " certain principles which no artist ought to lose sight of in laying out" such buildings and conveniences. " The barns, the stables, and the granary, should be under the eye, — should be readily seen from the dwelling-house;" and " the prevailing idea, at present, is, that the several buildings ought to form a regular figure, and enclose an area or farm-yard, either as a fold for loose cattle, or, where the stalling of cattle is practised, as a receptacle for dung, and the most prevailing figure is the square. But this form is, he thinks, more defective than the oval or circle, the angles being too sharp, and the corners too deep. Besides, the roadway, necessary to be carried round a farm-yard in order to have a free and easy passage between the different buildings, is inconveniently lengthened or made at greater expense. The view of the whole yard and buildings from the house on one side of it, is likewise more confined." He had formerly suggested the plan of a polygon, or many-sided figure, or an irregular semi-octagon, with the dwelling-house and stables on the largest side, having ranges of cattle-stalls opposite: but he has since formed one on the complete octagon (*fig.* 445.), the dwelling-house (*a*) being on one side, and the entrance gateway and granary opposite, the remaining six sides being occupied by stables and cattle-sheds (*c*, *d*), and other outbuildings (*e*), a barn and threshing machine (*f*), with a broad-way (*g*) dipping gently from the buildings, and surrounding a wide shallow dung-basin (*h*), which occupy the rest of the area of the yard.

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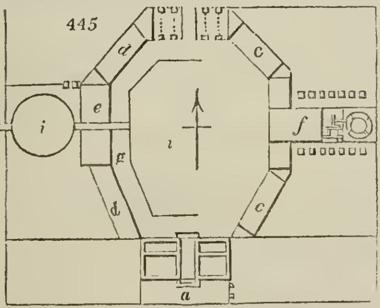

Externally is a basin (*i*) for the drainings of the yard; and grass enclosures for calves, poultry, and fruit-trees, and rick-yard. This is given as a hint to those engaged in laying out and directing buildings of this sort, which they may adapt to the particular nature of the site of such erections.

2952. An example of *the arrangement of a small farm-house and* [illegible]*ices* (*fig.* 446.) is given by Beatson, which he considers as very convenient. At the north-west corner is the barn (*a*), with a water threshing-mill; and a straw-house (*b*), being a continuation of the barn above, for holding a quantity of straw after it is threshed, or hay, that it may be at hand to give to the cattle in the feeding-house below. The upper part of this straw-house may consist of pillars to support the roof, with a space of about eight feet between them, whereby a good deal of building will be saved. In the floor should be hatches, at convenient distances, to put down the straw to the cattle below. A court for the dunghill (*c*) has a door to it from the feeding-house, and a large entry at the other end to admit carts to take away the dung: on the outside of this should be a urine-pit, in the most convenient place, according to the form of the ground. A cow-house (*d*) has a door also to the dung-court; and a calf-pen (*e*), with a rail across to keep in the calves, even though the doors are all open, adjoins. There are a stable, with a harness-room, and a place for keeping corn (*f*); a root-house (*g*), over which, or over the barn, may be a granary; a shed for carts (*h*); a place for keeping large implements, as ploughs and harrows (*i*); for keeping smaller implements, as spades, shovels, rakes, forks, &c., and for the reception of old iron and many other useful things that might otherwise be lost or thrown away (*k*); a pond for washing the horses' feet (*l*), which slopes down from each extremity towards the middle, where it is deepest, that the horses may easily go in at one end, and come out at the other, with a rail at each end, to prevent their going in during frost, or when not wanted to go in; a pump, with a trough for the horses or cattle to drink out of, especially while other water is frozen, or when the water in the pond is dirty (*m*); but, if it can be contrived so that the water which drives the mill may run through this pond, it will be preferable, as being at all times clean and wholesome. One material advantage of this arrangement, Beatson remarks, is, that the fodder consumed upon the farm goes progressively forward from the barn-yard through the cattle-houses to the dunghill, without the unnecessary labour generally occasioned by carrying it backwards and forwards: for it comes from the barn-yard into the barn, where it is threshed; it is then put in the straw-house, and given to the cattle immediately below; and, after passing through them, it is thrown into the dung-court. A rick of straw or hay, built behind the stable or cow-house, or in a shed contiguous to either, with proper conveniences, will have the same progressive course to the dunghill: for, it will be observed, the communication from these is equally easy from without or within; the rail across the calf-pen being intended chiefly to keep in the calves, while the doors on each side are open, during the conveyance of the dung that way from the stable to the dunghill.

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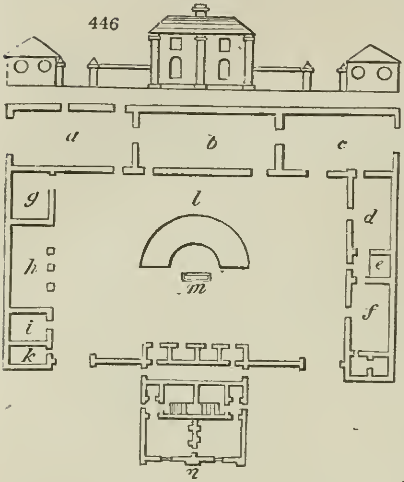

2953. *The ground plan of the dwelling-house* to this farmery (*n*) has a dairy, pantry, and various conveniences behind for keeping swine, poultry, coals, &c. The stair to the upper chambers rises from either side to the same landing-place; from which are a few steps up to the chamber-floor.

2954. *A convenient Berwickshire farmery* (*fig.* 447.) has the following accommodations: a smith's workshop detached from the court-yard (*a*); straw-rooms (*b*); barn

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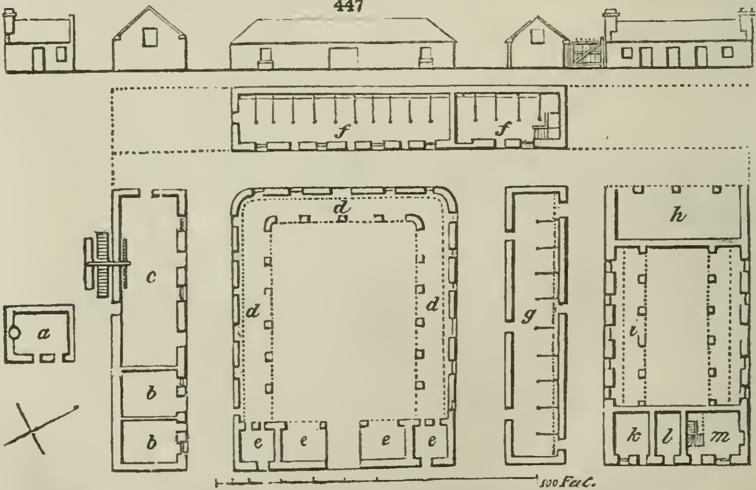

with threshing-machine driven by water (*c*) ; cattle-sheds (*d*) ; root-rooms and implements, or if preferred, hammels (*e*) ; stable (*f*) ; fatting cattle (*g*) ; cart-shed (*h*) ; cattle-sheds for feeding (*i*) ; riding-horse (*k*) ; tools (*l*) ; single men's room or bailiff (*m*).

2955. As an example of *a commodious arrangement for an arable farm* managed for a gentleman farmer by his superintendant, both resident at the farm (*fig.* 448.), we give the following details. The original design will be found in the account of the Marquess of Stafford's

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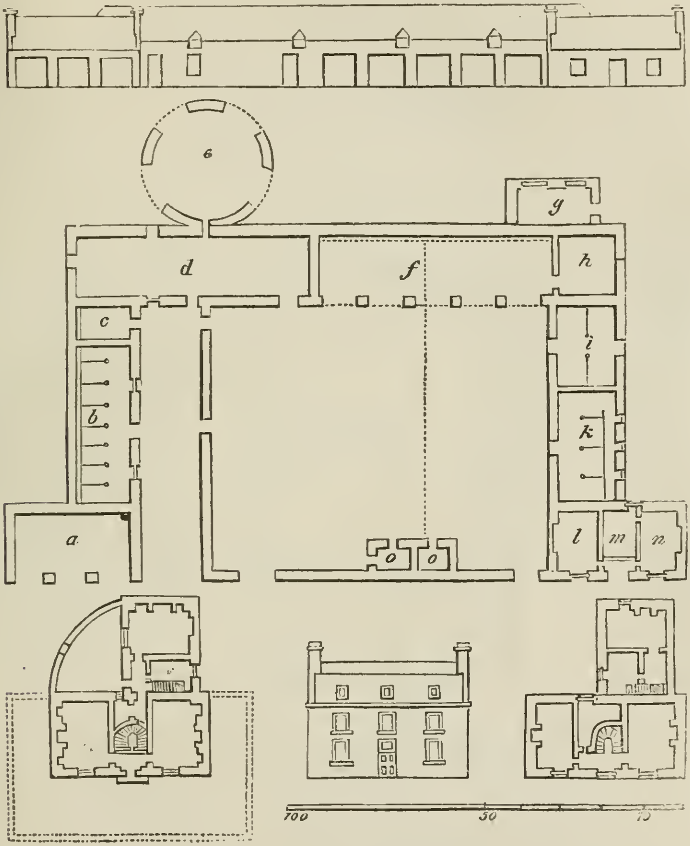

improvements by Mr. Loch; a work which, as it contains a great number of valuable plans and elevations, all of which have been executed, may be profitably consulted by every landed proprietor who contemplates either buildings or repairs, and by every architect, builder, or surveyor, whose practice is at all connected with agriculture or the country. The dwelling-house of the master contains two good sitting-rooms on the parlour floor ; three bed-rooms on the first floor, and attics over them, and over the cellar two kitchen offices. The farmery consists of a cart-shed (*a*) ; stable (*b*) ; riding-horse (*c*); barn (*d*) ; mill-shed (*e*) ; cattle-shed (*f*) ; steaming-place (*g*) ; root-house (*h*) ; cow-house (*i*) ; fatting cattle (*k*) ; intendant's house (*l*, *m*, *n*) ; piggeries (*o*). The intendant's house is situated about three times its height distant from the south side of the piggeries (*o o*), so that nothing unpleasant or inconvenient may be experienced either from the noise or the smell of the pigs, or from the general effluvia of the farmyard. This house, like every other built by the Marquess of Stafford, whether for his tenants, cottagers, or servants, exhibits a reasonable attention to the comforts of the occupants, and to the improvements of the age in domestic economy and architecture. In this respect, the Marquess, unlike some other extensive landed proprietors, cannot be considered as in arrear of the age in which he lives.

2956. *As a commodious and very complete design,* we give the following. The dwelling-house contains two parlours (*fig.* 449. *a, b*); kitchen (*c*); dairy (*d*); pantry (*e*); dining-parlour (*f*); bedrooms (*g, h*); cellars (*i*). The farmery consists of cart-sheds

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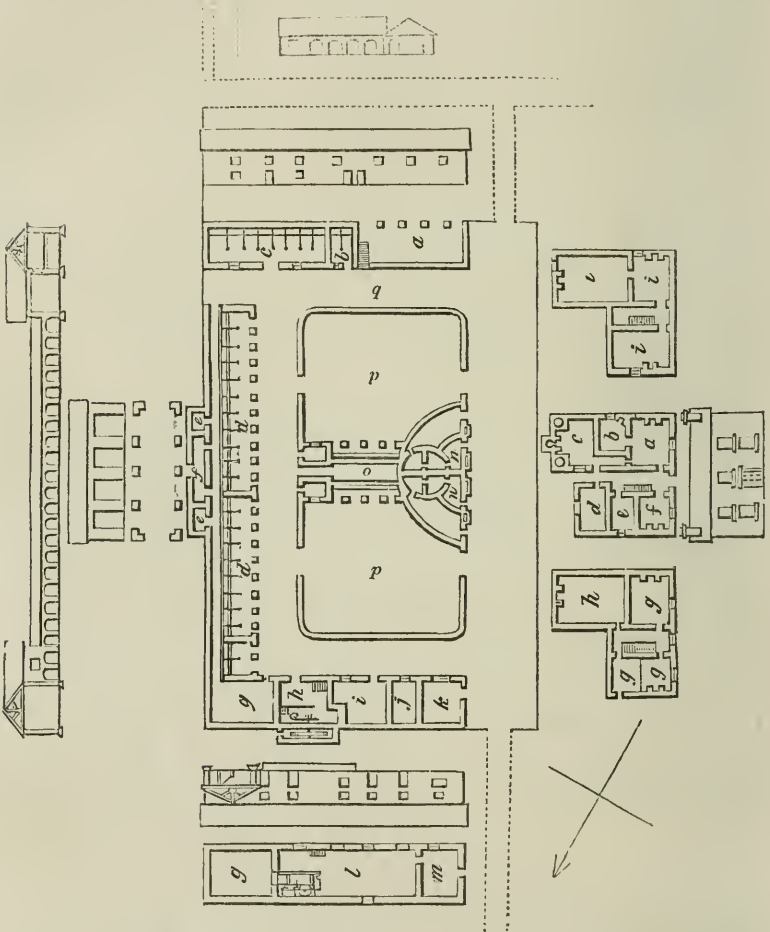

and granary over (*a*); riding-horse stable (*b*); common stable (*c*); stalled cattle (*d*); places for tools and other articles of the cattle attendant (*e*); entrance from the spacious root or turnip shed (*f*); straw (*g*); threshing-machine and water-wheel (*h*); granaries and straw-lofts over (*g, l, m*); tools and sundries (*i*); smith's shop (*j*); carpenter's (*k*); yard for pigs and sties (*n*); place for straw and turnips (*o*); open yards with sheds for wintering cattle (*p*), and exterior passage (*q*). The different elevations of this design here given are on too small a scale to be adequately judged of by a general observer; but whoever has paid a moderate degree of attention to architectural lines and forms will foresee the good effect of the ranges of arcades and pillars, the far-projecting roofs, and the general symmetry and regularity, as far as the requisite attention to fitness for the end in view will admit. We regret we cannot render justice to the author of this design by mentioning his name, and we have even forgotten whether we copied it from the *General Report of the Agricultural State of Scotland; The Husbandry of Scotland; Loch's Improvements of the Marquess of Stafford;* or one of the *County Reports.*

2957. An example of *a very complete farmery, with a threshing-machine driven by steam, to be farmed by a bailiff for the proprietor*, we give that of the Dayhouse in Staffordshire. (*fig.* 450.) The lands contain nearly 500 acres of mixed soil, and the buildings, besides

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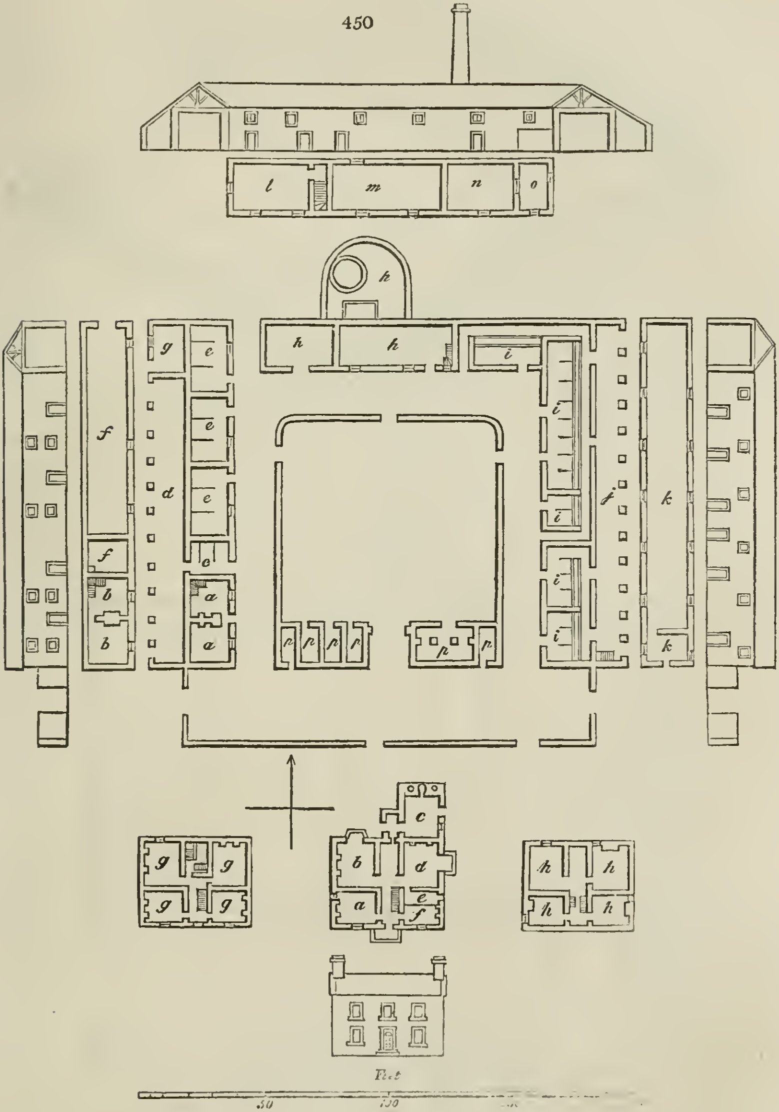

the bailiff's house, which consists of a parlour (*a*), family room (*b*), brewhouse (*c*), kitchen (*d*), pantry (*e*), milk-house (*f*), bedrooms (*g*), attics (*h*).

2958. *The farmery* contains the following accommodations. Men-servants' day-rooms (*a*); sleeping ditto, above (*b*); hackney stable (*c*); shed for implements (*d*); cart-horse stables (*e*); hay-loft (*f*); tool-house (*g*); barn and steam-engine (*h*); feeding and cow-tyings (*i*); turnip-house (*j*); great granary and hay-room (*k*), which room is used for the annual agricultural dinner given by Lord Stafford; small granary (*l*); corn-loft (*m*); straw-lofts (*n*, *o*); pigsties, and hen-houses over (*p*).

2959. *Waistell's farm-house and outbuildings of the largest dimensions* (*figs.* 451, 452.) exhibit a very complete arrangement, and his mode of giving isometrical perspective

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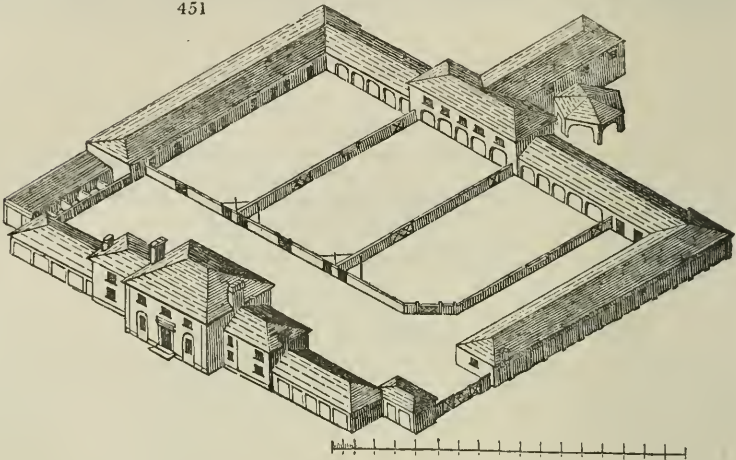

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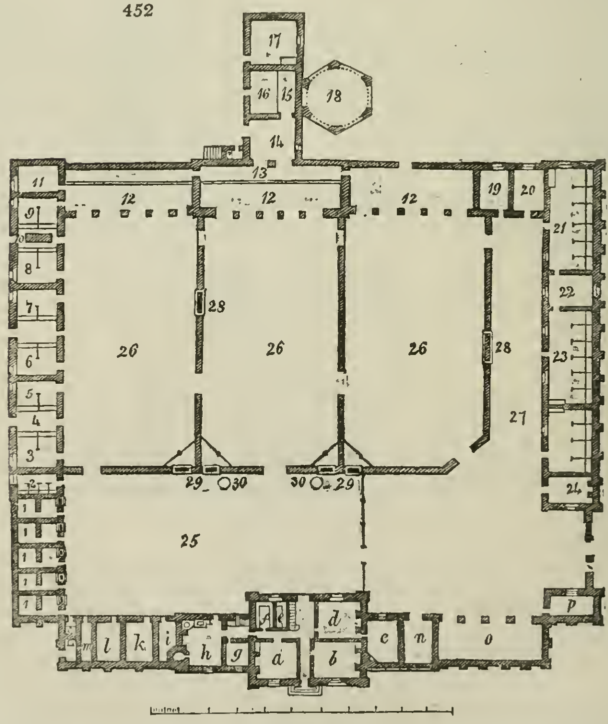

views of such buildings ought to be adopted by every architect (see Chap. III. Subsect. 3.). The farm-house of this design contains a kitchen (*a*), parlour (*b*), business-room (*c*), living-room (*d*), pantry (*e*), dairy (*f*), store-room (*g*), and brewhouse (*h*). Adjoining are a place for hogs' food (*i*), for wood (*k*), for coals (*l*), for dust and ashes (*m*); a chaise-house (*n*), cart-lodge (*o*), and tool-house (*p*). The west side of the quadrangle contains five pigmies (1), a calf-house (2), bay for four cattle (3), store and foddering-bay (4), bay for four cattle (5), the same bays repeated (6, 7, 8, 9); a place for a cistern for washing turnips (10), a bull-house (11), cattle-sheds (12), a gangway from the straw-room (13), straw-room (14), threshing-machine (15), clean corn room (16), unthreshed corn (17), horse-track (18), loose box (19), chaff and hay room (20), stable for six horses (21), harness-room (22), another stable for six horses (23), saddle-room (24). In the open area are, the horse court-yard (25), three fold-yards (26), the stable-court (27), two cisterns for the fold-yard (28), four hogs'-courts, with feeding cisterns (29), and two tanks for hogwash (30). " On the east side of this design is supposed to be a road, from which there is an entrance to a garden in the front of the house ; and from this road a gate is also supposed to open into the rick-yard, which is at the back of the cattle-shed, and north end of the barn ; through this, to the houses on the west side, pass the carts with turnips and other provender for the cattle."

Chap. IV.

Fences used in Agriculture.

2960. *Fences,* next to implements, machinery, and suitable buildings, are in most situations " indispensable to the profitable management of arable land. They are not only necessary to protect the crops from the live stock of the farm, but often contribute, in no small degree, by the shelter they afford, to augment and improve the produce itself. On all arable farms, on which cattle and sheep are pastured, the ease, security, and comfort, which good fences give, both to the owner and the animals themselves, are too evident to require particular notice. And as there are few tracts so rich as to admit of crops being carried off the land for a succession of years, without the intervention of green crops consumed where they grow, fences, of some description or other, can very rarely be dispensed with, even in the most fertile and highly improved districts." The same able author complains of the general mismanagement of this branch of husbandry, by which means fences not only often become comparatively useless, but even injurious by the space they occupy and the weeds they shelter. This, he says, " is particularly the case with thorn hedges, which are too often planted in soils where they can never, by any management, be expected to become a sufficient fence ; and which, even when planted on suitable soils, are in many cases so much neglected when young, as ever afterwards to be a nuisance, instead of being an ornamental, permanent, and impenetrable barrier, which with proper training they might have formed in a few years." (*Sup. Encyc. Brit.* art. *Agr.*) Fences may be considered in regard to their emplacement or situation, and their form or kind.

Sect. I. *Situation or Emplacement of Fences.*

2961. *The emplacement or disposition of fences* on a farm or an estate will depend on the purposes for which they are made. In laying out an estate, their disposition will depend on the natural surface and situation of roads ; water-courses ; on the lands to be planted with trees ; and on a variety of other considerations which will come under review in the succeeding part of this work. The situation of fences on a farm depends on a great variety of circumstances, as the extent of the farm ; its climate ; whether pasture, arable, or mixed ; on the inequalities of the surface ; on the nature of the soil ; on the supply of water ; and on the course of husbandry to be followed.

2962. In determining the *subdivisions of an arable farm,* the excellent author above quoted observes, " whatever may be the kind of fence which it is thought advisable to adopt, we would recommend that particular attention be paid to the course of crops which the quality of the soil points out as the most advantageous ; and that upon all farms, not below a medium size, there should be twice the number of enclosures that there are divisions or breaks in the course. Thus, if a six years' rotation be thought the most profitable, there should be twelve enclosures, two of which are always under the same crop. One very obvious advantage in this arrangement is, that it tends greatly to equalise labour, and, with a little attention, may contribute much to equalise the produce also. On large farms, where all the land under turnips and clover, for instance, is near the extremity of the grounds, or at a considerable distance from the buildings, supposed to be set down near the centre, it is clear that the labour of supplying the house and straw-yard stock with these crops, as well as the carriage of the manure to the field, is much greater than if the fields were so arranged as that the half of each of these crops should be nearer the offices : but by means of two fields for each crop in the rotation, it is quite easy to connect together one field near the houses with another at a distance, and thus to have a supply at hand for the home stock, while the distant crops may be consumed on the ground. The same equalisation of labour must be perceived in the cultivation of the corn-fields, and in harvesting the crops. The time lost in travelling to some of the fields, when working by the plough, is of itself a matter of some consequence on large farms. But the advantages of this arrangement are not confined to the equalisation and economy of labour; it may also, in a great measure, render the annual produce uniform and equable, notwithstanding a considerable diversity in the quality of the soil. A field of an inferior soil may be connected with one that is naturally rich; and in the consumption of the green crops, as well as in the allowance of manure, the poor land may be gradually brought nearer, in the quantity and quality of its produce, to the rich, without any injury to the latter. Thus a field under turnips may be so fertile that it would be destructive to the succeeding corn crops to consume the whole or the greater part on the ground; while another may be naturally so poor, or so deficient in tenacity, as to make it inexpedient to spare any part for consumption elsewhere. By connecting these two under the same crop, by carrying from the one what turnips are wanted for the feeding-houses and straw-yards, and eating the whole crop of the other on the ground with sheep, the ensuing crop of corn will not be over-luxuriant in growth on the former, while the latter will seldom fail to yield abundantly. The same plan will also be advantageous in the case of other crops. Hay or green clover may be taken from the richer field, and the poorer one depastured; and on the one wheat may succeed both turnips and clover, while the more gentle crops of barley and oats are appropriated to the less fertile field. These observations are particularly applicable to turnip soils, of such a quality as not to require more than one year's pasturage, and which are therefore cultivated with corn and green crops alternately; but the same principle may be extended to clay lands, and such as require to be depastured two or more years in succession.

2963. *Where hedges are employed as fences*, it is of importance that the ditches be drawn in such a direction as to serve the purposes of drains, and also that they may receive the water from the covered drains that may be required in the fields contiguous. According to the greater or less convenience of the line of the fence in this respect, the expense of draining may be considerably diminished or increased.

Sect. II. *Different Kinds of Fences.*

2964. *Fences, in regard to kind*, may be arranged as live fences, dead fences, and mixed kinds; but there are four elementary species which are the foundation of all the others; the hedge, the ditch, the wall, and the paling. The hedge, when formed of the whitethorn or blackthorn, of the plum or crab, or of the holly, is the cheapest, most durable, and the handsomest of all fences on a good deep soil: the ditch is the best on low, flat, wet lands requiring much drainage; the wall is the best for farming purposes in almost all cases whatever; and the paling, whether fixed or temporary (as of hurdles), is the most convenient as a nurse-fence to hedges for immediate or temporary use, and for fencing in parks and scenery where an air of lightness and freedom is a desirable object. From these simple or fundamental fences, a variety of compound ones may be formed. We shall consider them in the order of ditch or drain fences, hedge fences, compound hedge fences, paling fences, and wall fences.

Subsect. 1. *Ditch or Drain Fences.*

2965. *Ditch fences*, in their simple and original state, were considered rather in the light of open drains than as fences. In a variety of instances, ditches are made for this purpose only, where there is no intention whatever to enclose the field. They are, however, sometimes meant as a fence, but, in such cases, they are made very deep and wide; and the earth taken out of them is sometimes formed into a bank, the height of which, when added to the depth of the ditch, forms a tolerable barrier. In general, however, the ditch is of greatest value when used in conjunction with other fences.

2966. *The form of ditches* is various: some of them being of a uniform width both at top and bottom; others are wide above, and have a gradual slope downwards; a third kind have one side sloping and the other perpendicular. For whatever purpose the ditch is meant, the sloping form is by much the best; as it not only costs less money in the digging, but is at the same time much more durable, and has a neater appearance. Where open ditches are indispensably necessary for the drainage of the field, the sloping ditch is preferable to every other, as the sides are not liable to tumble in, or be undermined or excavated by the current of water, when properly executed. The slope should be considerable: perhaps never less than three, nor more than six, times the width at top that it is at bottom.

2967. *The simple ditch, with a bank of earth*, consists merely of a ditch sloping gradually towards the bottom; the earth taken out of it being formed into a bank on one side, leaving a scarcement, or projecting space, of six or eight inches, on the side where the bank is formed, to prevent the earth from tumbling in and filling up the ditch.

2968. *The bank of earth, with an upright facing of turves, and a slope behind*, is a very common sort of fence, and in some situations extremely useful; in making folds, for instance, for the confinement of sheep or cattle. It is also valuable on the sides of highways, for defending the adjoining grounds, and for laying off clumps or belts of planting in the middle or corners of arable fields, for enclosing stack-yards, cottages, gardens, &c. The front of the bank is made of a very steep slope with the turf pared off from the surface of the sloping ditch, and the mound at the back with the earth taken out of it.

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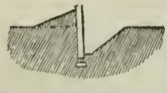

2969. *The ha-ha, or sunk fence*, is calculated chiefly for fields that require no shelter, and where a uniform unbroken prospect is an object, as is the case in gardens and extensive lawns; but in all situations where shelter is wanted, the sunk fence ought to be avoided, unless a hedge is planted upon the top of it. Sometimes a medium between the sunk and raised fence (*fig.* 453.) is adopted, which makes both a durable and unobtrusive barrier.

2970. *The double ditch, with a bank between* (*fig.* 454), is not often used, unless in cases where it is meant either to plant hedges or trees on the bank between the ditches. Considered as a fence, either with or without a hedge, it has an advantage over the single ditch, as the earth taken out of the two ditches, when properly laid up, will form a bank of a somewhat formidable appearance, which cattle will not very readily attempt to break over. For the purposes of open drainage it is well adapted, especially by the sides of highways, where the lands have a considerable declivity towards the road; the ditch next the field, by receiving the water on that side, prevents it from overflowing and washing the road,—a circumstance which very frequently happens in such situations; while the ditch on the side next the road, by receiving and carrying off the moisture that falls upon it, and which would otherwise lodge there and destroy it, keeps it constantly dry and in good repair. Where double ditches are made in the immediate vicinity of high grounds, or on the sides of highways, care should be taken to prevent the water from the furrows or side drains from running into the main ditch at right angles. Where this is neglected, much trouble and inconvenience arise; as when the water comes from a height, during heavy rains, in a straight line into the ditch, it presses with accelerated force against the sides of it; and if the soil is of a loose incoherent nature, the bank will be undermined and washed away in many places. To prevent this, nothing more is requisite than to alter the direction of the furrows, or small side ditches, at a few yards' distance from their opening into the main ditch.

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2971. *The double ditch and hedge* is now general in many parts of Britain, especially upon what are termed cold lands; from an idea, that a single row of plants would not grow sufficiently strong or thick to form a proper fence. The advocates for this fence farther allege, that in addition to the two rows of plants forming a more sufficient fence, an opportunity is afforded of planting a row or rows of trees on the middle of the bank. (*fig.* 455.) This fence is liable to many objections: the expense of forming the ditches, the hedge-plants made use of, and the ground occupied thereby being double what is requisite in a single ditch and hedge. From twelve to eighteen or twenty feet is the least that is required for a double ditch and hedge: this space, in the circumference of a large field, is so considerable, that upon a farm of 500 acres, divided into fifteen enclosures, the fences alone would occupy above forty acres. By throwing up a bank in the middle, the whole of the nourishment, not only of both hedges, but also of the row of trees, is confined solely to that space, which, from its being insulated by the ditches, and elevated so much above the common surface, not only curtails the nourishment of the hedges and row of trees, but exposes them to all the injuries arising from drought, frost, &c. The idea of two rows of plants making a better fence than one is certainly no good reason for such an unnecessary waste of land and money; as, in almost every instance, where the plants are properly adapted to the soil and climate, one row will be found quite sufficient; but, if it should be preferred to have two rows, the purpose will be answered equally well with a single ditch, or even without a ditch at all.

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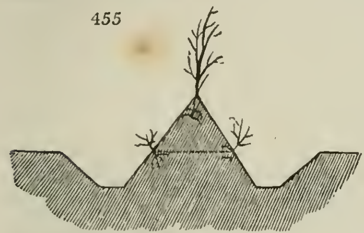

Subsect. 2. *Hedge Fences.*

2972. *Hedge fences* are of two kinds; either such as are made up of dead materials, or such as are formed of living plants of some sort or other.

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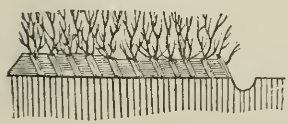

2973. *Dead hedges* (*fig.* 456.) are made with the prunings of trees, or the tops of old thorn or other hedges that have been cut down; and are principally intended for temporary purposes, such as the protection of young hedges till they have acquired a sufficient degree of strength to render them fencible without any other assistance. For this purpose the dead hedge is well adapted, and lasts so long as to enable the live fence to grow up and complete the enclosure. In many cases, however, dead hedges are had recourse to as the sole fence, and where there is no intention of planting quicks, or any other hedge. From their very perishable, nature, however, they are found to be exceedingly expensive; so much so, indeed, that, after the first or second year, they cannot be kept in repair at a less expense than from a fifth to a tenth part of the value of the land, and sometimes more. When dead hedges are meant for the protection of young live fences, if the quick fence is planted upon the common surface, the dead hedge is made in a trench or furrow immediately behind it, in such a way as to prevent the sheep or cattle grazing in the enclosed field from injuring it. Where the quick fence, however, is planted upon the side of a ditch, the dead hedge is for the most part made on the top of the mound formed by the earth taken out of the ditch: these are called plain dead hedges, being made by cutting the thorns or brush-wood, of which they consist, into certain lengths, and putting them into the earth. We call them plain, in opposition to other descriptions of dead hedges where more art is used; such as the dead hedge with upright stakes wattled, and the common plaited hedge bound together at the top with willows.

2974. *A dead hedge is made in the following manner*:—"A hedger and an assistant are necessary for this business. The man cuts the stems of the thorns about three feet long, with the cutting-bill or axe, as their strength may require, and he lays one cut piece above another, to form a bundle, taking care to add some of the small twigs to each bundle to thicken their appearance; and he then compresses the whole with his foot, so that the bundle may stick together. He thus makes and prepares several bundles in readiness. The hedger takes his spade, and, fixing on the part which the line of dead hedge is to occupy, he turns up a spadeful of the earth, as whole as possible, as if he were digging a piece of ground of the breadth of the spade. After he has laid this spadeful of earth, so as a bundle of thorns may lean against it in an inclining position, the man hands him one of the bundles over the breasted hedge with a fork. The butt-end of the bundle goes into the spade-furrow, and leans from him against the spadeful which he has placed. The hedger then lifts another spadeful, and places it upon the root of the bundle, and presses it firmly down with his foot, which should be fortified with a clog. He suits the inclination of the dead fence to the quarter whence the heaviest winds prevail, as is invariably done in choosing the position of the stake and rise. In this manner they proceed to form the whole line of dead hedge. As the fence proceeds, the hedger cuts all twigs that have a straggling appearance, with the bill, towards the fence, to give a neatness and finish to the work. This sort of dead hedge may be placed behind the thorns of a newly planted hedge, much nearer than a paling, as from the breadth of its top, and the sharpness of its spines, no beast can with impunity reach over it, to bite the twigs of the young hedge." (*Quar. Jour. Agr.* vol. i. p. 618.)

2975. *In respect to live hedges*, they are made either entirely with one kind of plants, or a mixture of different kinds; and for that purpose almost every tree or shrub known in Britain is either wholly or in part employed. The success of every attempt made to rear good fences will be found ultimately to depend on the plants being suited to the soil and climate, the preparation of the soil, the time and mode of planting, the age of the plants, their size, the dressing or pruning of the tops and roots before planting, weeding, hoeing, pruning, and after-management.

2976. *The proper choice of hedge plants* is of the first importance. Many failures in this part of the business might be enumerated; especially in the more elevated situations, where great labour and expense have been employed to raise hedges of hawthorn, which, after many years' care and attention, were found totally unfit for such inclement regions. In such situations, experience has now sufficiently proved that good fences can be reared in a short time with beech, birch, larch, and the Huntingdon willow: hedges of these kinds ought, therefore, to be the only ones used in hilly countries, or upon cold wet soils; the first three upon the dry soils, and the last, with the addition of poplars, upon such as are wet or marshy. In the low country, however, and in the less elevated parts of the uplands, the whitethorn will be found the best upon all the dry, or moderately dry, parts of the soil; especially the different kinds of loamy, sandy, or gravelly lands: upon cold wet-bottomed soils, however, beech, crab, birch, poplar, willow, and alder, may be used with advantage. The birch, poplar, alder, and Huntingdon willow, are peculiarly calculated for the coldest, wettest, and most marshy parts; while beech, crab, &c. will be found to answer best upon the stiff clays. Hazel, sweet-briar, mountain-ash, and indeed all the kinds of forest-trees that are at present known to delight in dry soils, may also be successfully employed for making hedges in the low lands; but whichever of these is used, it should, if possible, be without mixture. It is seldom that any soil, however good, will be found equally favourable to the growth of plants opposite in their natures; this circumstance alone will render their growth unequal, and of course make the fence faulty and defective. These defects in the fence, and inequalities in the growth of the plants, will increase with time, become every day more apparent, and be every day more sensibly felt; as the plants which have thus acquired the ascendancy will continue to keep it, and not only shade the weaker ones, and prevent them from enjoying the influence of the sun and air, but also deprive them of nourishment. Independently of these considerations, there is another, it is observed, of equal, perhaps greater, moment, that requires to be mentioned; allowing the soil to be equally favourable to the growth of the whole plants of which the mixture consists, there are certain plants which are highly inimical to the growth of others, when planted in their immediate vicinity; ivy and honeysuckle, for instance, when mixed with thorns, or other plants in a hedge, never fail to destroy such of the hedge-plants as they fasten upon; indeed moss, which is known to be one of the worst enemies to all hedges, is not more dangerous nor more certainly ruinous: even the different kinds of sweet-briar, virgin's bower, brambles, briony, cleavers, &c. have the same effect; and in the end never fail to produce a gap in that part of the hedge where they grow, by smothering the other plants. In general the common hawthorn (*Cratæ*gus *O*xyacántha) is the best British, and we might even say European, hedge plant. The black or sloe thorn (*P*rùnus spinòsa) is perhaps next in excellence, as far as the strength and durability of the fence is concerned; but unfortunately it throws up suckers in such abundance, as to encroach rapidly on the adjoining surface. The common hawthorn, like all plants raised from seed, produces innumerable varieties: some of these are much more abundantly furnished with prickles, and some grow much faster than others; and it might be desirable to save the seeds of fast-growing prickly individuals in preference to those of such as are less prickly or of slower growth. The smoothest, however, may be considered prickly enough for all ordinary purposes. Like all the ligneous plants of the natural order to which it belongs (*R*osàceæ), the thorn grows readily from cuttings of the roots.

2977. *The preparation of the soil for hedges* is one of those points intimately connected with, and, indeed, essential to their success. Except in a very few instances, however poor the soil may be, or however strong the cohesion of its parts, no attempt is made either to break that cohesion by tillage, or improve its quality by enriching or alterative manures: the young plants being for the most part laid upon the old surface, which has perhaps never been opened by the labour of man, and their roots covered with the earth taken out of the ditch, consisting very often of the poorest and coldest clay, or of earths loaded with iron or other metallic impregnations. To those who have considered the matter with the smallest attention, the fate of such a hedge will not appear doubtful: the surface upon which the plants are laid will be so hard and impervious to the roots, as to preclude the possibility of their penetrating it; of course, their only chance of either extending themselves, or procuring nourishment, is by spreading out between the surface and the mound made by the earth taken out of the ditch, or by striking up into the mound, where, though the soil will be sufficiently open to admit of this, the roots, in place of finding an establishment in a situation friendly to their growth, will very often be either starved or poisoned.

2978. With respect to *the age at which hedge plants ought to be used,* it is very common, especially where young hedges are made with thorns, to plant them of one, two, or three years old, seldom exceeding this last age. Plants of this description, when put into the earth at a proper season of the year, upon land well prepared, if they are afterwards carefully kept clean, and the earth soft and loose, by regular weeding and digging, seldom fail to make good fences; such young plants, however, are, it is observed, long in a state of infancy, and require great nursing and the most complete protection to bring them to perfection, and are liable to be either much hurt or totally destroyed by many accidents that would produce little or no effect upon older and stronger plants. Much time might be saved in the rearing of hedges, and the fences be much more perfect and useful, if older plants were employed for that purpose. Three years old is certainly the youngest that should be planted, and if they are even six or seven years old, so much the better: the prevailing idea that plants of that age will not thrive if transplanted, is totally unfounded. Thorns of six or seven years old, in place of being no thicker than a common straw, will be at a medium more than an inch in circumference: we leave those who are judges to determine how far a plant of this last description will be superior to one of two years old, and how much sooner it will answer the purposes of a fence.

2979. *In respect to the size of thorns or other hedge plants,* it may be necessary to observe, that, when the plants are once obtained, they should be separated into sorts, according to their size and apparent strength, picking out the largest first, and so on downwards. This will be attended with several very material advantages, which those who have made observations on the subject will very readily understand. Plants of the same size and strength, when planted together, keep pace with each other; no one of them takes from the earth more than its own share of nourishment, of course the growth of the whole is regular and uniform; and the hedge, when arrived at a certain age, becomes a substantial efficient fence, of an equal height throughout, and free from gaps: whereas, when no pains have been taken in assorting the plants, and they are planted promiscuously, great and small, strong and weak, the consequence is, that the strongest plants very soon outgrow such as are weaker, and not only overtop them, but also deprive them of that nourishment which they so much require; as the hedge advances in age, the evil becomes greater, innumerable gaps appearing throughout the whole line of the fence, and small stunted plants interspersed with others remarkable for their strength and luxuriance.

2980. *This assorting of hedge plants* has a farther advantage; namely, that of putting it in the power of the person who plants the hedge to put down the large, strong, healthy plants upon the poorest part of the line of the fence, and to set such as are smaller and weaker upon the richer and more fertile parts. He has it also in his power, by a more careful preparation of the soil, and bestowing a greater proportion of manure upon the spaces where the small plants are set, to give them that nourishment and assistance which they require, and which would very soon enable them to form a fence equal to the part occupied by the strongest plants.

2981. In regard to *the dressing and pruning of hedge plants before they are put into the earth,* there is perhaps no part of the system of managing them, or forest trees, more hurtful and defective than that now pursued in the common nurseries. It is a very common practice with nurserymen, in the spring, when they wish to clear their ground for other purposes, to take up great quantities of thorns and other hedge plants, and after pruning the tops, and cutting off nearly the whole of the roots, to tie them up in bundles, and lay these bundles in heaps till they are called for. In this mutilated state they often remain for many weeks, with the mangled roots naked and unprotected, exposed to every inclemency of the weather, before they are sold. In place of this treatment, the defects of which are so obvious, and the consequences resulting from it so hurtful, no hedge plants should be lifted out of the nursery-ground till the day, or at most a few days, before that on which they are to be replanted; and in place of the severe pruning and dressing already mentioned, every root, even to the smallest fibre, should be carefully preserved, and the use of the knife confined entirely to the necessary curtailing of the tops. Where this care is taken, and the plants are put into the ground at a proper season, they will suffer no kind of check, and when the spring arrives will grow luxuriantly and with vigour.

2982. *In the after-management of the hedge,* complete weeding, loosening, and laying new earth to the roots, for the first three or four years, are indispensable requisites: for whatever pains may have been previously taken in dunging and summer-fallowing the soil, unless it be properly attended to and kept clean afterwards, this dunging and summer-fallow, in place of being useful, will prove hurtful to the fence; as the manure and tillage, by enriching and opening the soil, will encourage and promote the growth of weeds; which, under such peculiarly fortunate circumstances, will become so luxuriant as either to destroy the hedge, or materially injure its growth, unless they be kept down by frequent and complete cleanings. In loosening the earth about the roots of hedges, whether old or young, it will be of advantage, if there is soil enough to lay up a few inches of it to the roots; this frequently done, encourages them to push out branches near the bottom, which prevent them from growing thin and open,—a fault to which, if due pains are not taken, almost all hedges are liable.

2983. *On the pruning and after-management of hedges* will depend a very considerable part of their beauty and future value. There is, perhaps, no part of the subject upon which a greater contrariety of opinion at present prevails, than the age at which the pruning of hedges ought to commence, the manner of that pruning, or the season of the year at which it may be given with the greatest possible advantage and the least risk : the practice with some is, to prune, from the first year, not only the lateral branches, but the tops also ; they give as a reason, that cutting off the extremities of the shoots contributes to the thickening of the hedge, by making them push out a great number of new ones. The fallacy of this argument, and the mischief with which the practice is attended, we shall afterwards have occasion to notice. As to the manner of pruning, and the form of the hedge, these seem, with many, to be matters of indifference ; no attention being paid to dressing them in such a way as to have them broad at bottom, and tapering gradually towards the top : many of them being of one width from top to bottom, and not a few much heavier and broader above than they are below, it is obvious that such hedges can neither look well nor be useful.

2984. *The season at which they are trimmed* is in many instances an improper one; for, in place of choosing the time when the plants are least in danger of suffering from an effusion of their juices, which is either at a late period in the autumn, very early in the spring, or about midsummer, the pruning is given late in the spring season, when the sap is flowing : the check and injury they must receive from having the whole of their extremities cut off at this period may easily be conceived. In speaking of the treatment of hedge plants before they are put into the ground, notice has been taken of the necessity of preserving the roots as much as possible, and at the same time shortening the tops : the latter operation has two good effects ; by curtailing the top and branches, the roots have less to nourish ; and by leaving only two or three inches of the top above ground, in place of growing up with a single stem, it sends out two or three ; and as these strike out from the plant so near the earth, each of them has the same effect, and strengthens the hedge as much as the original stem would have done by itself, with this addition, that, in place of one prop or support, the hedge will have three or four.

2985. *After this first pruning*, however, no hedge should be touched, or at least very gently, for some years : from inattention to this circumstance, and from the injudicious application of the knife or shears at an early period, many young hedges are rendered useless, which, under different treatment would have made excellent fences, with half the trouble required to destroy them. The practice of cutting over the tops yearly, which is done with a view to render the hedge thicker and more perfect, is one of those mistakes which we would naturally have supposed common sense and observation would have sooner corrected ; the effect produced being, in almost every instance, the very reverse of what was intended. Shortening the main stem of a thorn or any other plant makes it throw out a number of small stems immediately at the place where it has been cut ; and if this operation is repeated once or twice a year, every one of these is again subdivided, as it were, by sending out more branches : thus in a course of years, during which the hedge makes very small progress upwards, if it be examined, instead of being found to consist of strong vigorous plants, with a good main trunk, each reaching from top to bottom of the hedge, and a sufficient number of lateral branches throughout the whole length of it, it will be found, by such repeated cuttings, in the same stunted situation as certain young trees and shrubs that are frequently cropped by sheep or cattle. From the repeated crops of young shoots which the tops send out after every clipping, and the great quantity of nourishment necessary to support such additional numbers, the lateral shoots at the bottom, upon the strength and number of which the value of the hedge in a great measure depends, are stinted in their growth, and soon die ; the hedge, of course, becomes open and naked at the bottom, and consequently useless as a fence.

2986. *From the first year of planting, till the hedge has risen to the heighth of five or six feet*, the main stems ought to be left untouched, and the pruning confined solely to the side branches, leaving those next the root pretty long, and gradually tapering towards the top : this pruning of the side branches will make them send out many new shoots from their extremities, which, by repeated trimmings, will become so thick as to fill up every interstice from top to bottom of the hedge ; while the main stems, by being left untouched, continue their growth upward, till they arrive at the necessary height, when they may have their extremities cut off with perfect safety. When a hedge has attained the wished-for height, all that is requisite afterwards is cutting the sides regular with a hedge-bill, preserving it pretty broad at bottom, and drawing it gradually to a point at top ; this form of a hedge is pleasant to the eye, is well calculated to stand the weather, and becomes every year stronger and thicker. A hedge of this sort in full leaf has the appearance of a solid wall ; and, when viewed after the leaves are shed, presents to the eye a set of massy growing piles, so strong and formidable as to bid defiance to any attempts that may be made to break through them.

2987. In the *management of old hedges*, the above directions and observations apply, with strict propriety, only to such as have been regularly attended to from the time of their being planted ; as there are, however, innumerable hedges in the kingdom, which, by being neglected, have grown up to a great height, have become open and naked below, and bushy and unmanageable at top, it is of consequence to point out the means of reducing such hedges to a moderate scale, and rendering them useful. This purpose can only be effected *by cutting them down*, and procuring from their stumps a growth of new shoots, which, with proper management, will soon make a perfect fence. If the fields enclosed by such hedges are alternately in pasture and tillage, the period most proper for cutting them down is when the field is to be ploughed. Under a corn-crop, the confinement of the stock is no longer an object; and by the time the field is again brought under pasture, the hedge, if properly treated, will have acquired strength enough to become a good fence. This operation is performed in several ways.

2988. *In the first method of cutting over old hedges,* the plants are cut over about a yard above the surface (*fig.* 457.), and the hedge is left in that state without any other pains being taken with it; if it has originally been good, and the plants thick enough at bottom, this kind of cutting will answer the purpose perfectly well, and in a few years the hedge will, with proper dressing, become both a neat and a useful fence. But in this mode, when there has been a deficiency of plants, and the hedge is cut over in the manner above mentioned, innumerable gaps will appear, which, without some art, it will be impossible to fill up. It has also this farther disadvantage, that if either horses or cattle attempt to leap into, or out of, the enclosure, the sharp points of the stakes are apt to run into their bellies; this accordingly often happens, and many valuable horses and cattle are killed or greatly injured by such means.

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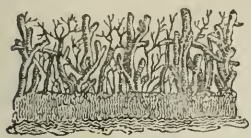

2989. *A preferable mode of cutting down old hedges is,* to cut a fourth part of the plants over, to the height which the fence is intended to be made; another fourth about six inches high; and to bend down and warp the remainder with the upright stems. (*fig.* 458.) This method very effectually cures the gaps and openness below, and with slight attention soon makes a good fence.

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2990. *A third way of cutting over old hedges* is that of cutting them close by the surface: this practice, when the plants are numerous, and there are no gaps in the hedge, answers very well; but when there is a deficiency of plants in any part of the hedge, the want will be very apparent. This last mode, though much inferior to the one immediately preceding, is nevertheless greatly preferable to that first described, as the young shoots sent out from the stumps, by being so near the ground, will in some measure remedy the defects occasioned by the want of original plants; whereas, when the old plants are cut at the distance of about a yard or four feet above the surface, the young shoots produced by the cutting will be so high, as to leave the hedge open at the bottom.

2991. *The last method of cutting down old hedges,* and which is yet but very little practised, is first to cut them down even with the surface, and afterwards to cover the stumps completely over, with the earth taken out of the ditch, or from the road-side. When this is carefully done, it is asserted that every single stump sends out a great number of young vigorous shoots, each of which, by branching out from below the surface, sends out roots, and acquires an establishment for itself; by this means the bottom of the hedge becomes so thick, that neither sheep, cattle, nor indeed any animal, can break through it.

2992. *In whichever of these ways the hedge is cut down,* the directions formerly given for the management of *young* hedges should be strictly attended to. As soon as the young shoots have made some progress, the side branches should be trimmed, and the hedge put into a proper shape, preserving it broad and full at bottom, and tapering gradually towards the top. The same caution is also to be observed with regard to the upright shoots, none of which should be shortened till the hedge has attained the wished-for height. It is surprising what close beautiful fences are raised in this way in a few years, from the stumps of some overgrown useless hedges; which, at the same time with their being naked below, and of course faulty as fences, occupied four times the space they ought to have done, to the great loss both of the proprietor and farmer.

2993. *Filling up gaps in hedges.* When *young hedges* are planted, if the plants made use of are of a nature suited to the soil, the hedge may be kept free from gaps with very little trouble; for that purpose it is, however, necessary, about the end of the first autumn after the hedge has been planted, to examine it carefully throughout its whole extent, take out such plants as are either in a decaying sickly state or those that are actually dead, and fill up the spaces they occupied with the strongest and most vigorous ones that can be found: where this care is taken for the first two or three years, there will be no defects in the hedge, which will be uniformly thick and strong throughout. Thus far of young hedges; but when *old hedges* are meant to be cut down, that have many gaps or open spaces in them, so wide as to prevent the possibility of the young shoots filling them up, some expedient must be had recourse to, in order to render the fence complete. This purpose may be answered in different ways; the easiest and indeed the most common method is, for the hedger, when he comes to a place where any of the plants are wanting, to take one of the strongest plants next to it, and after giving it a gentle stroke with the hedge-bill, to bend it across the opening, and entwine it with the thorns on the opposite side; indeed, as has been already stated, some have a custom of cutting down only a fourth part of the stems, and warping the remainder with these, which appear like stakes driven into the earth. Where the hedge is shortened to within three or four feet of the ground, both of these methods answer pretty well, and the openings, which would otherwise have been left, are in some degree filled up; but when the old hedge is cut close to the earth, other methods of supplying the defects become necessary. One very simple, and at the same time very effectual mode is, first to dig the ground pretty deep with a spade, and afterwards to take two of the strongest plants purposely left uncut, one from each side of the opening, and removing the earth from their roots so as to loosen them and admit of their being bent down, to lay them close to the earth in the opening; they should then be fastened down with wooden hooks or pins, and entirely covered throughout the whole of their length with earth. Where this is properly executed, the plants so laid down send up a great number of young shoots, which very soon fill up the vacancy: where it is practised upon a hedge that is cut over close by the surface, no other care is requisite; but when it is done with hedges that are cut at three or four feet above it, there will be a necessity for placing a temporary paling in the gap, to protect the young shoots from injury till they acquire a sufficient degree of strength. In cases of emergency the stronger roots of thorns and crabs will, if their extremities are brought up to the surface and then cut over an inch above it, throw up vigorous shoots and fill up gaps.

2994. *To mend the defects of an old hedge* with success, two things are absolutely necessary: the first is, that the whole of the roots of the old plants, which extend themselves into the opening, be entirely cut off; the next, that the hedge shall be cut down close to the earth, for at least a yard or more on each side of it. By cutting away the roots which extend themselves into the opening, the young plants are prevented from being robbed of their nourishment; and cutting down the old ones, for a little distance on each side, keeps them from being shaded, and allows them to enjoy the full benefit of the light and air: cutting down so much of the old hedge, no doubt, renders the opening larger, and of course requires more paling to supply the defect; but this extra expense will be more than compensated by the success with which it will be attended. In many instances, these vacancies are filled up with dead wood; indeed it is a common practice, after a hedge is dressed, to cram the greatest part of the prunings into these spaces, and under the bottom of the hedge, where it is any way open or naked. The most perverse imagination could hardly suppose any thing more absurd; for, if it is the wish of the owner that the plants on each side should send out new branches to fill up the openings, the purpose is completely defeated by cramming them full of dead brush-wood, which not only excludes light and air, and prevents the extension of the branches, but, from the violence and injury that is committed in thrusting in dead thorns, the plants are often materially hurt; and when this brush-wood decays, the opening, in place of being diminished, is considerably enlarged: the mischief is the same where they are thrust under the hedge, — a practice which, when continued, never fails to render it naked at bottom. The use of stones for mending hedges is equally absurd and pernicious.

2995. *In every operation of this kind,* where old hedges are either cut over or bent down, the ground on each side, as soon as circumstances will admit of it, should be completely dug, cleared of weeds, and the earth laid up to the roots of the plants. It is surprising what numerous and luxuriant shoots the stumps send out, when managed in this way: while, on the contrary, when these necessary operations are neglected, fewer shoots proceed from the old trunks; and, of these few, a considerable proportion are choked and destroyed by the weeds and other rubbish in the bottom of the hedge.

Subsect. 3. *Compound Hedge Fences.*

2996. *The single hedge and ditch, with or without paling,* differs a little in different situations: the ditch varies in depth and width; the thorns are for the most part placed upon the common surface, upon what is termed a scarcement, or projection of six or seven inches, on which they lean, and which serves as a kind of bed when they are cleaned, and prevents the earth from the part of the bank above from sliding down into the ditch. Some object to this scarcement, alleging that it increases the difficulty of cleaning the hedge, and increases the growth of weeds; both of which statements are correct: but to counterbalance them, it is alleged, and with truth as far as we have been able to observe, that the scarcement mode retains the soil better about the roots of the plants. It is a practice in some parts of Norfolk, in planting hedges in this way, to coat the face of the bank and the projection with loamy earth from the bottom of the ditch made into puddle. This acts for a year or two like a coat of plaster, and prevents the seeds of weeds, which may be in the soil under it, from germinating. It also retains moisture; but the difficulty is to meet with a clay or loam that, when puddled and thus applied, will not crack with the summer's drought and winter's frost. Some have applied common lime plaster for the same purpose; others road stuff; and some plant in the face of a wall of stones, or bricks, or between tiles.

2997. *Stephens's mode of forming and planting the single hedge and ditch* differs somewhat from the general practice: it is given at length in the *Quarterly Journal of Agriculture;* and as it is most valuable from the minutiæ of its details, and their suitableness to all countries where thorn hedges are grown, we shall here transcribe all its important features.

2998. *Implements.* "Let three poles, made of dry fir to prevent their warping, be provided, of about an inch and a half in diameter, and from eight to ten feet in length. Let one end of them be shod with iron; and let them be painted at top with white and scarlet colours, as these colours are best discriminated by their brightness and contrast in a dull day. Three poles will serve to run any line straight upon a level piece of ground; but as irregularities in the ground will often occur, it will be necessary, in order to surmount them, to have two or three poles more. A strong nail of iron at one end of a stout line at least seventy yards long, and a strong iron pin at the other end of it, will be necessary. A rule of wood six feet long, divided into feet and inches, to measure the breadth of the ditch; and a piece of wood fastened at right angles to one end of it, to serve, when measuring the breadth of the ditch, to mark it off square from the line. A plane-table, by which to set off the lines of hedges parallel to each other, where that is required; and an iron measuring-chain, with which to mark equal lengths on the parallel lines across the fields by which the parallelism of the lines of hedge is determined, and to measure the whole work when executed, will be found very useful. A few painted pins of wood, with hooked heads, to direct the line of the hedge in a curve, must also be provided. Three men equally matched carry on the work to most advantage; and each must be provided with a spade, a hand pick to pick the sides, and a ditcher's shovel (*fig.* 459.), to shovel the bottom of the ditch, and beat the face of the hedge-bank; a foot-pick (*fig.* 460.), to raise the boulder stones that may appear in the sub-soil, will complete the whole implements necessary for the work. The shovel is one foot broad and one foot long, tapering to a point, with a shaft twenty-eight inches long. The foot-pick stands three feet nine inches high. The tramp (*fig.* 460. *a*), which is movable, and can be placed to suit the foot of the workman, is placed about sixteen inches from the point, which tapers, and is inclined forward. The iron is three fourths of an inch at the eye through which the handle passes, and is an inch and a quarter at the tramp where it is stoutest and thickest. The plane-table is useful for squaring the land, when it is to be ridged up. The poles are always used for marking off the breadth of the ridges, and the line and chain will be of service in marking off and measuring drains.

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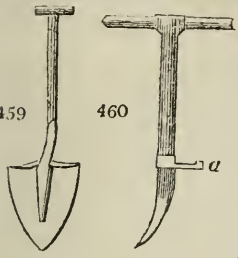

2999. *Plants.* The plant that is universally used for thorn-hedges is the whitethorn, hawthorn, or maythorn (*Cratæ`gus Oxyacántha*). Thorns ought never to be planted in a hedge, till they have been transplanted at least two years from the seed-bed, when they will have generally acquired a girth of one inch, and about fifteen inches of length, the stem from root to branch being about six inches. As thorns are always planted too thick in nursery beds, in order to save room and draw them up quicker, I would advise their being got from the nursery at that age, the year before they are intended to be planted as a fence, and planted out in lines of ample space in any garden or spare piece of ground where the soil is deep and free. By this process the stems will acquire a cleaner bark and greater strength, and the roots will be covered with an additional number of fibres; the constant effect of transplanting being to cause the production of numerous short fibrous roots. The freedom and celerity with which the plants will grow after this preparatory process, will amply repay the additional trouble and expense. But whether they be kept another year in the ground before they are planted or not, they should be immediately loosened out of the bundles of 200, in which they are sent from the nursery, and laid out in rows on the earth, in a convenient dry part of the field, and the earth well heaped about them to prevent the fibres being injured by the frost.

3000. *Preparation of the ground.* It were unreasonable to suppose that hedges will grow luxuriantly, and soon become fences, if the ground on which they are to grow be not previously prepared for their reception. If they are to be planted on land that has been under the usual rotation of cropping on the farm, no further preparation is necessary as to fallowing and cleaning it. If the line of hedge runs along or parallel to the ridges, the best period to commence planting in the rotation, is when the lea-ground is to be broken up for oats, as lea-ground makes the firmest hedge-bank, and no protecting fence will be required on that side till the field is again laid down to grass. But should the line of hedge run across the ridges, at whatever angle to them, the furrows will have to be made up to the level of the crown of the ridges, and the unequal shrinking of the earth in them will cause the beautifully continued line of hedge to be unequally depressed at the furrows; and much trouble, and, of course, expense, will be thereby incurred, in making drains to let off the water in each furrow through the hedge-bank, should the ground slope to the back of it. In such circumstances, I would advise the delay of planting at that time, and to wait till the land is fallowed and laid down again to grass, when the space for the line of hedge can be raised up longitudinally to the breadth required; the ground on each side of this hedge-ridge then forming the head-ridges of their respective fields. The delay thus advised on this particular line of hedge, need not cause any delay in the period of fencing the whole farm; for a line in another field, which is to be broken up from lea, and along the line of which the hedge is to be run, may be taken in the mean time, as it is certainly not essential to the well-being of the hedges, that the fencing of a farm be begun on one side of it, and carried successively through every adjoining field. It is much better to fence a farm by fields which are ready for the work, taken promiscuously, than to run the risk of crossing furrows with a hedge-bank, which, from the nature of ridges, will inevitably intercept surface-water, the injurious effects of which will soon appear upon the growth of the young hedge, in the shape of mildew and fog. Should an old turf-wall, or the site of one, cross a line of hedge, every particle of the old turf must be removed, and fresh earth from the field, or elsewhere, brought in its place; for no kind of treatment will render, for a great length of time, the soil of an old turf-wall congenial to the growth of thorn plants. Indeed, so impressed am I with the truth of this opinion, from sheer experience, that, should the line of hedge coincide with the line of an old turf-wall, I would advise that the line of hedge be bent so much as to avoid it, or, what is better, and better looking, that the whole line of hedge be put so much in advance or arrear of the originally intended line, as to avoid the turf-wall altogether. Whether the sterility of the soil from old turf-walls arises from its excessive dryness and pulverisation, I do not know; but such soil is no sooner manured or limed, than the moles immediately commence their operations, and turn the whole of it inside out. It is known that manure will not combine intimately with soil in such a state, and perhaps its confined heat in the dusty soil may encourage the hatching of the larvæ of insects, in quest of which, as food, the moles, — "that mining race," as Cowper calls them, — set so earnestly to work.

3001. *Division of the line of hedge.* Lines of hedge passing through cultivated land, in a north and south direction, should run in straight lines, and parallel to each other, by which means all short ridges unequal in length, and the ploughing of which consumes much time, will be avoided in every field of the farm, except those which are at its extreme end; and lines of hedge, which are drawn east and west, on the crest of undulating ground, on which situations hedges form the most effective shelter, should also run straight: and, where these two lines intersect each other, and where, of course, the corners of four fields will meet, a space should be rounded off, and planted for ornament and additional shelter, at little sacrifice of ground. (*fig.* 461.) Some may object to the formality of such things, but they look well, and, as a shelter, they are invaluable in exposed situations, where only they should be made. Formality, however, can never be out of keeping any where, in so artificial a thing as a cultivated farm. Lines of hedges which lie in an east and west direction need not necessarily be made straight or parallel to one another, at least the same strong reason, to save time in work, does not apply to them, as to those which are parallel to the ridges, which are invariably made to run north and south, for reasons well known to farmers. Indeed, in case of a hollow piece of ground, parallelism in fencing is impracticable, as the hedge-ditch must follow the "devious course" of the hollowed line of declivity.

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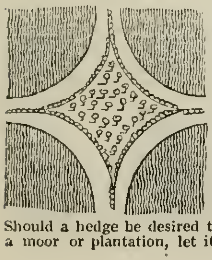

Should a hedge be desired to fence round a rough, moory, or rocky part in a field, or along the edge of a moor or plantation, let it be planted on the cultivated ground only; the yielding up of the good piece of ground will be soon repaid in value, by the quick growth of the hedge into a fence and shelter. On the other hand, if it be necessary to run a line of hedge through a moor, or waste piece of ground, let the ground be, in the first place, pitted in the line of hedge; and if it is discovered that the sward grows upon a loamy soil, of whatever tenacity, to the depth of a spit of the spade, thorns may safely be planted upon it, with a prospect of their becoming a fence. Should the soil be very thin and ferruginous, but the subsoil, to the depth of two feet, of a fully better quality than the soil, then a space, comprehending the breadth of hedge, bank, and ditch, must be trenched over to about eighteen inches deep, and the soil fallowed next season with potatoes, well manured and cleaned. The crop of potatoes will, most probably, repay the expense of the trenching and dung. If the dung be not sufficiently rotted by the potato crop, owing to the state of the weather, rather take a crop of oats after it, than run the risk of planting the thorns among undecomposed manure.

3002. *Planting the hedge.* If a line of fence is to be straight, let the poles be in as straight a line as possible from one end of the line to the other. Should the ground be quite plain, this can be done with great accuracy; but, should an elevation or a hollow, however small it may be, intervene, great care is necessary to preserve the straightness of the line, as, without it, the fence may be made to advance upon the true line in the hollow, and recede from it on the elevation. There is an instrument used by surveyors, which guides them in these difficulties; but without it, poles thickly set will perfectly well preserve the proper direction. In case any evil-disposed persons should shift the poles during the night, it is a good precautionary measure to drive stout short pins into the ground at the side of the poles, to serve as marks. Having set the poles so as to please the eye, take then the reel and cord, and, fastening its pin firmly into the ground at that end of the line of fence where you wish to begin, run out the cord to its full length, except a small piece, which should be twisted round the shank of the reel. Be sure you guide the cord exactly along the bottoms of the poles, and, should any obstacle be in the way of it, such as twigs, tufts of grass, stems of plants, stones, &c. remove it with the spade, then draw the cord with considerable force till it has stretched out as far as it can, and then fasten the reel firmly into the ground. As the least obstruction on the ground will cause the cord to deviate from the right line, lift it up about three feet high in the middle, keeping it close by the sides of the poles, and let it fall down suddenly to the ground, when, it is probable, it may lie as straight as practicable. Place a rather heavy stone here and there upon the cord, to prevent it changing its position, and then take a spade, and cut, or, as it is technically said, "*rut*," the line of hedge-bed behind the cord, with your face toward the ditch, taking care not to cut the cord with the spade. Take then the rule, and, with its cross-head, set off the breadth of the ditch at right angles from the rutted line four and a half feet, first at both ends, and then here and there, and mark the intermediate places with pins, which will serve to check any remarkable deviation at either end; and stretch the cord along this line in the same manner as on the other, and rut it also with your face to the ditch. Remove any intermediate poles along the lines in question, and the ditch is thus marked out ready for the forming of the thorn-bed. When about to form the bed for the thorns, that end of the line must be chosen for commencing the work, which best suits the hand of the workman. The rule is, that with whichever foot he tramps, or with whichever hand he grasps the shank of the spade, it is that which is farthest from the thorn-bed. If he tramps with the left foot, his right hand will hold the eye of the spade, and will of course be next the hedge, and *vice versâ*. Raise now a sod along the marked line of the thorns, five or six inches thick, and broader than the spade, and lay it over on its back, grass to grass, along the edge of the marked line; beat it down with the back of the spade; pare its nearest edge, as if it were a continuation of the inclination of the side of the ditch, and beat it also, and smooth it; then pare away the upper face of the inverted sod, keeping its edge next you (which should be cut sharp with the spade) the highest, and sloping the back of the sod down towards the back of the hedge. Place another similar sod quite close to the end of that now placed; use it in the same manner; and continue so with the rest, going backwards, so as to see your finished work before you, and taking care to connect all the sods together as neatly as if they were only one. While the principal labourer, or hedger, as we shall call him, is doing this part of the work, the other two should be stripping the sods from the surface of the whole ditch, and throwing them immediately behind the inverted sod, or thorn-bed, as it is called. The sod first raised and inverted, and which is meant for the bed of the thorns, should be taken up as entire as possible; but the more comminuted the others are, the better for vegetation. This conducts us to the end of the first part of the work, a vertical section of which (*fig.* 462.) represents the surface of the ditch with the sod removed (*a*), the sod in its new position inverted (*b*), and the turfy mould thrown off the surface of the ditch (*c*).

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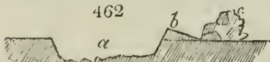

3003. *Preparing of the thorns to plant.* The thorn-plants (*fig.* 463.), as they are taken out of the layer, with their top and root and fibres on, must be prepared for planting by cutting off the tops (*fig.* 464.). To accomplish this, take the plant, and, grasping it firmly in the left hand, immediately above the root, cut the stem through above your hand with a sharp knife, giving the cut an inclination upwards, towards the top of the plant, and the cut thus made will be about five inches from the root. Cut away the long part of the tap root, and any of the diseased or injured parts of the roots and fibres. Bury or burn the tops which are cut off, as they are very troublesome in sheep's wool; but if they are not completely covered up with earth, they will vegetate. Take great care in a frosty day to cover up the prepared roots in earth, as frosted roots will not vegetate In such a day, take but a few at a time out of the layer, and as soon as these are cut ready for planting, relay them immediately in the earth. In frosty weather, avoid planting in the afternoon, as you will probably not have time to cover the plants with a sufficient quantity of earth on the thorn-bed, to resist the effects of frost. Indeed, in such weather, when the ground is becoming hard, leave off the work altogether, not only on account of the unfitness of the earth for work under such circumstances, but of the chilliness of the frosted earth probably injuring the fibres. On the other hand, in dry weather in spring, when the hedge is to be planted on dry land, put the roots of the prepared plants in a puddle of earth and water, in a shady place, for some hours before laying them on the thorn-bed, and their vegetative powers will be much accelerated. All the men assist at the preparing of the plants, as it is rather a cold and tedious work. When the plants are quite ready, lay them firmly, by giving them a squeeze on the thorn-bed, the stem inclining upwards, and projecting about a quarter of an inch at farthest beyond the face of the bed, and the root lying toward the heap of mould behind; and place them from one another, at a distance varying from four to eight inches; the former distance being adapted to weak land, and the latter to a soil in good heart. While the two men are laying the plants, let the hedger, with his spade, shovel up, from the surface of the ditch next the thorn-bed, all the fine mould earth which had been left after the ditch had been divested of its turf; and inverting his spade dexterously, place this earth on the bed above the stems of the plants, which will then be kept firmly in their places. The two men having accomplished laying the thorns, which should never exceed by one span a distance which all the men can have time to cover with earth thickly before the usual time of quitting work, let them take their spades, and dig and shovel up all the black mould which remains in the ditch, and throw it upon the roots and stems, till a sort of level bank of earth is formed over the laid plants. As the hedger will have finished his part of the work first, and while the other two are employed at clearing the ditch of the mould earth, let him step upon this bank of earth with his face to the ditch, and compress it firmly and equally with his feet, as far as the plants extend. By the time this process is finished, all the mould will have been taken off the ditch. When this quantity of earth is laid

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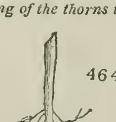

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upon the thorns, they are in safety from the frost: but it is not safe at any time in frosty weather to leave them, for even one night, with less earth; for the plants may not only be frosted in that time, but the earth may be put in such a state by the frost as to be unfit for working the next day; and should the frost afterwards continue so hard as to prevent working altogether, the plant thus left exposed will inevitably perish. The plants may be laid another length or two of the cord, if the weather appear favourable, and the plants be quite safe, before any more of the ditch be removed, as the last operation on the ditch and bank will be more uniform, and look better when a considerable length of it is finished at the same time, than when joinings are visible at short intervals; but in frosty or very wet weather, the sooner a piece of it is finished, the better it is for the labourers and the work itself. This concludes the second part of our work, and its effects are represented by the annexed figure (465.), exhibiting the laid plant (*a*) and the trodden part of the earth (*b*). When the work has proceeded to this length, the other implements come unto use. If the substratum of the ditch be a tenacious or ductile clay, without any admixture of small stones, the spade should be used for removing it, as no picking is generally necessary in such circumstances; especially if there be any water in the ditch: but if it consists of hard clay, ramified with small veins of sand, and intermixed with numberless small stones,—which composition forms a very common subsoil,—picking is absolutely necessary, and in such matter the spade alone cannot be made to work with effect. Let, then, one of the men with the foot-pick loosen the substratum, as deep as he can reach for the tramp, going backwards, and leaving the loosened material before him. Let another take his spade, and dig up what has been loosened, and throw it upon the top of the mould above the thorns, taking care to place the soil so thrown up continuous with the face of the bank, and having at the same time regard to its inclination backwards. Throw some also to the back part of the bank, so as to cover the whole black mould, and endeavour to make the shape of the bank quite uniform all along, the right management of which devolves upon this labourer, and upon which much of the beauty of the work depends. He must go backwards upon the loosened soil, and pare down the side of the ditch next his right hand, which in this case will be the opposite one from the hedge. If there is more earth at one place of the ditch than another, which will happen where there are inequalities in the ground, the surplus soil should rather be thrown to the back of the bank, than the top of the latter be made higher at one place than another; or it could be wheeled away to a spot on which a deficiency of the soil is apprehended. Let the hedger follow with the ditcher's shovel, and throw up all the mould-soil which has been left by the men before him, going forward upon his work, face to face with the other man, and leaving the ditch behind him completely finished. He will take care to throw the soil rather full on the face of the bank, even though some of it should trickle down again into the ditch; rejecting all the larger stones that may come in his way, and beating with the back of the shovel the whole face of the bank, and smoothing it downwards from its top, to as far as the black mould is seen down the side of the ditch, giving the whole of it a uniform inclination upwards and backwards, as if the side of the ditch were produced. If going over the ditch once in this manner finishes the work, the soil will have been in a friable and easily worked state, but in hard substrata this cannot be the case. The hand-pick is almost always required to raise four or five inches more of the bottom of the ditch, in the accomplishment of which, the same process as to the arrangement of the men, and the kind of work to each, will have to be gone through as described above. In this case, when the picking is proceeding, the hedger must again tread down the top of the bank, before throwing up more soil. This description proves the necessity of projecting the thorn-plants but a very short way out of the bank, as the necessary beating process on its face would otherwise wound them. The beating is absolutely necessary, too, in order to produce a skin, as it were, on the face of the bank, which will prevent the frost from abrading and trickling down all the fine mould-soil with which its whole face is covered, down to the firm earth of the substratum in the ditch. This covering of clay, and the poorer it is the better for the purpose, is, fortunately, extremely inimical to the vegetation of small seeds, which would otherwise take root upon the mould, grow up, and either create great trouble to eradicate them, or injure the vegetation of the young hedge. Instead of permitting the plants to project too far out, I would prefer their being nearly buried in the bank, so that the young sprouts had to be relieved in the manner afterwards described, but, in most cases, the force of vegetation itself would easily accomplish this. The state of the work will appear thus in the annexed figure (466.). While the two men are preparing the rut and cord, &c. to begin another sketch of it, let the hedger take the shovel, and push back from the top of the bank three or four inches of its crest, or more or less if necessary, in order to make the intended top parallel along with the line of thorns, and let him beat the top gently in a rounded form, as in figure 467.; which last touch finishes the whole process of planting thorns.

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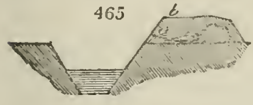

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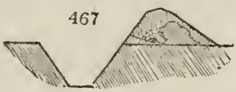

3004. *Dimensions of the ditch.* The rule observed for the depth of ditch is half its breadth, and the breadth of bottom about one sixth of it; so that when the breadth is four and one half feet, as we have supposed, the depth will be two feet three inches below the surface of the original ground. The hedge-bank is always broader than the ditch, and, in this case, will be five feet; and, of course, the perpendicular height of the hedge-bank, especially after the crest has been rounded and beaten down, will be something less than the depth of the ditch. These are, in general, very desirable dimensions for a hedge ditch and bank, when no constant run of water has to be accommodated; but should a stream of water run along the ditch, though in winter only, the ditch should be made proportionally capacious; for, if not so made at first, the force of water will soon make it so for itself, and probably endanger the thorn-bed. Should the quantity of earth thrown out to accommodate the water make the hedge-bank too high, part of it should be shovelled back, as it is not desirable to load the young thorns too heavily with a superincumbent load of earth, so as to exclude the action of the air from the roots.

3005. *Averting obstacles.* Hitherto all our work has been quite smooth; no obstacles have presented themselves to frustrate our designs: but these will be met with sometimes, and we must, therefore, be prepared to avert their injurious effects. These obstacles generally consist of large stones, unequal ground, and surface-water. Landfast stones are often found in such substrata as we have been describing, and when they can, they ought to be removed, and the foot-pick will be found a most efficient lever for that purpose. Some stones are so large and amorphous, that it is impossible to remove them without the assistance of gunpowder; but blasting isolated masses of rock, whose structure is unknown to ignorant men, is a dangerous business. If they lie across the ditch, it must be taken round them, and its sides so sloped and pared as to permit water to flow round them without obstruction. If they lie under the thorn-bed, and there is plenty of mould over them, they will do no harm to the thorns; but should the mould be thin over them, an additional thickness of sod must be placed, to form the thorn-bed above them, though this should cause an elevation there above the general line of hedge. With regard to inequality of surface, where the general dip of the ground is in one continued direction in the line of hedge, and yet the undulations on its surface are so deep as that water could not run in the bottom of the ditch in the general dip of the ground, but would collect in the hollows, were its bottom made parallel to these undulations, the elevated part of these inequalities must be cut deeper, and the hollows less deep, than usual, so that a common level may be obtained by the bottom of the ditch, to give egress to the water. A sort of compromise must thus be made between the heights and hollows in the bottom of the ditch, though the line of thorn-bed must still be placed on the natural surface of the undulations, and will therefore partake of their inequalities. When such a compromise is necessary, the superabundant earth thrown out of the deep parts must be wheeled away to the shallow parts, to equalise the dimensions of the hedge-bank. Should any hollow part be so deep as that the heights next it cannot possibly be cut down so as to let the water flow away on either side, a drain must be made from the hollowest point in the bottom of the ditch, down an inclining hollow or plain ground in the adjoining field, to some ditch or drain already existing in it at a lower level. These undulations will cause another evil, that is, the collection in their hollows of stagnant surface-water behind the hedge-banks. The only effectual method of getting quit of this evil, and it is fortunately a simple one, is the building of drains under the hedge-bed, opening into the ditch; and whatever number of hollows there are, and almost however small, there must be the same number of drains. As these drains must be formed completely under the black mould, and at only a little elevation above the level of the bottom of the ditch, they can be conveniently built only after the ditch has been entirely dug out; and for this purpose, that part of the hedge-bed which lies over these drains must be left undone till the drains are built, and finished afterwards. A little taste and dexterity in the hedger, who should, of course, be a good spademan, will fill up these gaps in the hedge-bank with neatness. If the hedge is to be planted along the side of a road, especially of an ornamental road, and where a hollow in the road has been filled up to make the whole a continuous level, the hedge-bed should also be brought up to the same level, with earth or turf, as may be most expedient; but still the thorn-plants, here as elsewhere, must be laid among mould. The annexed figure (468.) will give an idea of the work to be performed in such inequalities of ground, and of the position of the drains: it indicates the line of hedge-bed, with undulations (*a a*); the top of hedge-bank parallel to the bed (*b b*); the bottom of ditch (*c c*), made to slope, to let the water run down to the leading drain (*e*); and the small drains (*d d d*) under the hedge-bed, to convey away the surface-water from behind the hedge-bank.

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3006. *Marking off parallel lines of hedges.* Thus one whole line of hedge may be planted, and all the probable obstacles to its right accomplishment may be anticipated. Let us now surmount another difficulty — the marking off another line parallel to the first. Take the rule with the cross-head, and measure from the thorn-bed already made, across its ditch, a distance so as to leave a scarcement of one foot in breadth on the edge of the ditch, that is, in the present case, six feet from the thorn-bed. Any distance from the hedge-bed will, of course, answer the purpose intended, but I have taken the above, that the scarcement necessary for the preservation of the edge of the ditch might be indicated. Set off other two such distances at about one hundred yards from each other, place poles in the three points, and adjust their accuracy to one another. Make these measurements at such a place of the line of hedge, as from it you may have a view of the places at which you wish to plant the new parallel line. Erect the plane-table midway between two of the poles, and fix the eye-sights so as through them you may see one of the poles in one direction, and the other two in another direction. This is the base line. Fix the other eye-sights so as by looking through them you may see the place of the new line as clearly as the field of vision will permit, and mark the angle of observation. This angle may be of any degree; but the nearer it is to the right angle, the more certainly will the breadth of the field be set off, so as to contain its exact complement of ridges of a given breadth. Cause one of the men to fix a pole in the line of observation where he will be most distinctly seen. Fix other poles along this line, so appropriately, that how unequal soever the ground may be, the right line may be kept. From the stalk of the plane-table measure by the chain, along the line of poles, the distance necessary for the proposed breadth of the field. If your line of poles is at, or nearly at, right angles to the furrows of the ridges of the field, the breadth of the field may be conveniently marked off, so as to contain a given number of ridges of a given breadth. It is necessary to attend to this, as a half ridge left at the side of the field would be inconvenient. Fix this point by a pole. Remove then the plane-table to between the other two poles, the middle pole being common to both stations; adjust it to them without changing the relative positions of the eye-sights, and, of course, the angle of observation; and, in the same manner, measure another line from the stalk of the plane-table, which will, of course, be parallel to the first across the field, of exactly the same length, and mark it also with another pole. Fix a third pole at a specified distance, on the line passing through these two last placed poles, and measure from it across the field to a point on the scarcement of the ditch, at a distance from the stalk of the plane-table, where last placed, exactly corresponding to the specified distance mentioned above; and if this third line, which may be considered as the line of proof by trial and error, agree exactly with the length of the other two lines severally measured across the field, your observations and operations have been correct. But, should the error be considerable, as of one yard, it must be found out by another trial, and corrected.

3007. *Forming hedges in curved lines.* All these observations apply to hedges in straight lines; but where irregularly curved lines are to be formed, they can be made by the poles above, but must be judged of by the eye, so that a pleasing sweep may be made according to the nature of the ground, and which would not offend the taste of the most fastidious, and the curves drawn conformably to the ploughing of the adjoining land; for if this latter consideration is not attended to, land may be lost for utility in tillage in the depths of the curves. But poles set, in the first place, to guide the outlines of the sweeps, and the spaces between them filled up by the cord distended over the hooked-headed pins, with curves which please the eye, will generally accomplish all that can be done in this way, where geometrical curves cannot be introduced. The rutting of the breadth of the ditch must follow the cord in its curved position, and the sod for the thorn-bed must also take the sweep of the curves; but great care is necessary in making the curved sides of the ditch parallel to one another, for if the cross-headed rule is not held at right angles to the line of the thorns, at whatever spot the measurement is taken, the breadth of the ditch will vary considerably in different places. There is no error into which the labourers will fall more easily than into this, as they will most probably measure, without thinking of the consequences, across the ditch at any angle; and this is an error of such magnitude, that, if not rectified in time, it will not only rob parts of the hedge-bank of some of its essential covering, but twist the ditch out of the parallelism of its sides.

3008. *Season of planting.* Thorns may be planted any time from October to April, when the weather is neither very frosty nor very wet. The autumnal season is upon the whole preferable, as the plants are then ready to push forward in the earliest spring; the months of January and February are also excellent for the purpose, but in most seasons March and April are rather late, particularly in a dry soil, in which young thorns suffer very much from drought. A southern and western aspect should always be preferred, if possible, for thorn hedges.

3009. *Arguments for and against a scarcement.* All the writers which I have perused on the planting of hedges, recommend a scarcement of nine or ten inches in breadth to be left in front of the thorn plants; and Lord Kames, in *The Gentleman Farmer*, who is the most minute writer on the planting of thorn hedges, though not nearly minute enough, gives a reason for doing this, which no other writer condescends to do; and his reason is, that it keeps the moisture about the thorns: and, indeed, he carries his notions of the necessity of moisture to such a length, as to recommend the plants being placed parallel, instead of square, to the ditch. At page 277, he says, "Instead of laying the thorns fronting the ditch, would it not do better to lay them parallel to the ditch, covering the roots with three or four inches of the best earth, which would make a hollow between the plants and the sloping bank? This hollow would intercept any drops of rain that fall on the bank to sink gradually among the roots. If this be not a better position for a thorn, it must be of a singular constitution." He thinks that the face of the mound being beaten down solid, it will be made impervious to water; and at the same time recommends it to be made as upright as possible, for a safeguard to the young plants, — a position well adapted to throw off water. He thinks there is no good reason for thorns being laid sloping in the ground, as they might as well be planted, like all other plants, upright, when, he thinks, they would sooner become a fence; and, indeed, suggests that thorns six feet high might be planted in this way. He also recommends the plants being placed one inch projecting from the face of the bank. In the method of planting hedges so fully described above, the scarcement is dispensed with, for this sufficient reason — that it would become a receptacle, a perfect hot-bed, for weeds; and if very great vigilance and trouble were not exercised in keeping them down, they would inevitably choke the young plants. Along the sides of public roads these scarcements are frequently made footpaths by idle people. The facing of the bank must be beaten down, to prevent the frost abrading the earth of the substratum, which had been put up to hinder the growth of weeds, and all the beating that can be given to it, will never make it entirely impervious to rain; besides, there is no need of rain entering them, when the back of the bank is composed of loose earth, through which it can easily percolate to the roots immediately below. Nor can such a mound, whatever be its shape, be any protection to the young thorns from any beast, either from behind or before; its main use being to admit the ditch being made of a sufficient size to carry off water, to afford the hedge roots a covering against drought, and to envelop the black mould which surrounds the roots with a covering of sterile earth, which is itself inimical to vegetation, and which, at the same time, tends to check the ardour of vegetation in the black mould. Thorns will, no doubt, grow in an upright position as well as in a sloping one; but the latter position is the most convenient for planting with mound and ditch, and in this position the whole stem is converted into root. The transplanting of old thorns to any great extent is, I fear, a hopeless task; besides, where are they to be obtained in quantities sufficient to fence a farm? The projecting of the thorn-plants from the face of the bank is a bad plan; as they are not only liable to be wounded in the working up of the face of the mound, by the rolling down of the earth and stones, and by the process of beating and smoothing, but when stems spring up from their extremities, and the wind tosses them about, the tops exert a lever power on the root, and loosen it in the soil. Hence, when a thorn-hedge is examined in the first year of its growth, particularly in the autumn, when the stems are strong and leafy, and the winds prevail, it is often observed, that all those plants, which have been accidently left projecting farther out than the others, have worked an upright oblong hole about them in the earth, whereas all those which have been left even with the face of the bank, or been relieved from some fettering earth, by the force of vegetation, or the hand, are quite firmly imbedded in the earth; a state, without doubt, much preferable to the other.

3010. *Management of the ditch and thorn-hedge.* The implements necessary for the proper management of hedges are: — A common Dutch hoe, 7 inches broad and 5 feet long, for cleaning (*fig.* 469. *a*). A hedge-spade, 5 or 6 inches wide at the mouth, and about 3 feet 3 inches long altogether, for cleaning (*b*). A hooked-headed stick, for freeing the earth from the points of the sets (*c*). A switching-bill, blade 9 inches long, and $1\frac{1}{2}$ inch broad; shaft 2 feet 3 inches long, and weighing altogether about $2\frac{1}{2}$ pounds (*d*). A breasting-knife, which resembles the switching-bill, but considerably stronger, and of course heavier. A cutting-bill, blade 7 inches long and $2\frac{1}{2}$ inches broad; shaft $2\frac{1}{2}$ feet long, and weighing altogether about 6 pounds (*e*). A light axe, weighing about 3 pounds, and a shaft 36 inches long (*f*).

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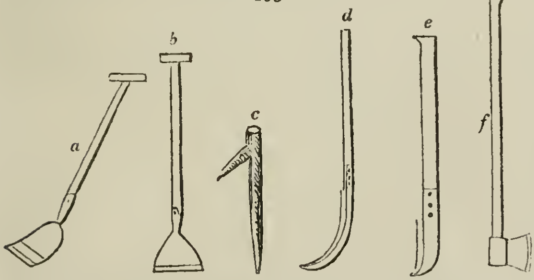

3011. *Releasing the buds on the points of the sets.* The first attention which a young hedge requires is to release those buds which may have been prevented by the tenacity of the clayey earth from pushing out, and this is done either by the finger or a small piece of stick; but great care must be taken that none of the sprouts be broken off in the work. The force of vegetation will generally accomplish all that is required; but in some cases assistance is beneficial to the plant.

3012. *Cleaning.* If the hedge has been planted in the autumn, the grass between the inverted sod and the original surface will have decayed so much, as to create little trouble in the early part of the season in clearing away grass. Indeed, both the hedge and bank will not be injured by those plants that may have sprung up from the seed, as they will rather ward off the effects of frost during winter. If they are, however, likely to scatter their own seed, it would be prudent to remove them before that time. Should the hedge have been planted in the spring, the vernal influence will keep alive the grass under the inverted sod, and it will grow rapidly, so that it may be necessary to clear it away about midsummer at least, in order that the luxuriance of its growth may be checked. The seam between the inverted sod and the original ground is the only very troublesome place of the hedge-bank to keep clear of weeds, but even that is six inches below the thorn-bed; and if the ground had been properly cleaned of quickens, couch-grass, and knot-grass, before the hedge was planted, which it ought undoubtedly to have been, the other kinds of weeds which will spring up will be easily got rid of. Couch-grass, when it gets entangled about the roots of a young hedge, injures its growth very much, and it is, in such a situation, quite impossible ever after to get quit of it altogether. When cleaning is to be performed, it is done in the following manner: — Let the hedger, — for one man is now only necessary, — take the weeding-spade, and hold it in a horizontal position with both hands, the right hand upon the handle. Let him stand in the bottom of the ditch, with his face towards the hedge, and begin to cut away the grass under the line of hedge, with horizontal strokes of the spade, making progress up the ditch with his left side foremost. Let a woman place herself upon the top of the bank, with her face also towards the hedge; and taking the Dutch hoe, with her right hand upon the handle, work with it on the top and face of the bank behind the hedge, and there nimbly and dexterously, by a peculiar twitch given to the hoe by the wrist, eradicate the weeds, and raise as little of the earth as possible. She progresses on the top of the bank with her right side foremost. One or two women, according to the quantity of weeds, follow with the crooked sticks; and, stooping in the ditch, pull out the loosened weeds from between the thorns, and all that may be growing where the weeding-spade and Dutch hoe cannot enter. In this manner the cleaning process is carried on with great despatch. The man has by far the severest work to do, but even he will move on rapidly if the grass is not allowed to be too old before it is cleared away. After all, it is very seldom that a hedge requires to be so thoroughly cleaned in the first season; but in the second year it is absolutely necessary to be very vigilant in cleaning early in spring, before vegetation is much advanced. If weeding is delayed till the roots of the weeds take firm hold of the ground, the displacing of them bears away a great deal of earth from the face of the bank. There is no specific time of the season to clean a hedge, but the safe rule is always to clean it before the weeds in the least envelop it. The most common weeds which infest hedges in loamy ground are, the tussilago, way thistle, corn sow-thistle, common docks, sorrel, ribwort, groundsel, hedge vetch (a trailing plant very like the vetch, but with a bright yellow pea-blossom), bindweed, sticking-grass, cow-clover, wild mustard, chickweed, dead-nettle, rest-harrow, great white ox-eye, corn poppy, white lychnis, blaewort, and several of the grasses. The tussilago, rest-harrow, ox-eye, and docks, are most difficult to eradicate; the bindweed, sticking-grass, vetch, and the yellow-flowering trailing plant, interlace the branches of the thorns, and are exceedingly difficult to eradicate; and if there be but a single fibre of the wild mustard attaching the plant to the ground, it will grow again with vigour.

3013. *Pruning.* A hedge will hardly require pruning in the first year of its growth; but should it grow very luxuriantly, it is very proper to cut off the upper part of the tops of all overgrown plants, as it is very desirable for the well-being of a hedge that all the plants grow alike, and that no plant by its overgrowth overshadow its neighbours. On examining those luxuriant plants, they will be found to be of that variety to which I have given the preference. Any branch that may be straggling much in front, may also be curbed. The use of the bill at this period of growth arises more from a precautionary feeling of preventing injury from weight of snow, than from any necessity that exists to check the growth of the plant. In the second winter, however, the lateral branches which have shot over the ditch should be twitched off, leaving those behind toward the bank untouched, and the tops should be so cut off as to make them all of the same height. The stroke of the switching-bill should be made upwards, and not across the top of the hedge. If switching is neglected this winter, the least load of snow, which will easily lie upon the straggling branches, will inevitably crush the tops and lateral branches down; and, instead of being cut off, they will be forcibly broken off, — a kind of pruning which cannot be too much deprecated. One season, in the second year of a hedge, a piece of it was left unswitched for want of time, and not for experiment; and that part was so completely crushed down by the snow, that in the spring it was obliged to be cut down to the ground by the pruning-knife; whereas that part which had been switched sustained very little injury, the sharp vertical points piercing through the snow when it was subsiding, which is the time it does the damage. Now, however, (which is five years after the accident), that part which was cut down by the pruning-knife is by far the strongest part, both in girth of stem and height of fence. This fact tends to countenance the free use of the knife on hedges, though few would perhaps have the courage to cut down a fine thriving young hedge. It is certainly undeniable that a thorn plant is very tenacious of life; and this tenacity is exhibited in no way more remarkably, than in the hedge conforming its shape to the will of the hedger.

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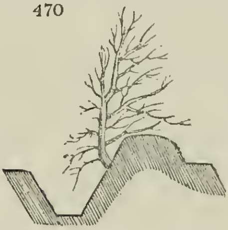

In this manner, let him continue to cut away part of the tender shoots on the top, and switch the lateral branches upwards in a sloping direction towards the top, so that the former shall present a uniform row of pointed spikes, till the hedge is six feet high, beyond which height he cannot use the bill to advantage. There is nothing done to the hedge behind. After it has acquired this height, the top should get leave to grow upwards, till the whole hedge shall be ten or twelve feet high, the lateral wood being still cut away to prevent the top overshadowing and baring the root of the hedge. The object of thus allowing the top to grow up, is to increase the girth, and consequently the strength of the stem below, otherwise it will continue puny for a long time. Indeed, if a hedge is not allowed to grow up at all, it will shoot out determinately in a lateral direction to a great extent, and then occupy a greater breadth of ground than will be convenient or profitable. The annexed figure (470.) will illustrate the appearance of the hedge when the top should be allowed to grow up.

3014. *Water-tabling.* When the grass below the thorn-bed, and the weeds on the face of the bank, have been cleaned away, at least once, if not twice, in a season, and if the ground is loamy, it is probable that, during the course of four or five years of such work, the soil may have mouldered away, and left part of the root that was embedded in the bank exposed. Such will undoubtedly be the state of things in any kind of soil, in the course of time; and its effects on the root of the hedge thus exposed, will be the same as pointed out before, in regard to the effects produced by leaving the young plants projecting from the face of the bank; but if such an evil be concomitant with the necessary process of cleaning, how much more must it be aggravated in the case, when the plants are left, at first, projecting from the face of the bank? But, happily, there is a remedy for this evil, which, if allowed to remain any length of time, would injure the hedge materially; and that is, by the simple process of water-tabling. The annexed figure (471.) will show the effects which weeding has upon the roots of thorns, in which the dotted line shows the state in which the bank and ditch came from the hands of the workman. The following figure (472.) will show the process of water-tabling. One man could do this work, but two men will carry it on more expeditiously, in proportion to the number. Let the hedger take a spade, and make a notch three inches deep in the side of the ditch, about a foot below the thorns (*a*), and then pare away all the loose earth from that notch up to the thorn root.

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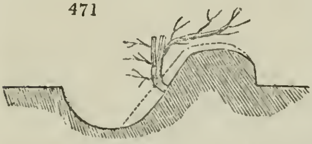

In the mean time the other man raises sods from the bottom of the ditch, choosing the best parts of it for them, nine inches broad and four inches thick, and of a convenient length. The hedger takes these sods and puts them on their edge upon the notch (*a*), with the grass side outwards, and beats them to the bank with the back of the spade, making the upper edge of them level with the spade by paring and beating. The reason that the grass side is put outwards is, that these sods may adhere to the bank; whereas, if they were put with the grass side inwards, the frost of the ensuing winter, getting between them and the bank, would cause them to slide down; and there need be no apprehension of the grass, though placed outwards, growing up so as to injure the hedge; for by that time the latter will have acquired such a thicket of branches and foliage as to smother all weeds. This sod is called the "set-sod." The other man must also raise other sods, about six inches broad and four inches deep, and of a convenient length. The hedger then takes them and inverts them, with the grass side downwards, upon the upper edge of the sod (*b*), and beats them even with it, and pushes them quite in contact, and below the roots (*c*). This sod is called the "table." The reason for inverting its grass side downwards is obvious, as its grass would spring up immediately among the roots of the thorns. The other man, at intervals of leisure, if he have any, or both together, may then shovel up all the fine mouldery earth they can get, and throw it between the stems, and form the sloping bank (*d*) on the upper side of the roots. If more earth has been worn away than of the thickness the sods can be raised, the space must be filled up with earth before inserting the sod (as between the dotted line *a c d*, and the sod *b*). Water-tabling thorns, when the earth has been worn away by weeding from their roots, renovates their growth, so that the process of engrossing the stems proceeds after it with great rapidity, re-establishes their hold on the bank,

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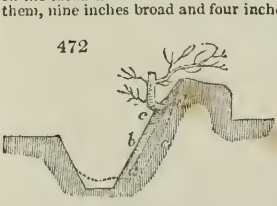

so that no wind can shake the plant to injure its roots; and the growth of the numerous twigs from the branches is so encouraged, that weeds ever afterwards can do little injury to the plants themselves.

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When thorns are planted on a scarcement, no water-tabling is required, because it prevents the mouldering away of the earth; but such scarcements are nurseries for weeds, and it is impossible to clean a hedge thoroughly where they exist, — to "deracinate such savagery." Earth, to be sure, from the bottom of the ditch, can be thrown upon the scarcement, to smother the weeds upon them; but the accumulation of earth there must be limited to the height of the thorn roots, and upon this earth weeds can, of course, grow as luxuriantly as upon the scarcement itself. In short, in such a situation, weeds cannot be eradicated. They can be cut over like mown grass, but their roots will ever be ready to spring up afresh in favourable weather. A figure of a thorn hedge, planted on a scarcement, will at once show the inconveniency of such a construction for the eradicating of weeds (*fig.* 473.).

3015. *Protecting fence.* Lord Kames says, "The hedge is fenced from cattle on the one side by the ditch; but it is necessary that it be fenced on both sides. The ordinary method of a paling is no sufficient fence against cattle; the most gentle make it a rubbing-post, and the vicious break it down wantonly with their horns. The only effectual remedy is expensive; but better no fence than one that is imperfect. The remedy is two ditches and two hedges, with a high mound of earth between them." We are left to infer from this, that a paling is no protection to a hedge; two ditches and a mound of earth are. Other writers nearly hold the same opinion. It is astonishing to see persons who pretend to know the practice of husbandry, assert that hedge-ditches, or a mound, or a ditch of almost any dimensions, will protect a young hedge from the depredation of cattle and sheep. If such notions at all prevail among proprietors and farmers, it is no wonder that those hedges are so often seen in a ruinous state. If a good paling is not a sufficient fence against cattle and sheep, it is not a ditch or two, nor a mound, that will prevent them committing depredations. If "two ditches" are to be fenced, they will require as much paling as a single hedge before and behind, besides the additional quantity of ground occupied by fencing. If gaps cannot be prevented in hedges but by double rows of thorns, their owners must be negligent hedgers indeed. As to making a rubbing-post of a paling, rubbing-posts ought to be erected in every pasture field, and then neither the "gentle" nor the "vicious" cattle will ever have occasion to use a paling, which is at least a very inconvenient "rubbing-post." The truth is, a fence, of whatever nature it may be, is absolutely necessary on both sides of a young thorn hedge, if that hedge separates fields that are to be pastured; and what that fence may be made of depends, of course, on the nature of the materials which are most easily obtained for the purpose.

3016. *Protecting by a paling.* If tall-grown Scots pine of eight inches diameter, or weedings of larch plantations, can be procured at no great distance, or grow upon the property that is to be inclosed, better materials for temporary fencings need not be wished. The Scots pine of the above size will cut up into six deals, besides the outside slabs, and divide again up the middle for rails of perhaps twenty-four feet long; or twice up the middle, at right angles, for stakes, which should be sawn across, and pointed, four and a half feet in length. These stakes should be driven at least one foot from the edge of the ditch, by a mallet, into holes formed by the foot-pick, at a distance from one another not exceeding five or six feet, fifteen inches into the ground, and which will make the fence stand three feet three inches high. Two of the rails are sufficient for fencing cattle, but three are necessary to keep in sheep. To give additional strength to the fence, the rails should be placed on the face of the stakes next the field, and made to pass

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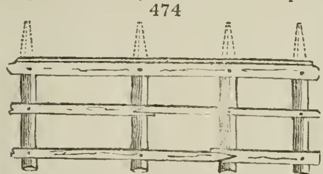

each other's ends, so that all the ends of the three rails should not be nailed on the same stake; nor should the root or thick end of the rails be nailed together, even after being thinned by the adze, but top and bottom ends nailed together alternately; as this plan equalises the weight of the rails upon the stakes. The upper rail should be at the height of the stakes: the upper edge of the lowest one nine inches, and that of the middle one twenty-two inches, from the ground, as the best arrangement as a fence for sheep (*fig.* 474.). The best nails for such a purpose are called "stout paling-nails," three to three and a half inches long, made in Scotland; for it seems the nails manufactured in the sister kingdom are not in good repute here. A similar fence may be erected on the sides of the bank behind the hedge; but it is necessary to keep in remembrance, that it should be placed clear of the hedge-mound altogether. There is a temptation to place it upon the hedge-mound, as more space is given to the plough, and shorter stakes will there make an equally high fence; but when a fence is placed so near a young hedge as on any part of the mound, cattle, and particularly horses, after they have eaten their fill of grass, and on Sunday, when they are idle, will reach over, and bite off the tops of it, as if delighting in mischief, to the serious injury of the young hedge.

3017. *Protecting by stake and rice* (*fig.* 475.). When trees are felled, or bought by a proprietor for the

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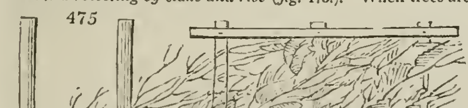

construction of paling to fence young hedges, the top stems and branches may be made available to the same purpose, in "stake and rice." The branches should all be cut off the tops of the trees, and their stems, if large enough, converted into stakes of the above dimensions; but as these will not suffice altogether, other stakes must be sawn from the bole of the tree. These stakes should be driven into the ground in the same manner, and at the same distance, as recommended for paling. Take then the branches, and place their butt-end on the ground, and warp the upper parts backwards and forwards round the alternate stakes, and give them an inclining position upwards, towards the tops of the stakes. This inclination must lie away in the direction in which the heaviest winds will blow; for instance, if the fence runs north and south, the inclination must be to the south, as the north winds are the most severe; and for the same reason, an inclination to the east will avoid the heavy south-west winds. A strong wind acting against the tops, is apt to ruffle and bend them back. A single rail nailed at the top of the stakes, completes this mode of fencing. I may remark, that any brushwood, provided it is so long as to reach from stake to stake, will serve this purpose as well as the tops of trees; at least a mixture of them is excellent. Such a fence requires fewer nails, and less good wood, than a regular paling, and is therefore cheaper, and it will stand an equal length of time; and, indeed, the stakes have less strain upon them, in this mode, than the other, as they have not the weight of the materials to bear, and the warping of the branches around them protects them from many accidents to which paling is liable; such as people trespassing over them, swingle-trees of ploughs rubbing upon them and catching hold of them, and the like. This is an excellent fence for sheep, affording them shelter from the sweeping blast behind its matted texture; and, for this purpose, it is generally placed on the north and west sides of fields — the quarters from which the greatest winds prevail. There is one, and only one, greater objection to it than paling — that being close in its construction, it is liable to lodge more snow about a hedge than a paling, through the rails of which the drift can make its way.

3018. *Protecting by a turf-wall and single rail* (*fig.* 476.) There is another mode of fencing young thorn-hedges, which I shall mention, and it is adapted to situations where there is plenty of turf and little wood. It is to build a turf-wall, that will stand three and a half feet high, after the sods have consolidated, to support the hedge-bank behind the thorns. This wall is built like masonry, with heavy sods, with the grass sides downward, and finished at top with one sod nine inches broad, with its grassy surface uppermost. The face of the wall should be built with an inclination backwards towards the top, in order that the grass may grow so luxuriantly upon it, as to protect it from injury, and strengthen the sods. A short stake, with a single rail of paling at top, is all the fencing the hedge requires from this side, till it can protect itself. Such a style of fence is well adapted to large fields of perpetual pasture, in exposed situations, and forms an excellent shelter to cattle and sheep. Cattle, however, will box with their heads against such a wall, sometimes only in sport, after they are satisfied with grass; but more likely in hot weather, when insects sting and startle them. The two former kinds of fences should be put up, only when the adjoining fields to the hedges are to be pastured with stock, and on whichever side the hedge may first require them. If the hedge has been planted when the lea ground was broken up, the fourth year is the soonest that will see the return of grass in the rotation of cropping; but, should the grass be cut for hay or soiling, and the field be intended to lie only one year in grass, it will be unnecessary to incur the expense of a regular paling for the eating down of the aftermath, as hurdles for cattle, and nets for sheep, will serve the purpose of a fence for so short a time. The turf-wall, however, must be built at the time the hedge is planted. When the fields are pastured in the second rotation, and if the paling has been erected in the first, which will always be the case when the grass is to lie more than one year, it will be advisable to drive here and there, at the weakest parts, stakes in an inclined position, into the side of the ditch next the paling, and to nail their heads against the upright stakes of the paling, to act as spurs to support the stakes against any violence. The rails will yet be quite fresh, though the stakes are apt to break over at the ground, in consequence of their being exposed, at that part, to the alternate effects of wet and drought, — effects which are injurious to every kind of wood. If this precaution be adopted, the same paling will last to the commencement of a rotation, in which the hedge will be able to defend itself. The paling will stand, with this assistance, which is not expensive, from the fourth to the twelfth year of the age of the hedge, that is, eight years. But should the paling be completely useless before the hedge can defend itself, and if the latter has been planted in some very unfavourable situation this may be the case, a few stakes driven on the top of the bank behind the hedge, with a single rail nailed at the top, will secure the hedge from all danger. Cattle will not attempt to pass through the hedge on the ditch side, on account of this rail above their heads; and, from the other side they will be deterred, by the depth of the ditch, from leaping over it; nor will horses browse readily on so old a hedge. As to sheep, they will not attempt it on either side; and, if they are the only kind of stock that is pastured in the fields, even such a rail is not absolutely necessary for them.

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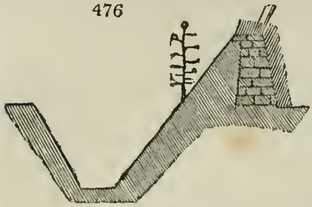

3019. *Gates and gate-posts in hedges.* Gate-posts, which are to support the gates through which an entrance is effected into any fields, should be placed in the line of the quick hedge, and not in that of the paling, which is only a temporary fence. Charring, by fire, the part of these gate-posts which is to be sunk in the ground, and about a foot above it, will be found a preservative against rot for a long time; and even the common stakes of the paling might be treated in the same manner, by those who do not grudge a little more expense to insure greater security. In passing over a hedge-ditch to a gateway in a field, it will be necessary to build a small square drain in the bottom of the ditch, in length equal to the breadth of the gateway, that is, ten feet; and the stones of the drain should be covered with other stones, broken small, like road metal, in order to form a firm road in and out of the field, at a place which is, in general, dreadfully cut up in winter, especially to a turnip field, to the great grievance of men, horses, tackle, and gates; and also to allow the water in the ditch to flow away without interruption.

3020. *The management of hedges, after they have arrived at maturity*, is often as difficult a task, as the training of the young hedge to maturity. If we judge of its difficulty, by the woful manner in which we see old hedges managed throughout the country, we might conclude that a thorn is so obdurate a plant, that it is almost impossible to make it subservient to the purposes of a field fence, and that that man would confer a signal benefit on his country, who could discover another kind of plant more susceptible of the fostering care of man: and yet we would ask, and as we have already stated, What hardy plant is so obedient to our will as thorns? The very miserably contorted state in which we daily see thorn-hedges is strong evidence of *their pliancy*, and of the *obduracy of their proprietors* in keeping them in such a state. If such effects are the offspring of ignorance, how is it that occupiers of land will permit ignorance to mismanage that which is so essential to the comfort and well-being of their stock, and, through them, their own profit? And how is it, that if they, or their servants, are ignorant of so necessary an operation, they do not apparently use the requisite means of acquiring a better knowledge of it? It is not that experience has yet to teach such knowledge; for I believe that, in certain districts of Scotland, the management of thorn-hedges is as well understood, and as successfully practised an operation, as any other in husbandry, in which farmers and their servants take pride to excel. It is not, that it is so abstruse a subject, as that the difficulty of acquiring it cannot be overcome, or that it can only be acquired by the learned; for even a hedger, a common peasant, can understand the principles of hedge planting and management as clearly as any learned man. These principles are exceedingly simple; for what is the main purpose of planting a hedge? Surely to confine stock within the boundaries of a field, and to save the trouble and expense of keeping a person to herd them constantly. If they can be confined, that trouble may, of course, be dispensed with. How, then, can they be best confined? Not by large bur-headed, bare-stemmed thorns, between which sheep and young cattle could easily creep, and snow crush down; but by plants, the management of which has encouraged nature to envelop their stems with matted branches, and twigs, and leaves, all forming so close a thicket of a pyramidal shape, as to obstruct the transmission of the solar ray, or even to avert the insinuating intrusion of the zephyr. The mystery is here disclosed; for, to get a good fence, all that is necessary is to cut the thorns so as they may be kept thick near the ground; for grow they will just as you please, and grow they will whenever they are cut. But will cutting them over three feet above the ground, encourage the growth of small branches and twigs below that height? Will cutting branches, and plashing them two feet above the ground, fill up gaps below the plashes? Will permitting them to grow up as trees with heavy heads, the invariable tendency of which in other trees which are deciduous is, by their shade, to prune off the small branches on the trunks, and kill or curb the growth of weaker neighbouring trees, be the most proper method to encourage the growth of twigs around their base, where alone they can be used as a fence? Impossible. Indeed the very terms of these questions, and they are borrowed from the practice of those around us, show the absurdity of such a practice. But not only are old hedges thus abused; young ones, which would thrive much better, and become a fence much sooner, if let alone altogether, are often hacked and cut over about eighteen inches from the ground, at which height a bush of weak stems grows up, the shade of which destroys the young twigs, and strips the stems quite bare. Nay, the cutting process is performed with the view, one would suppose, to destroy the plant, which it would inevitably do, were the thorn not pliant in its growth, and very tenacious of life; for, instead of the strokes of the bill being made upwards, which would leave the standing and growing stem *clean* cut, they are made downwards, by which the part of the stem which is taken away is cut *clean*, but the part which is left growing is hacked and split into many rents. As to weeding, it is seldom thought of till the hedge is almost choked to death; but, indeed, the common practice which so much prevails, of leaving a broad scarcement before the thorn-bed, renders weeding so irksome, laborious, and frequent a task, that one may cease to wonder hat farmers will not incur the expense of it, though proprietors ought, rather than ruin their fences. It is easier, however, to train up a hedge from infancy, in the proper manner (a truth which many parents, as well as hedge planters, have bitterly experienced), than to renovate it into a superlatively good fence after it has been mismanaged; but even that difficulty is not insurmountable to those who will observe with common eyes, and be guided by common sense.

3021. *Cutting down or breasting over an old top-heavy hedge. (fig. 477.)* When the hedge, which we left to grow some time ago, gets heavy in the top, and begins to affect the density of the foliage at the roots, and by which period the stems below will have acquired considerable strength, it should be cut down with the breasting-bill, in a sloping direction upwards, from the root in the face of the bank, to the back of the hedge on its top. This figure will illustrate the effect of this operation. The hedger stands on the face of the ditch, at the root of the hedge, with his right hand to it. He carries the bill in his right hand, and his left is covered with a glove of stout leather. After he has cleared away all the small twigs about the main stem, that the cutting process may not be in the least obstructed, he holds the bill with its edge inclined upwards, and gives the stem a cut upwards with the whole length and swing of his right arm, a stroke in a direction not unlike cut four in sword exercise, but much stronger. His left hand, the left arm being half stretched out, is ready to receive the back of the bill, in order to steady it for a repeated stroke; and as the main stems are the thickest, they may require repeated blows before they are cut through; and even it may be necessary to give a cut downwards on the end of the stem that is cutting away, that a wedge-shaped piece of wood may be removed, in order to allow the upward blows to take more effect. If the main stems are strong, the cutting-bill should be used for them, and the breasting one for the lighter stems. If the man is left-handed, he, of course, goes in an opposite direction to that mentioned above. It is absolutely necessary to make the blows cut upwards, and not downwards, as particularly and properly insisted on by Mr. Blaikie, in his little work *On Hedges*, whose sentiments on that subject, I shall here transcribe: —" A moment's reflection," he says, " will show that it is impossible for an edgetool to pass through a piece of timber, without causing a severe pressure against one or both of the sides of the wood, because the tool occupies *space*. The teeth of a saw drag the chips out of the cut, and give the *space* requisite for the tool to pass, but an edgetool can only pass by pressure.... In cutting the stem of a bush or young tree which is growing upright, if the blow is struck down, nearly the whole pressure falls on the stub (the growing stem), which is thereby shattered to pieces, while the stem cut off is left sound; but when the blow is struck up (as it always should be), the effect is reversed, the slab is then left sound and smooth (cut clean), and the stem cut off is shattered;" and when this practice obtains, "the wet does not penetrate through the stub into the crown of the roots, canker is not encouraged, and the young shoots grow up strong and healthy, and able to contend against the vicissitudes of the weather. The branches which grow out of the stem, many of them, not being thick, will be cut through by a dexterous cutter at one stroke. These cuts across the stems are not made in the plane of the line of the hedge, but at so considerable an angle with it, that they will not be seen, if viewed from the direction in which the hedger proceeds, but they will almost face the spectator in the opposite direction. When this operation is performed by a man who is dexterous in the use of the bill, there is nothing in hedging, that looks liker a nice piece of art, than this way of cutting down a hedge, not even that of its original planting. As the branches of a hedge interlace, the stems, as they are cut off, do not fall down like a tree. The hedger has to pull the end of the stem, that has been cut off, towards him with the bill, in order to seize it by the left hand, which having done, he pulls asunder the tops with the assistance of the bill, and lets the whole branch fall gently out of his hand, on the opposite side of the ditch to that on which he stands.

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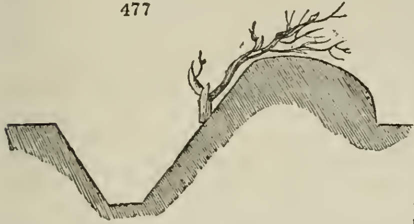

3022. *Season of performing the operation.* It should be kept in remembrance that this operation must not be performed during a hard frost. I once saw a very fine hedge breasted over, and that part, which had been cut down during a hard frost, did not send out a stem next summer exceeding four inches in length, whereas the parts of the hedge cut by the same hedger in fresh weather, pushed up strong and healthy stems three feet high. It was remarked at the time the hedge was being cut down, in frosty weather, that the stroke of the bill made a peculiarly ringing sound on the stems, and that they were more brittle, more easily split and cut over, than in fresh weather. Notwithstanding these peculiar symptoms, no suspicions of an injurious effect were entertained at the time. After such an operation in seasonable weather, it is astonishing how luxurious a growth of stems is generally developed. This kind of young hedge is switched and trained in the same manner as described above for newly planted hedges, till it comes to maturity. The hedge should be cut down when the field next the ditch is to be broken up out of lea, as the young hedge will be a fence by the time the field is again in grass. As the field behind the hedge will not likely be in the same part of the rotation as the other, it will be necessary to employ the cut thorns as a dead hedge on the mound. If the hedge cut down was strong, the dead fence will not require all the thorns, a part of which may be taken away for other purposes, or a similar purpose in another place. A dead hedge is made in the manner described.

3023. *After-management of a breasted over hedge.* If, in the course of years, when this hedge has arrived at maturity, it is found that the stems are so gross that few twigs grow from them, and that the bottom of it is too open as a fence for sheep, it will be necessary to cut the whole down within a few inches of the ground, with the axe or cutting-bill, according to the strength of the stem. If the cutting-bill is used, it is managed like the breasting-bill, and at times with both hands; but if the axe, then the hedger stands with his face in an opposite direction to the bent cutting one; that is, he keeps his left hand next the hedge, and using the long-handled but light axe, with both hands, he cuts the thick stems in a sloping direction upwards. It may, in the first instance, be necessary to cut away the small branches with the bill, which may interfere with the action of the axe, or injure his hands; for, in this process, which requires strength and dexterity, gloves are not convenient pieces of dress. He pulls the thorns asunder, after they are cut, and deposits them on the same side of the ditch as when they were breasted over; and it is just as absolutely necessary now as before, to leave the growing stem clean cut. Cutting with the axe is a very laborious operation at all times, but particularly when cutting down old thick-stemmed thorn hedges. Old thorns are sometimes so bulky and heavy, that it is necessary to drag them away with horses, instead of attempting to put them on carts. Both after this and the other process of cutting, the ground around all the roots should be thoroughly cleared of all weeds, and it would even be advisable to water-table the hedge, and to throw the shovellings of the ditch upon the face of the mound. But should water-tabling not be necessary, there can be no doubt that the ditch will require scouring; and there cannot be a more favourable opportunity for the work being done, than when the hedge is cut down, amongst the stems of which the shovellings of the ditch can be deposited.

3024. *Rectifying the old age of a thorn hedge improperly treated in its youth.* In this operation much care and judgment are required. It is found that in ordinary-sized gaps, which exist between the old stems of a thorn, young plants will not easily take root and thrive. This effect is produced, partly by the shadowing of the stems which grow quickly out of the old stem and overtop the young plant, and partly by the want of nourishment from the earth, the juices of which have been extracted already by the older tenants. To remedy such defects, plashing has been resorted to, and when that has been judiciously done, by laying the plashes near the ground, a small gap may be filled up for some time. But I agree perfectly with the following observations of Lord Kames on the nature of plashing in general: —

3025. "*Plashing an old hedge,*" says his Lordship, "an ordinary practice in England, makes indeed a good interim fence, but at the long run is destructive to the plants; and accordingly there is scarce to be met with a complete good hedge where plashing has been long practised. A cat is said among the vulgar to have nine lives. Is it their opinion that a thorn, like a cat, may be cut and slashed at without suffering by it? A thorn is a tree of long life. If, instead of being massacred by plashing, it were raised and dressed in the way here described, it would continue a firm hedge, perhaps, for five hundred years." This merits attention. If plashing really be practised, and such an old practice cannot be easily forsaken, it may be necessary to remind the operator to cut the stem no deeper in than necessary to bend it down with considerable difficulty, as near the ground as possible; for plashing at a great height above the ground defeats its own object, namely, that of filling up gaps below. Keep the end of the plash down, either by inserting it under a hooked branch of a neighbouring thorn, or by a hooked stick driven into the ground; and push a bit of wedge-shaped stick into the cut, to assist in preventing the plash from starting up. Stuff then some worked up clay into the cut, and thus close it up from the effects of wet and drought.

3026. *Laying an old hedge.* It will be a much better practice to renew the earth in the gaps with fresh soil, mixed with dung and lime, in the first year after the hedge has been cut down, and then in the second year to take a stem from each side of the gap which has shot up from the old stem, and lay them in the soil so prepared, as gardeners lay carnations and roses, by fastening them down to the earth with pins. These layers will strike root, and grow up as young plants; and when they have acquired sufficient strength, they then can of course be cut away from the parent stem. When the gaps extend many yards between the old stems, and when of course it would not be practicable to fill up all the space with such layers, the old earth between them must be completely taken out, and new and fresh soil, prepared as above, substituted in its place, and young plants must be laid on a thorn-bed, and the whole work of repair carried on and finished in the same manner as described in the original planting. In training these renewed plants, it will be necessary to check the growth of the old stems, and encourage that of the young plants, till both have acquired the same length, when both may be treated alike. An old gateway may be beat up in this manner; but if still to be used on emergencies, a dead fence of thorns will protect the gap for a great length of time. In repairing hedges, of whatever age, it ought to be kept in remembrance, that a hedge ought never to be planted on the top of a mound thrown up from the ditch. It has, indeed, the advantage of an imposing situation; but being planted in bad soil, and destitute of moisture, it cannot thrive: it is at best dwarfish, and frequently decays and dies. (*Stephens of Balmadies in Quar. Jour. Agr.*, vol. ii. p. 621.)

3027. *The hedge and bank* consists of a hedge planted upon the plain surface, with a bank or mound of earth raised behind it by way of protection.

3028. *The hedge in the face of a bank* differs from the former, principally in having the hedge in the front of the bank considerably above the common surface, in place of having it at the bottom.

3029. *The Devonshire fence* is a sort of hedge and bank, as it consists of an earthen mound, seven feet wide at bottom, five feet in height, and four feet broad at top, upon the middle of which a row of quicks is planted; and on each side, at two feet distant, a row of willow-stakes, of about an inch in diameter each, and from eighteen inches to two feet long, is stuck in, sloping a little outwards: these stakes soon take root, and form a kind of live fence for the preservation of the quicks in the middle. This fence nearly resembles the hedge on the top of a bank, and is equally expensive in the erection: the formation of the bank deprives the adjoining surface of its best soil, and the plants made use of are liable to every injury that can possibly arise from drought, frost, and gradual decay or crumbling down of the mound. The addition of the willows to this fence is certainly a disadvantage; if the quicks require protection, dead wood is equal to every purpose that could be wished or expected, and at the same time possesses the additional advantage of requiring no nourishment, and having no foliage to shade the thorns or other plants.

3030. *In the hedge with posts and rails,* the railings are employed for the protection of hedges, as well those that are planted upon the plain surface, as for the hedge and ditch united. The addition of a paling is, however, more immediately necessary in cases where the hedge is planted upon the plain surface, especially when the fields so enclosed are in pasture.

3031. *The hedge and dead hedge* is a fence that consists of a row of quicks or other hedge-plants, set either upon the plain surface, or in the face of a ditch or bank. The dead hedge answers a double purpose, namely, that of protecting the young plants from the injuries they may receive from cattle or the inclemency of the weather, and at the same time forming a temporary enclosure which lasts till the hedge is grown up.

3032. *The hedge and wall fence* is of two kinds, namely, a coarse open wall, built of loose stones, on the top of the bank formed by the earth taken out of the ditch; and when hedges are planted upon the plain surface, a thin and low wall regularly built alongside answers the double purpose of sheltering and encouraging the growth of the plants while they are in a weak tender state, and afterwards prevents the possibility of the hedge becoming open below. Where gardens are entirely, or in part, surrounded by hedges, and in the enclosing of fields by the sides of highways, especially in the vicinity of great towns, where dogs and other destructive vermin are apt to creep into the enclosures, and annoy the stock, the law wall forms a valuable addition to the fence.

3033. *The hedge in the middle or in the face of a wall* is executed in the following manner:—The face of the bank is first cut down with a spade, not quite perpendicularly, but nearly so; a facing of stone is then begun at the bottom, and carried up regularly, in the manner that stone-walls are generally built: when it is raised about eighteen inches, or two feet high, according to circumstances, the space between the wall and the bank is filled up with good earth, well broken and mixed with lime or compost: the thorns are laid upon this earth in such a manner, as that at least four inches of the root and stem shall rest upon the earth, and the extremity of the top shall project beyond the wall. When the plants are thus regularly laid, the roots are covered with earth, and the building of the wall continued upwards, filling up the space between the wall and the bank gradually, as the wall advances upwards: when completed the wall is finished with a coping of sod, or stone and lime. When the plants begin to vegetate, the young shoots appear in the face of the wall, rising in a perpendicular manner. This sort of fence is much in use in some of the western counties of Scotland, and wherever there is plenty of stones; it is a good and cheap method, especially where wood for rails or paling cannot be got readily. (*C.*)

3034. *The hedge and ditch, with row of trees,* differs from those which have been described only in having a row of trees planted in the line of the fence along with the hedge. The advocates for this practice say, that, by planting rows of trees in the direction of the fence, the country is at once sheltered, beautified, and improved; and that the interest of the proprietor is ultimately promoted by the increasing value of the timber raised in these hedgerows. It is also said, that such trees produce more branches for stack-wood, knees for ship-builders, and bark for the tanners, and they sell at a higher price per load, than trees grown in woods and groves. Besides, close pruning hedgerow trees to the height of twelve or fifteen feet, prevents their damaging the hedge; the shelter which they afford is favourable to the vegetation both of grass and corn; it also tends to produce an equable temperature in the climate, which is favourable both to the production of, and greater perfection and beauty in, animals, and of longevity to man. Though the practice of planting hedgerows of trees is very common, though its advocates are numerous, and though these arguments are urged in its favour, yet the objections are also entitled to very serious consideration. When trees are planted in the line of a fence, if that fence is a hedge, the plants of which it consists will not only be deprived of a great part of their nourishment by the trees, but will also be greatly injured by the shade they occasion, and the drop that falls from them during wet weather: upon this point little reasoning is necessary; for, if we appeal to facts, we shall find that no good hedge is to be met with where there is a row of trees planted along with it. The mischief is not, however, confined solely to hedges; the effects are equally bad, perhaps worse, where the fence is a stone-wall; for though in this case the shade or drop of the trees is hardly if at all felt, yet, when they have attained a certain height, the working and straining of the roots during high winds is such, that the foundations of the wall are shaken and destroyed; accordingly, wherever large trees are found growing near stone walls, the fence is cracked and shaken by every gale of wind, is perpetually falling into large gaps, and costs ten times the expense to keep it in repair that would otherwise be required if no trees were near it. Admitting, however, that the trees in hedgerows were no way prejudicial to the fence, which we have already shown is by no means the case, another argument may be successfully used against the practice. It is seldom, indeed, that trees planted in hedgerows arrive at any great size; on the contrary, they are generally low and stunted: and while they occasion a visible loss by the mischief they do the fence, their utmost worth, when they come to be sold, will seldom be found adequate to the loss and inconvenience they have occasioned.

3035. *Stephens is decidedly inimical to planting trees in hedges.* It is quite impossible, he says, even with the greatest care imaginable, to rear thorns to a good fence under forest-trees; even trees growing on the top of the mound of a double hedge, abstract the moisture from the earth and injure the foliage of both the hedges; and though it may be probable that the two hedges may not be gapped by the trees in places exactly opposite, the injury the individual hedge suffers cannot be remedied under the overshadowing poison. Lord Kames makes the following judicious remarks on planting hedgerow trees:—"To plant trees in the line of the hedge, or within a few feet of it, ought to be absolutely prohibited as a pernicious practice; it is amazing that people should fall into this error, when they ought to know that there never was a good thorn hedge with trees in it: and how should it be otherwise? An oak, a beech, or an elm, grows faster than a thorn; when suffered to grow in the midst of a thorn hedge, it spreads its roots every where, and robs the thorns of their nourishment. Nor is this all: the tree overshadowing the thorns keeps the sun and air from them; at the same time, no tree takes worse with being overshadowed than a thorn. Hedgerow trees certainly give a closely fenced appearance to a country, and at a distance look not unlike trees in an orchard: but they are at best formal; the trees in them, though they may be very hardy, and yield strong, tough timber, never attain to great size, and are often distorted in shape by the force of the winds, which bend them to their will; and when their baneful effects on the hedges and crops are considered, it is astonishing to see their cultivation so prevalent. It may be ungracious treatment, now that they are planted and growing, to root out every one of them without delay; but they may be treated as annuitants whose consummation may be devoutly wished for, and whose places will not be replenished by similar occupants. Plantations, and clumps, and belts of trees, afford better shelter than single rows; and when they can be judiciously planted, in situations where little use can be made of the ground for culture — and there is no property without many such situations upon it — and in other situations where they would screen fields from the prevailing winds, they not only become useful timber, but ornamental objects in the landscape, — objects which fill the eye, rivet the attention, and are vastly more tasteful than any single row of stunted trees can be." (*Quar. Jour. Agr.* vol. i. p. 623.)

3036. *The hedge and ditch, or hedge and wall, with belt of planting,* in exposed situations, is strikingly useful and ornamental, while upon low grounds it is not only unnecessary, but in some instances absolutely hurtful. For instance, in deep and broad valleys surrounded by hills, and sheltered from severe blasts, belts of planting are not only unnecessary, but even hurtful and ruinous by the ground they occupy, which could certainly be employed to greater advantage, and the original expense of enclosing and planting saved.

3037. *The hedge and ditch, or wall, with the corners planted,* is employed upon some estates instead of the belt of planting. According to some, it has a good effect upon the scenery of the country, and answers the purpose of general shelter extremely well: it is, however, greatly inferior to the belt of planting, for the purpose of sheltering particular fields; but as in every field there is a space in each angle that cannot be ploughed, by planting these spaces, which would otherwise be left waste, many valuable trees are raised with little expense, and with scarce any waste of land.

3038. *The furze fence* may be had recourse to with advantage whenever such plants are found to grow vigorously in a soil. Fences of this sort are mostly made upon mounds or banks of earth, by sowing the seed of the plant. Sometimes the bank is only sloped on one side, but at others on both; in the former case the front is perpendicular, and faced with turf or stone. From these fences being raised so considerably above the common surface, they are very liable to injury from frosts and other causes in severe winters. In all cases where they are clipped or cut once a year, or once in every two years, the clippings may be bruised and given to horses or cattle, who are fond of them, and are found to thrive and fatten on this food.

Subsect. 4. *Paling Fences.*

3039. *Paling fences* are only to be considered in a secondary light; for, of whatever wood they are made, however substantially they may be executed, or in whatever situation they are placed, their decay commences the instant they are erected. Where permanent use therefore is required, palings ought never to be adopted; but for ornament in pleasure-grounds, or for the protection of young thorns, they are highly valuable. In all cases where either dead hedges or palings are used, the decay and ultimate loss of the fence is owing to that part of it which is let into the ground being rotted by the moisture. Where dead hedges are planted, it is no easy matter to provide a remedy against this evil; as the stems are so numerous, that, to give each of them a preparation that would completely defend it from the effects of moisture would be attended with an expense equal to, if not greater than, the value of the fence. Where palings, however, are used, especially the most expensive and substantial kind of them, and such as are meant both for duration and ornament, it is desirable to prepare the standards, or upright parts that are placed in the earth, in such a manner as will enable them to resist the moisture for many years. In the south of England, the post is always more bulky at the lower end than the upper, and is fixed in the ground by digging a hole, placing it therein, shovelling the soil in, and ramming it round the post till it be firmly fixed. It has been a practice from time immemorial, to *burn* or *char* that part of the standards or palings intended to be set or driven into the earth: the reason assigned for this practice was, that the fire hardened the parts thus subjected to it, and, by rendering them impervious to moisture, made them more durable than they would have been without such operation. But the best defence at present known against the effects of the weather is the bark of the tree. This covering it has from nature, and is possessed of every requisite, being impregnated with oil, resin, and other matters, which secure it completely, not only against moisture, but other injuries arising from the operation of air, light, heat, &c.; of this we have strong proofs by observing what happens where, by cutting off a branch or otherwise, the bark of any tree is destroyed. If the surface laid bare by the wound is considerable, that part of the body exposed by it begins immediately to decay, and continues to waste, unless some covering be made use of to supply the place of the bark; for that purpose nothing has yet been found so effectual as a coat either of boiled oil, or of oil-paint, which, by completely excluding both air and moisture, not only preserves the tree from rotting, but also prevents it from bleeding and wasting itself by an effusion of juices from the wound. When trees are cut down and sawn into planks, whether for palings or any other purpose, and are afterwards exposed to the weather, the same thing happens that we have mentioned as taking place with the growing tree when deprived of its bark, but in a much greater degree, as the whole surface is then without a covering. To prevent this decay, the same remedy should be applied, *viz.* painting the whole of the wood, or otherwise filling the pores with oil, in such a manner as to prevent the entrance of moisture. There are now coarse oil-paints sold of all colours, so cheap as to enable persons erecting palings, or other works of wood, to paint them at a small expense. Other very good remedies are to be had at a moderate price, as the pyrolignous acid from gasworks, which, if the points of the standards that are to be driven into the earth are dipped into it while the liquor is boiling hot, will preserve them from the bad effects of moisture for a very long time. Previously to the dipping, they should be properly sharpened, and that part which is to enter the ground, or even the entire post if convenient, moderately charred or burnt. Common tar, melted pitch, or gas liquor, may also be successfully employed for the purpose of defending the extremities of the upright parts of paling from moisture; linseed and train oils may also be used with success; the great object being to fill the pores completely with some unctuous or greasy matter, or contract them by partial charring, so as to prevent the admission of moisture. The posts should be completely dry before they are dipped in any of these preparations: for if they are either made of green wood, or have imbibed much moisture, or after being dipped are exposed either to the heat of the sun or to a severe frost, the moisture will become so much expanded thereby, as to burst through, and bring off the paint or other coating; whereas, when they are made of well seasoned wood, and are at the same time perfectly dry, and the pitch, oil, or varnish boiling hot, it readily enters the pores, and, by filling them completely, prevents the access of moisture, and consequently the injurious effects produced by it.

3040. *The simple nailed paling* consists of upright posts, driven or set into the earth at certain distances, and crossed in three, four, or more places, with pieces of wood in a horizontal direction. This paling is for the most part made of coarse sawn wood, without any dressing.

3041. *The jointed horizontal paling* consists of massy square poles, driven or set into the earth at regular distances, through which mortices or openings are cut for the reception of the extremities of the horizontal pieces which traverse them.

3042. *The upright lath paling* is made by driving or setting a number of strong piles into the earth at regular distances, and crossing these at top and bottom with horizontal pieces of equal strength; upon these last are nailed, at from six to twelve inches' distance, a number of square pieces of sawn wood, of the shape and size of the laths used for the roofs of tiled houses. This sort of paling, when properly executed, looks very well, and, notwithstanding its apparent slightness, if well supported by props or rests at regular intervals, lasts a long time. Where there are plantations of young firs in the neighbourhood, laths may be had at a trifling expense.

3043. *The horizontal paling of young firs, or the weedings of other young trees,* may be had recourse to with advantage upon estates with extensive woods, or surrounded with belts of thriving plants; the thinnings of such woods or belts being highly valuable for making palings, especially when the plantation consists chiefly of firs. The palings of young firs are of two kinds, either horizontal or upright. The horizontal resembles the jointed dressed paling already described, and the upright is similar to the lath paling.

3044. *The chain horizontal fence* is made by fixing a number of strong square piles into the earth at regular distances, in the direction in which the fence is to run; each of these piles has three strong staples or iron hooks driven into it on each side, one near the top, one within eighteen inches of the bottom, and one in the middle; to these staples or hooks chains are fastened and stretched horizontally, in the same manner as the pieces of wood are in a common horizontal wooden fence. When it is meant that the fence should be laid open for any temporary purpose, hooks are driven into the posts in place of staples, and the chains hung upon them; but where this is not wanted, the staples will be found the most secure method. In some cases the upright part of this fence, in place of wooden piles, such as have been described, consists of neat pillars of mason-work or cast iron.

3045. *The rope fence* is nearly the same as the former, that is, it consists of upright posts, driven into the earth at regular distances, with holes bored through them for the passage of the ropes; in general there are three, and in some cases four, courses of ropes. This can only be used for confining cattle or horses; for sheep it will be found quite incompetent; for stretching across rivers, or pieces of water, like the chain fence, the rope fence will be useful.

3046. *The movable wooden fence, flake, or hurdle.* This has hitherto been principally employed in cases where sheep or cattle are fed with turnips in the field, to separate a certain portion of their food at a time; in that way hurdles are extremely useful, as the sheep or cattle, by having a given quantity of food allotted them at once, eat it clean up without any loss, which they would not do if allowed to ranged at large over the whole field. There are, however, many other purposes to which hurdles may be applied with equal advantage. In the subdivision of gentlemen's parks, in order to subject them to a course of aration, no fence is so suitable as the hurdle, which may be taken up and set down at pleasure, and in a short time. This circumstance being generally known, these fences never convey the idea of impassable barriers; and, not being very common, they are never considered vulgar Were it not for their expense, they would be far preferable to common fences, in districts that do not require shelter; because they occupy less space than hedges or walls, and do not, by attracting cattle, cause their manure to be unequally distributed; nor do they harbour birds or insects.

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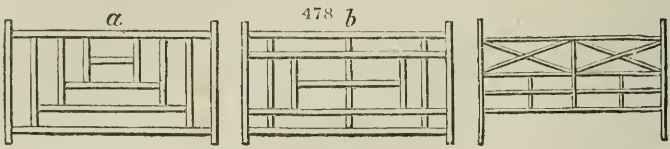

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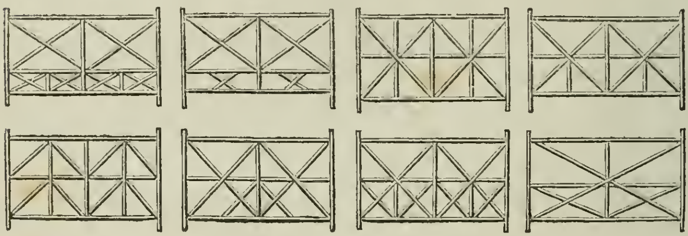

3047. *Ornamental wooden hurdles* (*fig.* 478. and 479.) may sometimes be formed at less expense of material than the common sort, because they admit of being made strong by working up short pieces of wood. Those which are highest (*fig.* 478. *a b*) may be made of oak, and six feet high, so as to be a fence for cattle; others (*fig.* 479.) may be made of the common prunings and thinnings of young plantations. In general it is an improvement in the construction of hurdles to make the two sides so as to answer either as bottom or top (*fig.* 480.); by which means, if a leg is broken off, it is only necessary to turn the hurdle upside down, and we have still a perfect hurdle. For this purpose make the heads eighteen inches or two feet longer than usual, and sharpen both ends (*fig.* 480.); then the side pieces should be always double, one on each side of the rails, and should shut in at their ends on the heads and the centre piece, that their bearings may be equally strong and firm whichever end is even uppermost. (*Gard. Mag.* vol. iv.)

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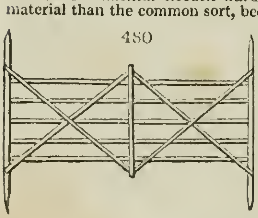
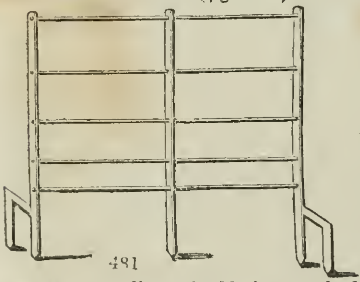


3048. *Iron hurdles* (*fig.* 481.) are found a very elegant and durable fence, though more than double the expense of wood. For park o lawn fences they are admirably adapted; but occupy rather too much capital for a commercial farmer.



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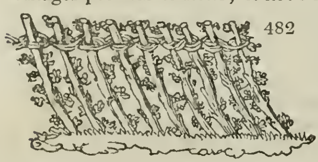
3049. *The willow, or wattled, fence* is made by driving a number of piles of any of the kinds of willow or poplar, about half the thickness of a man's wrist, into the earth, in the direction of the fence, and at the distance of about eighteen inches from each other. They are then twisted, or bound together along the top with small twigs of willow or poplar (*fig.* 482.). This kind of fence has some advantages peculiar to itself; it not only forms a cheap and neat paling, but if it is done either about the end of autumn or early in the spring, with willows or poplars recently cut down, the upright parts or stakes will take root, grow, and send out a number of lateral branches; and, if pains are taken in the following autumn to twist and interweave these branches properly, a permanent and almost impenetrable fence may be formed in two or three years. For the enclosing of marshy lands, or for completing any enclosure, where a part of the line in which the fence ought to run is so wet as to be unfit for the growth of thorns, or the building of a wall, the willow paling will be found an excellent contrivance, and the use of it will render many enclosures complete that could not otherwise have been formed. Sometimes stakes are used of a kind which do not take root and grow, in which case this form still makes a very neat and efficient temporary fence. (*fig.* 483.)



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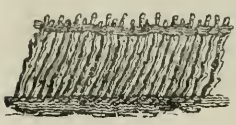

3050. *The paling of growing trees, or rails nailed to growing posts,* is made by planting beech, larch, or other trees, in the direction of the fence, at about a yard distant from each other, more or less, as may be thought necessary: these trees should be protected by a common dead paling, till they are ten or twelve feet high, when they should be cut down to six feet, and warped or bound together with willows at top and in the middle; cutting off the tops will have the effect of making them push out a great number of lateral branches, which, if properly warped and interwoven with the upright part of the trees in the manner described for the willow fence, will both have a beautiful effect, and will at the same time form a fine fence, which, in place of deep decaying, will grow stronger with time, and may with very little trouble be kept in perfect repair for a great length of time.

3051. *The upright and horizontal shingle fences* are chiefly made of firs, coarsely sawn into deals of from half an inch to an inch thick, and of different breadths according to the diameter of the tree. Pretty strong square piles are driven or set into the earth, and the deals nailed horizontally upon them, in such a manner that the under edge of the uppermost deal shall project or lap over the upper edge of the one immediately below it; the fence, when finished in this manner, will have nearly the same appearance as the bottom of a boat or cutter. An upright fence is made by fixing perpendicular posts in the earth, nailing three pieces of wood horizontally, and covering these with shingles placed perpendicularly; in this case the shingles are not above three inches broad, and the extremittes of each are pointed at the top.

3052. *The warped paling fence* consists of pieces of wood driven into the earth, bent down in different directions, and their tops fastened together; this fence resembles the *chevaux-de-frise,* with only this difference, that, in place of leaving the points standing up, as is the case with that part of fortification, they are bent down and tied together. When made of dead wood, this fence is equally perishable with others of the same description; but when made of growing plants, it will be found very lasting.

3053. *The light, open, paling fence, with thorns, or the branches of trees wove in* (*fig.* 484.), differs from the common paling fence already described, only in being warped either with thorns, or the branches of trees. When properly done, it forms at once a very complete fence; but, like all fences made with dead wood, it will be found very perishable, and will require many repairs. It has, however, one advantage, viz. that, when properly executed, it is proof against the entrance of animals of any kind.

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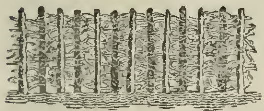

3054. *Primitive paling fences* are formed without nails or ties of any sort, by inserting the pales or stakes in the ground in different directions (*fig.* 485.), and by using forked or hooked stakes. They are chiefly desirable in forest or park scenery for maintaining a particular character, and for separating horses, deer, &c. Such fences sometimes occur in Poland, Hungary, &c.; but in a civilised country they are to be considered more in the light of effect than of practical utility.

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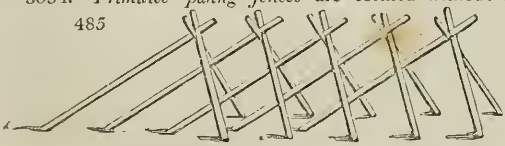

3055. *Park fences of iron* are the most efficient and elegant. (*fig.* 486. and 487.) Light cast-iron posts, with rails or round iron rods, five eighths of an inch in diameter, to the height of four feet, and, a foot higher, on the bent extremity of the posts, a chain instead of a rod (*fig.* 486.), are found to form a barrier against any description of the

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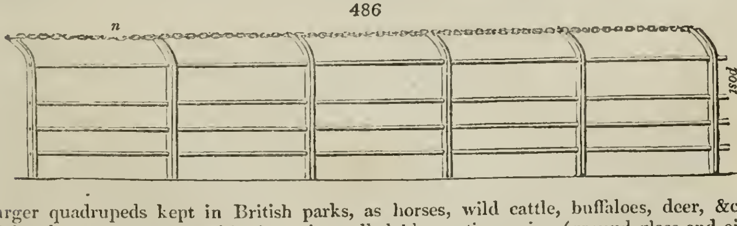

larger quadrupeds kept in British parks, as horses, wild cattle, buffaloes, deer, &c. Painted green, or even with the paint called blue anticorrosion (ground glass and oil chiefly), or coated over with the pyrolignous liquor from the gasworks, such fences are not obtrusive, and less liale to suggest ideas of limitation, confinement, restraint, &c., than walls or pales. Silarly characterised fences may be composed of connected hurdles (*fig.* 487), which are valuable, and probably the cheapest of all fences in dividing rich and extensive pastures, such as a park let out to a farmer for several years'

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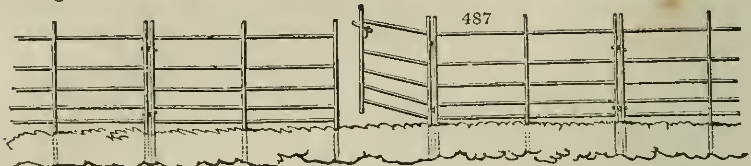
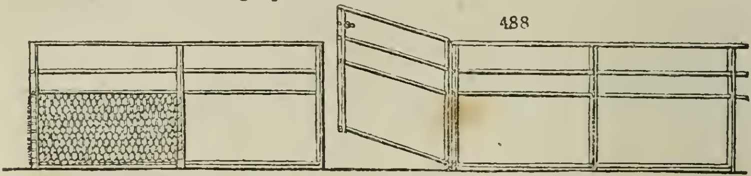


grazing. For poultry, or for excluding hares, rabbits, &c. the lower part of such fences is covered with a wire netting. (*fig.* 488.)

488



Subsect. 5. *Wall Fences.*

3056. *Wall fences* are constructed of different sorts of materials, and are of various kinds. They are for the most part good fences, though some of them, as those of the earthy kinds, are not by any means durable, and therefore should not be formed where better sorts can be used. In the construction of walls, it is essential that the stones be either taken from a quarry, or consist of the largest land-stones broken in such a manner as to have a good flat surface, in order that they may bind well; that they be built by masons, and well pinned; that they have as dry and deep a foundation as possible, in order to guard against frosts, &c.; that they be made wide at the bottom, and tapering upwards to about the breadth of ten inches, when the coping is to be applied; that the coping consist of materials that cannot be readily overturned or removed, as, upon the manner in which it is finished, much of the future value and durability of the wall will be found to depend.

3057. *Dry stone walls* are of three kinds: those constructed of round stones gathered from the fields, and coped with turves; of quarried stones, upon which some pains have been bestowed to put them into proper shape; and the Galloway dike, so denominated rom its being originally used in that country.

3058. *The wall or dike made with round or land-stones*, by labourers, and covered with a coping of turf, is a very indifferent fence. In most instances, it is not only very ill constructed as to shape, being of one uniform thickness from top to bottom, but the stones, from their round figure, do not present a sufficient surface to each other to bind and give stability to the building. This fence has long been known, and is still very common in the remote parts of the country, upon estates where the first rude essay is made in the way of improvement, and where masons cannot readily be had. In such situations it has a two-fold benefit; the surface is cleared of many stones that would otherwise have presented a considerable obstacle to its cultivation, and the field is at the same time enclosed: but, though these objects are accomplished for a time, their benefit is not permanent, as the wall is perpetually tumbling down; even the cattle rubbing against it make considerable gaps in many places; and in that way, great trouble and expense are annually required to keep it in repair.

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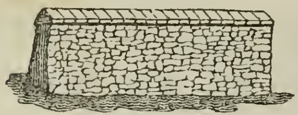

3059. *The wall in which the stones are quarried* (*fig.* 489.), and put together by skilful masons, broad at bottom, tapering gradually upwards, and finished at top with a substantial coping, has a very neat appearance, and has been known to last thirty and even forty years without repairs. A good foundation is highly essential in the construction of this fence; from nine to twelve inches is the smallest depth that it should be below the common surface, especially if the soil is open and porous; and the largest and heaviest stones should always be laid undermost. The best dikes of this kind are now built solid from bottom to top, and coped with stones resting upon others projecting beyond the width of the dike. (*C.*)

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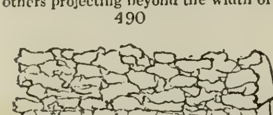


3060. *The Galloway dike or wall* (*fig.* 490.) is principally employed for enclosing high grounds that are depastured with sheep, for the confining of which it seems well calculated. From two feet to two and a half, at the bottom, it is built in a regular compact manner with dry stones, in every respect the same as a dry stone wall with a broad base, tapering gradually upwards: the building is then levelled with a course of flat stones, resembling a coping, in such a manner as that these flags or flat stones shall project two or three inches over the wall on each side. Above these flat stones is laid a course of rugged round ones, placed upon each other in a way secure enough to give stability to the building, but at the same time so open as to leave a considerable vacuity between each; by which means a free passage is afforded to the light and wind, which blows through them with a violent whistling noise. This rough open part of the building is generally raised three feet above the regular part of it, gradually tapering upwards, till it terminates in a top of about nine inches broad, every course of the rough stones being smaller than that immediately beneath it. Its tottering appearance is so well calculated to prevent sheep, cattle, or other animals from approaching it, that it is seldom indeed that any attempt is made to leap over it. This circumstance, together with the ease with which the stones are procured, in most of the situations where the Galloway dike is used, renders it a valuable fence.

3061. *Stone and lime walls*, in order to be durable, should have a good foundation, deep enough to prevent them from being hurt by frosts, with a broad base, tapering gradually upwards. This fence, when properly executed, is, next to hedges, the most durable: it is, however, very expensive; and its superiority over the dry stone-wall is so trifling in point of durability, as to render the latter the more eligible, being much cheaper, and answering every purpose of a fence equally well. For the building of this wall, stones taken from the quarry are to be preferred to the common land-stones; for though a mason may be able to remedy, in some measure, the inequality of surface in land-stones, by mixing plenty of lime with them, yet experience proves that walls made with such stones, notwithstanding every care on the part of the builder, are much less perfect, and last a much shorter time, than where quarried stones are employed. This, like every other stone fence, should be secured at the top with a substantial coping. Stone fences of every description not only form complete enclosures at once, and by that means allow the proprietor to enter into immediate possession of every advantage that can arise from the enclosing of his fields, but, by the little room they occupy, a considerable portion of land is saved.

3062. In the *construction of walls of stones and clay*, the clay is used like lime, and is meant to answer the same purpose. It requires slender observation to convince intelligent persons, that a wall made with such materials in the ordinary way cannot be a durable one; for if the clay made use of in building the fence has been very moist, the summer's heat will dry it so much as to leave considerable chasms in the building; these chasms must necessarily deprive many of the stones of that support which they require, and in that way endanger the building. This, however, is not the only inconvenience with which this kind of wall is attended; the effect of the summer's sun upon the clay parches it so completely, that when the wet weather commences about the end of autumn, it absorbs the moisture like a sponge, and if it is overtaken by frost while in that state, the fabric swells, bursts, and tumbles down.

3063. *Walls of stone and clay, dashed with lime*, differ in no respect from that described, except in the harling or dashing that is given them. Where that operation is well performed, and at a proper season of the year, the coating of lime, by preventing the entrance of moisture, will add greatly to the durability as well as beauty of the wall; so much so, indeed, that some fences made in this way, where the clay was properly tempered, and did not contain too much moisture, and where a harling or dashing of lime was afterwards given, have been known to last nearly as long as walls made entirely with stone and lime.

3064. *The dry stone wall, lipped with lime*, differs from the ordinary dry stone wall, in having about two or three inches of it on each side lipped with lime, which gives it the appearance of being built entirely with stone and lime. Where the external appearance of a fence is an object, something is gained by this practice; in point of real duration, however, it seems to possess very little advantage over the common dry stone-wall, which, when properly executed, lasts equally long.

3065. *Dry stone walls, lipped and harled*, are much the same, nothing more being added than a harling or dashing of lime after the other work is finished: this addition is to be considered merely as an improvement upon their appearance, and not as contributing to increase their utility, or render them more durable as fences.

3066. *Dry stone walls, pinned and harled*, are much the same: the mason only carefully pins or fills up all the interstices of the building with small stones, after they have been built in the ordinary way, and afterwards dashes or harls them over with lime. The pinning, by filling up every vacant space, and affording complete support to the stones in every part of the surface, adds considerably to the durability of the building, and the harling afterwards gives the whole a finished substantial appearance, which renders them at once agreeable to the eye, and lasting as fences.

3067. *The dry stone wall, with a light paling upon the top*, is sometimes made, and for particular purposes answers well, and has a handsome appearance when well executed.

3068. *Brick walls* are seldom had recourse to for ordinary enclosures, except in situations where stones are extremely scarce (as is the case in some counties), and for pleasure-grounds, and for park or garden walls. In Nottinghamshire, we have observed brick walls of open work, in the manner of the walls of MacPhail's dungpits; but the zigzag brick wall we should think preferable as a field wall. (See *Enc. of Gard.* and *Gard. Mag.* vol. v. p. 678.)

3069. *Frame walls* are constructed in the following manner: — A frame of deal boards, of a width and height proportioned to that of the intended fence, is placed upon the line in which it is intended to be made, a proper foundation having been previously dug; the frame is then filled with stones of all sorts, gathered principally from the adjoining fields: when the frame is filled to the top with such stones, a quantity of liquid mortar is poured in amongst them, sufficient to fill up every interstice; the whole is suffered to remain in that state till it is supposed that the mortar has acquired a suitable degree of firmness to give stability to the building, which in summer, when the weather is warm and dry, will not require above a day or two. The frame is then removed, and placed a little farther on in the same line, in such a manner as that one end of it shall join immediately with that part of the work from which it had been removed. In this way the line of fence is gradually completed, which, when the lime is of good quality and well mixed with sharp sand, and the proper pains taken to incorporate it with the stones, presents a smooth uniform surface, and will doubtless form a substantial and durable fence.

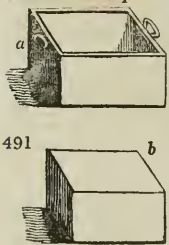
3070. *Turf walls* are met with in almost every upland or hilly district throughout Britain, and for temporary purposes are found very useful. In a variety of instances this sort of fence is used for enclosing fields, and is practised for that purpose to a very considerable extent; in others, however, it is used for the formation of folds, pens, or other places of confinement for cattle during the night. In general, the fence is made with turf only, pared off from the adjoining surface, and used without any mixture of earth; in other cases, the wall consists of a facing of turf on each side, while the space between is filled up with loose earth. For a fold, this fence answers extremely well; but for enclosing a field, or indeed any other purpose where durability is required, it should never be used, as from the moment it is finished its decay commences, and pains or attention will be able to keep it in repair after it has stood two or three years.

3071. *Stone and turf walls* are also very common in many situations, where better and more durable ones could be made at equal, perhaps less, expense. In many instances, however, they are employed from necessity, where lime is either very dear, or not obtainable at any price.

3072. *Mud walls, with a mixture of straw*, were formerly frequent in many places, not only for surrounding small enclosures and stack-yards, but also for the walls of farm-houses and offices, and for subdividing houses into different apartments. When either the outside walls, or the inside divisions of a house, are to be made of these materials, the custom is, to take a small quantity of straw, and incorporate it with a sufficient proportion of clay; the straw in this case answers the same purpose as hair in lime-plaster. When a sufficient number of small masses are made, the work is begun by laying a stratum at the bottom of the intended wall; this being done, and the different pieces firmly kneaded or worked together with the hand, a flat deal board is applied on each side, which, being properly pressed and rubbed against the building in a horizontal direction, not only serves to consolidate the work, but gives it a degree of smoothness and uniformity; successive strata are added, till the wall is raised to the intended height, care being taken to taper it gradually upwards. Walls made in this way, if properly constructed, will last for many years; and, if dashed or harled with lime at a proper season of the year, will have an appearance no way inferior to such as are made with stone and lime; along with this addition to their appearance, the harling or dashing with lime, if properly done, will, by preventing the access of moisture, render them much more durable.

3073. *Rammed earth, or en pisé, walls* are very common in France, both as fences and walls for buildings. They have been described at great length in the *Communications to the Board of Agriculture*, and in other works, and tried in various parts of this country with tolerable success, though they are by no means suited either to our moist climate, or degree of civilisation. In constructing them the earth is previously pounded, in order to crumble any stones therein; clay is added in a small quantity, about one eighth part. It is all beaten and mixed up together by repeated blows with a mallet about ten inches broad, ten or fifteen inches long, and two inches thick. The earth being thus prepared, and slightly wetted, the foundation of the wall is dug. This is laid with stone; and, when it is about one foot high above the surface of the ground, planks are arranged on each side, and the space between filled with the earth intended for the wall, which is strongly beaten. This method is continued successively, till the wall is completed.

3074. *Stamped earth walls* are the invention of François Cointeraux. Earth prepared in the same manner as for rammed walls, is put into a mould or box of any size, generally that of the proposed wall's thickness in width, one or two feet long, and about one foot high. (*fig.* 491. *a*) The mould is a strong oaken or iron box, and the earth being placed in it, is compressed either by the action of a press acted on by a lever or screw, or a stamping-engine similar to the pile-driver or great forge-hammer. The stone, or solid body of earth (*b*), thus acquired, is then used in the same way as common hewn stone, and either bedded or merely jointed with lime-mortar; it is then washed or harled, both for effect and duration. Various machines for forming bricks and stones for the ordinary purposes of building fence walls, and sheds, and other buildings of one story high, may be found in the eighth and ninth volumes of the *Mechanic's Magazine*.



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Chap. V.

Gates and Bridges appropriate to Agriculture.

3075. *The gate* may be considered as a movable part of a fence, or as a frame of timber, or iron, readily moved, and calculated to give a convenient inlet and outlet to enclosures. Gates may be considered in regard to the principles of their construction and fixing; the materials of which they are made; and their different kinds.

3076. With respect to *construction*, the great object is to combine strength with lightness. The absolute strength of materials depends on their hardness and tenacity. A gate, therefore, consisting of one solid plate of wood or iron, would seem to require most force to break or tear it in pieces: but this would not be consistent with lightness and economy, and in the use of such a gate it would be found to open and shut with more difficulty than one less strong. The skeleton of a plate of wood or iron is, therefore, resorted to by the employment of slips or bars, disposed and joined together on mechanical principles. These principles, applied to carpentry, direct the use of what are called ties and strutts, in the judicious composition of which, as far as construction is concerned, consists the whole art of carpentry. A *tie* (*fig.* 492. *a*) is a bar, or piece of timber, so placed in a structure as to resist a drawing or twisting power; a *strutt* (*b*) is one so placed as to resist weight, or whatever has a tendency to press or crush. The horizontal bars of a gate are all ties; the diagonal and perpendicular ones strutts. On the judicious combination of these ties and strutts depends the absolute strength of the gate; and on their lightness, and on the general form of the gate, depends its adaptation for opening and shutting by means of hinges.

3077. *The construction of a gate best adapted for opening and shutting* is next to be considered. All gates, after being hung, have from their gravitation a tendency to deviate from their original position, to sink at the head or falling post, and thus no longer to open and shut freely. If the construction and hanging of the gate were perfect, this could not possibly take place; but as the least degree of laxity in trussing the gate, or want of firmness in fixing the post in the ground, will occasion, after frequent use, a sensible depression at the head, it becomes requisite either to guard against it as much as possible in the first construction, or to have a provision in the design of the upper hinge (*fig.* 493.) for rectifying the deviations as they take place.

3078. *In order to understand the construction best calculated to resist depression,* suppose a gate hung, and resting on its heel (*fig.* 492.*c*) acting as a strutt, and maintained there by its upper hinge (*d*) acting as a tie, then the bottom rail of the gate considered as representing the whole, becomes a lever of the second kind, in which the prop is at one end (*c*), the power at the other (*g*), and the weight placed between them in the line of the centre of gravity of the gate (*i*). Now, as two equal forces, to hold each other in equilibrium, must act in the same direction, it follows that the power acting at the end of the lever (*g*) will have most influence when exerted at right angles to it in the line (*g e*); but as this cannot be accomplished in a gate where the power must be applied obliquely, it follows, that a large angle becomes requisite; that the greater the angle, the greater the power, or, in other words, the less the strain on the construction of the gate, or the less the tendency to sink at the head. The half of the right angle (*c e g*) seems a reasonable limit, by which, if the power requisite to hold the weight in equilibrium, when acting at a right angle, be as the side of a square of the length of the lower bar of the gate (*g c*), then the power requisite to effect the same end, when acting at an angle of 45 degrees, is as the diagonal to this square (*g h*). By changing the square to a parallelogram, the relative proportions will still be the same, and the advantages and disadvantages will be rendered more obvious.

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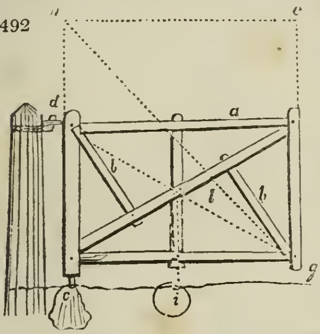

3079. *Waistell and Parker* have paid great attention to the construction of gates for many years. More than fifty years ago, Waistell circulated among his friends plans for ornamental gates with semi-oval and semicircular braces, and such gates (*fig.* 496.) have now become general. Parker has directed his principal attention to the hangings and fastenings of gates; and his forms of latches, hinges, &c., as well as his turnpike-gates (*fig.* 495.), are also very general.

3080. *The construction of the gate* is thus given by Waistell. The head (*fig.* 493. *a*) and heel (*b*) are to

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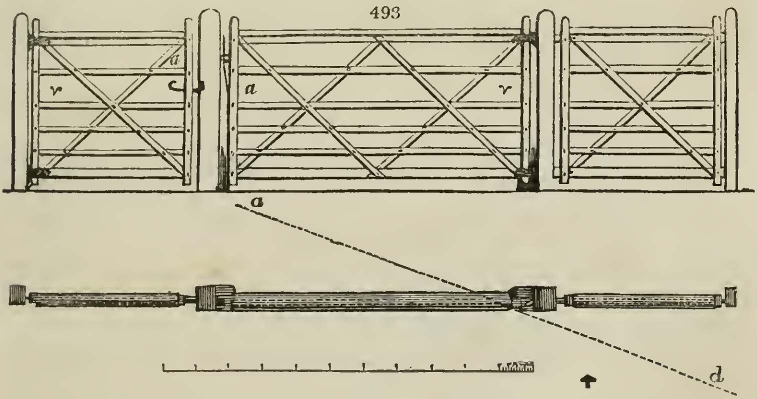

be formed of oak, and the bars and braces of foreign fir. "If inferior materials are used, they may be made a little thicker, but the breadth should remain the same.

	A		B	
The heel of the gate to be about	$3\frac{1}{2}$	by	$2\frac{3}{4}$	inches
The head of ditto	$2\frac{1}{2}$	-	$2\frac{3}{4}$	
The top rail, or bar, vertical piece	$3\frac{1}{2}$	-	$1\frac{1}{4}$	
Ditto horizontal piece	$1\frac{1}{4}$	-	6	
The bottom bar	$3\frac{1}{2}$	-	$1\frac{1}{4}$	
The other four bars, and the four braces	$2\frac{1}{2}$	-	$1\frac{1}{4}$	

The dimensions in column under A are taken on the face of the gate; those in the column under B are taken in the direction of its thickness. Narrow and thick bars, when braced as in this design, are stronger than broad and thin ones, containing the same quantity of timber, and they also oppose a less surface to the wind. The two points in the heel of the gate, to which the thimbles are fastened, may be considered as firm or fixed points. From these points, viz. 1 and 2, (*fig.* 494.) two braces proceed to 4 and 3 in the middle of the bottom and top bars, and being there secured, these become fixed points, and from these two points, viz. 4 and 3, two braces proceed to 5 and 6, fixing those points. The gate is thus doubly braced, viz. from the top of the heel to the top of the head, by means of the braces 1, 4, and 4, 5; and from the bottom of the heel to the bottom of the head, by means of the braces, 2, 3, and 3, 6. On each side of the gate are two braces, and those parallel to each other. The brace proceeding from the bottom of the heel of the gate, and that which is parallel to it, as also the bottom bar, are all strained in the way of compression; and the brace proceeding from the top of the heel, and the other brace which is parallel to it, and also the top bar, are all strained in the way of extension. The strains in this gate being none of them transverse, but all longitudinal, it would support a vast weight at its head, without having its form altered. All the braces serve the double purpose of keeping the gate in its due form, and of shortening the bearings of the bars, and strengthening them. Few gates have less timber in their braces, and, perhaps, in no other way can a gate be so firmly braced with so small a quantity of timber. At 3, 4, 7, and 8, two braces and a bar of the gate are firmly screwed together, by means of iron pins and screw-nuts. At the other points, where only one brace crosses a bar, common gate-nails are used. To resist the pressure of heavy cattle, a bar, or board, about six inches broad and one inch and a quarter thick, should be laid with its broad side upon the top bar (see section at C), and fixed thereto by means of the ends of the braces in the middle, and by the head and heel of the gate at the two ends of it. This board will, in this position, resist about the same horizontal pressure as a thick top bar three inches and a half square, although it contains little more than half the timber. It is necessary that the lower bars of a field or fold gate should be sufficiently close to prevent pigs, lambs, &c. from getting through; but the distances between the upper bars should be greater, that it may be constructed without either unnecessary wood or weight. In order, therefore, to arrange the bars so that the increase of their distances may be uniform, the following rule may be serviceable:—"The height between the bottom bar and the top bar being given, the position of the other four bars, or for any other number of bars, may be found; thus, suppose *a b* the given height, to which the width of an intermediate bar is added, one half on the top bar, and the other half on the bottom bar. One bar must always be exactly in the middle between these two, as at *c*, to which the braces, at their crossing, are to be bolted. In this design another bar is required between *a* and *c*, and two bars between *c* and *b*; that is, the whole distance, *a b*, is to be divided into five parts, in a regular progression to each other. Draw any line, *a d*, and from *a*, set off, of any length, five equal divisions; from the second division draw a line through *c*, in the direction *e*, and from the fifth division draw a line through *b*, also in the direction *e*, where the two lines will cross; then from the division 1, 3, and 4, draw other lines to *e*, the point last found, and where these lines cross, the line *a b* will be the position of the centres of the breadth of the other bars. From the centre of each bar, thus found, mark off half the length of each mortice, and whether the rails be of the same width as the mortices, or tenoned with an equal shoulder on their upper and lower edges, they will be all in a regular progression; or, in numbers, if the distance *a b* be divided into 110 equal parts;

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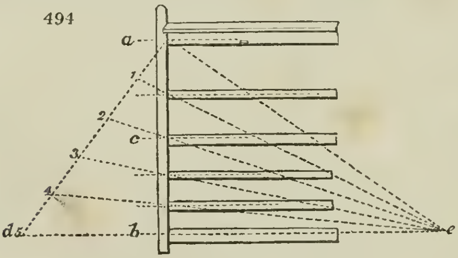

The First distance from B will be	16 of those parts	55	110
Second	18		
Third	21		
Fourth	25	55	
Fifth	30		

The progressive differences between the distances being 2, 3, 4, and 5, the three first being equal to the two last, and the whole equal to one hundred and ten. But if adjusted in the proportion of the following numbers, the whole height A B, being divided into thirty equal parts, the bars at the bottom of the gate will be a little closer:

The First distance	4	15	30
Second	5		
Third	6		
Fourth	7	15	
Fifth	8		

These numbers have one as a common difference. If these rails have shoulders, and are pinned so as to draw them close to the head and heel, they will be better than without shoulders. The pins should not be exactly in the middle of the breadth of the head and heel, but nearer the inner edge, that the piece of wood between the pin-hole and the end of the rails may not be so liable to split out.

3081. "*On the hanging of gates.* When gates are hung to open one way only, their heels and heads generally rest against the hanging and falling post, and are about six inches longer than the opening; but when they are hung according to this design, gates may be made one foot shorter, or six inches less than the opening; and, consequently, they are lighter, stronger, and less expensive. The heel may be three inches and a half from the hanging-post, and the head two inches and a half from the falling post. When the two hooks in the hanging-post are placed in the same perpendicular line, a gate, like a door, will rest in any position to which it may be opened; but in order that a gate may shut itself when thrown open, the hook must not be in the same perpendicular line, and the farther they are out of it, the greater will be the force with which the gate will close. The following is a method of fixing the hooks and eyes, or thimbles, to answer this purpose:—Supposing the hanging-post to be set perpendicular, and that one side or face of the gate is intended to be in a line with one side of the posts, as shown in the engraving, the centre of the upper hook may be two inches and a half from the inside, and one inch from the face of the post. The centre of the eye, or thimble, for the upper hook, may be one inch from the heel, and one inch from the face of the gate. The centre of the lower hook may be an inch and a half from the inside, and half an inch from the face of the post. The eye for the lower hook may be two inches from the heel, and half an inch from the face, of the gate. The best way of fixing the hooks to wooden posts, is to have shoulders to keep them at the proper distance, and a screw and nut on the end which is to go into the post, to which they should be tightly screwed. The eyes should have straps to go on each side of the heel, and along the bottom and top rails of the gate. The straps for the bottom eye may be about six inches long, with two holes for bolts; one of the bolts to go through the middle of the heel, and the other through the bottom rail and brace. The straps to the top eye may be nine inches long, with three holes for bolts. Blocks being fitted in between the straps and the bars, the nuts are then screwed on the bolts. Eyes of this description, which answered very well, have been made of cast iron; the pins and screws of the hooks were of wrought iron, the other part cast. The position of a plane passing through the centre of each hook, is shown in the engraving (*fig* 494.), by the dotted line A B on the plan. If the gate was opened to B, it would be at its highest elevation, and would have a tendency to fall either way until it arrives at A, when the head will be at its lowest descent. If the gate be shut, the spur and catch prevent the head from falling to its lowest position; but the tendency it has to fall to A, is designed to assist in keeping the gate closed. The iron-work of the gate ought at least to be painted. If the whole of the gate be painted, the appearance is greatly improved; and if, when painted, the wood be quite dry, it will be likely to last longer. Gates, in close situations under trees, although painted, will sooner decay than gates not painted, in open and more exposed grounds; and this circumstance has, perhaps, induced some persons to conclude that the paint, instead of the situation under trees, was injurious to the gates."

3082. *Parker's compensation hinge for gates which are much in use* (*fig.* 495.) is an excellent corrective to their falling; all that is necessary, when the gate sinks at the head, is to screw it up by the nut (*a*) till it regains its original position. For road and farm-yard gates the hinges are valuable parts of the construction.

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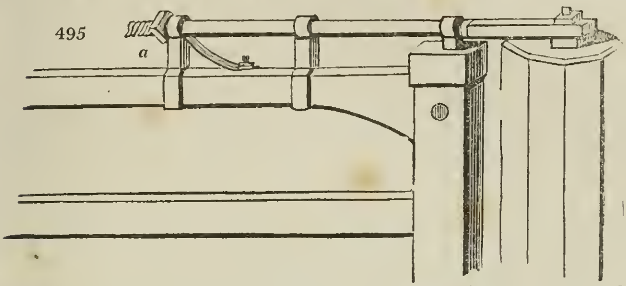

3083. *A gate should be so hung as to have two falls*; one to the hanging-post, to make it catch, and the other to a point at right angle with the gateway, so as to keep it fully open. To effect this purpose, having set the post perpendicular, let a plumb-line be drawn upon it: on this line, at a proper height, place the hook, so that it may project three inches and a half from the face of the post; and at a convenient distance below this place the lower hook an inch and a half to one side of the perpendicular line, and projecting two inches from the face of the post; then place the top loop or eye two inches from the face of the hanging style, and the bottom loop three inches and a half: thus hung, the gate will have a tendency to shut in every position. A gate so hung will have a tendency to shut in every position: because if the weight of the gate be represented by a diagonal line from the heel to the head, this, by the resolution of forces, is resolvable into other two lines, one perpendicular, and the other horizontal; the former representing that part of the weight which presses in a perpendicular position, and the latter that part of the weight which presses in a horizontal direction, and gives the gate a tendency to shut. (*Northumb. Rep.* 63.)

3084. *Gates are generally constructed of timber*, and whatever kind may be used it is essential that it be well seasoned, as, without attention in this respect, they are soon deranged in their structure by the heat of the sun: they should also be well and correctly put together. Oak is undoubtedly the best sort of wood for the purpose, where durability is the object; though some of the lighter kinds of woods, as deal, willow, &c. will often last a great length of time, as, from their lightness, they are not so apt to destroy themselves. The lighter gates are made towards the head or opening part the better, provided they are sufficiently strong for the purpose they are to serve; and on this account the top bars may, in many cases, as where horses are to be kept, be left considerably stronger than the others. If this is not done, they are liable to be broken by the animals rubbing their necks upon them, except where they are made very high. Gates are generally made eight and a half or nine feet in width, and from five to six feet in height; the bars being three or four feet broad, and five or six in number. In particular instances a smaller bar is introduced between the two lower ones, in order to prevent small animals getting through.

3085. *Iron, both hammered and cast metal*, has long been in use for ornamental gates (*fig.* 496.), and has lately come into use in some districts for field gates. Their eligibility

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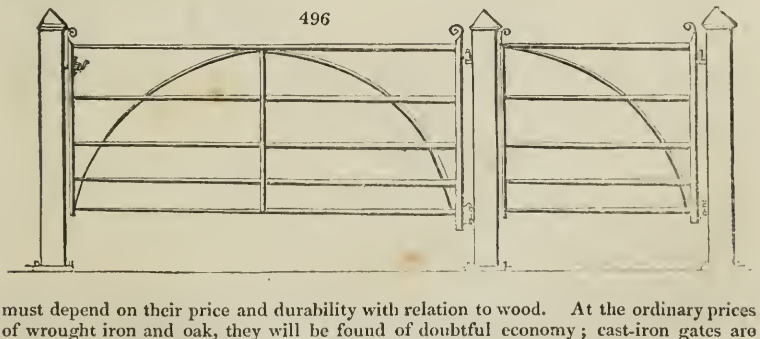

must depend on their price and durability with relation to wood. At the ordinary prices of wrought iron and oak, they will be found of doubtful economy; cast-iron gates are too heavy, and too liable to be broken, for agricultural purposes.

3086. *The posts or pillars to which gates are attached* should, in all convenient cases, be formed of stone; as this material, when hewn and properly constructed, will last for ages. When formed of wood, oak and larch are the best sorts. The latter, where suitable, should be used without removing the bark, which has been found to add greatly to their durability. In some places it is customary to plant trees for gate-posts, and after they have attained a certain size and thickness, to cut them over about ten feet above the surface: where the trees thrive, they form the most durable of all gate-posts in many instances, however, they fail, and much trouble is necessary to repair the defect. Where the posts are made of *dead timber*, they should always be strong, and the wood well prepared: that part which is let into the earth should also be defended, by dipping it in coarse oil, or giving it a coat of pyrolignous liquor; and all that is above ground exposed to the action of the weather, should be well covered with one or two good coats of oil-paint. The expense of this preparation is but trifling, while the benefit is very great.

3087. *The substance of a gate-post*, according to Parker, should be from eight to ten inches square, or for very heavy gates a foot square would not be too large. If made of still larger size, it is better. The steadiness of a gate-post, he says, depends in a great measure upon the depth to which it is set in the ground, which ought to be nearly equal to its height. Five or six feet are, in general, fully sufficient: but the posts may be kept in their places by a strong frame-work placed under the ground, extending between the posts.

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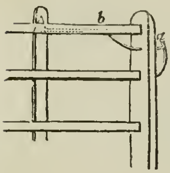

3088. *The fastenings of gates*, it is observed by Parker (*Essay*, &c. 1816.), are as various as the blacksmiths who construct them. The subject occupied his attention in connection with the hanging of gates, and he has introduced various improved forms. One of the most secure (*fig.* 497.) is a spring-latch (*a*), opened by a lever (*b*) which works in a groove in the upper bar of the gate, and therefore cannot be rubbed open by cattle, while, by means of a knob at the end of the lever, and rising up against the top of the upright bar (*c*), so that cattle cannot touch it, it is very easily opened by persons on horseback with or without a stick or whip.

3089. *A simple, economical, and effective spring-latch* consists of a bolt (*fig.* 498 *a.*), which is loose, and plays freely in two morticed openings in the upright bars, and is kept in place by a spring (*b*). The gate may be shut from either side, when the bar, striking against the projection (*c*) on the falling-post, is pushed back, till, arriving at the mortice (*e*), the spring (*b*) forces it in, and the gate is shut securely. Such a gate is easily opened by a rider. This is a good latch for the common field gates of a farm.

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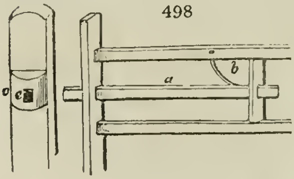

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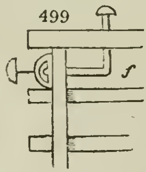

3090. *For gates of an ornamental kind*, Parker says, he does not know a better latch than the crooked lever (*fig.* 499.) now in common use.

3091. *The reversed latch* (*fig.* 500.) is one of the latest improvements in this department, and is particularly suitable for the gates in a gentleman's park. On the edge of the head of the gate a pin (*a*) is screwed; and on the falling post a plate containing two latches (*b c*) turning on pivots. Whichever way the gate is opened, if left to shut itself, or if shut by force, it easily passes within the one latch, and is retained between that and the other. Taking it altogether, this is one of the cheapest and best field-gate latches. Where a gate opens only on one side, the latch plate may be made of one half the size, and with only one of the latches, according to the side on which the gate opens. A contrivance of this sort is in use at some of the pleasure-ground gates at Bretton Hall, near Barnsley, Yorkshire, and is found very efficacious and satisfactory. There are also some very handsome iron gates at that residence, which, with the latch stopper alluded to, will be found figured and described in the *Gardener's Magazine*, vols. vi. and vii.

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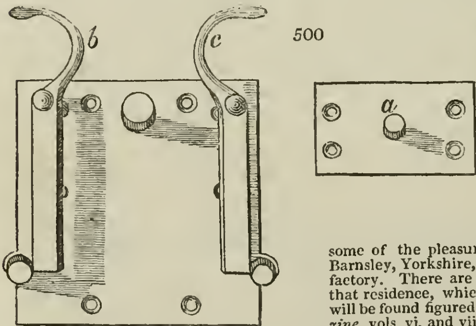

3092. *Gates are of different kinds* (*figs.* 501. and 502.), according to the particular custom of the district; but the principal sorts made use of are, the swing gate, the folding gate, the slip-bar gate, and the wicket and turn-about gate.

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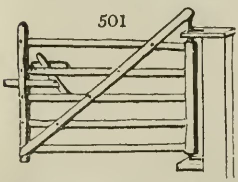

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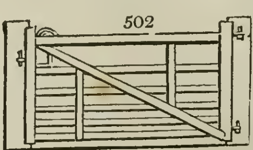
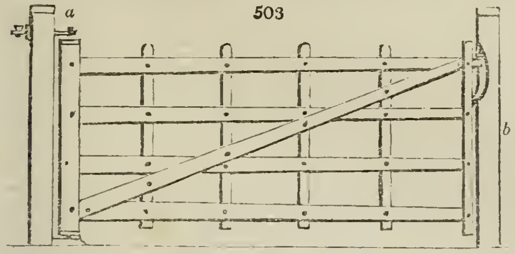


3093. *The improved swing gate* of the northern counties is well adapted for agricultural purposes. There is a projection on the forepart of the hanging style, which rises nine inches, and on which the lower end of the diagonal bar, passing upwards, rests; there is also a diagonal bar through which the three middle horizontal bars pass. It is found to be a very strong and durable gate, and its construction, hanging, and principle of operation, are well understood among the country carpenters and hedgers of those parts.

3094. *In Parker's improved swing gate*, the diagonal bar rising from the lower part of the heel of the gate meets the middle of the rail, and the two upright bars are placed at proper distances between the middle and the head of the gate: these cross bars must, he thinks, assist very much in keeping the gate together; but what is most to be guarded against is its sinking at the head, to prevent which this gate is, he says, well contrived.



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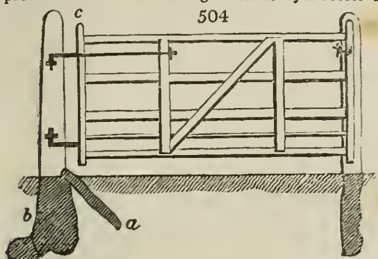
3095. *Menteath's field-gate* (*fig.* 503.) is a very light and strong form, and at the same time not expensive. When the head sinks, it is raised by the simple operation of applying a larger washer between the key-wedge, which retains the hook of the upper part of the heel (*a*), and the hanging-post. The fastening latch is protected from the rubbing of cattle by a recess in the falling-post (*b*). Gates of this description are generally made in Scotland of pine or fir timber, or what is called foreign plank or deal. Mr. Menteath has the good fortune to possess on his own estates extensive plantations of pine planted by himself, and already affording an ample supply for gates and other purposes. We have already adverted to his mode of rendering this timber more durable by steeping it in lime-water; the same process will also render it less liable to warp when applied to the construction of gates. In England, when gates are to be painted or tarred, they are generally made of pine or fir; when not to be painted, of oak.



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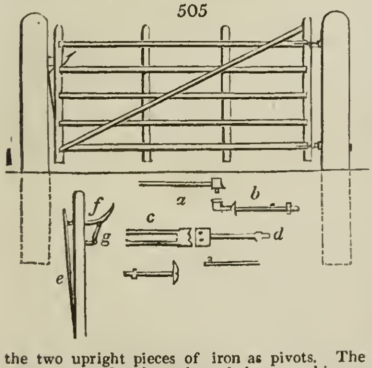
3096. *Hunter of Thurston's economical field-gate* (*fig.* 504.) is said to be very light and durable. The hanging-post is held in its place by one or two coarse props of wood (*a*), and when it can be got, by a large stone (*b*). The inventor gives the following

Description and	*Advantages.*
"With the exception of a small spar for lambs, all parts of the above gate taper regularly from four inches to three inches in breadth, and from one and a quarter to three quarters in thickness, but any other proportions may be adopted.	"This makes the gate as light as possible, without diminishing its strength; and, by bending, it will save the risk of breaking, like the reed in the fable.
"It is not placed between the posts, but on the face of the hanging-post.	"This causes it to fall back on the hedge when open, so that a cart cannot strike it.
"The hinges are not near any joinings of the wood.	"This gate will not rot at the hinges.
"Each part of the under hinge is one inch and a half longer than the upper; and the upper shortens by means of a screw and nut.	"It will either open or shut of itself, except when three quarters open; and, if the point should droop, the upper hinge will take it up; and it prevents the joining of the upper bar at the head of the heel (*c*) from separating.
"The gate is divided into four parts, of which the diagonal embraces two."	"The gate being ten feet by four, this is probably the best angle for a diagonal; and it hardly requires a nail to keep it in its place." (*Quart. Journ. Agr.* vol. ii.)

3097. *The improved park-gate* (*fig.* 505.) deserves to be more generally adopted, particularly in the fields near gentlemen's houses, where there is much intercourse. Much of the excellence of this gate depends on the manner in which it is hung, and the following improved mode of hanging is given in the *Quarterly Journal of Agriculture.* "The upper hinge (*a a*), fixed on the topmost bar of the gate, is formed with a band or crook in the common manner, and is received into the socket of the hinge (*b*), which may either be fixed in the post by lead, or continued through it, and fixed with a screw-nut. The advantages of forming the upper hinge to move in a socket are, 1. That, while space is given it to play, it is firmly supported in its place; 2. That the means are afforded of causing it to move smoothly at all times, by pouring a little oil into the socket. The lower hinge is formed on the principle of affording two pivots, or points of support, to the lower part of the gate. It consists of two iron plates, placed horizontally at the distance from each other of three eighths of an inch, the upper of which (*d*) is fixed to the post, and the lower (*c*) to the gate. From the underside of the upper plate project two cylindrical knobs of iron, placed perpendicularly. These are received into the upper plate *c*, so that the gate rests upon the two upright pieces of iron as pivots. The gate, when shut, has thus three distinct points of support, namely, the socket of the upper hinge, and the two lower pivots, the former of which is thus placed at the vertex, and the latter at the base of an isosceles triangle. From this construction, it results that the gate is only in a state of equilibrium when, being shut, it rests on both the lower pivots, and that, when opened, it must tend to regain its former position. The more distant from the lower points of support the socket is placed, the more firmly is the gate retained in its place, and prevented from trailing on the ground; and the more distant from each other these two points are, the more strongly does the gate



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tend to regain that perpendicular position in which alone it is in a state of equilibrium. The upper hinge should, therefore, be placed on the highest bar of the gate. The distance between the centres of the two cylindrical knobs of iron (on *d*) may be 5 inches, which will be found sufficient to give a strong impetus to the gate to shut itself. The power of a gate to shut itself, in all cases, is a certain advantage, even where fields are in a course of constant cultivation, and a very obvious advantage where they are kept chiefly in grass. There is no providing, in ordinary cases, against the carelessness of persons, who will rather leave a gate open than undergo the little labour required to shut it. There is an apparent objection, indeed, to this species of gate, which is, that each time a cart or waggon passes, the gate must not only be opened, but held open until the carriage has passed. The inconvenience, however, from this is not so great in practice as might be supposed. It is very rare that farm horses will not obey the voice of the driver, and pass while he holds the gate open with his hand. Where the gate must be kept constantly open, as when there is a leading of corn or hay from the field, or of manure to it, it can either be propped back by a stone, or removed from the hinges, and laid aside till wanted; or all inconvenience of this nature may be obviated effectually, by sinking a stone in the ground, and fixing to it a simple hook or latch, to which the gate may be attached when opened.

3098. "*The latch of a gate of this kind* must be made to open with as little force as possible. To this end, the spring (*e*), two feet in length, is fixed nearly at right angles to the piece of iron (*f*), which passes through the head of the gate, and is attached to the handle by a joint or hinge fixed to the handle (*g*), while the handle itself is attached to the back of the head by a similar joint. The notch in the horizontal plate, for the reception of the spring, must be in the plane of a perpendicular from the upper hinge."

3099. *The dimensions of this gate* are as follow: — "There are five horizontal, one diagonal, and four upright bars. The hindmost of the latter, or, as it is generally called, the heel, is 4 inches by 3, and the foremost, or head, 3 inches square. Into these are mortised the extremities of the horizontal bars. The uprights, or braces, consist of pieces of plank nailed to one side of the gate, 3 inches by $1\frac{1}{4}$. The diagonal, from the lower end of the head to the upper end of the heel, is of the same dimensions, and is nailed to the opposite side of the gate. The heel rises a foot above the upper bar, the other uprights 6 inches above it, and all of them project about 4 inches below the lower bar, which again is 6 inches from the ground. The horizontal bars taper from the heel to the head, being $2\frac{3}{4}$ inches square at their junction with the former, and $2\frac{1}{2}$ inches at their junction with the latter. They may be bevelled a little at top. The length of the gate, including the breadth of the head and heel, is 9 feet; the height over the bars 3 feet 9 inches; the distance between the heel and the pillar 5 inches; and between the head and the pillar 3 inches. The plate for receiving the spring of the latch is 11 inches in horizontal breadth."

3100. *The best species of post or pillar* "is a single stone of granite, greenstone, or any of the harder rocks. In this case, instead of fixing the bands of the hinges into the stone, by running them in with lead, they should be carried through to the opposite side, and fixed by a bolt or screw-nut. When wood is used for posts, any coarse kind, whether fir or hard wood, which is unfit for other useful purposes, may be employed. For the gate itself, the best Memel timber only should be used. Spruce is liable to break, and larch to warp; and Scotch pine, it is well known, when exposed to the weather, is one of the least durable of the pine tribe. All the mortises of the gate, and the parts at which the uprights and diagonal cross the bars, should be carefully coated with white lead; and when the parts of the gate are joined together, the whole should afterwards receive two coats of paint. Gates of Memel wood, constructed on these principles, and with these precautions, have been known to last for thirty years, without repair, or tending to trail upon the ground. Expense in all 2*l.* 7*s.*" (*Quar. Jour. Agr.* vol. i. p. 727.)

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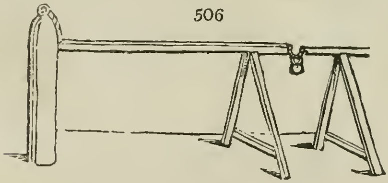

3101. *The tressel-bar gate* (*fig.* 506.) consists of two bars, one hung by a few links to each gate-post, and in the middle of the opening, where the bars meet, they are supported by two legs, like a tressel, and may be padlocked, or fastened by a pin and a few links, &c. In the promenade at Florence such gates are made use of to close the larger carriage openings.

3102. *The slip-bar gate* is, perhaps, the most durable of any, especially where the gate-posts are of stone, with proper openings left for the reception of the bars. The only objection that can possibly be made to the slip-bar gate is the trouble of opening and shutting, which, when servants or others are passing through it in a hurry, occasions its being frequently left open. In other respects, it is preferable to every other description of gate, both in the original cost, and greater durability. It is to be noticed, however, that upon the verge of a farm or estate, especially where it is bounded by a high road, the slip-bar gate will not answer, as it does not admit of being locked or secured in the same way as other gates; but in the interior of a farm or estate, it will be found the cheapest sort of gate.

3103. *The chained slip-bar gate*, though more expensive, is not liable to the same objections as the last. Here the bars are connected by a chain down the middle of the gate, and therefore, if one bar is padlocked to the post, none of them can be moved till that one is unlocked.

3104. *The turn-about, or wicket-gate*, is only used in cases where there is a necessity for leaving an entry for the people employed to pass backwards and forwards. This purpose it answers very well, and at the same time keeps the field completely enclosed, as it requires no trouble to shut it in the time of passing.

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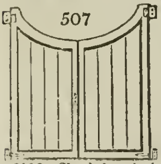

3105. *The double, or folding gate* (*fig.* 507.), is considered by some to be much more durable than those of the swing kind; because the bars, from being only half the length, render the joints of the gate not so liable to be broken, or the hinges to be hurt by straining. On the other hand, such gates require more time and attention in the opening and shutting, and the latter operation is troublesome to perform, when both halves have fallen at the head. These gates are not, therefore, in such general use in agriculture as the swing kind; but they are common as gates to parks, and other scenes of dignity and ornament.

3106. *Clarke's window-sash gate* (*fig.* 508.) is a recent invention, which may be of use in some cases, especially in farm-yards. It is suspended by two weights, and opens and shuts exactly on the principle of the window-sash. The weights may be of stone or cast iron, and the pulleys are of iron and nine inches in diameter. It was applied in the first instance to a cattle-court; but has since been erected in different situations. Its advantages the inventor considers to be the following: — It is easy to open (*b*), or shut (*a*); remains in whatever situation it is placed; is not liable to be beaten to pieces by the action of the wind; shuts always perfectly close, whatever be the height of the straw or dung in the court or gateway; a cart may be driven quite close on either side before opening; is perfectly out of the way when fully open, and not liable to shut on what is passing; the gate bottom not liable to decay by being immersed in the dung, as is commonly the case with cattle-court gates; not liable to go out of order; may be erected in a hollow place, where a swinging gate could not open either outwardly or inwardly; and is likely to be more durable than ordinary gates. A small gate of this description (*fig.* 509.) is said, by Lasteyrie (*Col. de Machines, &c.*) to have been long in use by the Dutch.

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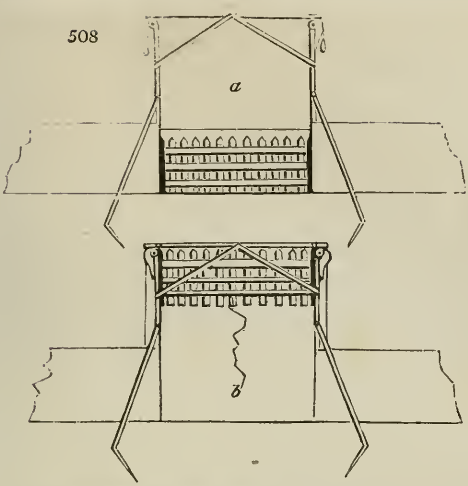

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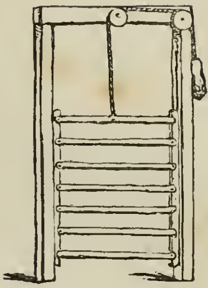

3107. *Parker's sympathetic park-gate* (*fig.* 510.) is an ingenious contrivance, by which, on the approach of a carriage, the gate opens apparently by its own volition, and closes again after the carriage has passed through, without any apparent cause. The manner in which this extraordinary effect is intended to be produced is by small plates let into the ground at short distances from the gate, and when the carriage wheels roll over them, they are made to descend like a weighing machine, and to act upon certain levers concealed

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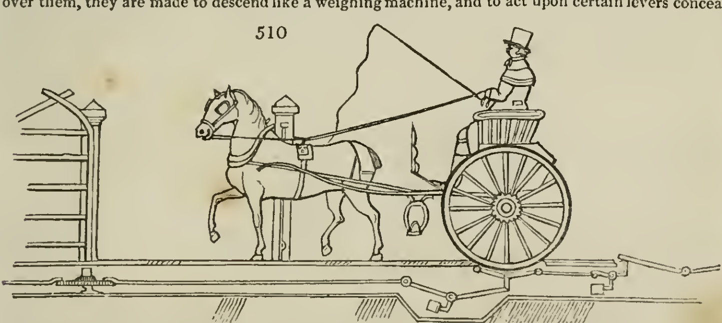

in a trunk under the road, by means of which a toothed wheel is made to revolve, and to turn a toothed pinion affixed to the swinging-post or axle of the gate, and hence to throw it open or close it. (*Newton's Journal*, vol. xiv. p. 225.) In an agricultural point of view, this gate is of no use; but as a curiosity it is worth noticing, and perhaps in the drives or ridings in some pleasure-grounds and parks it might be worth executing. In England it might save the tax on a groom, and in America and Australia it might be as good as a helper, which, for such aids as opening gates are not very easy to be found.

3108. *Stiles* are contrivances for man to pass over or through fences, without the risk of even permitting the larger quadrupeds to accompany or follow him. There are many forms perfectly well known every where: as by steps over a wall; by a zig-zag passage, formed by stakes, through a hedge or paling; a turning-bar or turnstile, &c.

3109. *The stile of falling bars* (*fig.* 511.) is chiefly used in pleasure-grounds, or between paddocks;

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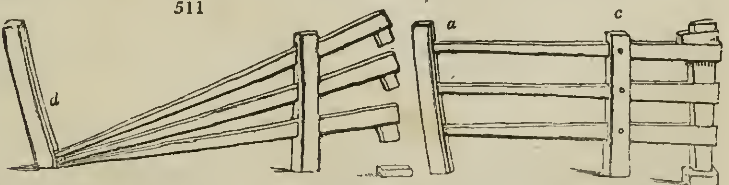

It consists of bars, light at one end (*a*) and heavy at the other (*b*), with concealed joints or pivots, in an upright post (*c*) placed nearer one end of the bars than the other. Then, while the weight of the short ends of the bars keeps them in a fencible position, a slight pressure on the other end will form a passage (*d*) which any one may easily step across.

3110. *Bridges* are frequently required on estates and farms, for crossing ditches and water-courses. They are generally large stone conduits or barrel-drains; or in the case of large streams, arches of masonry. In the case of small drains, wooden pipes or boarded tubes are sometimes resorted to, and even earthen pipes have been used; but masonry should generally have the preference.

BOOK V.

OF THE OPERATIONS OF AGRICULTURE.

3111. *The operations of agriculture* are effected under the direction of man, and by means of the mechanical agents, or implements and buildings, which have passed in review in the preceding book. They are either performed directly on plants or animals, which may be considered the objects of agriculture; or on the soil and climate, which are the natural agents of growth and culture. They may be arranged as manual labours and operations, operations with beasts of labour, and mixed operations.

Chap. I.

Manual Labours and Operations.

3112. *The labours and operations* of any art can seldom be described with great advantage. Whoever wishes to acquire them should resort at once to the scene of practice: no description, however minute, will teach a man to dig, plough, or mow, equal to a few hours' trial in the field, though a knowledge of the mechanical principles on which the implements and the human machine act in such operations, will afford some assistance in acquiring them, and in performing them with ease. Our observations shall chiefly be directed to these parts of the subject, and to the most suitable weather and other circumstances for the performance of the different field labours of the manual kind. We shall arrange these as manual labours common to all arts; manual operations on the soil; and mixed manual operations, or such as are performed on the soil, plants, and animals, together or connectedly.

Sect. I. *Mechanical Operations common to all Arts of Manual Labour.*

3113. *All the operations which man performs with implements or machines* are, as far as his own person is concerned, reducible to lifting, carrying, drawing, and thrusting. Man himself, considered as an engine, derives his power from alteration in the position of the centre of gravity, and he applies it chiefly by his hands, arms, and legs acting as levers of the third kind.

3114. *Lifting* is performed by first stooping, or lowering the centre of gravity, and at the same time throwing it to one side. The object being then laid hold of by the hands, the body is raised, and the centre of gravity, in being restored to its true position, acts as a counterbalancing weight to the weight to be raised. The weight retained by the hand is now raised a certain height, never exceeding half that of the man; if to be raised higher, recourse is had to muscular strength, or the power of the arms to act as levers.

3115. *Carrying.* To carry a thing is merely to walk with a greater weight than before, and walking is performed by a series of alternate derangements and adjustments of the centre of gravity, slow or rapid, as the person may walk or run. According to Delolme, the most advantageous weight for a man of common size to carry horizontally is 112 lbs.; or, if he returns unladen, 135 lbs.

3116. *Drawing.* In this operation, the upper part of the body is thrown forward, so as to act as a power to counterbalance or lift up the body or weight to be moved; and by joining to this lifting motion the operation of walking, the weight is at once lifted up and drawn along. This compound operation is exemplified in a horse, when straining at a draught in a plough or cart: he first lowers his chest, than raises it, and lastly steps forward. When drawing at ease, the lifting motion is scarcely distinguishable from the progressive one.

3117. *Pushing, or thrusting,* is performed exactly on the same principles as drawing, and differs from it chiefly in the kind of implement or machine which requires to be employed: all machines which are to be pushed requiring to be attached to the animal machine by parts acting by their rigidity; whereas those to be drawn may be attached by parts acting by their tenacity merely.

3118. *Wheeling* is a mode of carrying materials in which the weight is divided between the axle of the wheel and the arms of the operator. The arms or shafts of the barrow thus become levers of the second kind, in which the power is at one end, the fulcrum at the other, and the weight between them. The weight is carried or moved on by the continual change of the fulcrum with the turning of the wheel; and this turning is produced by the operator throwing forward his centre of gravity so as to push against the wheel by means of the movable axle, &c. The chief obstacles to wheeling are the roughness or softness of the surface to be wheeled on. Where this is firm, there wheeling will be best performed with the greater part of the load resting on the axle; but where soft and deep, the centre of gravity should be nearest the operator, who will find it easier to carry than to overcome excessive friction. Dry weather is obviously preferable for this operation. "With wheelbarrows," Dr. Young observes, "men will do half as much more work as with hods."

3119. *All these operations may be varied in quantity*, either by a variation in the weight or gravity of the man, or moving power; or by a variation in the time or rapidity of his motions. Thus a heavy man may, in one movement, lift a weight ten times greater than can be done by one of less weight; but a light man may, by increasing the time of performance, lift the same weight at ten times. A man, who in digging can apply with his feet five cwt. of his weight towards pushing the wedge or blade of the spade into the soil, has an apparent advantage over a lighter man who can only apply three cwt. of mere gravity for that purpose; but yet the latter may equal the former, by accompanying his power, or foot, with a proportionate increase of motion. The power in this last case is said to be obtained by the momentum, or quantity of matter in a body multiplied by the velocity with which it is moved. Power, therefore, we thus ascertain, is obtained by matter and motion jointly, and what may be deficient in the one, may be made up by excess in the other. Thus, a small light workman may (though with more animal exertion) produce as much work as a larger or heavier man: for if we suppose the quantity of matter in the large man to be thirty, and his motion at the rate of two, then if the quantity of matter in the small man be twenty, and his motion at the rate of three, he will produce an equal effect with the large man. As small human machines, or men, are generally constructed of finer materials, or more healthy and animated, than large ones, the small man performs his rapid motions with nearly as great ease to himself as the heavy man moves his ponderous weight; so that in point of final result they are very nearly on a par.

Sect. II. *Agricultural Labours of the simplest Kind.*

3120. *The manual labours of the field* are, next to the general labours enumerated, among the simplest required of the human operator, demanding, in addition to health and strength, but little skill in their performance.

3121. *Breaking stones* is an easy labour, requiring very little skill, and no great degree of strength. The stones are previously reduced in the quarrying, or otherwise, to sizes at which they can be broken by one blow or more of an iron-headed hammer. In general they are broken on the plane on which the operator stands, but the blow has more effect when the stone is raised about eighteen inches; and, for small stones, the most work will be done when they are broken on a table nearly as high as a man's middle, which is now the practice under the direction of the best road-makers.

3122. *Picking.* The pick is a blunt wedge, with a lever attached to it nearly at right angles; and the operation of picking consists in driving in the wedge so as to produce fracture, and then causing it to operate as a compound lever by the first lever or handle, so as to effect separation, and thus break up and loosen hard, compact, or stony soils. It is also used to loosen stones or roots; and the pick-axe is used to cut the latter. For breaking and pulverising the soil, the most favourable conditions are, that the earth should be moderately moist, to facilitate the entrance of the pick, but in tenacious soils not so much so as to impede fracture and separation.

3123. *Digging.* The spade is a thin wedge, with a lever attached in the same plane, and the operation of digging consists in thrusting in the wedge by the momentum (or weight and motion) of the operator, which effects fracture; a movement of the lever or handle next effects separation, whilst the operator, by stooping and rising again, lifts up the spitful or section of earth on the blade or wedge of the spade, which, when so raised, is dropped in a reversed position, and at a short distance from the unbroken ground. The separation between the dug and undug ground is called the trench or furrow; and when a piece of ground is to be dug, a furrow is first opened at that end of it where the work is to commence, and the earth carried to that end where it is to terminate, where it serves to close the furrow. In digging, regard must be had to maintain a uniform depth throughout; to reverse the position of each spitful, so that what was before surface may now be buried; to break and comminute every part, where pulverisation is the leading object; to preserve each spitful as entire as possible, and place it separated or isolated as much as can be effected, where aeration is the object; to mix in manures regularly, where they are added; to bury weeds not likely to rise again, and to remove others, and all extraneous matters, as stones, &c., in every case. For all these purposes a deep open trench is requisite; and, that this may not be diminished in width and depth in the course of the operation, it must never be increased in length. If allowed to become crooked by irregular advances in the digging, it is thus increased in length, and necessarily diminished in capacity, unless, indeed, the dug ground is allowed to assume an uneven surface, which is an equally great fault. Digging for pulverisation, and mixing in manures, is best performed in dry weather; but for the purposes of aeration, a degree of moisture and tenacity in the soil is more favourable for laying it up in lumps or entire pieces. The usual length of the blade of the spade is from ten inches to a foot; but as it is always inserted somewhat obliquely, the depth of pulverisation attained by simple digging seldom exceeds nine inches, and in breaking up firm grounds it is seldom so much.

3124. *Shovelling* is merely the lifting part of digging, and the shovel, being broader than the spade, is used to lift up fragments separated by that implement or the pick.

3125. *Marking with the line* is an operation preparatory to some others, and consists in stretching and fixing the line or cord along the surface, by means of its attached pins or stakes, in the direction or position desired, and cutting a slight continuous notch, mark, or slit, in the ground, along its edge, with the spade.

3126. *Trenching* is a mode of pulverising and mixing the soil, or of pulverising and changing its surface, to any greater depth than can be done by the spade alone. For trenching with a view to pulverising and changing the surface, a trench is formed like the furrow in digging, but twice or three times as wide and deep; the plot or piece to be trenched is next marked off with the line into parallel strips of this width; and, beginning at one of these, the operator digs or picks the surface stratum, and throws it in the bottom of the trench. Having completed with the shovel the removal of the surface stratum, a second, and a third, or fourth, according to the depth of the soil and other circumstances, are removed in the same way; and thus, when the operation is completed, the position of the different strata is exactly the reverse of what it was before. In trenching with a view to mixture and pulverisation (*fig.* 512.), all that is necessary is to open, at one corner of the plot, a trench or excavation of the desired depth, three or four feet broad, and six or eight feet long. Then proceed to fill this excavation from one end by working out a similar one. In this way proceed across the piece to be trenched, and then return, and so on in parallel courses to the end of the plot, observing that the face or position of the moved soil in the trench must always be that of a slope, in order that whatever is thrown there may be mixed, and not deposited in regular layers as in the other case. To effect this most completely, the operator should always stand in the bottom of the trench, and first picking down and mixing the materials, from the solid side (*a*), should next take them up with a shovel, or throw them on the slope or face of the moved soil (*b*), keeping a distinct space of two or three feet between the sides.

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For want of attention to this, in trenching new soils for plantations, or other purposes, it may be truly said that half the benefit derivable from the operation is lost. In general in trenching, those points which were mentioned under digging, such as turning, breaking, dunging, &c. required to be attended to, and sometimes an additional object—that of producing a level from an irregular surface—is desired. In this case double care is requisite, to avoid forming subterraneous basins or hollows, which might retain water in the substratum, at the bottom of the moved soil, and also to mix inferior with better soil, &c. where it becomes requisite to penetrate into depositions of inferior earthy matters. The removal of large stones, rocks, or roots, from ground trenched for the first time, will be treated of under Improvement of Lands lying waste. (Book III. Chap. IV.)

3127. *Ridging* is a mode of finishing the surface, applicable either to dug or trenched grounds, which, when so finished, are called ridge-dug or ridge-trenched. Instead of being formed with an even surface, ridged grounds are finished in ridges or close ranges of parallel elevations, whose sections are nearly equilateral triangles. Hence, supposing the triangles to touch at their bases, two thirds more surface will be exposed to the influence of the atmosphere and the weather, than in even surfaces.

3128. *Forking.* The fork is composed of two or three separate, parallel, and uniform wedges, joined so as to form one general blade, which is acted on like the spade, by means of a shoulder or hilt for thrusting it into the matters to be forked, and a lever or handle for separating and lifting them. Forking is used for two purposes; for pulverising the soil among growing crops, and for moving vegetable substances, such as faggots of wood, sheaves of corn, hay, manure, &c. In the first case the operation is similar to digging, the only difference being that pulverisation is more attended to than reversing the surface; in the other, the fork separates chiefly by drawing and lifting; hence, for this purpose, a round-pronged or (dung) fork produces least friction during the discharge of the forkful and reinsertion, and a broad-pronged fork separates and lifts the soil more readily. Dry weather is essentially requisite in forking soils, and most desirable for spreading manures, but dunghills may be turned during rain with no great injury.

3129. *Dragging* out dung or earth is performed by the dung-drag, and is adopted in the case of distributing dung from a cart in regular portions or little heaps over a field. When lime in a state of pulverisation, earth, or sand, is to be distributed in the same way, a scraper or large hoe is used; and sometimes, for want of these, the dung-drag, aided by the spade or common hoe.

3130. *Hand-hoeing* is performed by drawing or thrusting the wedge or blade of the draw or thrust hoe along the surface of the soil, so as to cut weeds at or under the surface, and slightly to pulverise the soil. It is used for four purposes, sometimes together, but in general separately: first, to loosen weeds or thin out plants, so that those hoed up may die for want of nourishment, or be gathered or raked off, for which purpose either the thrust or draw hoe may be used; the second, to stir the soil, and for this purpose, when no weeds require killing, the pronged hoe is preferable, as being thrust deeper with less force, and as less likely to cut the roots of plants; the third is to draw up or accumulate soil about the stems of plants, for which purpose a hoe with a large blade or shovel will produce most effect; and the fourth is to form a hollow gutter or drill in which to sow or insert the seeds of plants, for which a large or small draw-hoe may be used, according to the size of the seeds to be buried. The use of the hoe for any of the above purposes requires dry weather.

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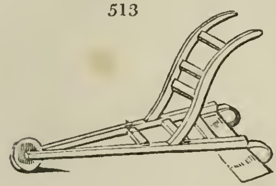


3131. *Hoeing between rows of crops* is somtimes performed by what is called a hoe-plough, which is a small plough having a share with double fins, drawn by one man, and pushed by another. It is in use in India, and is sold in London under the name of the Indian hoe-plough, but it is more for the exercise of amateurs on free soils than for useful culture. In this way a master may exercise both himself and his valet, and clear his potatoes or turnip crop at the same time. The Dutch have a hoe (*fig.* 513.) which is drawn and pushed at the same time, for the purpose of cleaning walks, or scraping turf or mud from roads or court-yards.

3132. *Hand-raking* is performed by drawing through the surface of the soil, or over it, a series of small equidistant wedges or teeth, either with a view to minute pulverisation, or to collecting herbage, straw, leaves, stones, or such other matters as do not pass through the interstices of the teeth of the rake. The teeth of the rake being placed nearly at right angles to the handle, it follows that the lower the handle is held in performing the operation, the deeper will be the pulverisation, when that is the object; and, on the contrary, that the higher it is held, the interstices being lessened, the fewer extraneous matters will pass through the teeth. The angle at which the handle of the rake is held must therefore depend on the object in view; the medium is forty-five degrees. For all raking, dry weather is essentially requisite; and, for raking hay, the angle which the handle of the rake makes with the ground's surface ought to be fifty degrees.

3133. *Scraping* may be described as the drawing of a large broad blunt hoe along the surface, for the purpose of collecting loose excrementitious or other useless or injurious matters from roads, yards, or from grassy surfaces to be rolled or mown. The Dutch hoe (*fig.* 513.) is a good road and lawn scraper.

3134. *Sweeping* is a mode of scraping with a bundle of flexible rods, twigs, or wires, which enters better into the hollows of irregular surfaces, and performs the operation of cleaning more effectually. In agriculture it is used in barns and in stables, though shovelling is generally sufficient for the common stable and ox-house.

3135. *Screening, or sifting,* earth or gravel, is an operation performed with the gravel-sieve or earth screen, for separating the coarser from the finer particles. The materials require to be dry, well broken, and then thrown loosely on the upper part of the screen, which, being a grated inclined plane, in sliding down it, the smaller matters drop through while the large ones pass on and accumulate at the bottom. In sifting, the same effect is more completely, but more laboriously, produced, by giving the sieve a circular motion with the arms.

3136. *Gathering* is a very simple operation, generally performed by women and children, as in taking up potatoes or other roots, or picking up stones, weeds, or other matters considered injurious to the surface on which they lie or grow.

3137. *Cleaning* roots or other matters is generally performed by washing, and, on a large scale, by the root-washing machine, which has already been described, together with the mode of using it.

3138. *Various manual labours and operations* might be added; such as slicing turnips; chopping them with the chopping-hoe (2572.) in the fields; *cutting* straw or hay into chaff; bruising beans or other grain, or whins, or thistles, between rollers; pushing a drill-barrow, &c.; all which require only bodily exertion, with very little skill, being performed by the aid of machines, which, in describing, we have also indicated the mode of working. (2537. to 2583.)

Sect. III. *Agricultural Operations with Plants.*

3139. *Agricultural operations with the vegetable kingdom* rank higher than those with the soil or machines, as requiring not only strength, but some of them a considerable degree of skill.

3140. *Weeding,* however simple an operation, requires a certain degree of botanical skill to know what to weed or extract. These are such plants as it is not desired to cultivate. The operation is performed in various ways: by the hand simply; by the hand, aided by a broad-pointed knife, or a bit of iron hoop; by the hand, aided by gloves tipped with iron; by pincers, as in weeding tall weeds from growing corn, or close-hedges, or out of water; and by the aid of forks, spuds, or other weeding-tools. In weeding, it is essential that the weeder know at sight the plants to be left from such as are to be removed, which in agriculture is generally a matter of no difficulty, as, however numerous the weeds, the cultivated plants are but few. In weeding ferns, thistles, nettles, &c. from pasture lands, it has been found that breaking or bruising them over renders the roots much less liable to spring again the same season, than cutting or even pulling them up. For this sort of weeding the pincers seem well adapted.

3141. *Thinning* or reducing the number of plants on any surface is sometimes performed by hand, but most generally with the hoe. Thinning, to be perfectly performed, ought to leave the plants at regular distances; but as this can seldom be done, owing to the irregularity with which seeds come up, whether sown in drills or broadcast, an attempt to compensate the irregularity is made by a similar irregularity in the distances allowed between the plants at such places. Thus, if turnips in rows are to be thinned out to nine inches' distance in the row, and a blank of eighteen inches or two feet occurs, the last two plants on each side of the blank may be left at half the usual distance, or less, by which means each plant having ample room on one side, they will grow nearly as large as if left at the usual distance. The same principle is to be attended to in thinning broadcast crops, or trees in a plantation. Thinning may be performed in moist weather; but dryness is greatly to be preferred, especially where the hoe is used.

3142. *Planting* is the operation of inserting plants in the soil with a view to their growth, and the term is also applied to the insertion of seeds, roots, or bulbs, when these are inserted singly.

3143. *Planting, as applied to seeds and tubers,* as beans, potatoes, &c. is most frequently performed in drills, but sometimes also by making separate holes with the dibber. In either case, the seeds or sets are deposited singly at regular distances, and covered by raking or harrowing, with or without pressure, according to the greater or less looseness of the soil, and to its dryness or moisture. In general, planting seeds or tubers in drills, or in single openings made by a draw-hoe or spade, is greatly preferable to planting with the dibber; because, in the latter case, the earth can seldom be placed in close and somewhat firm contact with the seed or set, — a circumstance essential to its speedy germination and vigorous future growth.

3144. *Planting, as applied to plants already originated,* is commonly termed *transplanting.* Transplanting may be considered as involving four things: first, the preparation of the soil to which the plant is to be removed; secondly, the removal of the plant; thirdly, its preparation; and, fourthly, its insertion in the prepared soil. Preparation of the soil implies, in all cases, stirring, comminution, and mixing; and sometimes the addition of manure or compost, according to the nature of the soil and plants to be inserted. The removal of the plant is generally effected by loosening the earth around it, and then drawing it out of the soil with the hand; in all cases avoiding, as much as possible, to break or bruise, or otherwise injure, the roots. In the case of small seedling plants, merely inserting the spade, and raising the portion of earth in which they grow, will suffice; but, in removing large plants, it is necessary to dig a trench round, or on one side of, the plant. In some cases, the plant may be lifted with a ball or mass of earth, containing all or great part of its roots; and in others, as in the case of large shrubs or trees, it may be necessary to open the soil around them a year previously to their removal, and cut the larger roots at a certain distance from the plant, in order that they may throw out fibres to enable them to support the operation of transplantation. By two years' previous preparation, and the use of a machine to be afterwards described, very large trees of such kinds as stole may be removed; but resinous trees seldom succeed.

3145. *The preparation of the plant* consists in pruning its roots and top, or shoots. In the smallest seedlings, such as cabbage-plants and thorns, all that is necessary is to shorten a little the tap or main root; but in seedlings of trees two or three years old, or in transplanted or large trees, several of the side shoots will require to be shortened, and also the roots, always proportioning what is taken off the top or shoots, to what has been taken from the root, that the latter may be duly fitted to support the former.

3146. *The insertion of the removed plant in the prepared soil* is performed by making an excavation suitable to the size of the plant's root, inserting it therein, filling up the interstices with fine earth, and then compressing the whole by the hand, dibber, foot, or, what is best, by abundant watering. Plants should not be inserted deeper in the soil than they were before removal; they should be placed upright, and the same side should be turned towards the sun as before; the fibrous roots should be distributed equally round the stem among the mould or finer soil; and the most difficult and important part of the whole is to compress the earth about the roots without crowding them or injuring them by bruises. The only effectual way of attaining this end is, after carefully spreading the fibres, and distributing them as equally as possible among the mould, to give abundant waterings, holding the vessel from which the water is poured as high as possible, so as to consolidate the earth by that means, rather than by compression with the foot. On an extensive scale, however, this cannot be done, and in planting seedlings or cuttings it is not required, as these have few and short fibres, and may be *firmed* sufficiently by the planting instrument or the foot. It should never be forgotten that, in all planting, it is an essential point to have the earth firmly compressed to the roots, and especially to the lower parts or extremities. Any one may be convinced of this, by planting one cabbage loosely, and compressing the root of another well with the dibber at the lower part; or, instead of a cabbage, try a cutting, say of gooseberry, elder, or vine: both no doubt will grow, but the growth of the plant or cutting compressed at the lower extremity will be incomparably more vigorous than that of the other.

3147. *Watering* becomes requisite for various purposes: as aliment to plants in a growing state; as support to newly transplanted plants; for keeping under insects; and keeping clean the leaves of vegetables. One general rule must be ever kept in mind during the employment of water; that is, never to water the top or leaves of a plant when the sun shines. A moment's reflection will convince any one that this rule is agreeable to the laws of nature, for during rain the sun's rays are intercepted by a screen of fog or clouds. All artificial watering, therefore, should be carried on in the evening, or early in the morning, unless it be confined to watering the roots; in which case, transplanted plants, and others in a growing state, may be watered at any time; and, if they are shaded from the sun, they may also be watered over their tops.

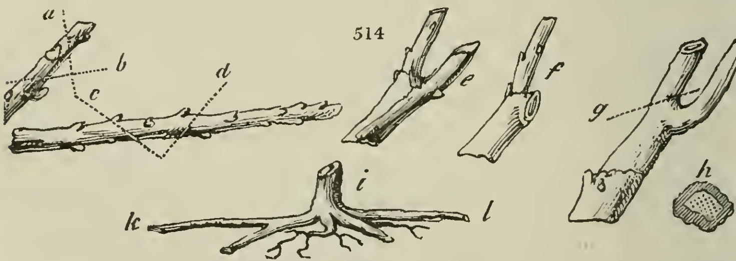
3148. *Sowing* is the operation of dispersing seeds over the surface of the soil, with a view to their future vegetation and growth. Where seeds are deposited singly, they are said to be planted, as in the case of dibbling wheat or beans; where they are dropped in numbers together, they are said to be sown. When dropped in numbers together in a line, they are said to be drilled or sown in a row; and when scattered over the general surface by the hand, they are said to be sown broadcast.

3149. *In broadcast-sowing*, the operator being furnished with a basket (*fig.* 525.), or sheetful of seed hanging on his left side, takes out a handful with his right hand, and disperses it by a horizontal and rather rising movement of the arm to the extent of a semicircle, gradually opening his hand at the same time. The most usual practice, when land is laid up in ridges of equal breadth, and not too wide, as five or six yards, is that of dispersing the seed regularly over each land or ridge, in once walking round; the seedsman, by different casts of the hand, sowing one half in going, and the other in returning. In doing this, it is the custom of some seedsmen to fill the hand from the basket or bag, which they carry along with them, as they make one step forward, and disperse the seed in the time of performing the next; while others scatter the seed, or make their casts, as they are termed by farmers, in advancing each step. It is evident, therefore, that, in accomplishing this business with regularity and exactness, there is considerable difficulty, the proper knowledge and habit of which can only be acquired by experience. It is consequently of importance for the cultivator to perform the operation himself, or to be careful in selecting such persons as are conversant with the business, as he may otherwise incur much unnecessary expense in the waste of seed, and run considerable risk in respect of his crops.

3150. *Sawing*. The saw is a conjoined series of uniform wedges, which, when drawn or thrust in succession across a branch or trunk, gradually wear it through. In performing the operation, the regularity of the pressure and motion are chiefly to be attended to. In green or live shoots, the double-toothed saw lessens the friction on the sides of the plate, by opening a large channel for its motion. Where parts are detached from living trees, the living section ought generally to be smoothed over with a knife, chisel, or file; and a previous precaution in large trees is to cut a notch in the lower part of the branch immediately under and in the line of the section, in order to prevent any accident to the bark, when the amputated part falls off. Sawing is a coarser mode of cutting, mowing, or shaving; or a finer mode of raking, in which the teeth follow all in one line.

3151. *Cutting* is performed by means of a very sharp wedge, and either by drawing this through obliquely or across the body to be cut, as in using the knife; or by pressing or striking the axe or hedge-bill obliquely into the body, first on one side of an imaginary line of section, and then on the other, so as to work out a trench across the branch or trunk, and so effect its separation. The axe, in gardening, is chiefly used in felling trees, and for separating their trunks, branches, and roots, into parts. The knife is extensively used for small trees, and the hedge-bill and chisel for those of larger size. In amputating with the knife, one operation or *draw-cut* ought generally to be sufficient to separate the parts; and this ought to be made with the knife sufficiently sharp, and the motion so quick as to produce a clean smooth section, with the bark uninjured.

3152. Every *draw-cut* produces a smooth section, and a fractured or bruised section; and one essential part of cutting living vegetables, is to take care that the fractured section be on the part amputated. Another desirable object is, that the section of the living or remaining part should be so inclined (*fig.* 514. *a*), as not to lodge water or overflowing sap, and so far turned to the ground (*d*), or to the north, as



not to be struck by the direct rays of the sun. To accomplish both these purposes, as well as to make sure of having the fractured section on the part amputated, the general practice is to cut from below, or from the under edge of the branch or shoot, unless the position of the leading bud occasions a deviation from the rule (*b*). The cuts should also be made, in all shoots of not more than three or four years old, within from one fourth to half an inch, or a little more, of the bud intended to take the lead; when this is not done, and half an inch or more of shoot is left without a bud (*c* and *e*), the consequence is, the stump dies back to the bud in the course of the season (*g*), and if not carefully cut off (*f*), will end in a decaying orifice both unsightly and injurious. The bud selected for a leader ought always to be a leaf-bud, and in general the plane of the section ought to be parallel to the angle which the bud makes with the stem (*d*). Exceptions occur in the case of plants with much pith (*h*), as the vine, elder, &c., in cutting the year-old shoots of which, an inch or more ought to be left, as these always die back a few lines; and thus the leading bud might be injured, if this precaution were not taken. In pruning roots, the same principle, as far as applicable, ought to be attended to; the trunk or stem, when cut over, ought to be sloped to the north (*i*), and the lateral roots cut so as the section may be on the under side (*k*), and therefore less likely to rot than when the cut faces the surface of the ground (*l*), or is bruised by neglecting to form the smooth section on the attached extremity.

3153. In like manner, *when pruning a large tree*, the section of amputation ought to be made so oblique as to throw off the rain; as generally as possible, it should be turned from the sun, and rather downwards than upwards, in order to shield it from heat and cracking; and, whenever it can be done, it should be made near a branch, shoot, or bud, which may take the lead in the room of that cut off, and thus, by keeping the principle of life in action at the section, speedily heal up the wound.

3154. *In cutting with the chisel*, the blade is applied below the branch to be amputated, so as to rest on the trunk or main branch, and a quick blow with a mallet is given to the handle of the chisel by the operator or his assistant. If this does not effect a separation, it is to be repeated. In forest-pruning it is often advantageous to make one cut with the chisel on the under side of the branch, and then saw it through with the forest-saw from the upper.

3155. *Clipping* is an imperfect mode of cutting, adapted for expedition, and for small shoots. The separation is effected by bruising or crushing along with cutting, and, in consequence, both sections are fractured. In agriculture, it is chiefly applied for keeping hedges in shape; but the hedge-knife, which operates by clean rapid draw-cuts given always from below, is generally preferable, as not crushing the live ends of the amputated shoots. The new pruning-shears and the averruncator, it is to be observed, by producing cuts much more like the draw-cuts of knives, are greatly to be preferred to the common hedge-shears.

3156. *The best seasons for sawing, cutting, or clipping living trees,* are early in spring and in midsummer. Early in autumn, trees are apt to bleed; later, and in winter, the section is liable to injury from the weather: but trees pruned early in spring remain only a short period before they begin to heal; and in those pruned at midsummer, wounds heal immediately. There are, however, exceptions as to spring-pruning in evergreens, cherries, and other gummiferous trees; and summer-pruning is but ill adapted for forest-work or trees in crowded scenery.

3157. *Splitting* is an operation generally performed on roots of trees remaining in the soil for the purpose of facilitating their eradication. The wedge, in its simplest form, and of iron, is driven in by a hammer or mallet, till it produces fracture and separation, when the parts are removed as detached, &c.

3158. *Pruning*, or the amputation of part of a plant with the knife, or other instrument, is practised for various purposes, but chiefly on trees, and more especially on those of the fruit-bearing kinds. Of two adjoining and equal-sized branches of the same tree, if the one be cut off, that remaining will profit by the sap which would have nourished the other, and both the leaves and the fruits which it may produce will exceed their natural size. If part of a branch be cut off which would have carried a number of fruits, those which remain will set, or fix, better, and become larger. On the observation of these facts is founded the whole theory of pruning; which, though, like many other practices of culture, it cannot be said to exist very obviously in nature, is yet the most essential of all operations for the culture of fruit produced on trees.

3159. *The objects of pruning* may be reduced to the following: promoting growth and bulk; lessening bulk; modifying form; adjusting the stem and branches to the roots; renewal of decayed plants or trees; and removal or cure of diseases.

3160. *Pruning for promoting the growth and bulk of a tree* is the simplest object of pruning, and is that species which is chiefly employed by nursery-men with young trees of every description. The art is to cut off all the weak lateral shoots, that the portion of sap destined for their nourishment may be thrown into the strong ones. In some cases, besides cutting off the weak shoots, the strong ones are shortened, in order to produce three or four shoots instead of one. In general, mere bulk being the object, upright shoots are encouraged rather than lateral ones; except in the case of trees trained on walls, where shoots are encouraged at all angles, from the horizontal to the perpendicular, but more especially at the medium of 45 degrees. In old trees, this object is greatly promoted by the removal, with the proper instruments, of the dead outer bark.

3161. *Pruning for lessening the bulk of the tree* is also chiefly confined to nursery practice, as necessary to keep unsold trees portable. It consists in little more than what is technically called *heading down;* that is, cutting off the leading shoots within an inch or two of the main stem, leaving, in some cases, some of the lower lateral shoots. Care is taken to cut to a leaf bud, and to choose such from among the side, upper, or under buds of the shoot, as the succeeding year's shoots may be wanted, in radiated lines from the stem, or in oblique lines in some places to fill up vacancies. It is evident that this unnatural operation persisted in for a few years must render the tree knotty and unsightly; and in stone-fruits, at least, it is apt to generate canker and gum.

3162. *Pruning for modifying the form of the tree* embraces the management of the plant from the time of its propagation. In rearing trees planted for timber, it is desirable to throw the timber produced, as much as possible, into long compact masses; and hence pruning is employed to remove the side branches, and encourage the growth of the bole or stem. Where this operation is begun when the trees are young, it is easily performed every two or three years, and the progress of the trees under it is most satisfactory; when, however, it is delayed till they have attained a timber size, it is, in all cases, much less conducive to the desired end, and sometimes may prove injurious. It is safer, in such cases, to shorten or lessen the size of lateral branches, rather than to cut them off close by the stem, as the large wounds produced by the latter practice either do not cicatrize at all, or not till the central part is rotten, and has contaminated the timber of the trunk. In all cases, a moderate number of small branches, to be taken off as they grow large, are to be left on the trunk, to facilitate the circulation of the sap and juices. Where timber-trees are planted for shelter or shade, unless intermixed with shrubs or copse, it is evident pruning must be directed to clothing them from the summit to the ground with side branches. In avenues, and hedgerow trees, it is generally desirable that the lowest branches should be a considerable distance from the ground; in trees intended to conceal objects, as many branches should be left as possible; and in others, which conceal distant objects desired to be seen, or injure or conceal near objects, the form must be modified accordingly. In all these cases, the superfluous parts are to be cut off with a clean section, near a bud or shoot if a branch is shortened, or close to the trunk if it is entirely removed; the object being to facilitate cicatrization.

3163. *Pruning for adjusting the stem and branches to the roots* is almost solely applicable to transplanted trees, in which it is an essential operation, and should be performed in general in the interval between removal and replanting, when the plant is entirely out of the ground. Supposing only the extremities of the fibres broken off, as is the case with very small plants and seedlings, then no part of the top will require to be removed; but if the roots have been broken or bruised in any of their main branches or ramifications, then the pruner, estimating the quantity of root of which the plant is deprived by the sections of fracture and other circumstances, peculiar and general, will be able to form a notion of what was the bulk of the whole roots before the tree was disturbed. Then he may state the question of lessening the top to adjust it to the roots, thus: — as the whole quantity of roots which the tree had before removal is to the whole quantity of branches which it now has, so is the quantity of roots which it now has to the quantity of top which it ought to have. In selecting the shoots to be removed, regard must be had to the ultimate character the tree is to assume, whether a standard, or trained fruit-tree, or ornamental bush. In general, bearing-wood and weak shoots should be removed, and the stronger lateral and upright shoots, with leaf or shoot-eyes, left.

3164. *Pruning for renewal of the head* is performed by cutting over the stem a little way, say its own thickness above the collar, or the surface of the ground. This practice applies to old ozier-beds, coppice woods, and to young forest-trees. Sometimes also it is performed on old or ill-thriving fruit-trees which are headed down to the top of their stems. This operation is performed with the saw, and better after scarification, as in cutting off the broken limb of an animal. The live section should be smoothed with the chisel or knife, covered with the bark, and coated over with grafting-clay, or any convenient composition, which will resist drought and rain for a year. Those who are advocates for pruning when the sap is dormant, will not of course be able to perform the operation of scarification, and covering the section with bark.

3165. *Pruning for curing diseases* has acquired much celebrity since the time of Forsyth, whose amputations and scarifications for the canker, together with the plaster or composition which he employed to protect the wounds from air, are treated of at large in his *Treatise on Fruit-Trees.* Almost all vegetable diseases either have their origin in the weakness of the individual, or induce a degree of weakness; hence to amputate a part of a diseased tree, is to strengthen the remaining part, because the roots remaining of the same force, the same quantity of sap will be thrown upwards as when the head and branches were entire. If the disease is constitutional, or in the system, this practice may probably, in some cases, communicate to the tree so much strength as to enable it to throw it off; if it be local, the amputation of the part will at once remove the disease, and strengthen the tree.

3166. *Mowing* is the operation of cutting down corn, grass, and other herbage crops, with the scythe. It requires great force in the operator, and also a twisting motion of the body which brings almost every muscle into action, and is in short one of the most severe of agricultural labours. The chief art consists in cutting the crop as close to the surface of the ground as possible, and perfectly level, pointing the swaths well out so as to leave scarcely any ridges under them. In the mowing of grain crops, scythes shorter in the blade than the common ones, and to which either a cradle or two twigs of ozier put semicircular-wise into holes made in the handles near the blades, in such a manner that one semicircle intersects the other, are made use of. Commonly, in mowing barley, oats, or other grain, the corn is on the right hand of the workman; but M. de Lisle adopted something like the Hainault method of mowing wheat (2479.), in which the corn was at his left hand: he mowed it inwards, bearing the corn he cuts on his scythe, till it comes to that which is standing, against which it gently leans. After every mower a gatherer follows, who may be a lad, or a woman. The gatherer keeps within five or six feet of the mower, and being provided either with a hook or stick about two feet long, gathers up the corn, making it into parcels, and laying it gently on the ground; this must be done with speed, as another mower immediately follows, and to every mower there is a particular gatherer. To do this work properly, the mower should form but one track with his feet, advancing in a posture nearly as if he was going to fence, one foot chasing the other. In this manner the standing corn is mowed; and the workman should take care to have the wind at his left, as it bears the corn towards the scythe, and causes it to be cut nearer the ground. When wheat is bent, the workman takes the corn as it presents itself to him, which has the same effect as if the wind was at his left side. When it is laid, it is more troublesome to the gatherer, because the cut corn is apt to be mixed with that which is standing; but a good mower takes the advantage of the wind, and cuts it against the way it is laid. No particular directions can be given for corn that is lodged and entangled, unless it be to take it as it is inclined, as if the wind were on the back of the mower

3167. *The usual method of mowing grain* is the same as for grass, the scythe only having a cradle or bow fixed upon the heel of the handle. (*fig.* 226.) In the "practice of most districts, the scythe is swung horizontally or nearly level, leaving the stubble of almost an even height; or if it rise on either side, forming what are called swath-balks: the butts of the swaths are suffered to rest upon them, the heads or ears of the corn falling into the hollow or close mown part of the preceding swath width. They are of course liable, in a wet season, not only to receive an undue portion of rain water, but to be fouled with the splashings of heavy showers. But in the Kentish practice, which is said to excel those of other districts, the position of the swaths is different. Here, the heads of the corn rest on the top of the swath-balk, provincially the *beever*, which is left of extraordinary height, as ten to fifteen inches; so that the wind has a free circulation beneath the swaths. The workman, in performing this judicious operation, proceeds with his right foot forward, entering the point of his scythe with a downward stroke, and raising it as abruptly out, bringing the handle round to the left until it forms nearly a right angle with the line of the swath, carrying the corn in the cradle three or four feet behind the place where it grew, lifting it high, and letting it fall on the beever behind his left foot, and in the position above described. The disadvantages of this method are, the loss of some straw, the incumbrance arising from the length of stubble, and a little additional labour; but in a district where cattle are not numerous, the loss of straw is not felt, and in any country the principle of laying the heads instead of the butts of the corn upon the swath-balk, whether left high or low, might be well adopted."

3168. *In the cutting of grass crops for the purpose of being converted into hay*, it is necessary that they be in the most suitable states of growth and maturity for affording the best and most nutritious fodder. With this view they should neither be cut at too early a period, nor suffered to stand too long; as in the former case there will be considerable loss in the drying, from the produce being in so soft and green a condition, and in the latter from a large proportion of the nourishing properties being expended. Grass, before it becomes in full flower, while the rich saccharine juice is in part retained at the joints of the flower-stems, is in the most proper condition for being cut down, as at that period it must contain the largest proportion of nutritious matter; but in proportion as the flowers expand and the seeds ripen, the juice is taken up to constitute the meal or starch of the seed lobes, and is thus either dispersed upon the land, or fed upon by birds; the grass stems with their leaves being left in a similar situation to that of the straw of ripened grain. But there are other circumstances, besides those of ripeness, to be attended to in determining the period of cutting crops of grass, as in some cases when they are thick upon the ground the bottom parts become of a yellow colour before the flowering fully takes place: under such circumstances it will often be the most advisable practice to mow as soon as the weather will possibly admit; for if this be neglected, there will be great danger of its rotting, or at any rate of its acquiring a disagreeable flavour, and of becoming of but little value. Where grass is very tall, as is often the case in moist meadows, it is liable to fall down and lodge, by which the same effects are produced.

3169. *In cutting rouen or second crops of grass*, more attention will be requisite than in the first, as the crops are mostly much lighter and more difficult to cut, the scythe being apt to rise and slip through the grass without cutting it fairly, except when in the hands of an expert workman. Crops of this sort should always be cut as much as possible when the dew is upon them, and as soon as ever there is a tolerable growth; as, by waiting, the season is constantly getting more unfavourable for making them into hay; and when not well made, this hay is of little or no value. When the grass has been decided to be in the proper condition for being cut down, a set of mowers proportioned to the extent of the crop should be immediately provided. In some districts, it is the custom to pay these labourers by the day, but a better and more general practice is to let the work at a certain price by the acre. The extent or proportion of ground that can be mown in any given space of time must obviously vary much according to the nature of the ground, the fulness of the crop, and the goodness of the workman; but in general an acre is supposed a full day's work for an expert mower.

3170. *The mowing of weeds and coarse tussocks of grass in pasture* should take place before they come into flower, or at all events before they ripen their seed. Bruising or clipping with a sort of blunt wooden shears is considered preferable for ferns, thistles, and nettles (3140.), as they are said not to spring up again the same season, which they are apt to do if cut over with the clean cut of the scythe.

3171. *The mowing of weeds in rivers and ponds* is done in the usual way from a boat, in which the operator stands, and is rowed forward by another as required. Sometimes scythe-blades are tied or rivetted together, and worked by means of ropes like a saw from one shore to the other; but the first mode is generally reckoned the best, even in public canals, and is unquestionably so in agriculture.

3172. *The Hainault mowing* is a process which is exclusively applicable to corn crops; it has been long practised in Flanders, and though various attempts have been made at different times and places to introduce it to this country, and notwithstanding the great advantages promised, it is still little known. We have already described the implement, and the mode of using it, and suggested reasons for its not being more generally employed. (2479.) The breadths of corn cut at every stroke, are carried forward by the joint operation of the blade and the hook, and collected at the left hand of the mower, where he leaves them standing almost erect, but leaning to the left against the standing corn. When as much is cut as will make a sheaf, the mower turns to the left so as to face the standing corn, introduces his hook behind the middle of the leaning parcels, and at the same time the scythe points near the bottom; then mowing sideways to the left, returning over the ground he has mown, he draws and collects the cut corn, still by means of the hook and scythe preserving the erect position of the straw, to the place where the last collecting operation ended; then wheeling round to the left, with the hook still embracing the middle of the whole cut corn, he stops the motion of the scythe, whilst the hook still moves forward to the left, so as to overset the corn and lay it evenly along on the stubble, with the ears towards the right, ready for the binder. In oversetting the collected corn he uses his left foot if necessary. The mower now advances to the front, and commences the cuts for a new sheaf as before, always working towards the standing corn and not from it

3173. *Reaping* is the operation of cutting corn with the hook or sickle, the former called provincially bagging, the latter shearing or reaping. The operation of reaping is most general in the northern counties. The corn is cut in handfuls with the sickle (2481.), and these are immediately deposited upon bands, formed by twisting together a few of the stalks of the corn at the ends next the ears, and afterwards bound up into sheaves, in order to their being set up into *shocks* or *hattocks*. The method is in most instances adopted with the wheat and rye crops in every part of the island, as it is difficult to cut without much loss from the shedding of the grain; and, in addition, it is of great advantage to have these sorts of crops bound up regularly into sheaves, the straw being much better.

3174. *In bagging*, the operator hooks up the corn towards him, and then lays it on bands as in reaping. By this mode corn is cut lower than by reaping with the sickle, but rather more straws drop unless great care is taken.

3175. *Sheaving and shocking*, or, as termed in the north, binding and stooking, are operations performed for the most part immediately after the corn is cut. In binding it is tied up in sheaves or bundles by the bands already mentioned; and in shocking or stooking, the sheaves are set on end in pairs leaning against each other, and covered or otherwise by what are called heading sheaves, laid on the upright ones so as to cover and protect the ears from the weather, and act as a roof to the shock or stook. The number of sheaves brought together in a stook, and even the modes of placing them, vary in different districts. The operation is performed with most care and neatness in the wet climates of the north.

3176. *Gaiting, or gaitning*, as it is called in Northumberland, is an operation of much nicety in the performance, and in a damp climate of great consequence in its results. In the upland parts of Northumberland, it is performed in the following manner with the crops of oats, frequently with those of barley, and sometimes with those of wheat: — The gaitner follows immediately after about eight or nine sheaves have been cut and laid down; the corn being laid into the band near the tops or spikes of the corn, he seizes the ends of the band with each hand, brings the gaitning (sheaf) up to the left knee, gives the band a slight and peculiar twist, and then sets the sheaf up singly; but in doing so he gives it a half turn round, which makes the skirts fly out and gives it exactly the appearance of the straw cover of a bee-hive; if properly done, the band should be so loose that the master can thrust his hand easily through the middle. The utility of this practice is that no rain can lodge, and the corn therefore never sprouts unless the band has been tied too tight; it also wins [dries] and is fit for the stack sooner. Gaitned sheaves are not good to keep standing in stormy weather; some, therefore, now set three gaitned sheaves together, which keeps them up; they are always sound before they are carted to the stack, but frequently they are not stooked. (*J. C., R. near Alnwick.*)

3177. *An improved method of setting up sheaves of corn* is thus described. Take a stake about twice the height of a sheaf, and drive it six inches into the ground at its thicker end, in an upright position, and around this place eight sheaves in the usual manner; two more sheaves are then to be bound together at the straw end, and being inverted, are to be thrust down on the top of the stake, so that it shall pass up into the centre of the bound part, and their lower ends being then spread out so as to cover the lower sheaves will protect them from wet in the manner of a hood sheaf. (*Gard. Mag.* vol. v.).

3178. *In the reaping of grain crops*, whether the sickle, hook, or scythe is employed for the purpose, there is much difference in the height at which the crops are cut in different places. In some it is the practice to have the business performed in as close a manner as possible; while in others a stubble of eight, ten, and fifteen inches or more is left. These different practices have their advocates; one party supposing that the work proceeds more slowly where it is executed in so close a manner, while the other contends that the contrary is the case. But as the stubble which is left is not only useless to the land, but in many cases very troublesome in its succeeding culture, being frequently under the necessity of being removed, it would seem to be the best as well as cheapest practice, to have the business constantly executed in a close manner. By this means the agriculturist will not only have more litter at command for the bedding of his yards, stalls, and other places, and consequently an increase of manure, but with much less waste of grain, and at the same time be freed from the trouble and expense of removing the stubble. It has, indeed, been fully shown, by a careful trial, made with the view of ascertaining the difference between high and low reaping, that the advantage is considerably in favour of the latter.

3179. *The sickle and the scythe in reaping grain crops* have each their advantages and disadvantages. In the first manner, the crops are deposited with more regularity and exactness, and consequently bound into sheaves with greater facility and despatch. Besides, in many cases, less loss is incurred by the shedding of the grain in the time the work is performing; but the labour is executed with greater difficulty and trouble. Reaping by the scythe possesses the superiority of being more expeditious, and of being performed to any degree of closeness that may be required; while it has the evident disadvantage of leaving the cut grain in a more irregular and uneven situation, by which it is rendered less fit for being bound up into sheaves, which in many cases is an inconvenience of great consequence. Another objection is, that the ears not being so regularly presented to the rollers of the threshing-mill, the threshing is not done so perfectly. When the grain has attained a high degree of ripeness, there may, likewise, be great loss sustained, by its being shed during the operation, in this way of reaping or cutting the crop. Where this method is practised, it is, however, not unfrequently bound into sheaves, though the more common custom is to let it remain in the rows or swaths till fit for being put into the stack. It is generally the practice to cut it inwards against the crop on which it rests. In the other case, it is cut in the manner of grass for hay. It is obvious, therefore, that where operators are procured with difficulty, this mode of reaping is the most advisable; while, under the contrary circumstances, the former may be had recourse to with more advantage, as the work may be executed in a neater and more exact way.

3180. *Reaping, whatever mode be adopted, is often let by the acre* to persons that go about for harvest work, and it may, in many cases, be best performed in this manner; but great attention should be paid by the cultivator to see that the grain is cut and bound up in a proper method, and that the work is not performed in improper weather. The prices vary according to the nature of the crops, the season, and other circumstances. In

Forfarshire, and in some other parts of the north of Scotland, reaping is performed by the *threave*, which consists of twenty-four sheaves. By this practice it is the interest of the reapers to cut as close as possible, because they know, that the lower ends of the stalks fill the sheaf better than the upper parts.

3181. *Pulling* is a mode of taking a crop applicable chiefly to flax and hemp. These are pulled in handfuls, the earth beat and shaken from their roots, and after the handfuls have lain a day or more separately, they are collected together and tied in bundles. In the case of hemp, it being a diœcious plant, the male stalks are pulled some weeks before the others. Dry weather is preferable for the operation.

3182. *Digging up or forking up* is occasionally resorted to for taking crops of roots, as potatoes, carrots, &c. In performing this operation, the principal thing is to avoid cutting or bruising the roots with the spade or fork, and to separate the roots from the soil by first lifting up the spitful and then throwing it down in such a way as to break and scatter it, and bring to light the roots or tubers. When crops of this sort are planted in rows, they are frequently raised by a plough, the coulter being withdrawn.

Sect. IV. *Mixed Operations performed by Manual Labour.*

3183. *The mixed agricultural operations* differ little from the last as to the skill or strength required in the operator: they are chiefly ropemaking, thatching, turning straw or hay, drawing or sorting straw, flail-threshing, hedging and ditching, weighing, measuring, stack-building, sheep-shearing, paring and burning turf, burning clay, and forming compost soils or manures.

3184. *Straw rope making* is an operation which requires two persons when performed in the usual manner with a crook. (*fig.* 222.) In this case the person who forms the rope is stationary, and the twister moves from him backwards the length of the rope; but if the crook is turned by machinery, as, for example, by a movement from a threshing machine, or by a detached machine turned by hand (*fig.* 223.), then the person who forms the rope moves backwards as he lets out the material to be twisted. These sorts of ropes are commonly made of oat or rye straw; but they are also formed of coarse hay or rushes, long moss, ferns, &c. In all cases the material requires to be moistened and thoroughly mixed together before it is made use of by the ropemaker.

3185. *Thatching* is the operation of covering the roofs of buildings, stacks, &c. with some sort of thatch. It is an art that requires considerable care, attention, and practice, to perform it in a proper manner. Before this business is begun, it is necessary that the materials, of whatever kind they may be, should undergo some preparation. With articles of the straw kind the usual method is this: the substances, after being well moistened with water, are drawn out in handfuls perfectly straight and even, into regular lengths, and the short straw separated from them, leaving them placed in convenient bundles to be carried to the thatcher by the person who has the serving of him.

3186. *The application of thatch to stacks* of hay or corn is performed by different methods, according to the nature of the materials employed. Where long straw is made use of, the operator or workman usually begins at the eaves or bottom of the roof, depositing it in handfuls in regular breadths till he reaches the top, the different handfuls being so placed endwise as to overlap each other, the upper ends being constantly pushed a little into the bottom parts of the sheaves. In this manner he gradually proceeds, breadth after breadth, till the whole of the roof is covered, which is usually done to the thickness of about four or five inches. In order to retain the thatch in its place, short sharp-pointed sticks are sometimes thrust in, in a slanting direction upwards, and sometimes small sticks sharpened at the ends are bent and thrust in along the top parts and sides: but as the water is apt to follow the course of the sticks, it is a better practice to make use of ropes of twisted straw for this purpose. In some cases these are applied only round the bottom parts of the roof and the sides; while in others, which is a much better and more secure method, they are applied in such a manner over the whole stacks, as to form a sort of net or lozenge work of nine or twelve inches in width in the meshes (*fig.* 515.), the ends being well fastened either to the sides of the stack under the eaves, or to a rope carried round in that situation on purpose to fasten them to. This method of tying on the thatch should always be had recourse to where the stackyards are greatly exposed to the effects of wind, as without such precautions much injury and loss may frequently be sustained by the farmer. It is in common use in Northumberland and northwards.

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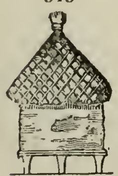

3187. *In the application of stubble as a thatch for ricks*, it is mostly put on by sticking one of its ends into the roof of the stack in a regular and exact manner, so that it may stand very close and thick; when the other, with such loose straws as may occur, is to be cut over or pared off with the thatching knife, or a very sharp tool for the purpose, so as to form a neat and impenetrable thatch, having the appearance of a newly thatched house-roof (*fig.* 516.); the whole being well secured in its place by short pegs made for the purpose, somewhat in the same way as in the other stacks.

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3188. *The time of commencing the thatching of hay and corn stacks* in England is generally delayed until they have fully settled, as under the contrary circumstance it is sure to rise into ridges afterwards, and by that means admit the water to pass down into them, and of course do much injury to the corn or hay. In Scotland, the stacks are covered with all convenient speed after being built, and a great deal of loss is sometimes sustained, when they are left uncovered even for a few days. When the stack subsides, it is only necessary to tighten the ropes, or, in some instances, a part of the ropes are left to be applied, when this subsidence takes place.

3189. *In thatching the roofs of houses* or other buildings with any of the sorts of straw, the same rules are in some respects to be followed, only the materials are to be laid on to a considerable thickness, and be more firmly secured. They are applied in regular narrow slips, or what in some districts are termed *gangs* or *courses*, from the eaves of the building to the ridges, the ladder being moved forward as the work proceeds. The thatch is secured by short sharpened sticks thrust in where necessary; and bended sticks sharpened at each end are sometimes made use of near the ridges, being thrust in at each end. In finishing the work, the thatcher employs an iron-toothed rake, with which the whole is raked over from the top to the bottom, so as to render it completely smooth and even, and take away all the short straws.

3190. *The method of thatching with reed,* according to Marshall, who seems to have paid much attention to the subject, in his account of *The Rural Economy of Norfolk*, is this: " No laths being made use of, in laying it a little of the longest and stoutest of the reed is scattered irregularly across the naked spars, as a foundation to lay the main coat upon: this partial gauze-like covering is called the *fleaking*.

3191. On this *fleaking* the main covering is laid, and fastened down to the spars by means of long rods (provincially, *sways*) laid across the middle of the reed, and tied to the spars with rope yarn, or with *bramble bonds*, which formerly were much in use, but which are now nearly laid aside, especially for new roofs.

3192. *Reed is not laid on in longitudinal courses*, in the manner that straw thatch is usually put on, nor are the whole eaves set at once. The workman begins at the lower corner of the roof, on his right hand, for instance, and keeps an irregular diagonal line or face, until he reach the upper corner to his left, a narrow eaves-board being nailed across the feet of the spars, and some *fleaking* scattered on; the thatcher begins to 'set his eaves,' by laying a coat of reed, eight or ten inches thick, with the heads resting upon the fleaking, and the butts upon the eaves-board. He then lays on his *sway* (a rod rather thicker than a large withy), about six or eight inches from the lower points of the reeds; whilst his assistant, on the inside, runs a needle, threaded with rope yarn, close to the spar; and in this case, close to the upper edge of the eaves-board. The thatcher draws it through on one side of the sway, and enters it again on the contrary side, both of the sway and of the spar: the assistant draws it through, unthreads it, and with the two ends of the yarn makes a knot round the spar, thereby drawing the sway, and consequently the reed, right down to the roof; whilst the thatcher above, beating the sway and pressing it down, assists in making the work the firmer. The assistant having made good the knot below, he proceeds with another length of thread to the next spar, and so on till the sway be bound down the whole length; namely, eight or ten feet. This being done, 'another stratum of reed is laid on upon the first, so as to make the entire coat eighteen or twenty inches thick at the butts; and another sway laid along, and bound down, about twelve inches above the first.'

3193. *The eaves* are adjusted and formed, not square with the spars, but nearly horizontal; nor are they formed by cutting; but by 'driving' them with a '*legget*,' a tool made of a board eight or nine inches square, with a handle two feet long, fixed upon the back of it, obliquely, in the manner of the tool used by gardeners in beating turf. The face of the *legget* is set with large-headed nails, to render it rough, and make it lay hold of the butts of the reeds. Then another layer of reed is laid on, and bound down by another *sway*, somewhat shorter than the last, and placed eighteen or twenty inches above it; and above this another, and another, continuing to shorten the sways until they be brought off to nothing, and a triangular corner of thatching formed. After this, the sways are used their whole length, whatever it happens to be, until the workman arrives at the finishing corner. By proceeding in this irregular manner, seams between the courses are prevented, and unnecessary shifting of ladders avoided.

3194. *The face of the roof* is formed and adjusted like the eaves, by driving the reed with the *legget*; which operation, if performed by a good workman, not only gives the roof a beautiful polished surface, but at the same time fastens the reed, which being thickest towards the butts, becomes like a tapering pin, the tighter the farther it is driven.

3195. *Finishing the ridge of the roof.* In the case of reed running from four to six or eight feet long, the heads meet at the ridge of the roof, whilst the butts are still at a distance from each other. For this reason, as well as for that of the wear being less towards the ridge, the shortest (which is generally the worst) reed is saved for the upper part of the roof. But even supposing the uppermost courses to be only four feet long, and that the heads (belonging to the two sides) be interwoven in some degree with each other, the butts will still remain six or seven feet asunder; and the ridge of the roof consequently be left in a great measure exposed to the weather. In order to remedy this inconvenience, and to give a finish to the ridges, a *cap* (provincially, a *roof*) of straw is set on in a masterly, but in an expensive, manner. In this operation, the workman begins, it is observed, by bringing the roof to an angle, with straw laid lengthwise upon the ridge, in the manner in which a rick is topped up; and to render it firm, to keep it in its place, and to prevent the wind from blowing it off or ruffling it, he pegs it down slightly with 'double broaches;' namely, cleft twigs, two feet long and as thick as the finger, sharpened at both ends, bent double, and perhaps barbed by partial chops on the sides, to make them hold in the better after being thrust down. This done, the workman lays a coat of straight straw, six or eight inches thick across the ridge, beginning on either side at the uppermost butts of the reed, and finishing with straight handfuls evenly across the top of the ridge. Having laid a length of about four feet in this manner, he proceeds to fasten it firmly down, so as to render it proof against wind and rain. This is done by laying a '*brochen ligger*' (a quarter-cleft rod as thick as the finger, and four feet in length) along the middle of the ridge, pegging it down at every four inches with a double broach, which is thrust down with the hands, and afterwards driven with the *legget*, or with a mallet used for this purpose. The middle ligger being firmly laid, the thatcher smooths down the straw with a rake and his hands, about eight or nine inches on one side, and at six inches from the first lays another ligger, and pegs it down with a similar number of double broaches, thus proceeding to smooth the straw, and to fasten on liggers at every six inches, until he reach the bottom of the cap. One side finished, the other is treated in the same manner; and the first length being completed, another and another length is laid, and finished as the first, until the other end of the ridge be reached. He then cuts off the tails of the straw square and neatly with a pair of shears, level with the uppermost butts of the reed, above which the cap (or most properly the *roofiet*) shows an eaves of about six inches thick; and, lastly, he sweeps the sides of the main roof with a bough of holly; when the work is completed."

3196. *Trussing straw or hay* is the operation of binding it in bundles for more convenient deportation. In trussing hay from a rick, it is cut into cubic masses with the hay-knife (2484.), and tied by a hay rope passing once across each of its sides. If the trusses are intended for the London market, they are weighed with a steelyard, and each truss of old stacked hay must weigh 56 pounds, and of new hay, during June, July, and August, 60 pounds. We have described a very convenient machine for the operation of trussing. (2561.)

3197. *Straw is commonly trussed* by tying it into bundles by a band of a handful of straws, or a short rope across the middle of the bundle, or by a particular mode of twisting and turning back the two straggling ends of a loose armful of straw, and tying these ends in the middle. This mode, more easily practised than described, is termed in the north bottling or windling. When wheat-straw or any other sort is to be trussed for thatch, it is first drawn into regular lengths, leaving out the refuse, as already alluded to under thatching. In London, the straw sold for litter is always required to be trussed in this manner, and each truss is required to weigh 56 pounds.

3198. *Threshing by the flail* is still a very general practice in most of the southern counties, though all intelligent men agree that it is more expensive and less effectual than threshing by a machine. Even on the smallest-sized farms, where a horse machine would be too expensive, either the hand machine or portable machine (2546.) might be employed. Besides threshing cleaner, and that too in a manner independently of the care of the operators, the work is performed without the aid of expensive threshing floors, goes on rapidly, is a more agreeable description of labour for servants, employs women and children, and, finally, exposes the corn to less risk of pilfering.

3199. *In the flail mode of threshing*, the produce is constantly exposed to the depredations of the persons employed in executing the business, which is a great objection, and in many cases this mode proves a source of great loss to the farmer, as he cannot by any means prevent the impositions to which it renders him liable. It has been observed by Middleton, in his *Survey of Middlesex*, that "where threshers are employed by the day, they frequently do not perform half the work that ought to be done in the time, nor even that in a perfectly clean manner;" and that if "it be executed by the quarter, or by the truss, the freest corn is threshed out, and the rest left in the ear." The same thing takes place in a greater or less degree in every other mode that can be devised for having the work performed by the hand; and it is consequently only by the general introduction and use of the threshing machine that the property and interest of the farmer can be fully secured, and work be executed with a proper degree of economy.

3200. *In respect to the mode of threshing corn by the flail*, it is the practice in some districts for only one person to be employed upon a floor, yet as two can thresh together with equal if not greater expedition and dispatch, it must be a disadvantageous mode; but where more than two labourers thresh together, which is sometimes the case, there must be frequent interruptions, and a consequent loss of time. The flail or tool by which this sort of business is performed should be well adapted to the size and strength of the person who makes use of it, as, when disproportionately heavy in that part which acts upon the grain, it much sooner fatigues the labourer, without any advantage being gained in the beating out of the grain. The best method of attaching the different parts of the implement together is probably by means of caps and thongs of good tough leather. Iron is, however, sometimes employed. In threshing most sorts of corn, but particularly wheat, the operators should wear thin light shoes, in order to avoid bruising the grains as much as possible. In the execution of the work, when the corn is bound into sheaves, it is usual for the threshers to begin at the ear-ends, and proceed regularly to the others, then turning the sheaves in a quick manner by means of the flail, to proceed in the same way with the other side, thus finishing the work.

3201. *The quantity of corn that a labourer will thresh with the flail* in any given period of time, must depend on the nature of the grain, the freeness with which it threshes, and the exertions of the labourer; in general it may be of wheat, from one to one and a half quarter; of barley, from one and a half to two quarters; and of oats mostly about two in the day. The exertions of labourers in this sort of work in the northern districts of the kingdom are, however, much greater than in those of the south; of course a much larger proportion of labour must be performed. In some places it is the practice to thresh by the measure of grain, as the bushel, quarter, &c.; while in others it is done by the threave of twenty-four sheaves, and in some by the day. In whatever way the agricultor has this sort of business performed, there is always much necessity for his constant inspection, in order to prevent the frauds and impositions that are too frequently practised upon him by the persons engaged in the execution of it.

3202. *The practice of whipping out grain* is resorted to in some districts with wheat, when the straw is much wanted for thatch. The operator takes a handful, and strikes the ears repeatedly against a stone, the edge of a board, or the face of a strong wattled hurdle, till the corn is separated.

3203. *Burning out*, a mode formerly practised in the Highlands of Scotland, and not yet obsolete, may be noticed here. It is to burn the straw with the corn in it, instead of subjecting it to the flail. This has been described in several of the County Reports, particularly in *Walker's Hebrides* and *Macdonald's Report of the Western Islands*. The corn is thus not only separated from the straw but sufficiently dried or parched to grind without being sent to the kiln. It is a bad practice, as the straw is lost, and consequently the soil, for want of manure, must soon become barren.

3204. *Rippling* is the operation of separating the boles or seed-pods of flax and hemp by striking in the manner of whipping, or more commonly by drawing them through an implement of the comb kind, constructed with several upright triangular prongs set near together in a strong piece of wood.

3205. *Hedging and ditching*, the operation of making and mending fences and open water-courses of the different kinds already enumerated, consists of the combined application of digging, shovelling, cutting, clipping, and faggoting, described in this section and the two foregoing.

3206. *Faggoting* is a term applied to the dressing or binding of the prunings or superfluous branches and spray of hedges. The bundles are made of different sizes in different parts of the country, and in the same place according to the purpose to which they are to be applied. They are tied with willow, hazel, or some other pliable wood, twisted before application.

3207. *Stacking wood for fuel* occurs in the practice of common agriculture when hedges and pollard trees or tree-roots are stocked or dug up. The wood, whether roots or trunk, is cut into lengths of from eighteen inches to two feet with a saw, then split with iron wedges into pieces of not more than an inch and a half, or two inches in diameter, and built into an oblong stack generally three feet broad and high, and six feet long.

3208. *Stacking wood for burning, stewing for tar* or pyrolignous acid, charring, and similar purposes, are peculiar to forest culture, and will be treated of in the proper place. (See Part III. or *Index*.)

3209. *Paring and burning* is the process of paring off the surface of lands in a state of grass, in order to prepare them for arable culture by means of fire. In the method of performing the process there is some slight difference in different districts, and an attention to the nature of the lands is as necessary as in other husbandry operations. It would seem that some soils, as those of the more clayey and heavy kinds, would be most benefited by having the fire as much as possible in contact with the whole of their superficial parts, without being carried too far, as by that means they may be rendered more proper for the reception of the roots of vegetables after being slightly ploughed, as well as more suitable for supplying nourishment to them; while in others, as those of the more light and thin description, it might be most advantageous merely to consume the thin paring of sward after being piled up for the purpose, without permitting the fire to exert its influence upon the mould or soil immediately below, as in this way there would not probably be so much danger of injuring the staplé by destroying the vegetable matters contained in such soils. Of course, in the first of these modes of burning the sward, the sods or parings should be piled up as little as possible into heaps, the advantage of a suitable season being taken to apply the fire to them in the state in which they lie or are set at first after being cut up, or after a few only have been placed together, as in some instances where they are, immediately after being cut, set on edge to dry, and placed in serpentine directions in order to prevent them from falling over. In the latter cases they should be formed or built up into little circular heaps or piles, somewhat in the form and size of the little cocks made in hay-fields, the sods being placed the grass-side downwards, in order to admit air; but the openings both at the bottoms and tops, after they have been fully set on fire by some combustible substance, such as straw, &c., are to be closed up, and those in other parts covered by an addition of sods, so that the combustion may proceed in a slow smothering manner, as practised in the making of charcoal. When the whole of the earth in each of the piles has been acted upon by the fire, the heaps may be suffered to extinguish themselves by slowly burning out.

3210. *A variety of this operation, called skirting or peat-burning*, is practised in Devonshire and Cornwall, for breaking up and preparing grass lands for the reception of fallow crops. A part of the sward or surface is alternately left unturned, upon which the next thin furrow slice is constantly turned, so that the swards of each come in contact, by which means the putrefactive fermentation is speedily excited, and the greatest part of the grassy vegetable matter converted into manure. What ultimately remains undestroyed being, after repeated cross-cuttings with the plough and harrowings, collected into small heaps and burnt, the ashes are then spread evenly over the land.

3211. With respect to the *implements used in paring*, different kinds are made use of in different parts of the island: that which was the most employed in the infancy of the art, was a kind of curved mattock or adze, about seven or eight inches in length, and five or six in breadth; and which, from its shape, would appear to have been better adapted for cutting up the roots of brushwood, furze, broom, or other coarse shrubs, than for paring off the surface of a field free from such incumbrances. Where the sod is pared off by manual labour, the ordinary breast-spade, in some places called the breast-plough, and in Scotland the flaughter-spade, is mostly employed. In working the tool, the labourer generally cuts the sods at about an inch or an inch and a half thick, and from ten to twelve inches broad; and when the spade has run under the sod to the length of about three feet, he throws it off, by turning the instrument to one side; and proceeds in the same way, cutting and throwing over the sods, the whole length of the ridge. In this way of performing the operation, the labourers, by following each other with a slice of the sward or surface of the land, accomplish the business with much ease, and in an expeditious manner.

3212. *In the fenny districts*, on the eastern coasts, where paring and burning is practised on a large scale, the horse paring-plough is used, made of different constructions, according to the circumstances of the ground to be pared. These ploughs are calculated for paring off the sward or sod of such grounds as are level, and where neither stones, brush-wood, ant-hills, nor other impediments obstruct their progress; but where such obstacles present themselves, the breast-spade, or the common team-plough with a small alteration of the share, will be found preferable, both in respect to the extent of ground that can be pared, and the superior manner in which the work in such cases can be performed. Ploughs, from their great expedition and regularity of performing the business, should always be made use of where the nature and situation of the land will admit them, in preference to such tools as require manual labour.

3213. *In some of the western counties*, the common plough only is used. There the old grass fields, when it is proposed to burn the sward, are rib or slob furrowed about the beginning of winter; and being again cross ploughed the following spring, the sods are collected and managed in the manner mentioned in speaking of skirting. In those cases, the plough has, however, a wing turned up on the furrow side of the ploughshare, by which the furrow is cut any breadth required.

3214. *The season for paring and burning* is in April, May, and June: the particular period must, however, always depend much on the state of the weather and the nature of the crop. When the east winds prevail, in February and March, this sort of business may sometimes be carried on. But for accomplishing the work with the greatest dispatch, and also with the least trouble and expense, a dry season is obviously the best. The prudent cultivator shnuld not embark in the undertaking, unless there is a reasonable probability of his accomplishing it while the weather keeps dry and favourable. In the more northern districts, the latter end of May or the beginning of June, when the hurry of the spring seed-time is over and a number of hands can be most easily procured, may, upon the whole, be considered the best and most convenient season; as at this period the green vegetable products are in their most succulent state, and of course may probably afford more saline matter: but, in the more southern counties, either a much earlier season must be taken, or the interval between the hay season and the harvest time must be fixed upon; the latter of which is, on the principle just stated, evidently the best, where the extent of ground to be burnt is not too large. In other seasons it would frequently be impossible to procure a sufficient number of hands for performing the business. In bringing waste lands into cultivation, where an extensive tract of ground is to undergo this process, the autumn may, in many cases, afford a convenient opportunity for the operation. A good deal depends on the crops that are to be sown after paring and burning. When rape or turnips are to be cultivated, the end of May or the beginning of June will be the most proper time; but if barley or oats are to be sown, the paring and burning must be completed as early in spring as the nature of the season will admit: and when lands are pared and burned as a preparation for a crop of wheat, July, or even the beginning of August, may, in favourable seasons, answer; but it is better to have the ground ready sooner if possible.

3215. In respect to *the depth to which lands of different qualities may be pared* with the most advantage, it is obvious that, as it can hardly be proper to pare light thin-stapled soils to the same depths as those of the more deep and heavy kinds, it should, in some degree, be regulated by their particular nature, and their difference in depth and heaviness. Boys, who is in the habit of breaking up thin chalky soils, and such as have been in tillage, in this way, observes, that in Kent, where the method of paring most in use is with *down-shares* or breast-ploughs, they take off turf as thick as the nature of the soil will admit, from half an inch to two inches; the thicker the better, provided there is a sufficient portion of vegetable matter contained within them to make them burn well. The most usual depths of paring are from about one inch to three.

3216. In regard to *burning*, when the season is not very wet, the turves will commonly be sufficiently dried in about a fortnight or three weeks, even without being turned; but in rainy weather they require a longer time, and must be turned more than once to prevent their striking out roots and shoots, which might hinder them from burning.

3217. *Spreading the ashes.* As soon as the turves have fully undergone the process of burning, and are reduced to the state of ashes and a powdery earthy matter, the whole should, as soon as possible, be spread out over the land in as regular and equal a manner as the nature of the work will admit of; for, without great attention in this respect, great inequality in the crops may take place; besides, the soil will be made lighter in some places than in others, which may be disadvantageous in the same way. The spreading, where it can by any means be accomplished, should always be performed before any rain falls; as, where this point is not attended to, a great loss may be sustained by the saline matters being carried down in a state of solution, and their beneficial effects in a great measure lost before the crops are in a condition to receive them. In order to secure the full influence of the ashes, the land is frequently slightly ploughed over immediately after the ashes are spread out; and it is stated by Donaldson, that those who are more than ordinarily attentive in this respect, only rib or slob furrow the field, so that the ashes after burning may be covered up with the greater expedition and dispatch. By this mode, however, they probably cannot be so equally mixed with the soil as by that of ploughing the whole field with a very slight furrow, so as just to cover them.

3218. *The expense of the operation of paring and burning* will vary according to the nature and situation of the land, the method in which it is performed, and the customs of the district in regard to the price of labour. On the thin sort of chalky soils it is stated by Boys, that the expense for paring at a moderate thickness, where the land is not very flinty, is about equal to four or five ploughings.

3219. *The operation of drying and burning clay for manure* is in several respects similar to that of paring and burning the verdant surface. The practice of burning clay has at various times been pursued with energy and success, and at other times has fallen into neglect. The oldest book in which it is mentioned, is probably *The Country Gentleman's Companion*, by Stephen Switzer, Gardener, London, 1732. In that work it is stated that the Earl of Halifax was the inventor of this useful improvement; and that it was much practised in Sussex. There are engravings of two kilns for burning clay, one adopted in England, and the other in Scotland; where it is said to have been ascertained, that lands reduced by tillage to poverty, would produce an excellent crop of turnips, if the ground were ploughed two or three times, and clay ashes spread over it. In the same work, there are several letters, written in the years 1730 and 1731, stating that the plan of burning clay had answered in several parts of England; and accounts were received from Scotland, that upon experiment it had answered better than either lime or dung, but was found too expensive. The practice is described at length in Ellis's *Practical Farmer, or Hertfordshire Husbandman*, 1732. In 1786, James Arbuthnot of Peterhead tried several successful experiments with burning clay, and various others have since been made in different parts of the empire. In 1814, the practice was revived and written on by Craig of Cally, near Dumfries, and soon after by General Beatson, near Tunbridge; by Curwen, Burrows, and several correspondents of agricultural journals. In Ireland, it would appear, the practice prevails in several places, and Craig says he adopted it from seeing its effects there. The result of the whole is, that the benefits of this mode of manuring have been greatly exaggerated;

though they certainly appear to be considerable on clayey soils. Aiton (*Farmer's Mag.* vol. xxii. p. 423.) compares this rage for burning clay, which existed in 1815, to the fiorin mania of a few years' prior date. In 1822, he found few of the advocates for these improvements disposed to say much on the subject, and saw very few clay-kilns smoking. "To give my ultimatum upon this subject," he says, "I regret that the discoverers of fiorin grass, and of the effects of burnt clay, have so far overrated their value. Both are useful and proper to be attended to; — the grass to be raised on patches of marshy ground, and used as green food to cattle in winter; and the burnt earth as a corrector of the mechanical arrangement of a stubborn clay soil; and I have no doubt, but if they had been only recommended for those valuable purposes, they would have been brought into more general use than they yet are, or will be, till the prejudices against them, arising from the disappointment of expectations raised high by too flattering descriptions, are removed."

3220. *The action of burnt clay on the soil* is thus described by the same author: —" It must be obvious to every person who has paid attention to the subject, that when clay or other earth is burnt into ashes like brick-dust, it will not (unless acids are applied to it) return again to its former state of clay, but will remain in the granulated state of ashes or friable mould, to which it was reduced by the operation of burning. An admixture of that kind with a strong adhesive clay must evidently operate as a powerful manure, by changing the mechanical arrangement of the latter, and rendering it more friable; giving greater facility to the percolation of redundant moisture, and to the spreading of the roots of vegetables in quest of food. The application of as much water, sand, or any similar substance, would have exactly the same effect, in opening and keeping open the pores of an adhesive clay soil, and converting it into the quality of loam. Besides this, which would be a permanent improvement upon the staple or texture of every clay soil, burnt clay or torrefied earth may sometimes acquire, in that operation, a small quantity of soot or carbonic matter, that may, in favourable circumstances, operate for one season as a manure, or as a stimulus, to a small extent, to the growth of vegetables. This at least may be the case, if the clay or earth burnt shall abound with vegetable matter, and if the burning is conducted in such a smothered way, as to prevent the smoke or vegetable matter from escaping. But as it is the subsoil that is recommended, and seems to be generally used for burning, it is impossible any considerable quantity of vegetable matter can be found in it.

3221. *The calcareous matter* in the soil, it is said, will be calcined and formed into lime by the operation of burning; but I am disposed to consider this argument as far more plausible than solid. Calcareous matter is no doubt found, on chemical analysis, to a certain extent in some soils; perhaps some perceptible portion of it may be found in every soil: but it is seldom or never found in any soil, to such an extent as to be of much use as a manure to other land. Even where the soil is impregnated with a large portion of calcareous matter, if it is not in the form of limestone, but minutely mixed with it, the burning cannot either increase or much alter the lime. If it is in the form of stones, however small, or in what is called limestone gravel, there is little chance of its being calcined in the operation of burning the clay; it would go through that ordeal unaltered. Any change, therefore, that can be made upon the small portion of calcareous matter in the soil by burning in the manner directed, can scarcely have any perceptible effect, when that matter is applied as manure to other soils. And though it is possible that some qualities in particular soils, unfavourable to vegetation, may be corrected by burning, and that in some other instances the fire may render the clay more nutritive to plants (though I have not been able to trace this, or even to conjecture how it can happen), yet I am much disposed to believe, that its effect as a mechanical mixture in opening the pores of the soil, is the chief improvement that can be derived from the application of burnt clay as a manure. If it has any other effect, it must be from the soot or carbonic matter collected during the operation of burning; or perhaps it may acquire, by the torrefaction, something of a stimulating quality, that may for a short time promote the growth of particular plants: but these qualities can only be to a small extent, and continue to act for a very limited period." (*Far. Mag.* xxii. 422.)

3222. *The action of burnt clay*, according to a writer in *The Farmer's Journal*, is at least three-fold, and may be manifold. It opens the texture of stubborn clays, gives a drain to the water, spiracles to the air, and affords to the roots facility of penetrating. Clay ashes burnt from turves, containing an admixture of vegetable matter, consist, in some small proportion, of vegetable alkali or potass, a salt which is known to be a good manure. It also, in most cases, happens that a stiff cold clay is impregnated with pyrites, a compound of sulphuric acid and iron. Although the chemical attraction between these two bodies is so strong, that it is one of the most difficult operations in the arts totally to free iron from sulphur, yet a very moderate heat sublimes a large portion of the sulphur. The iron is then left at liberty to re-absorb a portion of the redundant sulphuric acid, which too generally is found in these soils, and thereby sweetens the land; and it is probable that the bright red or crimson calx of iron, which gives colouring to the ashes when over-burnt, is beneficial to vegetation in the present case, insomuch as it is, of itself, one of the happiest aids to fertility, as exemplified in the red marl strata and red sand strata throughout the kingdom. The evolution and recombination of different gases, no doubt, materially affect the question; but it is reserved for accurate chemical observers to give us an account of the processes which take place in this respect. Curwen notices that clay ashes do no benefit as a top-dressing on grass, which is in part to be explained by reason that the ashes, when spread on the surface of the grass, cannot exert mechanical action on the soil in the ways enumerated. Neither can the calx of iron come so immediately in contact with the particles of the soil, for the production of any chemical effect, as it would do if the ashes were ploughed in. In short, like many other manures which are laid on the surface, unless it contains something soluble which may be washed into the ground by rains, it does very little good; and the feeble proportion of vegetable alkali is probably the only soluble matter the ashes contain. However sanguine may be the admirers of burnt clay, all experience confirms that the most beneficial clay ashes are those which are burnt from the greatest proportion of rich old turf, ancient banks, roots of bushes, and other vegetable matters; and, I conceive, the value of mere powdered pottery (for such it is) may easily be overrated. (*Far. Journ.* 1819.)

3223. *The common method of burning clay* is to make an oblong enclosure, of the dimensions of a small house (say 15 feet by 10) of green turf sods, raised to the height of 3½ or 4 feet. In the inside of this enclosure, air-pipes are drawn diagonally, which communicate with holes left at each corner of the exterior wall. These pipes are formed of sods put on edge, and the space between these as wide only as another sod can easily cover. In each of the four spaces left between the air-pipes and the outer wall, a fire is kindled with wood and dry turf, and then the whole of the inside of the enclosure or kiln filled with dry turf, which is very soon on fire; and on the top of that, when well kindled, is thrown the clay, in small quantities at a time, and repeated as often as necessary, which must be regulated by the intensity of the burning. The air-pipes are of use only at first, because, if the fire burn with tolerable keenness, the sods forming the pipes will soon be reduced to ashes. The pipe on the weather side of the kiln only is left open, the mouths of the other three being stopped up, and not opened except the wind should veer about. As the inside of the enclosure or kiln begins to be filled up with clay, the outer wall must be raised in height, always taking care to have it at least fifteen inches higher than the top of the clay, for the purpose of keeping the wind from acting on the fire. When the fire burns through the outer wall, which it often does, and particularly when the top is overloaded with clay, the breach must be stopped up immediately, which can only be effectually done by building another sod wall from the foundation, opposite to it, and the sods that formed that part of the first wall are soon reduced to ashes. The wall can be raised as high as may be convenient to throw on the clay, and the kiln may be increased to any size, by forming a new wall when the previous one is burnt through.

3224. *The principal art in burning* consists in having the outer wall made quite close and impervious to the external air, and taking care to have the top always lightly, but completely, covered with clay; because if the external air should come in contact with the fire, either on the top of the kiln, or by means of its bursting through the sides, the fire will be very soon extinguished. In short, the kilns require to be attended nearly as closely as charcoal pits. Clay is much more easily burnt than either moss or loam; — it does not undergo any alteration in its shape, and on that account allows the fire and smoke to get up easily between the lumps; whereas moss and loam, by crumbling down, are very apt to smother the fire, unless carefully attended to. No rule can be laid down for regulating the size of the lumps of clay thrown on the kiln, as that must depend on the state of the fire; but every lump has been found completely burnt on opening the kiln, when some of them were thrown on larger than my head. Clay, no doubt, burns more readily if it be dug up and dried for a day or two before it be thrown on the kiln; but this operation is not necessary, as it will burn though thrown on quite wet. After a kiln is fairly set a going, no coal or wood, or any sort of combustible, is necessary, the wet clay burning of itself; and it can only be extinguished by intention, or the carelessness of the operator, — the vicissitudes of the weather having hardly any effect on the fire, if properly attended to. It may, perhaps, be necessary to mention, that when the kiln is burning with great keenness, a stranger to the operation may be apt to think that the fire is extinguished. If, therefore, any person, either through impatience, or too great curiosity, should insist on looking into the interior of the kiln, he will certainly retard, and may possibly extinguish the fire; for, as before mentioned, the chief art consists in keeping out the external air from the fire. Where there is abundance of clay, and no great quantity of green turf, it would, perhaps, be best to burn the clay in draw-kilns, the same as lime.

3225. *An improved method of burning clay* has been adopted by Colonel Dickson, at Hexham, and by other gentlemen in Northumberland. Instead of building a kiln, gratings or arches of cast iron are used to form a vault or funnel for the fuel, and over this funnel the clay is built. The grated arches are made about two feet and a half long, two feet diameter, and about fourteen inches high. One grating is to be filled with brushwood, stubble, or any other cheap fuel, and the clay, as it is dug, built upon it to a convenient height, leaving small vacancies, or boring holes, to allow the heat to penetrate to the middle and outer parts of the clay. When a sufficient quantity is built upon the first grating, another is added at either end, or at both, filled with similar fuel, and the clay built upon them as before. This process is continued until 10, 12, or a greater number, of the gratings have been used, when one end is built up or covered with clay, and at the other, under the last grating, a fire is made of coals or faggot wood. The end at which the fire is made should face the wind if possible, and if the process has been properly conducted the clay will be effectually burnt. By commencing with a centre grating in the form of a cross (*fig.* 517.), the workman may build from four ends in the place of two; this contrivance will afford a facility in the work, and have a draft of wind at two entrances.

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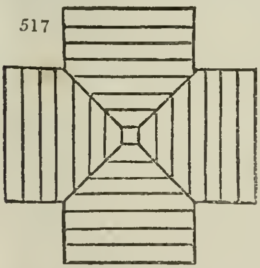


3226. *The advantage of this mode of burning clay* is the saving of cartage, as the clay may be always burned where it is dug.

3227. *Burning clay and surface soil by lime, without fuel*, has been practised by Curwen (*Farm. Mag.* vol. xvi. p. 11, 12.) in the following manner: — Mounds of seven yards in length, and three and a half in breadth, are kindled with seventy-two Winchester bushels of lime. First, a layer of dry sods or parings, on which a quantity of lime is spread, mixing sods with it, then a covering of eight inches of sods, on which the other half of the lime is spread, and covered a foot thick; the height of the mound being about a yard. In twenty-four hours it will take fire. The lime should be immediately from the kiln. It is better to suffer it to ignite itself, than to effect it by the operation of water. When the fire is fairly kindled, fresh sods must be applied. Mr. Curwen recommends obtaining a sufficient body of ashes before any clay is put on the mounds. The fire naturally rises to the top. It takes less time, and does more work, to draw down the ashes from the top, and not to suffer it to rise above six feet. The former practice of burning in kilns was more expensive, did much less work, and, in many instances, calcined the ashes, and rendered them of no value.

3228. *Use of pyrites in burning clay.* A writer in *The Farmer's Journal* (Dec. 1821), asserts that "the greater part of many beds of cold clay contain in them a substance, or ingredient, which is in itself, to a great degree, combustible, as known to every brick-burner. This probably is, in most cases, the sulphur of the pyrites contained in the clay; but be it what it may, it prevails to such a degree that a very small quantity of fuel is sufficient to burn a very large body of clay. It is only requisite to have sufficient fuel to set fire to the heap at first, so as to raise a body of heat; and, for the rest, the clay will nearly burn of itself, being judiciously arranged round and upon the burning centre. The ashes are in the best state when they have been exposed only to a moderate heat; namely, to a heat not only far below what will produce vitrification, but even so low as not to produce a permanent red colour: the black ashes, or dirty red, and brownish red, being made superior in value to bright red ashes, that is, to well-burnt bricks. The heat is moderated chiefly by the judicious application of the crumbs and mouldering fragments of clay or soil, so as to prevent the draft of the air through the apertures between the large clods or tufts from being too free. A very small admixture of vegetable fuel suffices to keep up the fire.

3229. *The application of burnt clay as a manure* is the same as that of lime: it is spread over fallows or lands in preparation for turnips, at the rate of from thirty to fifty loads or upwards per acre. A few years ago this practice made considerable noise, but at present it has fallen into disrepute.

3230. *The general manual operations* common to British agriculture being now described, a variety of operations peculiar to particular departments, such as boring for water, puddling to retain water, building drains, &c. which belong to draining; and barking timber, burning charcoal, distilling pyrolignous acid, which belong to planting; will be found under these departments.

Chap. II.

Agricultural Operations requiring the Aid of Labouring Cattle.

3231. *Operations requiring the aid of labouring cattle* are in a peculiar manner entitled to the appellation of agricultural. Almost all the operations described in the former chapter, may be performed by common country labourers; but those we are now to enter on, are exclusively performed by farm servants. They may be classed as operations for the use and management of live stock, labours on the soil, and compound operations.

Sect. I. *Operations for the Care of Live Stock.*

3232. *Herding*, or tending of cattle, as an operation, is the simplest which is connected with domestic animals. It consists in conducting them to a certain pasturage; keeping them within the prescribed limits; preventing them from injuring one another; observing if any are diseased, and the like. It is commonly performed with the aid of the dog, and by boys or girls for a small herd or flock, and aged or elderly men for larger herds. In modern times, the place of the cow and cattle herd is generally supplied by fences; but where large flocks of sheep are kept, it is still necessary to have a shepherd; not, in many cases, so much to keep the flock together and in its proper place, as to watch the progress of their growth, the approaches of disease, parturition, &c. In almost all cases, mild and gentle treatment ought to be made the *sine quâ non* of the herdsman's conduct. The duties of the shepherd, who has the general care of either a flock or herd, are various and important, and, to be duly executed, imply no inconsiderable degree of physiological and veterinary knowledge. See Part III. Book VII. *The Economy of Live Stock.*

3233. *Cleaning cattle* is the operation of rubbing, brushing, combing, and washing their bodies, and picking their feet. The legs of cattle, when soiled by labour, are commonly washed by walking them two or three times through a pond, formed on purpose in or near to farmeries. As soon as they are put in the stable and unharnessed, the legs, and such parts as are wetted, should be powerfully rubbed with dry straw, so as to dry the hair; and the same process should be applied to the rest of the body, if they have been in a state of copious perspiration. At the same time their feet should be picked, and their hoofs freed from any earth or small stones which may have lodged under the shoe, or in the case of labouring oxen between the hoofs. Combing and brushing can only be performed when the hair and skin are perfectly dry, and in farmeries is generally done in the morning when they are first fed, and in the evening when last fed. In general, it may be considered as experimentally decided, that cleaning cattle of every description, cows and oxen as well as horses, contributes much to their health as well as to their beauty. If swine were cleaned as regularly as horses, there can be no doubt they would be equally benefited by it. Some amateurs have their feeding swine regularly cleaned; but the greater part of professional agriculturists content themselves with fixing one or more rubbing posts in each sty, with frequent renewing of the litter.

3234. *Feeding, or supplying food to cattle,* is an operation which, like every other, however simple or humble, requires attention and a principle of action. Food ought to be given at stated times, in such quantities as to satisfy but not to glut the animals, and varied in quality so as to keep appetite alive. Water ought to be regularly supplied according to the kind of food, the state of the animal, and the season of the year. Cattle, that are fed in part on green food or roots, will require less water than those fed on dry hay, straw, or corn; and cattle that have been at work and perspiring, will require more water than such as have been idle or at pasture. In summer, cattle fed on dry food obviously require more water than in winter, owing to the increased perspiration. The case of sick animals must be regulated by the nature of their disease, or directed by the veterinary surgeon. In treating of agricultural animals (Part III.), we shall give the diseases, and treatment of each.

3235. *The harnessing of cattle* requires attention, first, that the harness be in complete order; and, secondly, that it fit the parts of the animal to which it is applied. Collars and saddles are the leading articles, and when they gall or in any way incommode the animal, they are ruinous to his comfort, and soon render him unfit for labour. Even when they fit properly, an improper mode of fixing the collar-blades (hames), and tying the girth of the saddle, may greatly annoy the animal, and render him restive during the whole period he is in yoke.

3236. *The yoking of draught animals* requires still more attention than harnessing them. To know when an animal is properly yoked, or placed in proper circumstances to perform the kind of labour assigned to him, it is necessary to have clear ideas as to the kind of power to be exerted by the animal, whether drawing, carrying, pushing, or two or all of these. The horse and ox draw from their shoulders, carry from their back, and push with their breech. The point of resistance in all weights, or objects to be dragged or pushed along the ground's surface, lies below the centre of gravity; and in all cases of drawing, a line from this point of resistance to the collar of the animal should form a right angle with the plane of the collar-bone. Hence the necessity of allowing the plough chains from the back of the animal to hang freely, so as to form a straight line from the collar-blades through the muzzle of the plough to the point of resistance. Hence, also, the advantage of yoking two horses in a cart by means of the endless rope or chain already described. (2755.) In yoking animals where the labour is principally carrying a weight, as in carting, great care is requisite that the weight be not oppressive, and that the suspending chain move freely in the groove of the saddle, so as to produce a perfect equipoise. Various opinions are entertained as to the weight which a horse can carry with or without drawing at the same time. According to the practice of experienced carters, if a one-horse cart is loaded with 20 cwt., 5 cwt., but not more, may be allowed to rest on the back of the horse by means of the traces, chain, and saddle. This is meant to apply where the roads are level; in going up or down hill, to admit of the same proportion of weight, the traces, or shafts, or the bearing chain, must be lowered or raised according to circumstances. Yoking animals to push only is a case that seldom or never occurs; but it will be useful to mention, that, as the line of the breech of animals is nearly perpendicular to the horizon, and the principle being that the line of exertion should be at right angles to the exerting surface, so the direction of pushing or backing, as it is commonly called, may be a horizontal line, or a line parallel to the surface on which the animal stands.

3237. *The hours of consecutive labour to which animals are subjected* form a matter which deserves consideration. The advantage of short stages in drawing heavy loads has been proved by Mr. Stuart Menteath of Closeburn: this gentleman, who is proprietor of one of the richest coal fields in the island, both as to quantity and quality, has very successfully employed horse power to the drawing of heavy loads, by dividing the roads into short stages. Before this expedient was resorted to, each horse could travel the distance of only 18 miles, and return with a load of 24 cwt. thrice a week; that is to say, the aggregate of the labour of each horse amounted to 3 tons 2 cwt. weekly: but by dividing that distance into 4 stages of $4\frac{1}{2}$ miles each, 4 horses can make 3 trips daily, and draw a load of 33 cwt. each trip, or very nearly 5 tons daily, or 30 tons weekly. Hence, according to this method, the aggregate of the labour of each horse amounts to about 7 tons weekly. Suppose 16 horses are employed; instead of making them travel 18 miles one day, and return with a load the following, the more advantageous plan is to arrange them in 4 divisions, and make each division travel only $4\frac{1}{2}$ miles in succession: were this distance divided into six stages, the load might be proportionally increased, with less fatigue to the horses; for it will invariably be found that the most profitable mode of applying the labour of horses, is to vary their muscular action, and revive its tone by short and frequent intervals of repose. Were stone rail-tracks laid down on the *pulls* between Sheriff Hall and Edinburgh, and the above plan adopted with waggons not exceeding 11 cwt. similar to those used by Mr. Stuart Menteath, the inhabitants might be supplied with coal at a cheaper rate than by any other existing mode of conveyance. Mr. Stuart Menteath considers the same principle equally applicable to ploughing; instead of 2 yokings, as at present, of 4 hours each, were 3 yokings of $2\frac{1}{2}$ hours each substituted, the horses would be less exhausted, and more work accomplished. (*Scotsman*, Jan. 6. 1830.)

3238. *The labour of a horse in a day*, according to Professor Leslie, is commonly reckoned equal to that of five men; but he works only 8 hours, while a man easily continues his exertions for 10 hours. Horses likewise display much greater force in carrying than in pulling; and yet an active walker will beat them on a long journey: their power of traction seldom exceeds 144 lbs, but they are capable of carrying more than six times as much weight. The pack-horses in the West Riding of Yorkshire are accustomed to transport loads of 420 lb. over a hilly country; but in many parts of England, the mill-horses will carry the enormous burthen of 910 lbs. to a short distance. The action of a horse is greatly reduced by the duration of his task; though not encumbered at all with any load or draught, he would be completely exhausted, perhaps, by a continued motion for 20 hours in a day. Though a horse might start with a celerity of 16 miles, this would be reduced in 4 hours to $10\frac{1}{4}$, and in 8 hours to $5\frac{3}{4}$. Hence the great advantages resulting from short stages, lately adopted for the rapid conveyance of the mail. (*Elements of Natural Philosophy.*)

Sect. II. *Labours with Cattle on the Soil.*

3239. *Ploughing* is justly considered the most important of agricultural operations, as on the manner in which this is performed depends the facility of executing all succeeding operations on the same piece of land. The plough acts as a wedge, separating a portion of the soil, and turning it over at the same time. If this wedge were properly constructed, and if the soil presented everywhere the same resistance to it, it would require no holding, but would maintain its position when drawn along by the cattle; but as the least inequality of surface or tenacity, or the additional resistance of a root or stone, destroys the equilibrium of the forces acting against the wedge, the presence of the holder or ploughman becomes necessary to adjust its position. In two-wheeled ploughs, however, this is done in a great measure by the wheels, but not so rapidly as by the instantaneous movement of the holder on the ends of the handles acting as levers. The manual operation of holding the plough in a proper position, and directing the horses or cattle which draw it at the same time, is only to be acquired by experience: when once attained, it is perhaps the most agreeable and healthy of agricultural exercises; the body being kept upright, the arms and legs brought into action, and also the eye and the mind, to keep the furrow straight and of regular width and depth, and the voice to speak to the horses. It is almost needless to mention that the art of drawing a straight furrow with a plough in which the horses are yoked in pairs, consists in keeping each of the horses a small distance apart, so as to see forward between them; and next to fix the eye on two or more objects beyond the land to be ploughed, and keep these objects and the coulter or muzzle of the plough always in one line. By far the best practical directions for ploughing have been given by the author of the article *Agriculture* in the Supplement to the *Encyclopædia Brit.*, which we shall quote at length.

3240. *Three different points require particular attention in ploughing:* 1. The breadth of the slice to be cut; 2. its depth; and 3. the degree in which it is to be turned over; — which last circumstance depends both upon the construction of the plough, particularly the mould-board, and the care of the ploughman.

3241. *The breadth and depth of the furrow-slice* are regulated by judiciously placing the draught on the nozzle or bridle of the plough; setting it so as to go more or less deep, and to take more or less land or breadth of slice, according as may be desired. In general the plough is so regulated that, if left to itself, and merely kept from falling over, it would cut a little broader and a little deeper than is required. The coulter is also placed with some inclination towards the left or land side, and the point of the sock or share has a slight tendency downwards.

3242. *The degree to which the furrow-slice turns over* is in a great measure determined by the proportion between its breadth and depth, which for general purposes is usually as three is to two; or when the furrow is nine inches broad, it ought to be six inches in depth. When the slice is cut in this proportion, it will be nearly half turned over, or recline at an angle of forty or forty-five degrees; and a field so ploughed will have its ridges longitudinally ribbed into angular drills or ridgelets. But if the slice is much broader in proportion to its depth, it will be almost completely overturned, or left nearly flat, with its original surface downwards, and each successive slice will be somewhat overlapped by that which was turned over immediately before it. And finally, when the depth materially exceeds the width, each furrow-slice will fall over on its side, leaving all the original surface bare, and only laid somewhat obliquely to the horizon.

3243. *Ploughing with the breadth and depth nearly in the proportion of three to two* is best adapted for laying up stubble land after harvest, when it is to remain during winter exposed to the mellowing influence of frost, preparatory to fallow or turnips.

3244. *The shallow furrow of considerable width*, as five inches in depth by eight or nine wide, is understood to answer best for breaking up old leys; because it covers up the grass turf, and does not bury the manured soil.

3245. *Ploughing with the depth of the furrow considerably exceeding the width* is a most unprofitable and uselessly slow operation, which ought seldom or never to be adopted.

3246. *The most generally useful breadth of a furrow-slice* is from eight to ten inches, and the depth, which ought to be seldom less than four inches, cannot often exceed six or eight inches, except in soils uncommonly thick and fertile. When it is necessary to go deeper, as for carrots and some other deep-rooted plants, a trench-ploughing may be given by means of a second plough following in the same furrow.

3247. *Shallow ploughing* ought always to be adopted after turnips are eaten on the ground, that the manure may not be buried too deep; and also in covering lime, especially if the ground has been pulverised by fallowing, because it naturally tends to sink in the soil. In ploughing down farm-yard dung, it is commonly necessary to go rather deep, that no part of the manure may be left exposed to the atmosphere. In the first ploughing for fallows or green crops, it is advisable to work as deep as possible; and no great danger is to be apprehended, though a small portion of the subsoil be at that time brought to the surface.

3248. *The furrow-slices are generally distributed into beds* varying in breadth according to circumstances; these are called *ridges* or *lands*, and are divided from one another by gutters or open furrows. These last serve as guides to the hand and eye of the sower, to the reapers, and also for the application of manures in a regular manner. In soils of a strong or retentive nature, or which have wet close subsoils, these furrows serve likewise as drains for carrying off the surface water; and being cleared out, after the land is sown and harrowed, have the name of *water furrows.* In wet lands, furrows are sometimes drawn or dug across the ridges, for the purpose of carrying off the surface water from hollows; these are called *cross water-furrows.*

3249. *Ridges* are not only different in breadth, but are raised more or less in the middle, on different soils. On clayey retentive soils, the great point to be attended to is the discharge of superfluous water. But narrow ridges or *stitches*, of from three to five feet, are not approved of in some of the best cultivated counties. In these a breadth of fifteen or eighteen feet, the land raised by two gatherings of the plough, is most commonly adopted for such soils; such ridges being thought more convenient for manuring, sowing, harrowing, and reaping, than narrower ones; and the water is drained off quite as effectually.

3250. *Ridges, on dry porous turnip soils*, may be formed much broader; and, were it not for their use in directing the labourers, may be, and sometimes are, dispensed with altogether. They are often thirty or thirty-six feet broad, which in Scotland are called *band-win* ridges, because reaped by a band of shearers, commonly six, served by one binder. If it be wished to obliterate the intermediate furrows, this may be done by casting up a narrow ridgelet or single bout-drill between the broad ridges, which is afterwards levelled by the harrows.

3251. *The mode of forming ridges straight and of uniform breadth* is as follows: — Let us suppose a field perfectly level, that is intended to be laid off into ridges of any determinable breadth. The best ploughman belonging to the farm conducts the operation, with the aid of three or more poles shod with iron, in the following manner: The first thing is to mark off the head ridges, on which the horses turn in ploughing, which should in general be of an equal breadth from the bounding lines of the field, if these lines are not very crooked or irregular. The next operation, assuming one straight side of the field, or a line that has been made straight, as the proper direction of the ridges, is to measure off from it, with one of the poles (all of them of a certain length, or expressing specific measures), half the intended breadth of the ridge if it is to be gathered, or one breadth and a half if to be ploughed flat; and there the ploughman sets up a pole as a direction for the plough to enter. On a line with this, and at some distance, he plants a second pole, and then in the same manner a third, fourth, &c., as the irregularity of the surface may render necessary, though three must always be employed, — the last of them at the end of the intended ridge, and the whole in one straight line. He then enters the plough at the first pole, keeping the line of poles exactly between his horses, and ploughs down all the poles successively; halting his horses at each, and replacing it at so many feet distant as the ridges are to be broad; so that when he reaches the end of the ridge, all his poles are again set up in a new line parallel to the first. He returns, however, along his former track, correcting any deviations, and throwing a shallow furrow on the side opposite to his former one. These furrows, when reversed, form the crown of the ridge, and direct the ploughmen who are to follow. The same operations are carried on until the whole field is marked out. This is called *feiring* in Scotland, and *striking or drawing out the furrows* in England. It is surprising with what accuracy these lines are drawn by skilful ploughmen.

3252. *Another method* has been adopted for the same purpose, which promises to be useful with less experienced workmen. A stout lath or pole, exactly equal in length to the breadth of the intended ridge, is fixed to the plough, at right angles to the line of the draught, one end of which is placed across the handles exactly opposite the coulter, while the other end projects towards the left hand of the ploughman, and is preserved in its place by a rope passing from it to the collar of the near side horse. At the outer end of the lath, a coulter or harrow tine is fixed perpendicularly, which makes a trace or mark on the ground as the plough moves onwards, exactly parallel to the line of draught. By this device, when the plough is *feiring* the crown of one ridge, the marker traces the line on which the next ridge is to be *feired*. (*General Report of Scotland*, vol. i. p. 354.)

3253. *The direction and length of ridges* are points which must evidently be regulated by the nature of the surface and the size of the field. Short angular ridges, called *butts or short work*, which are often necessary in a field with irregular boundaries, are always attended with a considerable loss of time, and ought to be avoided as much as possible.

3254. *In ploughing steep land* it is advisable to give the ridges an inclination towards the right hand at the top, by which, in going up the acclivity, the furrow falls more readily from the plough, and with less fatigue to the horses. Another advantage of forming ridges in a slanting direction on such land is, that the soil is not so apt to be washed down from the higher ground, as if the ridges were laid at right angles. Wherever circumstances will permit, the best direction, however, is due north and south, by which the grain on both sides of the ridge enjoys nearly equal advantages from the influence of the sun.

3255. *Ribbing*, a kind of imperfect ploughing, was formerly common on land intended for barley, and was executed soon after harvest, as a preparation for the spring ploughings. A similar operation is still in use in some places, after land has been pulverised by clean ploughings, and is ready for receiving the seed. By this method only half the land is stirred, the furrow being laid over quite flat, and covering an equal space of the level surface. But, except in the latter instance, where corn is meant to grown in parallel lines, and where it is used as a substitute for a drill-machine, ribbing is highly objectionable, and has become almost obsolete.

3256. *Land thus formed into ridges is afterwards cultivated without marking out the ridges anew*, until the inter-furrows have been obliterated by a fallow or fallow crop. This is done by one or other of the following modes of ploughing: — 1. If the soil be dry, and the land has been ploughed flat, the ridges are split out in such a way, that the space which the crown of the old ridge occupied is now allotted to the open furrow between the new ones. This is technically called *crown and furrow ploughing*. 2. When the soil is naturally rather wet, or if the ridges have been raised a little by former ploughings, the form of the old ridges, and the situation of the inter-furrows, are preserved by what is called *casting*, that is, the furrows of each ridge are all laid in one direction, while those of the next adjoining ridges are turned the contrary way; two ridges being always ploughed together. 3. It is commonly necessary to raise the ridges on soils very tenacious of moistuie, by what is called *gathering*, which is done by the plough going round the ridge, beginning at the crown and raising all the furrow-slices inwards. 4. This last operation, when it is wished to give the land a level surface, as in fallowing, is reversed by turning all the furrow slices outwards; beginning at the inter-furrows, and leaving an open furrow on the crown of each ridge. In order to bring the land into as level a state as possible, the same mode of ploughing or casting, as it is called, may be repeated as often as necessary.

3257. *With respect to ploughing relatively to time*, in the strongest lands, a pair of good horses ought to plough three quarters of an acre in nine hours; but upon the same land, after the first ploughing, on friable soils, one acre, or an acre and a quarter, is a common day's work. Throughout the year, an acre a day may be considered as a full average, on soils of a medium consistency. The whole series of furrows on an English statute acre, supposing each to be nine inches broad, would extend to 19,360 yards; and adding 12 yards to every 220 for the ground travelled over in turning, the whole work of an acre may be estimated at 20,416 yards, or 11 miles and nearly 5 furlongs.

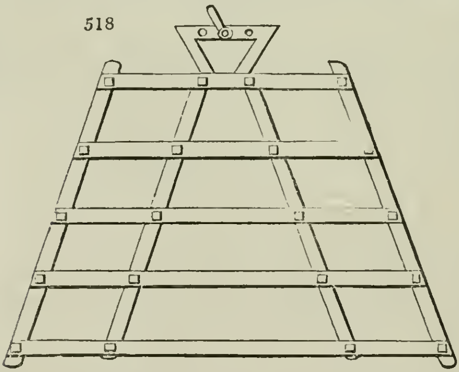
3258. *In ploughing relatively to season*, it is well known that clayey or tenacious soils should never be ploughed when wet; and that it is almost equally improper to allow them to become too dry, especially if a crop is to be sown without a second ploughing. The state in which such lands should be ploughed is that which is commonly indicated by the phrase, "between the wet and the dry," — while the ground is slightly moist, mellow, and the least cohesive.

3259. *The season best for ploughing the first time, for fallow or green crops*, is immediately after harvest, or after wheat-sowing is finished; and when this land has been gone over, the old tough swards, if there be any, are next turned up. The reasons for ploughing so early are sufficiently obvious; as the frosts of winter render the soil more friable for the spring operations, and assist in destroying the weed roots. In some places, however, the first ploughing for fallow is still delayed till after the spring seed-time. On extraordinary occasions land may be ploughed in the night as well as in the day, by hanging lanterns to the horses' collars. This, it is said, is sometimes done in East Lothian, during a hurried seed-time. (*Farm. Mag.* vol. ix. p. 55.)

3260. *The cultivator, grubber, scuffler, scarifiers,* and such like implements (2650.), are used to lessen the number of ploughings in fallows or light free soils. Their operation differs from that of the plough in not reversing the surface, and therefore they can never, as some have proposed, become a substitute for that implement in all cases. Still the grubber is a valuable implement. William Lester, late of Northampton, who is said first to have invented an implement of this kind, declares himself confident that one man, a boy, and six horses, will move as much land in a day, and as effectually, as six ploughs; meaning land in a fallow state, that has been previously ploughed. We have elsewhere pointed out the mode of using this description of tillage implements (2650.), one great advantage of which is, that they may be used by the unskilful, and even by operators who cannot guide a plough. As soon as steam shall be employed as a moving power in this department of agriculture, implements of this kind, and especially Finlayson's harrow (2657.) and Wilkie's brake (2656.), will come into very general use.

3261. *The operation of harrowing* is intended both to drag out weeds and to cover the seeds when sown. It is obvious that implements of different sizes are not only necessary, but even that these implements should be worked in different ways, according to the strength and condition of the soil on which they are employed, and the nature of the work to be executed. When employed to reduce a strong obdurate soil, not more than two of the old or common sort should be yoked together, because they are apt to ride and tumble upon each other, and thus impede the work, and execute it imperfectly. It may also be remarked, that on rough soils harrows ought to be driven as fast as the horses can walk; because their effect is in direct proportion to the degree of velocity with which they are driven. In ordinary cases, and in every case where harrowing is meant for covering the seeds, and the common implement in use, three harrows are the best yoke, because they fill up the ground more effectually, and leave fewer vacancies, than when a smaller number is employed: the improved forms, calculated to cover the breadth of two or more of the old harrows by one frame (*fig.* 518.), are only calculated for flat ridges, or for working dry lands in which ridging is not requisite.

518



3262. *The harrow-man's attention, at the seed process,* should be constantly directed to prevent these implements from riding upon each other, and to keep them clear of every impediment, from stones, lumps of earth, or clods, and quickens or grass roots; for any of these prevent the implement from working with perfection, and causes a mark or trail upon the surface, always unpleasing to the eye, and generally detrimental to the vegetation of the seed.

3263. *Harrowing is usually given in different directions;* first in length, then across, and finally in length, as at first. Careful agricultors study, in the finishing part of the process, to have the harrows drawn in a straight line, without suffering the horses to go in a zigzag manner, and are also attentive that the horses enter fairly upon the ridge, without making a curve at the outset. In some instances, an excess of harrowing has been found very prejudicial to the succeeding crop; but it is always necessary to give so much as to break the furrow, and level the surface, otherwise the operation is imperfectly performed.

3264. *Horse-hoeing* is the operation of stirring the ground between rows of vegetables, by means of implements of the hoe, coulter, or pronged kind, drawn by horses. Whoever can guide a plough, will find no difficulty in managing any implement used for stirring ground. The easiest kinds are those which have few hoes, or coulters, or shares, and a wheel in front; and the easiest circumstances, wide intervals between the rows, and a loose friable soil. Wherever soil is hard, rough, and rounded, as in the case of high-raised ridges, there should not be more than three prongs or shares in the implement, because more than three points can never touch a curved surface, and be in one plane; and if not in one plane, they will never work steadily, equally, and agreeably.

3265. *Turnip hoeing* of every kind is accordingly exceedingly easy; but stirring the earth between rows of beans on a strong clay soil in a time of drought, is proportionally difficult, and sometimes, when the ground rises in large lumps, dangerous for the plants. In stirring the soil between rows of beans, cabbages, or other plants, on strong or loamy soils, a small plough often answers better than any of the pronged or coultered implements, at least for the first and last operations of bean culture. Dr. Anderson, indeed, affirms with great truth, that nearly all the various operations of horse-hoeing may be executed by the common swing-plough, in an equally effectual manner as by any of the hoe-ploughs usually made use of.

3266. *Drilling*, or the deposition of seed in rows by means of a drill machine, is an operation that requires considerable care in the performance. The points that require particular attention are keeping the rows straight and at equal distances throughout their length, depositing the seed at a proper depth, and delivering the seed in proper quantity according to its kind and the nature of the soil. For these purposes the ground must have been previously well prepared by ploughings and harrowings, except in the particular case of drilling beans with one furrow. This operation is generally performed in the course of ploughing, either by a person pushing forward a bean-drill barrow, or by attaching a hopper and wheel, with the necessary apparatus, to the plough itself. The mode of regulating the depth of the drill, and the quantity of seed delivered, must depend on the kind of drill used, and only requires attention in the holder. In drilling turnips the land is most generally made up into ridgelets twenty-seven or thirty inches centre from centre, by a single *bout* (go about), or return, of the common plough. The Northumberland machine, which sows two rows at once, is then drawn over them by one horse walking between the ridges without a driver, the holder at once performing that operation and keeping the machine steady on the tops of the drills. One of the two rollers of this machine smooths the tops of the ridges before the seed is deposited, and the other follows and compresses the soil and covers the seed.

3267. *In drilling corn* several rows are sown at once, and great care is requisite to keep the machine steady and in a straight line: for most soils two horses and a driver are required for this purpose; the driver aiding in filling the hopper with seed, &c.

3268. *In all cases of drilling* it must be recollected that the principal intention of the operation is to admit of horse-hoeing the crop afterwards; hence the necessity of straight rows and uniform distances; and hence also the advantage of burying the manure under the drill or row, that it may not be exposed to the air in after-working.

3269. *Rolling* is the operation of drawing a roller over the surface of the ground with the view of breaking down the clods, rendering it more compact, and bringing it even and level; or it may be limited to smoothing and consolidating the surface. It is practised both upon the tillage and grass lands, and is of much utility in both sorts of husbandry. In the former case it is made use of for the purpose of breaking down and reducing the cloddy and lumpy parts of the soil in preparing it for the reception of crops, and in rendering light soils more firm, even, and solid, after the seed is put in. It is likewise found beneficial to the young crops in the early spring, in various instances. In order to perform this operation in the most complete and effectual manner a roller of considerable weight is necessary; and in order as much as possible to prevent the ground from being injured by the feet of the animals that draw it, as may frequently be the case where they follow each other in the same track, it is the best practice to have them yoked double, as by that means there will be less treading on the same portion of surface. Where two horses are sufficient to execute the work, more should never be made use of; but if a third should be found necessary, it may be attached as a leader in the middle before the other two: a greater number of horses can seldom or never be of any material advantage in this sort of work. It is necessary to see that every part of the surface receives the due impression of the implement, and that the head lands are not injured by the turnings. On lands where the work is regularly performed, it will seldom be requisite to pass more than once in a place, but in other cases it may often be done more frequently with benefit, and in particular cases a more frequent repetition of the operation is absolutely requisite, in order to bring the ground into a proper state.

3270. *In rolling* grass lands it is necessary to attend in a particular manner to the season, as it cannot be performed with advantage either when the surface is in too dry or too moist a condition. In these cases the work of rolling may be advantageously performed at different seasons, as in the beginning of the autumn, and in the commencement of the year, or very early spring months; but the latter is the most common period. In the drier descriptions of land it may frequently be performed, in the most beneficial manner, after the land has been rendered a little soft by a moderate fall of rain; but in those of the contrary sort it may be necessary to wait till the superabundant moisture be so much dried up, as to admit the animals employed in drawing the machine without subjecting the surface of the ground to poaching or other injury, while the process is going on. The rolling of watered meadows, it has been remarked by Boswell, should be executed towards the latter end of February or beginning of the following month, after the land has been left in a dry state for a week or ten days. The work should be performed along the panes, going up one side of the trenches and down the other; and in the case of rolling the common hay lands, it is a good mode to proceed up one side of the field and down the other, somewhat in a similar manner, as by that means the work may be the most completely executed.

3271. *Horse-raking*, or the collecting of the scattered straws of corn or hay crops by the rake, is an operation of little art or trouble in the execution. The proper implement being employed, it is generally drawn by one horse, conducted by a man, who walks behind, and, when the rake fills, lifts it up without stopping the horse, and always at the same place, so as to deposit the rakings in regular rows across the field. The same mode is followed whether in raking hay, corn, stubble, or weeds from fallow grounds.

3272. *Driving carts and waggons*, though the easiest of all operations, is very frequently shamefully performed by servants. Almost every body knows this; and it is humiliating to consider that we are considered the most inhuman nation in Europe in our treatment of horses. In most other countries these animals, and even oxen, are taught to obey the word of the driver; but in Britain he requires both halter or rein, and a whip; and in most parts of England the slightest movement from right to left is indicated to the animal by the latter implement. Driving is more especially neglected, or wretchedly performed, near large towns, and especially round London, where little or no attention is paid to avoiding the ruts; choosing the best part of the road; going in a direct line; altering the position of the load (by means of the back chain or the construction of the cart where that admits of it) in going up or down hill; or seeing whether both horses (where two are used) draw equally. The reverse of this conduct ought to be that of a careful and humane driver, who, being first certain that his cattle are properly yoked, and his load fairly adjusted so as to be neither too heavy nor too light for the wheel or shaft horse, will see that they proceed along the best part of the road in a straight line, avoiding the ruts when deep or unequal; that all the horses draw equally as far as practicable; that proper care and timely precautions be taken to avoid other machines meeting or passing; and that no sudden motion or jerk of the horses be required on any occasion. In dividing the road where it is steep or in a bad state, the horses ought to be drawn aside gradually, and gradually led on again; it being easier to descend or ascend either a good or bad convex road obliquely, than at an acute angle. Lastly, servants ought on no account to be allowed to ride on laden carts or waggons, especially he former; or to walk at a distance from them either before or behind. There are many other points which require attending to in this department of agriculture; such as not striking animals on the head or legs, nor kicking them, nor using a pole or handle of any implement that may be at hand, in administering chastisement; but these must be left to the care and discretion of masters, whose interest it is to be most vigilant in watching those who are engaged in this department.

3273. *One mode of lessening the evils of careless driving* and inhumanity to animals consists in employing chiefly married servants, and, as is generally the case, letting each have the exclusive care and working of one pair of horses. Such men are steadier, and remain much longer in their situations, than single men, and are therefore more likely to feel an interest in the welfare and good condition of their horses, as well as in the good opinion of their employer.

3274. *Driving cattle in a threshing-machine* required particular care before the ingenious invention, described § 2755., to equalise the draught of the different animals; where this invention is applied, it requires little more than calling to such of the cattle as have a tendency to relax in their exertions.

Sect. III. *Labours and Operations with the Crop, performed with the Aid of Cattle.*

3275. *Labours with the crop* chiefly comprise stacking and housing.

3276. *Stacking* is the operation of building or piling up unthreshed corn, hay, straw, or other dried crops, in convenient forms, and so as to admit of their being thatched as a defence from the weather. Stacks are of various forms and dimensions, according to circumstances; in some districts they are formed square or oblong, both for hay and corn; but where threshing-machines are in use, the circular base with cylindrical body, diverging a little at the eaves, and a conical top, is decidedly preferred, as being more convenient in size and form, and better adapted for early stacking in wet seasons than any other. For hay the form of the stack is a matter of less consequence; the long square or oblong shapes are perhaps the most safe and convenient, especially when not too broad, as they are the most suitable to cut from in trussing hay for sale.

3277. In respect to *the sizes of corn-stacks of the square sort*, they of course vary greatly according to circumstances; but they should never be made too large, as there is a great deal more risk in securing and getting in the grain from them; and from their being built at different times, they do not settle altogether in so perfect a manner, or resist the effects of the weather and keep the grain so well, as those of less dimensions that can be completed at once: and, in addition, they are less convenient in the threshing out, especially where the flail is employed. The chief advantages they possess, are those of taking something less in thatch and labour in covering them.

3278. *The proper size of the hay-stack* should probably be different in some degree according to the state and nature of the hay; but a middling size is perhaps the best, say from twenty to thirty loads of about one ton each, as there are inconveniences in both small and large stacks, the former having too much outside, while the latter are liable to take on too much heat, and at the same time permit less moisture to be preserved in the hay. In small stacks the bellying forms with very narrow bottoms have often much advantage, and are in some districts termed sheep-stacks, probably from the slovenly practice of sheep having been permitted to feed at them.

3279. *In building every description of stack,* the stem or body should be so formed as to swell gradually outwards, quite up to the part termed the eaves; as by this method it is more perfectly secured against the entrance of moisture, and at the same time requires a less space of stand to rest upon; and, when the building of them is well performed, they have equal solidity, and stand in as firm a manner.

3280. *The stem* should contain about two thirds, and the roof one third, of the whole stack. If it be built on a frame, the stem should contain less and the roof more; if on a bottom, the reverse. The corners of the stem should not be built too sharp, but should be carried up rather roundish; by which the sides will look fuller, and the swell given by the pressure will be more perceptible.

3281. *The ends of the roof* should have a gentle projection, answerable to the stem; and the sides should be carried up rather convex, than flat or concave. Perhaps a roof gently convex shoots off the rains better than any other.

3282. *Where corn is stacked that has not been sheaved,* and in building hay-stacks, it is the usual practice to have a number of persons upon the stack, the corn or hay being forked up and deposited on the different sides all round in a similar method; after this, other parcels are laid all round on the inside of these, so as to bind them in a secure manner from slipping outwards; the operator proceeding in the same manner till the whole of the middle space is perfectly filled up: when he begins another course in the same method, and goes on in this mode, with course after course, till he has raised the whole of the stem; when he begins to take in for the roof, in a very gradual manner, in every succeeding course, until the whole is brought to a ridge or point according to the manner in which the stack is formed. But for the purpose that the roofs may throw off the water in a more perfect and effectual manner, they should be made so as to have a slight degree of fulness or swell about the middle of them, and not be made flat, as is too frequently the practice with indifferent builders of stacks.

3283. *In stacking where the corn is bound into sheaves,* there is seldom more than one person employed in managing the work of building the stack, except in cases where the dimensions are very considerable; in which cases it is found necessary to have a boy to receive the sheaves from the pitcher, and hand them to the man who builds the stack. In executing the work, it is of the utmost importance that the centre of the stack be constantly kept in a somewhat raised state above the sides, as the sheaves have thus a sloping direction outwards, by which the entrance of moisture is more effectually guarded against and prevented. To accomplish this in the most perfect manner, the workman begins in the middle of the stand or staddle, setting the sheaves together so that they may incline a little against each other, placing the rest in successive rows against them till he comes to the outside, when he carries a course of sheaves quite round, in a more sloping manner than in the preceding courses. The bottom of the stack, being formed in this way, it is afterwards usual to begin at the outside, and advance with different courses round the whole, placing each course a little within the other, so as to bind them in an exact and careful manner, till the stacker comes to the middle. All the different courses are to be laid on in a similar manner until the whole of the stem is raised and completed; when the last outside row of sheaves is, in most cases, placed a very little more out than the others, in order to form a sort of projection for the eaves, that the water may be thrown off more effectually. But in cases where the stems of the stacks are formed so as to project outwards in the manner already noticed, this may be omitted without any bad consequences, as the water will be thrown off easily without touching the waste of the stack. The roof is to be formed by placing the sheaves gradually a little more in and in, in every course, until it comes to a ridge or point, according to the form of the stack, as has been already observed. But in forming and constructing this part of the stack, great care should constantly be taken to give the ear-ends of the sheaves a sufficiently sloping direction upwards, in order that they may be the better secured from wetness; and to the outside should be given a rounded form, in the manner that has been already noticed.

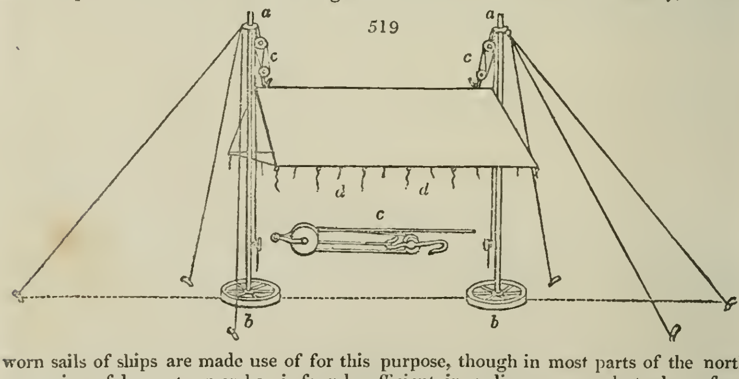
3284. *A funnel or chimney* is frequently formed or left in circular stacks, especially in wet districts, in order to prevent their taking on too much heat: where these funnels are not formed with the basement of timber, iron, or masonry, as already shown (2908.), they are produced by tying a sheaf up in a very tight manner, and placing it in the middle on the foundation of the stack, pulling it up occasionally as the building of the stack proceeds all round it. In setting up ricks in bad harvests, it is a practice in some places, particularly with barley crops, to have three or four pretty large poles tied together, by winding straw ropes round them, set up in the middle, round which the stacks are then built. But except the stacks are large, or the grain when put into them in an imperfect condition, such openings are quite unnecessary.

3285. *The stacking of hay* requires much care and attention in the person employed for the purpose, though less than that of building corn-stacks. There should constantly be a proper stand or foundation, somewhat raised by wood or other materials, prepared for placing the stacks upon; but nothing of the coping kind is here necessary. In the business of stacking hay, the work should be constantly performed, as much as possible, while the sun is upon the hay, as considerable advantage is thus gained in its quality: and it is necessary to have a stacker that has been accustomed to the business, and a proper number of persons to help upon the stack, in order that it may be well spread out and trodden down.

3286. *The building of hay-stacks* should be conducted much in the same way as the building of stacks of loose grain (3282.); the middle of the stack being always well kept up a little higher than the sides, and the sides and ends well bound in by the proper application of the successive portions of hay as the work advances; and during which it is a good way, where there are plenty of hands, to have the sides and ends properly pulled into form, as by this means much after-labour is prevented. It is likewise of advantage, that the hay should be well shaken and broken from the lumps, during the operation of stacking. The form in which the stacks are built is not of much consequence; but, if large, and made in the square form, it is better not to have them too broad, or of too great width, as by this means they are less apt to heat. With the intention of preventing too much heat, sometimes in building hay-stacks, as well as those of the grain kind, holes, pipes, and chimneys, are left in the middle, that the excessive heat may be discharged; but there is often injury sustained by them, from their attracting too much moisture.

3287. *The hay-stacks of Middlesex,* it is observed by Middleton, are more neatly formed and better secured than any where else. At every vacant time, while the stack is carrying up, the men are employed in pulling it with their hands into a proper shape; and about a week after it is finished the whole roof is properly thatched, and then secured from receiving any damage from the wind, by means of a straw rope extending along the eaves, up the ends, and near the ridge. The ends of the thatch are afterwards cut evenly below the eaves of the stack, just of sufficient length for the rain water to drip quite clear off the hay. When the stack happens to be placed in a situation which may be suspected of being too damp in the winter, a trench of about six or eight inches deep is dug round, and nearly close to it, which serves to convey all the water from the spot, and renders it perfectly dry and secure.

3288. *The stack guard* (*fig.* 519.), or covering of canvass, is employed in some districts to protect the stack while building in a wet season. In Kent and Surrey, the half



worn sails of ships are made use of for this purpose, though in most parts of the north a covering of loose straw or hay is found sufficient in ordinary cases; but where, from a continued rain, the stack is penetrated some way down, a part is removed on recommencing, and dried before being replaced. It is observed by Marshal, that a sail-cloth thrown over and immediately upon the hay of a stack in full heat, is liable to do more injury by increasing the heat, and at the same time checking the ascent of the steam, than service in shooting off rain water. The improved method of spreading the cloth he describes as follows: two tall poles (*a*, *a*) are inserted firmly in two cart wheels (*b*, *b*), which are laid flat upon the ground at each end of the stack, and loaded with stones to increase their stability. Another pole of the same kind, and somewhat longer than the stack, is furnished at each end with an iron ring or hoop, large enough to admit the upright poles and to pass freely upon them. Near the head of each of the standards is a pulley (*c, c*), over which a rope is passed from the ring or end of the horizontal pole, by which it is easily raised or lowered to suit the given height of the stack. A cloth being now thrown over the horizontal pole, and its lower margins loaded with weights, a complete roof is formed and neatly fitted to the stack, whether it be high or low, wide or narrow; the eaves being always adjusted to the wall plate, or upper part of the stem of the stack; thus effectually shooting off rain water, while the internal moisture or steam escapes freely at either end as the wind may happen to blow. This contrivance is readily put up or taken away; the poles being light, are easily moved from stack to stack, or laid up for another season, and the wheels are readily removed or returned to their axles. On the whole, it answers as a good substitute for the improved construction brought into use by Sir Joseph Banks, and is much less expensive. This construction, instead of the ring running on the poles, has blocks and tackle (*c, c*), and instead of weights to distend the cloth, ropes (*d, d*) are used to tighten it and keep it detached from the sides of the stack, so as to admit a more free circulation of air.

3289. *A stacking stage* (*fig.* 520.), or scaffold, has been contrived for finishing the

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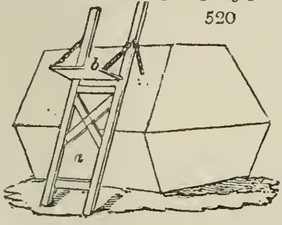

upper parts of high stacks, but it can seldom be requisite when a judicious size of stack is adopted. This stage, which consists of a frame (*a*) and a movable platform (*b*), easily understood and constructed, is set against the stack, when it becomes so high that it is inconvenient to pitch on to it from the cross plank of a waggon. The platform is commonly fixed by means of the chain pins and holes, about fourteen feet from the ground, which is about the height of a waggon load of hay. Were it fixed lower, it would be of no use; and were it fixed much higher, it would be found too high for a man to pitch on to, when the waggon should have become nearly empty.

3290. The term *housing* is chiefly applied to crops of the root kind, as potatoes, carrots, turnips, &c. Potatoes being gathered in dry weather are preserved by being laid up in heaps, secured from rain and frost more particularly, and from the weather generally, whether dry, moist, cold, or hot. The mode of doing this in some places is to form them into heaps on the surface of the soil, covering them with a thick layer of straw, and on that another of earth. Sometimes also, where the soil is dry, they are buried in pits and similarly covered; but, for common agricultural purposes, by much the best mode is to lay them up in a house, securing them from all extremes of weather by a covering of straw. By this mode they are much more easily got at when a portion is wanted, than by any other in use.

3291. *In housing carrots, and Swedish or yellow turnips,* the same modes may be adopted as for potatoes; but in housing white turnips, as they are apt to rot when heaped up, the best mode is to spread them thinly on any surface covered from the rain, but freely exposed to the circulation of air. This mode, it must be evident, can only be adopted to a limited extent, and, indeed, is only resorted to as a precautionary measure during winter, when frosts, snows, or continued rains, might interrupt the lifting and carting from the fields of the usual supplies for feeding stock.

3292. *Various modes of housing and preserving* these and other roots, will be treated of as each particular crop comes into notice in a succeeding Book (VI.).

Chap. III.

Scientific Operations, and Operations of Order and general Management.

3293. *All the operations which have hitherto been described* require to be practically known to every farm servant or operative agriculturist; the few about to be described belong more particularly to the superintendent or master: they may be arranged as scientific operations, and operations of order and management.

Sect. I. *Scientific Operations required of the Agriculturist.*

3294. *The scientific operations required of the agriculturist* are chiefly the measuring surfaces, measuring solids, taking the levels of surfaces, dividing lands; and valuing lands, timber, leases, and farming stock. A knowledge of the more common practices of surveying, measuring, and the calculation of annuities, may be considered as essential to every agriculturist, whether farmer, land agent, or proprietor, who is desirous of having clear ideas on the subject of letting labour, hiring or letting farms, or purchasing estates. Such knowledge is not to be expected in detail in this work, but must be procured from the ordinary school and annuity books, and is indeed implied in a regular education.

All we propose here is to direct the reader's attention to the most important points of the art of surveying, and lay down the leading principles of valuing agricultural property.

Subsect. 1. *Measuring relatively to Agriculture.*

3295. *The measuring of land*, or other objects, comprises three distinct operations; viz. taking the dimensions of any tract or piece of ground, delineating or laying down the same in a map or draught, and calculating the area or superficial contents. The dimensions on a small scale are best taken by rods of wood, but in all ordinary and extensive cases by a chain of iron, being less likely to contract or expand by changes of temperature than cord lines or tapes. In measuring a simple figure, such as a square field, nothing more is necessary than to take the length and breadth, which multiplied together give the superficial area; but as few fields are square, or even right angled, it becomes necessary to adopt some guiding line or form within the field, and from that line or form to measure to the different angles, so as to be able, from the dimensions taken, either to calculate the contents at once, or to lay down the form of the field on paper, according to a certain scale, or proportion to its real size, and from that to take dimensions and calculate the contents. The simplest and most accurate mode of ascertaining the contents of all irregular figures is by throwing them into triangles; and this also is the most accurate mode of measuring and protracting a whole landed estate, however large. In short, a triangle is the form universally adopted, whether in surveying a single field, or a whole kingdom. To find the contents of a triangle, every body knows that it is only necessary to multiply half the perpendicular into the base. These two principles, properly understood, form the foundation of measuring, protracting, and estimating the contents of territorial and all other surfaces. In surveying hilly lands, an allowance is made both in protracting them, and calculating their contents, well known to surveyors, and not necessary to be entered into here.

3296. *In measuring solid bodies*, the rule is to "find the area of one end, and multiply that by the length." This rule is of universal application, whether to land, as in excavating or removing protuberances; to ricks of corn; heaps of dung; timber; or water. The area of one end, or of one surface, whether the end, side, top, or bottom, is found exactly on the same principles as in ascertaining the superficial contents of land; and if the figure diminishes in the course of its length, as the top of a rick, or the trunk of a tree, the mean length or half is taken as a multiplier.

3297. *Measuring objects by the eye*, though a mode that can never be depended on as the foundation for any important calculation or transaction, yet should be constantly practised by young men, for the sake of gaining habits of attention, and acquiring ideas as to number and quantity at first sight. The principle on which this sort of eye measurement is acquired, is that of ascertaining the actual dimension of some near object, and applying it as a measure to all the others seen beyond it. Thus, if a man is seen standing by a post or a tree at a distance, taking the height of the man at five and a half or six feet; apply the figure of the man to the tree, and find how many applications will reach its top; that number multiplied by the ordinary height of a man, will of course be a near approximation to its height. Again, supposing this tree one in a row or avenue, then to estimate the length of the avenue, measure the third or fourth tree by the man, and measure by the same means the distance of that tree from the first, then state the question thus: As the difference between the height of the first and fourth tree is to the horizontal distance between them; so is the difference between the first and last tree of the avenue, to the length of the avenue. In this way, the length and breadth of a field may be estimated by observing the height of the hedge at the nearest side, and the apparent height at the farthest points. The breadth of ridges and their number, teams at work, or cattle grazing, or accidental passengers, are all objects of known dimensions, which may be made use of in this way of estimating the contents of lands. In regard to houses, the doors, and windows, and size of bricks, stones, boards, tiles, &c. are obvious and certain guides.

3298. *The recollection of surfaces and of country* is a matter of considerable interest to every one, but especially to the agriculturist. The most effectual mode of impressing scenery on the memory is by the study and practice of sketching landscape. In addition to this, it will be useful to pay attention to the natural surface and productions, as kind of tree or crop, hills, valleys, flats, lakes, rills, &c.; also to the distant scenery, as whether flat, hilly, cultivated, waste, woody, or watery; what processes are going on; what the style of houses, dress, &c. Having attended to these details, the next and the most important aid to the memory is to recollect what portion of country already known to us it most resembles.

3299. *In endeavouring to recollect the surface and objects composing an entire estate*, some leading central object, as the house, should be fixed on, and the bearings of other objects relative to it ascertained in idea. Then, either by going over the estate, or by a favourable position on the house-top or some other eminence, the outline of the fields, or other scenery nearest the house, may be taken down or remembered, and also the distant scenery, or that exterior to the estate. In riding through a country which it is desired to recollect, a sketch should be made in imagination of the road and the leading objects adjoining; another of what may be called the objects in the middle distance; and, finally, one of the farthest distance. If, instead of the imagination, a memorandum book were used, and the sketches accompanied with notes, the country examined would be firmly impressed on the memory. In this way temporary military maps are formed by the engineers of the army in a few hours, and with astonishing accuracy.

Subsect. 2. *Taking the Levels of Surfaces.*

3300. *Levelling*, or the operation of taking the levels of surfaces, is of essential use in agriculture, for ascertaining the practicability of bringing water to particular points in order to drive machinery; for irrigation; for roads led along the sides of hills; for drainages, and various other purposes. There are few works on the earth's surface more useful, grand, and agreeable, than a road ascending, passing over, and descending a range of steep irregular mountains, but every where of the same and of a convenient slope; next to this is a canal passing through an irregular country, yet every where on the same level.

3301. *Two or more places are said to be on a true level*, when they are equally distant from the centre of the earth. Also, one place is higher than another, or out of level with it, when it is farther from the centre of the earth: and a line equally distant from that centre in all its points, is called the line of true level. Hence, because the earth is round, that line must be a curve, and make a part of the earth's circumference, or at least be parallel to it, or concentrical with it.

3302. *The line of sight given by the operation of levelling* is a tangent, or a right line perpendicular to the semidiameter of the earth at the point of contact, rising always higher above the true line of level, the farther the distance is, which is called the *apparent line of level*, the difference of which is always equal to the excess of the secant of the arch of distance above the radius of the earth.

3303. *The common methods of levelling* are sufficient for conveying water to small distances, &c.; but in more extensive operations, as in levelling for canals, which are to convey water to the distance of many miles, and such like, the difference between the true and the apparent level must be taken into the account, which is equal to the square of the distance between the places, divided by the diameter of the earth, and consequently it is always proportional to the square of the distance; or from calculation almost eight inches, for the height of the *apparent* above the *true* level at a distance of one mile. Thus, by proportioning the excesses in altitude according to the squares of the distances, tables showing the height of the apparent above the true level for every hundred yards of distance on the one hand, and for every mile on the other, have been constructed. (See *Dr. Hutton's Mathematical Dictionary*, art. *Level.*)

3304. *The operation of levelling* is performed by placing poles or staves at different parts or points from which the levels are to be taken, with persons to raise or lower them, according to circumstances, when the levelling instrument is properly applied and adjusted. In describing the more common levels used in agriculture (2497.), we have also given some account of the mode of using them for common purposes. Their use, as well as that of the different kinds of spirit levels, will be better acquired by a few hours' practice with a surveyor than by any number of words: and indeed in practice, whenever any very important point or series of levels is to be taken, it will commonly be found better to call in the aid of a land surveyor than to be at the expense of implements to be seldom used, and with which errors might easily be made by a very skilful person not accustomed to their frequent use.

3305. *Levelling to produce an even line* (*fig.* 521.), as in road-making, whether that

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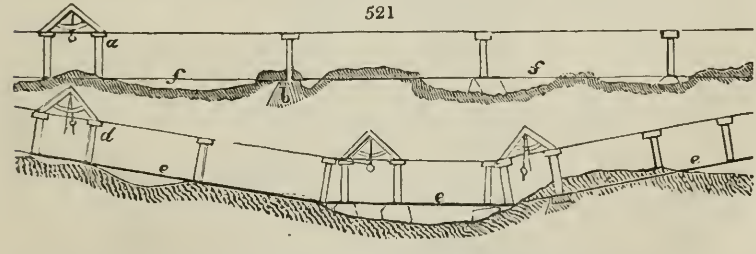

line be straight or curved in direction, can only be determined on an irregular surface by measuring down from an elevated level line (*a*), or from level lines in parallel directions, and so transferring the points by horizontal levels to the proper line. Straight rods are the ready means of measuring down, and the points must be marked by hillocks or hollows (*b*), or by smooth-headed stakes driven into the surface, and protruding above, or sunk under it, according to the obstructions.

3306. *Lines of uniform declivity or acclivity* (*fig.* 521. *e, e, e*) are readily formed on the same principle. In this and the former case, the common level and the borning pieces (*a* and *d*), with measuring-rods and stakes, are all the instruments required.

Subsect. 3. *Division and laying out of Lands.*

3307. *The division of lands* is one of the most important and not the least difficult parts of the land surveyor's art. In intricate cases, as in the subdivision of large estates or commons, the professional surveyor will generally be resorted to; but it is essential for the land-steward and proprietor, and even for the farmer, or professional cultivator, to know the general principles on which this business is founded. We shall therefore shortly develope these principles from Dr. Hutton's valuable Dictionary, and next offer some general rules of our own for ordinary cases of dividing and laying out lines.

3308. *In the division of commons*, after the whole is surveyed and cast up, and the proper quantities to be allowed for roads, &c. deducted, divide the net quantity remaining among the several proprietors, by the rule of fellowship, in proportion to the real value of their estates, and you will thereby obtain their proportional quantities of the land. But as this division supposes the land, which is to be divided, to be all of an equal goodness, you must observe, that if the part in which any one's share is to be marked off be better or worse than the general mean quality of the land, then you must diminish or augment the quantity of his share in the same proportion.

3309. *Or divide the ground among the claimants in the direct ratio of the value of their claims*, and the inverse ratio of the quality of the ground allotted to each: that is, in proportion to the quotients arising from the division of the value of each person's estate, by the number which expresses the quality of the ground in his share.

3310. But *these regular methods cannot always be put in practice;* so that, in the division of commons, the usual way is to measure separately all the land that is of different values, and add into two sums the contents and the values; then the value of every claimant's share is found by dividing the whole value among them in proportion to their estates; and lastly, a quantity is laid out for each person, that shall be of the value of his share before found.

3311. *It is required to divide any given quantity of ground, or its value, into any given number of parts, and in proportion to any given number.* — *Rule.* Divide the given piece, or its value, as in the rule of fellowship, by dividing the whole content or value by the sum of the numbers expressing the proportions of the several shares, and multiplying the quotient severally by the said proportional numbers for the respective shares required, when the land is all of the same quality. But if the shares be of different qualities, then divide the numbers expressing the proportions or values of the shares, by the numbers which express the qualities of the land in each share; and use the quotients instead of the former proportional numbers.

Ex. 1. If the total value of a common be 2500*l.* it is required to determine the values of the shares of the three claimants A, B, C, whose estates are of these values, 10,000*l.*, 15,000*l.*, and 25,000*l.* The estates being in proportion as the numbers 2, 3, 5, whose sum is 10, we shall have 2,500 ÷ 10=250; which being severally multiplied by 2, 3, 5, the products 500, 750, 1250, are the values of the shares required.

Ex. 2. It is required to divide 300 acres of land among A, B, C, D, E, F, G, and H, whose claims upon it are respectively in proportion as the numbers 1, 2, 3, 5, 8, 10, 15, 20. The sum of these proportional numbers is 64; by which dividing 300, the quotient is 4 ac. 2 r. 30 p.; which being multiplied by each of the numbers, 1, 2, 3, 5, &c. we obtain for the several shares as annexed.

	Ac.	R.	P.
A =	4	2	30
B =	9	1	20
C =	14	0	10
D =	23	1	30
E =	37	2	00
F =	46	3	20
G =	70	1	10
H =	93	3	00
Sum =	300	0	00

Ex. 3. It is required to divide 780 acres among A, B, and C, whose estates are 1,000*l.*, 3,000*l.*, and 4,000*l.* a year; the ground in their shares being worth 5, 8, and 10 shillings the acre respectively. Here their claims are as 1, 3, 4: and the qualities of their land are as 5, 8, 10; therefore their quantities must be as one fifth, three eighths, two fifths; or by reduction, as 8, 15, 16. Now the sum of these numbers is 39; by which dividing the 780 acres, the quotient is 20; which being multiplied severally by the three numbers 8, 15, 16, the three products are 160, 300, 320, for the shares of A, B, C, respectively.

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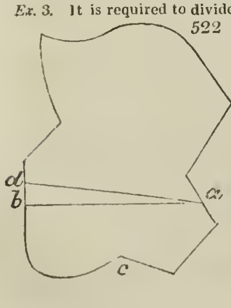

3312. *To cut off from a plan a given number of acres, &c. by a line drawn from any point in the side of it.* — *Rule.* Let *a* (*fig.* 522.) be the given point in the plan, from which a line is to be drawn cutting off suppose 5 ac. 2 r. 14 p. Draw *a b* cutting off the part *a b c* as near as can be judged equal to the quantity proposed; and let the true quantity of *a b c*, when calculated, be only 4 ac.

3 r. 20 p. which is less than 5 ac. 2 r. 14 p. the true quantity, by 0 ac. 2 r. 34 p. or 71,250 square links. Then measure *a b*, which suppose = 1,234 links, and divide 71,250 by 617, the half of it; and the quotient, 115 links, will be the altitude of the triangle to be added, and whose base is *a, b*. Therefore, if upon the centre *b*, with the radius 115, an arc be described, and a line be drawn parallel to *a, b*, touching the arc, and cutting *b, d* in *d*; and if *a, d* be drawn, it will be the line cutting off the required quantity *a, d, c, a*. On the other hand, if the first piece had been too much, then *d* must have been set below *b*. In this manner, the several shares of commons to be divided, may be laid down upon the plan, and transferred thence to the ground itself.

3313. *The simplest mode of dividing lands*, and that by which the agriculturist will make fewest errors, is by *trial and correction*. Thus, supposing a piece of unenclosed land of irregular shape to contain thirty-eight acres and a half, and it is desired to lay it out in three fields, each of the same extent. Take a plan of the field, and lay it down on paper; divide it into three parts as near as possible by the eye: then ascertain the contents of one of the outside divisions, which will be either somewhat too little or too much. Suppose it too little by half a rood; then, as the length of the straight line of the division is 1000 links, and 1000 links in length and 100 in breadth make an acre, and as half a rood is the eighth of an acre, it follows that by extending the line the eighth part of 100 links, or 12·4 links at both ends, or 24·8 links at one end, the requisite quantity will be added. Then go through the same operation with the projected field on the other extreme of the plot; and this being corrected, the middle field must necessarily be of the exact contents of each of the two others: but to prove the whole, this field also may be tried in the same manner.

3314. *In dividing a field with a view to sowing different crops* in certain proportions: say, for example, one acre and a half of common turnips, one acre of Swedish turnips, three quarters of an acre of potatoes, and five acres of peas. Suppose the field a parallelogram or nearly so; then first ascertain the length of the ridges, and next state the question thus:— Such a length being given, required the breadth to give a fourth of an acre — that being the smallest fraction in the proportions to be laid out; then, if the length of the ridges be ten chains, the breadth requisite to give a quarter of an acre will be 25 links; consequently, a breadth of five times that space will be required for the common turnips; four times for the Swedish turnips; three times for the potatoes; and twenty times for the peas.

3315. *In all more intricate cases*, first lay down the plan of the space to be divided on paper, to a large scale, say a chain to an inch; then cover the paper with lines, drawn so as to form squares, each square containing a certain number of feet and yards, or say a pole each; then on these squares adjust the figure, whatever it may be: thus, supposing it desired to lay out a thicket of trees on the face of a hill, the outline of which shall resemble the outline of the profile of a horse, dog, or say a human head, and yet shall contain only one acre: lay down the outline of the horse or head on a large scale, and divide it into squares; then by trial and correction ascertain what each square must necessarily contain. Say that there are 130 entire squares and 40 parts of squares, making up in all 160 squares; each of these squares must of course contain exactly one pole, or 625 links, and their sides the square root of that number, or 25 links. From these data it is easy to lay down the figure with perfect accuracy.

3316. *The laying out lines* on lands, for the purposes of roads, fences, &c. requires to be well understood by the agriculturist. On a plain surface, the business of tracing straight lines is effected by a series of poles, so placed that the one nearest the eye conceals all the rest. Where a straight line is to be indicated among objects or inequalities not more than fifteen or twenty feet high, its plan or track on the earth (*a, b, fig.* 523.)

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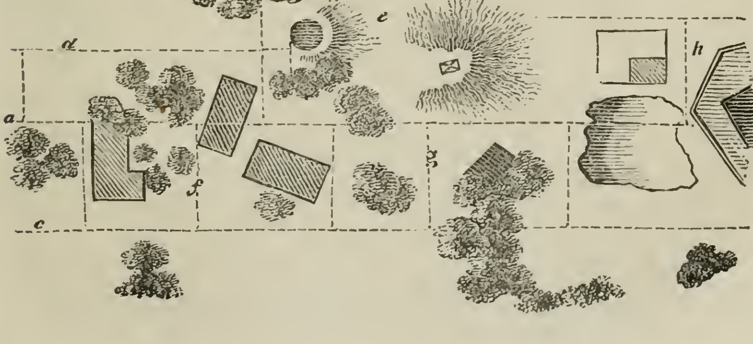

may be found by the use of poles a few feet higher than the elevation of the obstructions, the director being placed on a step-ladder, or other elevation, at one end. Where this method cannot be adopted on account of the height of the inequalities, the line must either be formed along the summits of these inequalities, which may be done if they are houses, hills, or trees; or parallel lines (*c*, *d*, *e*) formed where practicable, and the main line found by off-sets (*f*, *g*, *h*) from those collateral lines at such places as are suitable. A third method, but one not always perfectly accurate, is to take a plan of the field or scene of operations, and on this to set out the proposed line; then, by ascertaining its bearings and distances relatively to the obstructions, it may be transferred from the paper to the ground. In carrying straight lines through woods, lanterns have been used; but a much more correct method is to elevate poles above the surface of the wood.

3317. *Continuous lines* may always be made perfectly straight, however irregular the surface, by following the same parallel as indicated by points of the compass, or by the shadow of the operator during sunshine. If the needle does not move, or the shadow of the spectator be always projected at the same angle to his course, the direction in which he walks, in either case, must be straight. The mode of forming right lines in such circumstances being understood, the formation of right-lined figures is merely a repetition of the process, uniting each side by the required angle.

3318. *Curved lines* on irregular surfaces are in general only to be laid down by the previous establishment of straight lines; first, leading straight lines, and next secondary straight lines, which shall form skeletons to the curves. A second mode, and, on a large scale, by much the most certain, is to find the leading points of the curves, by triangles from a known base or known bases; but as both modes are rare, they need not be enlarged on.

Subsect. 4. *Estimating Weight, Power, and Quantities*

3319. *Ascertaining the weight of objects* is a part of agricultural knowledge, no less necessary than that of measuring their superficial or solid contents. In all ordinary cases, as of grain, roots, bundles of straw, bushels of lime, &c., this is best done by a common steelyard, suspended from a beam or a triangle of three posts. Cart or waggon loads are weighed on those well-known platforms sunk in the ground at toll gates; or sometimes by steelyards on a very large scale. Cattle are weighed by machines of a particular kind, which have been already described (2566. to 2568.). The weighing of cattle and grain chiefly concerns the farmer; and is of consequence, in the first case, to ascertain the progress of fattening animals, or the weight of those ready for the butcher; and, in the second, to determine the quantity of flour that may be produced from a given quantity of grain.

3320. *Estimating the quantity of power requisite to draw any implement or machine* is performed by the intervention of the draught machine already described (2563.), between the power and the implement. It would not be difficult to construct all agricultural implements with a fixed draught-machine and index, which would at all times, when they were at work, shew the amount of power employed in moving them; but such an arrangement would be of little use.

3321. *Estimating the quantity of work* which servants and cattle ought to perform in a given time, is an art that ought to be familiar to every agriculturist. In general no absolute rule can be laid down, because so much depends on soils, roads, cattle, and other circumstances; but in every particular case, the rate or market price of labour per day being given, and the quantity of work ascertained which a man can fairly perform in a certain time, a rate per yard, pole, or acre, or per solid quantity if materials are to be moved, can easily be determined on. A farmer should know by memory the number of ridges or of single furrows, or bouts, which it requires to make an acre on every field of his farm. This will aid him in every operation that requires to be performed on these fields, the quantity of manure, seed, ploughings, harrowings, hoeings, mowing, reaping, raking, &c.; as well as in estimating the produce, whether corn, hay, roots, or the number of cattle or sheep that may be grazed there for any given time.

3322. *Road work, ditching, hedging, draining, trenching, &c.* ought to be subjected to similar calculations, so as if possible to let out all work, not performed with the master's own men and cattle, by contract or quantity, instead of by time. As spade work is nearly the same in most parts of the country, certain general rules have been laid down by canal contractors and others, which, though seldom strictly followed up, it may be useful to know. Thus in moving ground, as in digging a drain or the foundations of a building, if the soil is soft, and no other tool than the spade is necessary, a man will throw up a cubic yard of 27 solid feet in an hour, or 10 cubic yards in a day. But if picking or hacking be necessary, an additional man will be required; and very strong gravel will require two. The rates of a cubic yard, depending thus upon each circumstance, will be in the ratio of the arithmetical numbers 1, 2, 3. If, therefore, the wages of a labourer be 2*s.* 6*d.* per day, the price of a yard will be 3*d.* for cutting only, 6*d.* for cutting and hacking, and 9*d.* when two hackers are necessary. In sandy ground, when wheeling is requisite, three men will be required to remove 30 cubic yards in a day, to the distance of 20 yards, two filling and one wheeling; but to remove the same quantity in a day, to a greater distance, an additional man will be required for every 20 yards.

3323. *To find the price of removing any number of cubic yards to any given distance:* Divide the distance in yards by 20, which gives the number of wheelers; add the two cutters to the quotient, and you will have the whole number employed; multiply the sum by the daily wages of a labourer, and the produce will be the price of 30 cubic yards. Then, as 30 cubic yards is to the whole number, so is the price of 30 cubic yards to the cost of the whole. *Example.* — What will it cost to remove 2,750 cubic yards to the distance of 120 yards, a man's wages being three shillings per day? First, $120 \div 20 = 6$, the number of wheelers; then $+ 2$ fillers $= 8$ men employed, which, at three shillings per day, gives twenty-four shillings as the price of 30 cubic yards; then 30 : 24 :: 2,750 and $24 \times 2,750 \div 30 = 110$*l.*

Subsect. 5. *Estimating the Value of Agricultural Labour and Materials, Rents and Tillages.*

3324. *Estimating the value of work done* is a necessary part of agricultural knowledge, and is founded upon the price of labour and the time of performance. The price of labour is every where determined by the operations of the public, and therefore in any given case can seldom admit of much difference of opinion. In a theoretical view of the subject the proper wages for a labourer in England has been considered, for ages, to be a peck of wheat; and that of a horse the amount of his keep, expenses of a year's shoeing, and ten per cent. on his value or cost price at a fair age, added together, and divided by the number of days such horse is supposed to work in a year: this brings the value of the day's work of a horse to something more than once and a half the value of the day's work of a man; so that supposing a labourer's wages two shillings per day, a man and a pair of horses would be worth eight shillings per day. This, however, it must be acknowledged, is a calculation not always to be depended on, as local circumstances continually intervene to alter the proportions. In all cases of valuing labour, therefore, all that the valuator can do is to ascertain the local price, and to estimate from his own experience the time requisite to perform the work.

3325. *In estimating the value of labour and materials,* considerable difficulty occurs in some departments of agriculture. Thus, in valuing fallows and sown crops it is often a nice point to determine satisfactorily the value of the manure or other dressings; and in valuing the tillages, or the condition of the arable lands of an out-going tenant, regard must be had not only to the actual number of ploughings a field may have been subjected to the preceding or current year, but to the position which the state of that field holds in the rotation, and to the value which may still be in the soil from manures or limings given to former crops. Supposing a field fallowed, limed, and dunged in the year 1820, and that when it fell to be valued in the spring of the year 1824, it was drilled with beans on one furrow, it would be no adequate compensation for the tenant to be paid for one ploughing, the beans, and the drilling; the fallow, the dung, and especially the lime given in 1820, must be considered as extending their influence even to this crop, and therefore an allowance ought to be, and generally is, made for these three articles, besides the mere value of the labour and seed. What this allowance should be it does not seem easy to determine: land valuers and appraisers have certain rules which they go upon, which are known to few but themselves, but which, having ourselves been initiated in the business, we know to differ considerably in different parts of the country. Some calculate that the value of dung extends to the fourth year, and declines in a geometrical ratio, or in the proportion 1, 2, 4, 8; others limit its effects to three years. Lime is allowed in some places to produce effects for three years only, and in others, especially on new lands, for twelve and fourteen years; and its value is generally supposed to decline in the proportion of 1, 2, 3, &c. Naked fallow is generally considered as of beneficial influence for five years, where it occurs every seven or eight years, and shorter periods in proportion. A crop sown on a single furrow after a drilled crop which has been manured, is considered as partaking of the manure or other dressings according to the extent to which these have been given, and generally in the same ratio as in manured fallows.

3326. *In estimating the value of materials alone,* the first thing is to ascertain their quantity, and the next their market price. Thus, in the case of heaps of manure, the cubic contents must first be found, by finding the area of the base of the heap, and its mean depth, and multiplying the one into the other; next, the quality of the material must be examined, and the expense of purchasing it in the nearest town or source of purchase, with the addition of the expense of carriage to the spot where it lies. Ricks, whether of straw or hay, are valued in a similar manner. Crops in a growing state are valued according to what they have cost, including tillage, manures, seed, rent, taxes, and other outgoings, and ten per cent. on the outlay of capital, crops arrived at maturity are valued according to their quantity and quality, deducting the expenses of reaping, threshing, &c. In coal countries an allowance is made for thorn-hedges which have been newly cut; but the reverse is the case where fuel is scarce, an allowance being made according to the quantity of brush or lop on the hedge. The lop of pollards, and prunings of hedgerow trees to a certain height, are generally valued to the tenant; but a better mode is for the landlord to take the timber trees entirely under his own management.

3327. *In valuing live stock*, a variety of circumstances require to be taken into consideration. The value of all young animals may be considered as prospective; the chief value of others depends on their breeds; of some, on accident or fashion; and of fed animals on their actual value to the butcher. Draught cattle may be valued on an abstract principle, derived from the probable value of their lives and labour; but in general nothing is to be depended on but a knowledge of the market price, and this ought to be familiar to every valuator.

3328. *In valuing buildings*, regard must be had to their absolute use as such, and to their effect on the value of surrounding property. In the case of buildings merely useful as farmeries, it will sometimes happen that more buildings are erected than the most approved mode of husbandry requires, as in the case of large barns and granaries, ornamental pigeon-houses, &c.: these can be valued on no other principle than that of the value of the materials, supposing them taken down; and, in regard to an in-coming tenant, they are to be considered as a drawback, rather than as of any value.

3329. *In valuing orchards, hop-grounds, osier plantations*, and similar crops, it is usual, for the first two or three years after planting, to allow only the cost, rent, all outgoings, and ten per cent. on their amount; but afterwards, the trees and plants having taken with the soil, and promising abundant crops, they are valued prospectively in the mode in which we shall next describe as applied to young plantations of timber-trees.

3330. *In valuing young plantations*, when they are only of two or three years' growth, it is usual to proceed as in valuing orchards; but afterwards, when their growth is becoming rapid, and the fences in a sufficient state, the plantation is valued prospectively in the following manner: — The contents being known, and the number of healthy young trees per acre ascertained, then their value at any distant period, not exceeding twenty or twenty-five years, is estimated; and whatever sum that estimate amounts to, the present value of that sum will give an idea of the value of the plantation, allowing liberally for accidents to the trees, and other unforeseen circumstances. Thus, suppose a plantation of oaks, intended as copse, or actually established as such, to have grown four years, its present value would be next to nothing; but if arrived at its twentieth year, it would fetch fifty pounds per acre. Then the question is, required the present value of fifty pounds due sixteen years hence, the market price of money being five per cent.? and this, according to any of the modern annuity tables (say *Bayley's* 4to. 1808. tab. iv.), is 22*l.* 18*s.* This principle is applicable to all kind of valuing by anticipation; and there is no other mode of valuing applicable to young plantations.

3331. *In valuing saleable trees*, their number per acre, or their total number, being ascertained, an average value must be made of each tree, according to its worth as fuel, timber, fence-wood, bark for the tan-pit, and other particulars, due allowance being made at the same time for the expenses of felling, cutting up, sorting, carriage, &c. The usual practice in this case, as well as in the valuation of copse-woods, will be given in treating of wood-lands in the succeeding Part of this work.

3332. *In valuing fields for rent*, regard must be had to their soil and subsoil, as of the greatest importance; next, to their aspect, form, length, and style of ridges; and, lastly, as to the sort of crops or rotation which may be followed on them, and their state of culture. Supposing the valuator to decide in his own mind as to the rotation, his next business is to calculate the expense and produce of the whole course; and after deducting all expenses whatever, and ten per cent. per annum on the capital employed, the balance may be considered as the rack-rent which such a field may afford.

3333. *In valuing a farm for rent*, each field must be valued separately in the manner above stated, and a particular rent per acre determined for each field, from which an average rent can be made out for the whole farm. In some cases it is customary to value the farm buildings, dwellings, yards, gardens, &c.; but when that is done, a sum in proportion to their value is deducted from the supposed profits as household and other expenses, so that no advantage is gained by it. It is by means of those buildings, threshing machine, and other conveniences, that so much can be paid for each field; and therefore to pay for the buildings, and pay also for their advantages, would be unjust. It must be further obvious, that a great variety of other considerations must be taken into account before even the value of a single field can be ascertained, such as distance from markets, roads, parochial and country towns, price of labour, &c. But after all, it is seldom that land is taken or let on such valuations; rent, like price of every kind, depending more on the quantity of land in the market, and the number of tenants in want of farms, than on the real value of land. This, indeed, often tends to the ruin of farmers, by obliging them to give higher rents than the land can bear; but the same thing takes place in every other trade or profession.

3334. *The amount of the rent of lands* is commonly determined in money alone; but owing to the fluctuations in the value of this commodity, rents are in some places made payable partly in money, and partly in corn (or beef or wool in some cases), or in money, and the money value of a certain quantity of produce per acre. In some cases the money value of the produce is determined by its price in the district for the current or preceding year; and in other cases by an average of the money price for the preceding three, five, or seven years. This plan has, within the last seven years, been adopted in many parts of Scotland, and been generally approved of, both by landlords and tenants. There is no plan that will in every year be perfectly equitable; and for this reason many consider the money rent as on the whole the simplest and best, as it certainly is that which occasions least trouble to all parties.

3335. *The valuation of leases* well deserves the study of the culturist, and especially of the farmer, who may often wish or find an opportunity of purchasing a renewal of his lease, or have occasion to dispose of an improved rent, or, in other words, sub-let his farm at a profit. It is customary, in many parts of the kingdom, for landlords to compound with their tenants, by accepting a sum of money paid down in place of advancing the rent at the expiration of a former or a current lease. To be able to point out the exact amount of the sum to be paid in any transaction of this nature, according to the annual profit, and the number of years for which the lease is to be granted, must obviously be particularly useful. The valuation of church leases and of college lands is of not less importance, as these for the most part are let on twenty-one years' leases, renewable for seven years longer at the end of every seven years; or on leases for lives, every life being renewable as it drops, for a certain sum to be determined according to the age of the life to be put in, and the value of the lands.

3336. *The principle on which all calculations as to the value of leases are made,* is as follows: — A sum being fixed on, which is considered or agreed on as the worth or profit which the tenant has in the lease, and the time which the lease has to run or for which it is to be renewed being agreed on, then the purchaser of the lease or of the renewal pays down to the seller the present value of an annuity equal to the profit or worth, reckoning money at its market price, or at what is called legal interest. Thus, should it be suitable to the convenience of both parties to renew a lease of twenty-one years, of which only one year had expired, the tenant ought to pay the landlord 7*s.* 2*d.* for every pound of profit he has in the lease. Should it be asked how the tenant is to pay the landlord only 7*s.* 2*d.* out of each pound that he had of profit in the one year that has elapsed, it is answered, that the landlord had no right to receive the 7*s.* 2*d.* until the expiration of twenty years, which is the number the lease has yet to run; and that this sum of 7*s.* 2*d.* laid out at compound interest, at 5 per cent., payable yearly, would, at the end of twenty years, amount exactly to 1*l.*; so that the landlord has received just the amount of what he was entitled to, and no more.

3337. *Or, as the most customary period at which to renew,* during the currency of a lease of twenty-one years, is when seven years have elapsed, then the exact sum that ought to be paid for adding seven years will be 2*l.* 18*s.* 5*d.* for every 1*l.* of annual profit, because 2*l.* 18*s.* 5*d.* laid out at compound interest, will, in twenty-one years, the length of lease obtained by paying it, amount exactly to 7*l.*, the profit that would have accrued to the landlord during the seven years of renewal.

3338. *The method of determining all questions as to the renewal of leases,* sale of profits on sub-leases, &c. is easily learned from the common books of arithmetic; and the value of lives from tables composed from a long series of observations in different places, as at London, Northampton, &c. But practical men can seldom have recourse to so tedious a method as calculating for themselves, by which, for want of daily practice, serious errors might be made. They therefore have recourse to published tables on the subject, by which the most intricate questions of this kind may be solved by the humblest individual who can add and subtract, in a few minutes. The tables in most repute at present are, *Baily's Tables for the Purchasing and Renewing of Leases,* 1807; *Clarke's Enquiry into the Nature and Value of Leasehold Property and Life Annuities, with many Tables,* 1806; and there is a useful pocket compendium entitled, *Tables for the Purchasing of Estates, Leases, Annuities, and the Renewing of Leases, by* W. Inwood, London, 1811. There is a recent work on *The Valuation of Rents and Tillages,* by J. S. Bayldon, which is the best of its kind extant.

3339. *The questions* following, and others of similar importance to agriculturists, and indeed to all men of property, may be answered from these tables.

Question. What sum must be paid down for a lease for twenty-one years to make five per cent. and get back the principal?
Answer. Twelve years and three quarters' purchase of the annual rent.

Q. What sum ought to be paid for a lease granted on a single life aged thirty, to make four per cent. and get back the principal?

A. Fourteen years and three quarters' purchase of the clear annual rent.

Q. What sum ought to be paid for a lease held on two lives of twenty and forty years, but determinable on the death of either, to pay five per cent. and get back the principal?

A. Ten years' purchase.

Q. What sum ought to be paid for a lease held like the last on two lives of twenty and forty years, but to continue during the existence of either of the lives, to pay five per cent. and get back the principal?

A. Sixteen years' purchase.

Q. What sum or fine ought a tenant to give for the renewal of four years lapsed in his lease of ten years, in order to make seven per cent. interest of his money and get back the principal?

A. Two years and a quarters' purchase of the annual value or clear profit which he makes of the holding.

Q. A farmer is offered a lease during the life of a person aged thirty years, to what term certain is that considered equivalent?

A. Twenty-one years.

Q. In a lease held originally on three lives, but of which one is dropped, the ages of the lives in possession being forty and sixty; what sum ought the tenant to pay for passing in a new life, aged fifteen, in order to make five per cent. interest and return the principal?

A. Three years and a quarter of the clear improved rent or profit which he has in the lease.

Q. A. has an estate in land and houses let for 105*l.* per annum. He wishes to sell the reversion of this rent after the death of his father aged sixty-five years, his wife aged forty-one, and himself aged forty-three; required the sum that must be paid by the purchaser?

A. The father's life is worth ten years; the wife's twenty; and his own eighteen years; say twenty-one years; as the probable period at which the property will fall to the purchaser of the reversion. Then the value to the latter is the present value of an annuity of 105*l.* a year, due twenty-one years hence. This, calculating interest at 5*l.* per cent., is 761*l.* 5*s.*, and at 4*l.* per cent. 1155*l.*

3340. *In the valuation of freehold landed property*, the clear annual value must first be ascertained by a minute examination of every part of the estate, and of every internal and external circumstance affecting it. An estate may be neglected, or underlet on short or long leases, or overlet by means of bonuses, or favourable conditions given to the tenants; or it may be burdened by parochial taxes: these, and a number of other circumstances, require to be taken into consideration in determining its annual value. The annual value is often different from the annual produce; and therefore, in making a calculation of the sum to be paid for an estate, the difference between them forms an essential part of the data. Thus, an estate of the annual value of 100*l.* may be let on a lease of which fourteen years and a half were unexpired for 80*l.*, in which case there must be deducted from the price the present value of an annuity of 20*l.* for fourteen years and a half. Thus, if twenty-five years' purchase or 2500*l.* was the price agreed on, there must be deducted 200*l.*

3341. *In determining the sum to be paid for estates in perpetuity* there are no guides of universal application but the state of the market and public opinion. However, a sort of abstract principle has been laid down as applicable to this country, which it may be worth while to notice. N. Kent, a land agent of much experience, says (*Hints to Gentlemen of Landed Property*, &c., 1793, p. 266.), "the want of a criterion to determine the price of estates creates doubt, and doubt impedes the transfer; any thing, therefore, that can aid the purpose of passing estates from one person to another with the greater facility, may be properly introduced here." Suppose then that the gradual scale, by way of an outline, be taken up thus: — When the funds stand pretty steady at four per cent. the standard of mortgages may be considered at four and a half: the fee simple on the nett return of land ought then to be current at three; copyholds of inheritance upon a fine certain, at three and a half; copyholds, with a fine at the will of the lord, at four. This general rule is short, and may be registered in the mind of every man of business. At the same time Kent states, that "nineteen times out of twenty, estates are bought and sold upon round numbers."

3342. *In making calculations* of the value of estates, the following rules deserve notice:— In order to know the number of years' purchase that ought to be given for an estate in perpetuity, according to the several rates of interest which the purchaser may wish to make of his money, it is only necessary to divide 100 by the rate of interest required, and the quotient will show the number of years' purchase that ought to be given.

3343. *With respect to the value of freehold estates*, or the gross *sum* which ought to be paid for the same, Bailey observes, we may either multiply the *number of years' purchase*, found as above, by the *annual rent* of the estate, or we may "multiply the *annual rent* of the estate by 100, and divide the product by the *rate of interest* which we propose to make of our money; the quotient will be the sum required." For example, the sum which ought to be paid for a freehold estate of the clear rent of 90*l.* per annum, so that the purchaser may make 4 per cent. interest of his money, is found either by multiplying 25 by 90, which gives 2250*l.* for the sum required; or by multiplying 90 by 100, which produces 9000, and then dividing this product by 4, which gives 2250*l.* as before. The first way is the most expeditious, where the number of years' purchase is an even quantity; but the latter will be found the most ready, where the number of years' purchase is a fractional quantity, or is not precisely known. Thus, the gross sum which ought to be paid for a freehold estate of the clear rent of 150*l.* per annum, in order that the purchaser may make 7 per cent. interest of his money, is found by multiplying 150 by 100, which produces 15,000, and then dividing this product by 7, which gives 2142*l.* 17*s.* 2*d.* for the sum required: now if, in answering this question, we had begun by finding the number of years' purchase which ought to have been given for the same, the process would have been rendered much more tedious and intricate.

3344. *In order to find the clear annual rent which a freehold ought to produce,* so as to allow the purchaser a given rate of interest for his money, we must "multiply the gross *sum* paid for the same, by the given rate of interest, and then divide the product by 100; the quotient of which will be the annual rent required:" thus, if a person gives 5940*l.* for a freehold estate, and he wishes to make $6\frac{1}{2}$ per cent. interest of his money, then 5940 multiplied by 6·5, will produce 38,610, which, divided by 100, will quote 386·1, or 386*l.* 2*s.*, for the clear *annual rent* required. Lastly,

3345. *The rate of interest allowed to the purchaser of a freehold,* is much more readily and more exactly ascertained than in the case of leases for terms, as we have nothing more to do here than to "multiply the clear *annual rent* of the estate by 100, and then divide the product by the *sum* paid for the estate; the quotient will be the *rate of interest* required:" thus, if a person gives 2000*l.* for a freehold estate, of the clear rent of 85*l.* per annum, then 85, multiplied by 100, will produce 8500, which, divided by 2000, will quote 4·25, or $4\frac{1}{4}$ per cent. for the *rate of interest* required.

3346. *The valuation of mines and minerals* is not a matter of much difficulty, when it extends merely to quarries of stone, lime, chalk, gravel, or other bodies "open to the day," or worked from the surface. If the quantity is indefinite, then the annual income afforded forms the ground-work; if it is limited, then the joint consideration of the quantity, and the probable time the current demand may take to exhaust it. The valuation of metallic mines belongs to a distinct class of professors known as mineral surveyors, and is a matter foreign from agriculture, which confines itself to the earth's surface, or at least to the epidermis of its upper crust.

Subsect. 6. *Professional Routine of Land Surveyors, Appraisers and Valuators, in making up their Plans and Reports.*

3347. *For portraying rural objects* various modes have been adopted by land surveyors: trees are sometimes shown by small crosses or ciphers, triangles or dots (*fig.* 524. *a*); by

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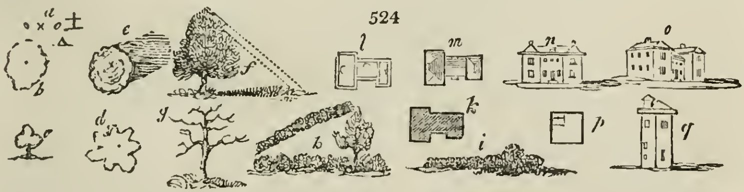

an orbicular line representing the extension of the branches or head, and a dot in the place of the trunk (*b* and *d*); by the same, with the addition of a shadow, taken when the sun is south or south-west, and his elevation exactly 45°, by which the points of the compass are readily ascertained throughout the plan, and the shape of the head, and the height of the tree, exhibited (*e*); sometimes an elevation or profile of the tree is given, either in foliage (*f*), or to show the form of the trunk and branches (*g*), or merely to give a rude idea of a tree (*c*). Hedgerows, whether with or without trees, are either shown in elevation or profile (*h*), or in vertical profile or birdseye view (*i*). They may be delineated either in skeleton or foliage. Buildings may be shown either in general plan (*k*), detailed plan (*l*), vertical profile of the roof (*m*), elevation (*n*), perspective view (*o*); or a plan may be given (*p*), and a diagonal elevation (*q*) taken and placed opposite the plan in the margin of the map. A pictorial surveyor, who understands perspective, and is desirous of conveying a correct idea of the subject he is to measure and delineate, will readily find expedients for attaining success.

3348. *In protracting elevations and depressions on paper,* the simplest way is to introduce sections, in dotted or otherwise distinguished lines, to prevent their being mistaken for surface-lines; or in wavy surfaces, figures may be introduced, thus $_{4}$ or ^{4}, to denote their elevation above, or depression below, some piece of water or other surface fixed on as a medium. Some excellent observations on this subject will be found in Major Lehman's *Topographical Plan-Drawing,* as translated by Lieutenant Sibern (oblong fol. Lond. 1822), which, it is to be hoped, will soon be appropriated in the popular books on land-surveying, and adopted in practice.

3349. *Where it is in contemplation to form canals,* or other reservoirs or pieces of water, the elevations and depressions or levels must be taken and recorded either by sections or arithmetically with the greatest accuracy; and, in some cases, sections may require to be taken, to show particular trees, buildings, the depth of water, or other objects. (*fig.* 525.)

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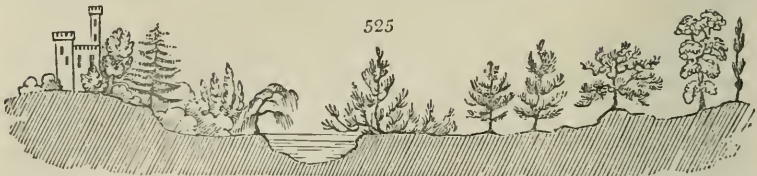

3350. With respect to *the elevations and shapes of hills and mountains*, they are only t be measured correctly by the quadrant and theodolite in the hands of regular land-surveyors. Their shape and dimensions are laid down in maps in the same manner as those of smaller deviations from the flat surface. Inaccessible dimensions of height, as of trees or buildings, are obtained by the quadrant, or by relative comparisons of shadows; of depth, as of water or wells, by rods; of breadth or length, by finding the two angles of a triangle whose base shall be in one extremity of the distance, and apex in the other. These, and many other equally simple problems in trigonometry, need not be enlarged on, because they must be supposed to form a part of general education.

3351. *In portraying the general surface of land estates*, different modes have been adopted by modern land-surveyors. The first we shall mention is the old mode of giving what may be called the ground-lines only; as of roads, fences, water-courses, situations of buildings and trees. (*fig.* 526.) This mode has no other pretension than that of accuracy of dimensions, and can give few ideas to a stranger who has not seen the property, beside those of its contents and general outline.

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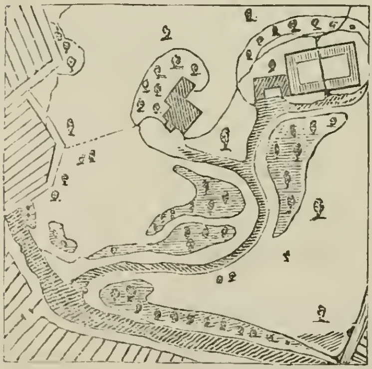

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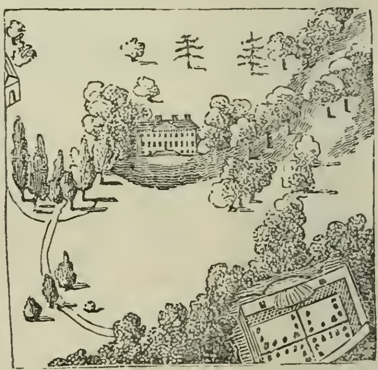

3352. In the second, *elevations of the objects* are added to these lines; but which, in crowded parts, tend much to obscure them. (*fig.* 527.) This mode is perhaps the best calculated of any to give common observers a general notion of an estate; more especially if ably executed. Very frequently, however, this mode is attempted by artists ignorant of the first principles of drawing, optics, or perspective, and without taste. The Germans who, in general, are far better topographical draughtsmen than any other people, excel in this manner, and contrive, by joining to it Lehman's mode of shading the surface, to produce pictorial plans of extraordinary accuracy and beauty. The most perfect artist in this style who has ever appeared in England is Mr. Hornor, whose work on the subject will be afterwards referred to. Were landed proprietors aware that their estates could be mapped in this manner almost as cheaply as by the ordinary mode, they would not rest satisfied with the meagre delineations generally made out.

3353. In the third, *a vertical profile*, or geometrical birdseye view, that is, a birdseye view in which all the objects are laid down to a scale, is presented. In this the upper surface of every object is seen exactly as it would appear to an eye considerably elevated above it, and looking centrally down on it. (*fig.* 528.) This mode, properly executed, is calculated to give a more accurate idea of the furniture or surface-objects of an estate than any other; and if the declivities be correctly indicated, and the shade of the hollows and eminences be laid on with reference to some medium elevation, referred to or illustrated by sections taken in the direction of indicated lines (*a b*), it will give an equally correct idea of the variations of the ground. In short, it is the best mode for most purposes, and is now coming into general use.

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3354. *A very complete method* of giving the plan of an estate, is to adopt the profile manner, and include such a portion of the plans of the adjoining estates or country, as shall be contained within a circle of moderate extent (*fig.* 529.), the centre of which may

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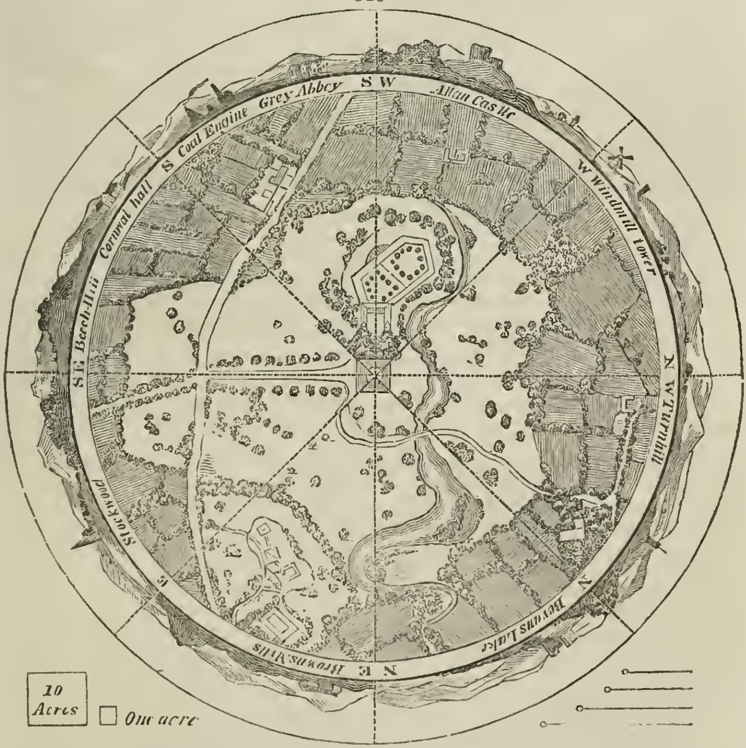

be the centre of the demesne lands, family mansion, or prospect tower. Around a map so formed, the distant scenery, as seen from the roof of the house, or prospect tower, may form a panoramic circumference, or margin of prospects (*fig.* 529.). In all these modes, dimensions and contents are given or obtainable along with effect; in all those which follow, effect or general appearance only is obtained.

3355. *The natural birdseye view* is intended to give a general idea of the external appearance of an estate. In this the eye of the spectator is supposed to be considerably elevated above the centre of the estate, and all the objects are portrayed exactly as they would appear to him in that situation; largest in the centre, and gradually diminishing to the circumference of the circle of vision. In such a delineation, parts of other adjoining estates may often require to be included, in order to complete the circle; but these are necessary to the general idea, and can easily be distinguished from the principal property by minute marks on the delineation.

3356. *In the panoramic view*, the delineator supposes himself placed on an eminence, as the roof of the mansion where central, and looking round on all that he sees on every side. Where there is a prominent hill, or where the mansion is on an eminence, this is a very desirable mode of giving a general idea of a demesne, and by the aid of horizontal lines, and lines converging to them from the centre of vision, some idea may be had, on flat surfaces at least, of the relative heights and distances of objects.

3357. A simple mode is to give *a general view, or distant prospect*, of the estate or its principal parts (*fig.* 530.), as seen from some elevated conspicuous hill, building, or object near it; or if the estate, as is frequently the case, is situated on the side of a hill, or range of hills, a position on the plain or flat grounds opposite to it will be sufficient.

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3358. *For the delineation of maps*, the most desirable material in point of durability is parchment; but where there is a chance of alterations being made on the estate, as in the lines of roads, fences, streams, &c., it is better to delineate on paper, as the corresponding alterations can be made on the map with greater ease. Such colours as are stains, and do not wash out, are proper for maps and plans on parchment; but where alterations may require to be made, or where shadow, or any thing like picturesque effect is to be attempted, water colours alone must be used. To delineate estates and plans of every kind in a beautiful and expressive manner, much depends on having the very best instruments and colours, and in knowing how to use them The sight of good models is also an important matter, and for this we may refer to Horner's elegant work, *The Art of delineating Estates*, 1813; and the very scientific work of Lehman, already mentioned.

3359. *In the writing or printing* on maps great want of taste is often displayed. No principle can be more obvious than that the name of a thing, or the ornaments of an object, should not be made more conspicuous than the thing or object itself. Yet this rule is constantly violated in plans of estates, by the large ornamental writing or print interspersed in and around them; conspicuous blazonry of the name of the estate and its owner at some corner, and of the compass and scale in others. All these adjuncts should be kept in due subordination to the main delineation.

3360. *Models* of very mountainous estates will be found preferable to any description of maps or views, for giving a correct idea of them. Such models might be formed in plaster of Paris, wax, or various other materials, and coloured after nature. We constructed such models in 1805 (See *Farm. Mag.* vol. vi. p. 126.); and Mr. Taylor of London has recently constructed them, both for the purpose of surface improvements and mineralogical examination. (See *Gard. Mag.* vol. v. p. 213.)

3361. *Reference books* are essential accompaniments to maps or models, and are of various kinds. Sometimes they merely contain the names and contents of the fields or other parts or divisions, with the state of culture or condition in which they are; in other cases the soil and subsoil are described; but in the most complete cases each farm is described, together with the history of its occupation or improvement under the following or similar heads: — Name, parish, extent, boundaries, when first enclosed, how let and managed hitherto, to whom and for how much let at present, description of the farmery and house, contents, fences, trees, ponds, soil, subsoil, surface, expense, &c. of each field; number of timber trees on the farm, copse woods, and various matters. In addition to such a description as the above, some add in the reference book a separate map of each farm, which renders the whole very comprehensive; and as nothing canbe more interesting than the contemplation of a man's own property on all sides, and in every possible bearing, these books are generally valued above all others by country gentlemen.

3362. *The valuations of farming stock, tillage, and leases,* being of temporary use, are made out with little form. In most cases, the value of particular articles is not given, but only an enumeration of them, and the sum total. The valuators have the separate values in their private memorandum books; and in cases where two valuators are employed, one on each side, if an umpire is obliged to be called in, in consequence of disagreement, then the parties have reference to their notes. In some cases of valuations by two parties, the umpire, being appointed beforehand, accompanies the valuators, hears their discussion on each article as it comes under review, and decides any difference that may occur as they go on. This is considered the best mode, and is that generally adopted in the case of valuations made by order of the Court of Chancery.

3363. *In making up valuations for purchasing or selling estates,* a report is generally required to accompany the valuation, stating the ground on which it is made. Such a report embraces a great variety of objects according to the nature and extent of the property, and ought to be drawn up in a clear and systematic manner, with such a table of contents and an index as may render it of easy reference.

3364. *In delineating buildings for agricultural purposes,* the ordinary plans, elevations, and sections, of architects and surveyors, should always be given, for the purpose of forming estimates and working plans. But for the purpose of enabling the proprietor, or other person not sufficiently acquainted with pictorial effect on paper, to form a due estimate from any drawing of the effect it will have when executed, we recommend models or isometrical views. The latter, in our opinion, ought to be in universal use among architects.

3365. " *Isometrical perspective* is a term given recently, by Professor Farish of Cambridge, to a projection

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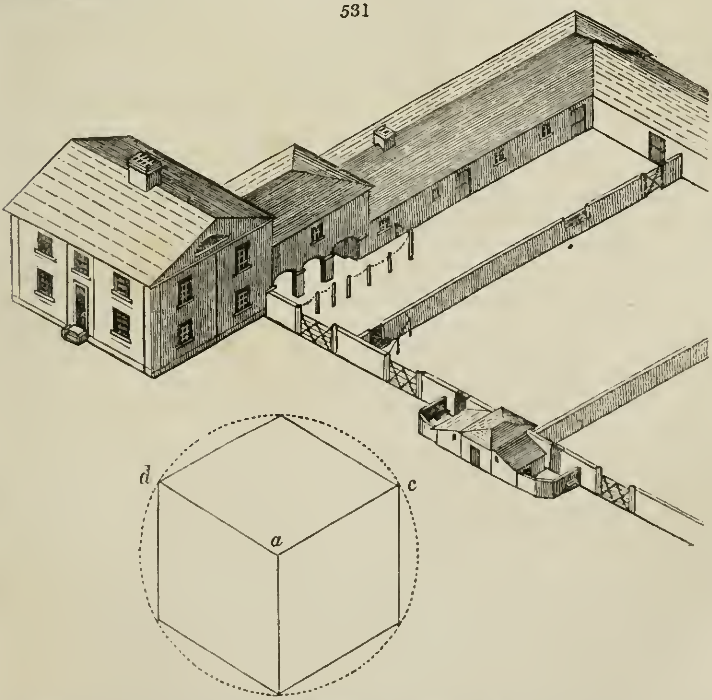


made in rays parallel to the diagonal of a cube upon a plane perpendicular thereto. This is a comprehensive and useful method of exhibiting the several parts of a homestead, and any person moderately acquainted with drawing, if they make the attempt, will find it extremely easy to perform; nothing more being required than to divide a circle into six equal parts, which may be done with the radius; and draw the hexagon and three radii, one radius to every other angle, to represent a cube (*fig.* 531.). All the vertical or plumb lines in any design are then to be drawn parallel to *a b*; all those in the direction, say north and south, parallel to *a c*; and all those at right angles, or perpendicular to the last, or in the direction east and west, parallel to *a d*: and the several heights, lengths, and breadths, being taken from a scale of equal parts, and set off, and lines drawn in these three directions, the projection is produced. The position of any point, or the direction of any other line, may be found, by finding where the first would fall upon any plane parallel to either of the three sides of the cube, and where the latter, if produced, would cross any lines in the three directions." (*Waistell's Designs, &c.* p. 91.) The elevation which this mode of drawing produces is highly explanatory and expressive (*fig.* 531.)

Sect. II. *Operations of Order and Management.*

3366. *The business of agriculture*, whether in the management of extensive estates or the culture of single farms, requires to be conducted in an orderly and systematic manner. For this purpose a certain establishment of operators, a certain style of books of accounts, and great attention in all commercial transactions, may be considered the fundamental requisites.

3367. *The establishment of co-operators and servants* must depend on the extent of the subject of management. An extensive landed estate, which, in addition to farming lands, contains woods, quarries, mills, mines, waters, manorial rights, game, and villages, will require a series of subordinate managers; but in general a steward as a head manager, a steward's clerk or assistant, and in some cases a local steward, are all the managers requisite; the subordinate care of quarries, woods, game, &c., being performed by a quarryman, forester, gamekeeper, or by common servants of tried fidelity.

3368. *The gradation of operators required on farms* depends on their size. Whenever the master does not labour himself, a foreman or operator having some charge is requisite; and in very extensive cases, where there is a considerable extent of grazing ground as well as tillage lands, a head ploughman and a head herdsman will be found advantageous. There should also be a confidential labourer, or *headman of all work*, to superintend and accompany women and children in their operations, as in hoeing, weeding, planting potatoes, &c. The grand point to be aimed at by the steward of an extensive estate, and the occupier of a large farm, is to hit on the proper number of submanagers; and to assign each his distinct province, so that the one may never interfere with the other. Having attained this, the next thing is to keep the whole machine in regular action; to keep every man, from the lowest operator to the highest, strictly to his duty. All operators ought to be adequately remunerated; and it is better in general to pay a liberal price and require vigilant, skilful, and active exertion, than to cheapen labour, and so encourage indolence and bad execution. For the lower class of labourers, especially such as are hired by the year, it will often be necessary to attend as well to the food they eat, as to their constancy at work. In the case of farm servants, for example, it will generally be found preferable to board and lodge single men, than to substitute a sum of money, which they will in many cases either save or spend otherwise than so as to strengthen their bodies. Where labour is done by the job, all that is requisite is to see that it is done well, and according to agreement; and this, as we have already observed, is the best mode wherever it can be adopted.

3369. *Orderly conduct in the lower classes of workmen* is a point to which we would wish particularly to direct the attention of the bailiff and farmer. Regularity in their hours; neatness and cleanness in their dress; punctuality in cleaning and putting away in the proper places their implements of labour or harness; humanity to working and other animals; decency in general deportment and conversation, and ambition to excel in their particular department. Neatness and order, whether on an estate, a farm, a stable, a dwelling-house, or in a man's dress and manner, form an index to every thing else. Estates and farms where these qualities prevail, are always well-managed and cultivated; a neat and clean stable is a sure sign of well-conditioned horses, and of economical feeding; a dwelling-house, with neatness around and within, is an index of comfort and peace; and a decently dressed and well behaved man or woman is sure to be approved in every station.

3370. *The necessity of order and neatness* we are most anxious to impress on the minds of all descriptions of masters and managers. Order, it has been well observed, is "Heaven's first law." It is, indeed, the end of all law: without it, nothing worth having is to be attained in life, even by the most fertile in resources; and with it, much may be accomplished with very slender means. A mind incapable of an orderly and regular disposition of its ideas or intentions will display a man confused and disorderly in his actions; he will begin them without a specific object in view; continue them at random, or from habit, without knowing well why, till some accident or discordant result puts an end to his present progress, unmans him for life, or awakens reflection. But a well-ordered mind considers, arranges, and systematises ideas before attempting to realise them; weighs well the end in view; considers the fitness of the means for attaining that end, and the best mode of employing these means. To every man who has the regulation and disposal of a number of servants, this mode of orderly arrangement is essentially necessary in order to reap the full effects of their labours; and to no man is it of more importance than to the agriculturist, whose cares are so various, and the success of whose operations, always connected with and dependent on living beings, depends so much on their being performed at the fitting moment.

3371. *Propriety* relates to what is fitting and suitable for particular circumstances; it is the natural result of an orderly mind, and may be said to include that part of order which directs the choice and adaptation of means to ends, and of ideas and objects to cases and situations. It belongs to order for a master to allow workmen proper periods for rest and refreshment; propriety dictates the time and duration of these periods; and prudence suggests the wisdom of departing as little as possible from established practices. Decorum is the refinement of propriety.

3372. *Neatness*, as opposed to slovenliness, is well understood; it consists in having every thing where it ought to be; and in attending to the decorum of finishing operations, and to minute things in general.

3373. *As maxims of order and neatness* which ought to be continually present to the minds both of masters and servants, we submit the following: —

3374. *Perform every operation in the proper season.* The natural, and therefore the best, indications for the operations of sowing and reaping, transplanting, &c. are given by the plants themselves, or by the progress of the season as indicated by other plants. There are artificial calendars, or remembrancers, the use of which is to remind the master of the leading crops and operations of culture and management throughout the years; but, even if such books were made as perfect as their nature admits of, still they are only calculated to aid the memory, not to supply the place of a watchful and vigilant eye, and habits of attention, observation, reflection, and decision. Unless a steward or farmer has these, either naturally, or partly from nature and partly from cultivation, in a considerable degree, he will be but little better than a common labourer, as to general management and culture.

3375. *Perform every operation in the best manner.* This is to be acquired in part by practice, and partly also by reflection.

3376. *Complete every part of an operation as you proceed.* This is an essential point in field operations; and though it cannot always be attended to, partly from the nature of the operation, partly from weather, &c., yet the judicious farmer or bailiff will keep it in view as much as possible.

3377. *Finish one job before you begin another.* This advice is trite, but it is of great importance; and there are few cases where it cannot be attended to.

3378. *In leaving off working at any job, leave your work and tools in an orderly manner.*

3379. *Attend strictly to the hours of commencing labour, and equally so to those of leaving off, unless extraordinary exertion is required.*

3380. *Whenever extraordinary exertions are required, extraordinary indulgences or rewards must be given as compensations.*

3381. *A regular system of accounts* is an obvious part of order and correctness; and it is equally obvious that the extent to which this must be carried will depend on the subject of management. In the case of extensive landed estates, the regular set of books usual in mercantile concerns becomes requisite, with the addition of some, as a forest-book, time-book, &c. rendered necessary by particular departments of the subject. On small farms, on the other hand, some memorandum-books, a cash-book, and a ledger, are all that will be found necessary. Our business here is to give the form of the time-book, which is or may be common to every department of agriculture and scale of management, though most necessary for bailiffs, where a number of day labourers are employed on improvements. In giving the practice of the different branches of agriculture, the books peculiar to each will be described. There is nothing, indeed, that should be more strenuously pressed upon the attention of farmers, than the importance of a good system of keeping their accounts, in which they are, generally speaking, very deficient.

3382. *The time-book* is a large folio volume, ruled so as to read across both pages, with columns titled as in the specimen annexed. In this the bailiff or master inserts the name of every hand; and the time in days, or proportions of a day, which each person under his care has been at work, and the particular work he or she has been engaged in. At the end of each week the bailiff or master sums up the time from the preceding Saturday or Monday, to the Friday or Saturday inclusive; the sum due or to be advanced to each man is put in one column, and when the man receives it he writes the word *received* in the column before it, and signs his name as a receipt in the succeeding column. The time-book, therefore, will show what every man has been engaged in during every hour in the year for which he has been paid, and it will also contain receipts for every sum, however trifling, which has been paid by the bailiff for rural labour. In short, it would be difficult to contrive a book more satisfactory for both master and servant than the time-book, as it prevents, as far as can well be done, the latter from deceiving either himself or his employer, and remains an authentic indisputable record of work done, and of vouchers for money paid during the whole period of the bailiff's services.

3383. *Time-Book.* 1824, Sept. 8th to 15th. Time, Expense, and Occupation of hired Servants and Labourers employed at Longlands, under the Steward A.D.

Names.	Time. Sept. 8, Sat.	9, Sun.	10, Mon.	11, Tues.	12, Wed.	13, Thur.	14, Fri.	15. Total.	Rate per Day. s. d.	Amount of Money. L. s. d.	Advances on Account, Jobs, &c. L. s. d.	Receipts and Signatures. L. s. d.	Daily Occupation. Saturday.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Remarks.
H. Todd	Foreman of the ploughmen, hired by the year.								0 0	0 0 0	1 5 0	Recd. 1 5 0 H. Todd.	Ploughing in Elms Vale.	At church, and reading, at home.	Carting oats and beans from Nos. 2 and 3.	Carting oats from 203.	In the fallow field No. 7.	In the fallow field No. 7.	In the fallow field No. 8.	There have been only two days of sunshine this week, when the thermometer was at 50 deg. and 52 deg.; the rest of the week cloudy and cold, the thermometer not above 48 deg. The fallows work well, and the clay burns with less fuel than usual. Crop now half got in. Hall, the lime-burner, has got one of Menteath's new lime kilns nearly completed. Cow Charlotte died on Thursday evening.
J. Moor	Ploughman hired by the year.												Superintending the women at turnip hoeing.	On a visit.	Carting turf.	In the rick yard.	Levelling in No. 7.	Carting lime.	Carting lime.	
J. Greig Ploughm. by day.	1	0	½	1	1	1	1	5½	3 0	0 16 6		Recd. 0 16 6 J. Greig.	Carting wheat from Peter's piece.	At church, and reading at home.	Carting wheat from Peter's piece.	At the grubber in fallow piece.	In the fallow field No. 7.	Carting burnt clay to No. 7.	Carting lime to No. 8.	
J. Reid, do.	1	0	1	1	1	1	1	6	2 6	0 15 0		Recd. 0 15 0 J. Red.	The same.	The same.	At dung cart.	At dung cart.	The same.	Carting lime.	Carting lime.	
R. Hill, do.	Labourer hired by the year.								0 0	0 0 0	1 6 6	Recd. 1 6 6 R. Hill.	Superintending the women at turnip hoeing.	On a visit.	Stooking wheat.	In the rick yard.	Levelling in No. 7.	In the garden.	Buried the cow Charlotte.	
Ann Hall	1	0	1	1	1	1	1	6	1 0	0 6 0		Recd. 0 6 0 A. Hall.	Attending the poultry, pigs, &c.	At church, in the evening.	Attending Charlotte, the new-calved cow.	Sifting in the barn.	Attending the cow Charlotte, and the pigs.	At the cow and the routine work of the yard.	Set a hen with nine eggs.	
Fox & Co.	Labourers by the job.										5 0 0	Recd. 5 0 0 Fox & Co.	At the new road at Bawdry.		At the new road at Bawdry.	At the new road at Bawdry.	At the new road at Bawdry.	At the new road at Bawdry.	At the new road at Bawdry.	
H. Smith	Labourer by the job.										1 0 0	Recd. 1 0 0 H. Smith.	Digging drains in fallow field No. 7.		Digging drains in fallow field No. 7.	Digging drains in fallow field, No. 7.	Digging drains in fallow field No. 7.	Digging drains in fallow field No. 7.	Digging drains in fallow field No. 7.	
	Amount									1 17 6	8 11 6	Total 10 9 0								

3384. *In commercial dealings* the agriculturist requires to be particularly vigilant, because the nature of his occupation and pursuits have not that tendency to sharpen his *bargaining* faculties which is given by a life of trade or manufacture. The purchase of an estate is so weighty a transaction, that few men trust to their own judgment as to value, and legal advice is always taken as to the validity of the title, &c.; but stewards, in dealing with timber merchants, workers of quarries, gravel dealers, brick-makers, and others, require to be ever on their guard. The farmer and bailiff require particular caution as to marketing, which is an important business, and not to be excelled in but after long experience in attending fairs and markets; learning the various devices of sellers to deceive the purchaser, or enhance the price of their goods; and of buyers to depreciate what is exposed to sale. To farmers who deal chiefly in live stock, marketing is by far the most difficult and important part of their business. There are salesmen or brokers, indeed, for transacting business in behalf of farmers, as there are agents for effecting transfers of landed property; but in neither case is it safe to trust entirely to their judgment and probity. Personal experience in this, as in every department of his art, is what ought to be aimed at by every agriculturist. Besides the professional advantages to the farmer of marketing for himself, the intercourse with society which this inevitably produces contributes to his general improvement as a man and a citizen.

SUPPLEMENT.

2789 *a* and 7790 *a*. *Threshing machines.* One of the most complete in England has been erected at the Duke of Gloucester's farmery at Bagshot Park; for the following description and drawings of which we are indebted to Mr. Anderson, an experienced agricultural engineer. This machine threshes the corn, hummels barley, winnows, sifts, and cleans corn, grinds it into flour, cuts the straw into chaff, and grinds bones for manure; and any one of these operations can be performed without the other. The different parts of this apparatus are chiefly taken from machines already in existence, but some also are original. It may be mentioned as a singular and melancholy sign of the times, that the parties who have the chief merit are afraid of giving their names to the public. The agriculturists of a future and, we trust, no distant day will hardly believe it possible that the destruction of threshing machines should have been popular in England in 1830. It is worthy of notice as an argument in favour of the diffusion of knowledge among the labouring classes, that, so far from threshing machines being destroyed in Scotland, they are so much in repute among the labourers of that country, that a farmer who is without one is obliged to pay higher wages to his servants. This fact is well authenticated by a correspondent in the *Examiner* newspaper of February 13. 1831. See the examination of Joseph Forster in No. 1. of *The Working Man's Companion*, and also in *Mech. Mag.* vol. xiv. p. 323.

The mechanical part of the machinery was executed and erected chiefly by Mr. George Miller, now residing near Bagshot. *Fig.* 1139. is partly a section, and partly a side view; *fig.* 1140. is partly a cross section, and partly an end view; and *fig.* 1141. is partly a vertical section, and partly a vertical profile. The same letters are applied to the same parts in all the figures.

Description of the machinery. (*figs.* 1139. 1140. 1141.) *a* is an overshot water wheel 15 feet diameter, which makes from six to eight revolutions per minute according to the supply of water; on the arms of the water wheel is fixed a bevel wheel *b* of 128 cogs (seven feet four inches diameter), working into the pinion *c* of 26 cogs (twenty inches diameter), on the upright shaft *d*: these wheels are below the ground floor, and entirely hid from the view.

On the shaft *d* are two driving wheels *g* and *f*: *g* is a spur wheel of 119 cogs (six feet two inches diameter), driving the pinion *e* of 22 cogs (14 inches diameter) on the shaft *h*, which leads to the floor above, and turns the upper millstone; *f* is a mitre wheel of 40 cogs (two feet diameter), working into two wheels *i* and *k* of the same dimensions.

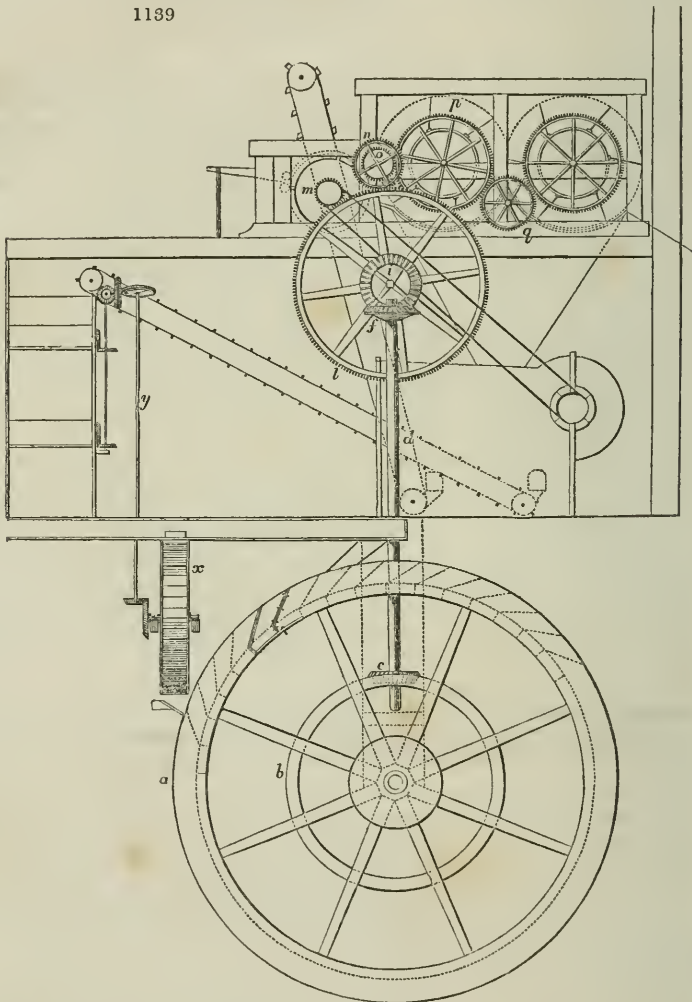
On the same shaft as the mitre wheel *i* is a spur wheel *l* of 200 cogs (six feet eight inches diameter) working into the threshing machine drum pinion *m* of 20 cogs (eleven inches diameter); the spur wheel *l* also drives a wheel *n* of 39 cogs (22 inches diameter), on the same axis of which is a small wheel *o* of 26 cogs (ten inches diameter), working into the wheel *p* of 121 cogs (three feet four inches diameter), on the axis of the first rake or shaker: the wheel *p* gives motion to the intermediate wheel *q* of 72 cogs (two feet diameter), which works into the second shaker wheel of the same dimensions as the first shaker wheel *p*.

On the spindle on which the wheel *n* is mounted is a small shifting pinion *r* of 17 cogs (seven inches diameter), working into the faced wheel *s*, on which are two rows of cogs, one of 20 and the other of 30 cogs each. On the same axis as the faced wheel *s* is a bevel wheel *t* of 20 cogs (eight inches diameter), working into the wheels *u* and *v* of 40 cogs (sixteen inches diameter), on the lower feeding roller spindle; these two wheels are not fixed on the spindle, but revolve freely on turned parts of the shaft, and give motion to it by means of the clutch and handle *w*. When the machine is at work the clutch is in the wheel *v*, giving to the feeding rollers the required motion; should it be necessary to stop the rollers, the handle *w* is moved from the feeding board, and the clutch disengaged from the wheel *v*. Should the handle be moved farther from the feeding board, the clutch is thrown into the wheel *u*, and the rollers turn the reverse way.

The winnowing machine under the shakers is driven by a sheave on the drum axis, and a rope leading to a sheave on the fanner spindle; to dress the grain thoroughly, it is conveyed from this machine, and passes through two winnowing machines, one placed above the other: this is effected by means of a canvass cloth on which are strips of wood half an inch in thickness; the cloth revolves on two rollers, and is set in motion by a rope leading from a sheave on the shaft *i* to a sheave on the upper roller spindle.

As it is absolutely necessary to have a steady and uniform motion to produce the best possible sample from a winnowing machine, and as the velocity of the threshing machine is subject to vary, from irregular feeding and other causes, the winnowing or dressing machines are set in motion by a small water-wheel *x*, five feet diameter, on the axis of

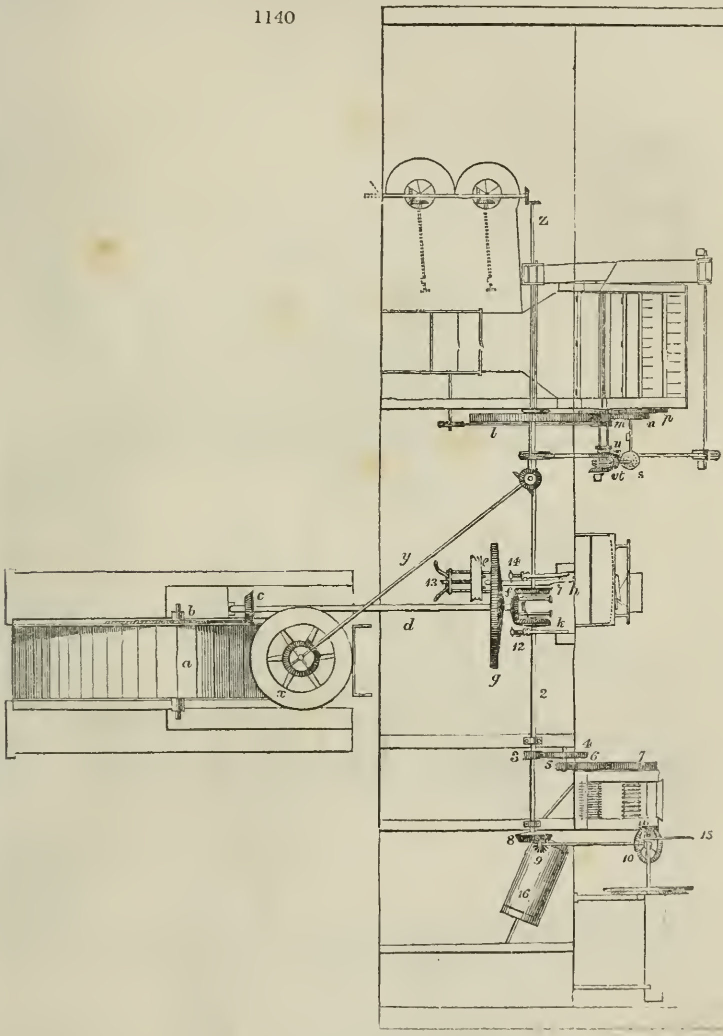
1139



which is a bevel wheel twenty inches in diameter, working into a pinion on an inclined shaft *y*. On the upper end of the shaft *y* is a bevel wheel working into a pinion, on the axis of which is another bevel wheel giving motion to the shaft *z*, which turns the fanners by means of small mitre wheels.

The bone-mill and chaff-cutting machine are driven by the mitre wheels *f* and *k*. On the shaft 2 is a shifting pinion 3 of sixteen cogs (ten inches diameter), working into the wheel 4 of 49 cogs (two feet four inches diameter), on the axis of which is a pinion 5 of 16 cogs (ten inches diameter), driving the wheel 6 of 49 cogs (two feet four inches diameter), in the axis of one of the lower crushers: the upper pair of crushers are driven by the wheel 6 working into a wheel 7 in the upper crush or spindle. The crushing rollers are set to or from each other as the nature of the work may require. When the bones are large, the upper pair of crushers only are used in passing the bones the first time through, an inclined board being placed to prevent them from falling into the lower set; this board is removed at the second time of grinding, and the bones pass through the two sets and fall into the revolving circular screen 16: any bones that wlli not pass through the mash of the screen are again put into the mill. The screen is set in motion by the wheel 6 working into a pinion, not shown in the drawing, and by a shaft and universal joint connecting with the axis of the screen.

1140



On the shaft 2 is a bevel wheel 8 of 46 cogs (21 inches diameter), driving the pinion 9 of 19 cogs (nine inches diameter), on an inclined shaft leading to the floor above; on the upper end of this shaft is a bevel wheel 10 of 52 cogs (twenty inches diameter), driving a pinion 11 of 17 cogs (nine inches diameter,) on the spindle of the chaff-cutting machine.

When the threshing machine only is at work, the mitre wheel *k* is thrown out of geer by the lifting screw 12; the pinion on the flour mill spindle is raised above the spur wheel *g* by the screw 13.

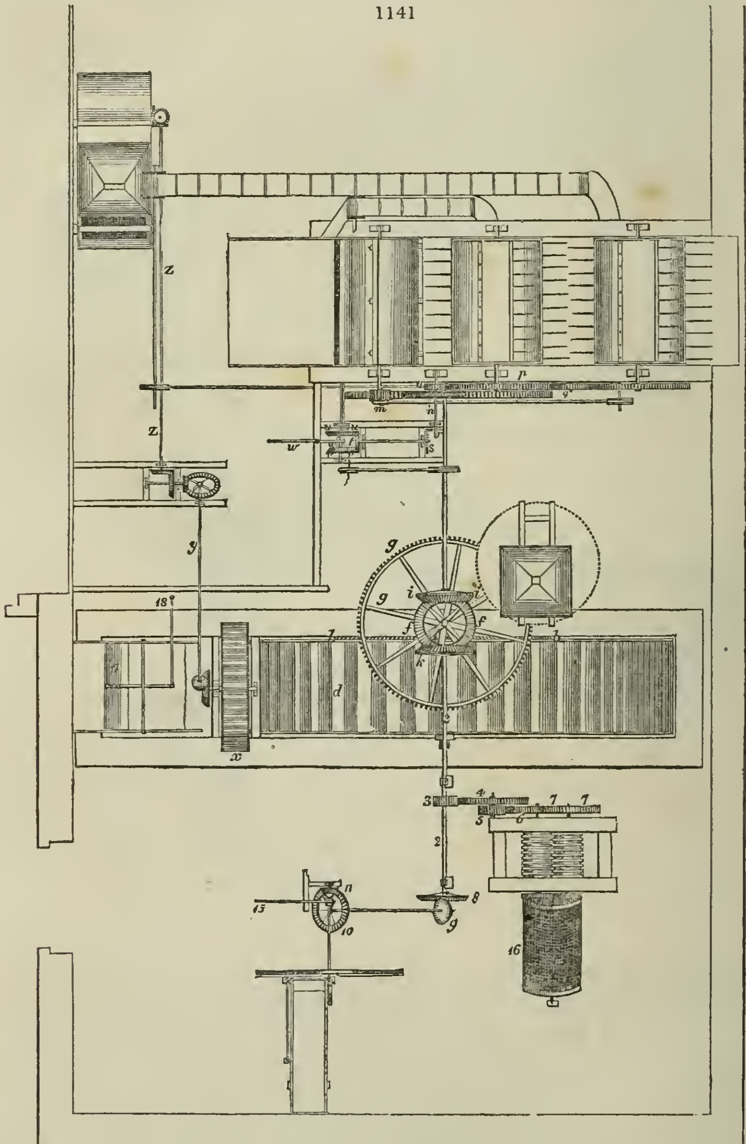
When the threshing machine is not at work, the mitre wheel *i* is thrown out of geer by the lifting screw 14.

The pinion 3 is kept in its place on the shaft 2 by a key; when the bone-mill is not at work, the pinion is slided along the shaft clear of the wheel 4.

There are three cogs dovetailed into the pinion 9; when the chaff-cutting machine is not at work these cogs are removed, and the vacant part turned towards the bevel wheel 8; the person attending the chaff-machine can also stop it by the clutch and handle 15.

To stop the water wheel the ring and lever 18 is raised by means of a chain leading over a pully at the upper part of the building; this raises the sluice board 17, and allows the water to escape clear of the wheel. The water which drives the small wheel *x* is also conveyed by a dash-board under it on to the large water wheel; as this water falls above the centre of the large wheel, the loss of power sustained is not great.

1141



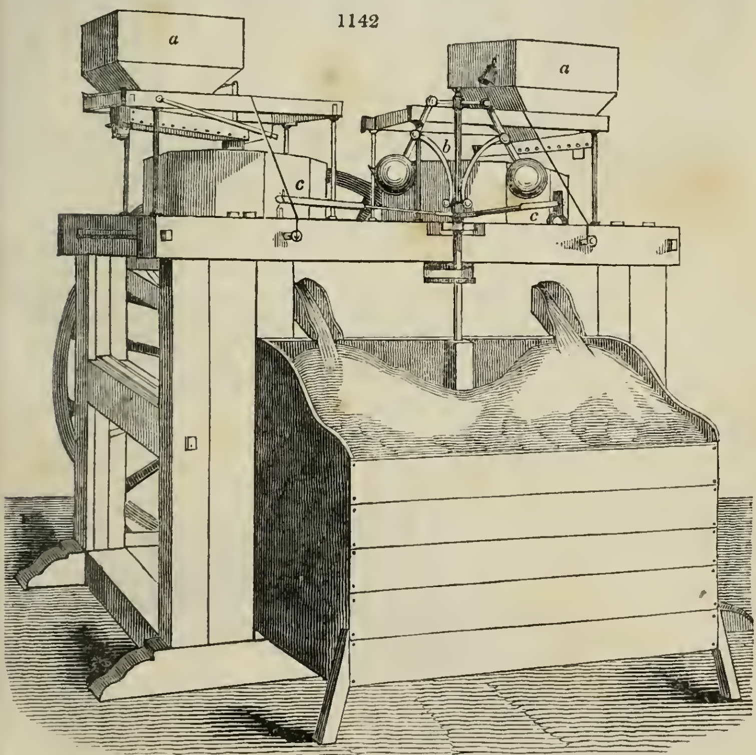
The velocity of the particular parts is found by dividing the product of the number of cogs in the driving wheels by the product of the number of cogs in the driven wheels, and the quotient will be the number of revolutions made by the last moved part, for one of the first moving part. The drum will, therefore, make 49·2 revolutions for one of the water wheel; which, multiplied by 7, the medium revolutions of the water wheel per minute, will give 344·4 revolutions of the drum per minute; as the diameter of the drum is three feet, the circumference will be 9·42 feet, which, multiplied by 344·4, will give 3244 feet, the velocity of the beaters or switchers on the drum per minute. By following the same rule

The shakers will be found to make	5·42	revolutions for one of the water-wheel.
The feeding rollers, quick motion	10·7	
slow motion	7·1	
The upper stone of the flour mill	26·6	
The chaff-cutting machine	36·4	
The bone mill	·52	

The operative part of erecting the machine was done by a Mr. George Millar, now residing near Bagshot.

2551 *a*. *A flour mill for a parish workhouse*, upon a new and improved principle, (*figs*. 1142. and 1143.) has lately been erected at the Islington parish workhouse, by

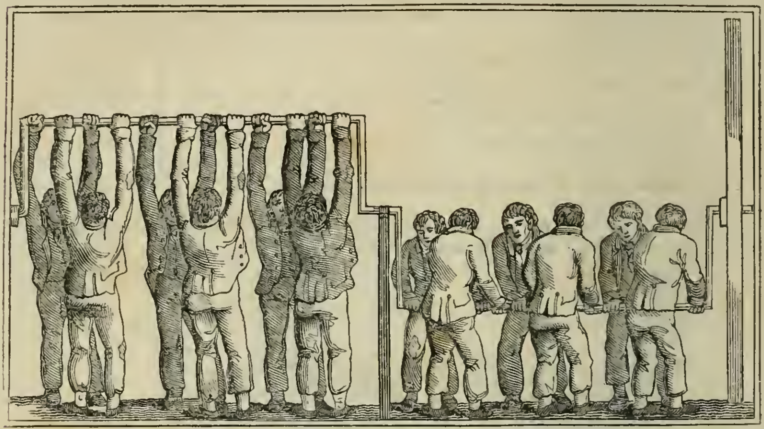
1142



Weir, Oxford street; and as it is admirably calculated for the purpose in view, and may be adopted in many similar cases, we have deemed it well worth a place in this Supplement. It consists of two pairs of stones; one pair of which can be worked separately by six men, or both together by twelve men. The moving power is a crank (*fig*. 1143.), on the spindle of which is a large fly wheel; and beyond which is a pinion, working into a spur wheel on an upright shaft: this last wheel works into the pinions on the spindles that set the stones in motion. Either of the pinions is of course easily thrown out of gear by a lever.

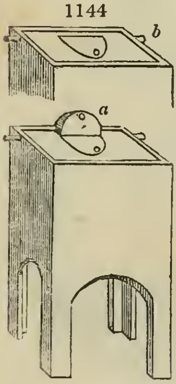
There is a hopper (*a*, *a*) to each pair of stones, and one governor (*b*) which, by means of steel yard bars (*c*, *c*) reaching to each pair of stones, regulates their motion. Each pair of stones grinds a bushel and a half of wheat an hour, and the work is performed in as perfect a manner as by any water mill whatever. There is a bolting machine, (see 2552.) worked by a crank and fly wheel, and set in motion by four men. The expense of a flour mill of the above description depends chiefly upon the size of the burr stones; these when large being very expensive. The improvements in this machine are the invention of Mr. Malpas, the foreman at Weir's establishment, a very intelligent mechanic, and the author of various improvements on the implements and machinery manufactured there, which do him the highest credit.

1143



3088 *a*. *A fall-down gate-stop* (*fig.* 1144.) has lately been invented, which deserves adoption wherever double gates are fastened in the middle by a bolt, attached to the lower bar, and entering a hole in a stone or other body fixed in the road. This gate-stopper is formed of cast iron, and is sunk in the ground till its upper surface is level with the road, its lower end being placed on a stone to prevent its sinking too deep. The gate stop has an ear (*a*) which is raised up when the gate is shut, so as to form a stopper and a hole for the bolt; and it is put down (*b*) when the gate is open, so as not to present an obstruction to the feet of horses. Sold by Messrs. Cottam and Hallen.

1144



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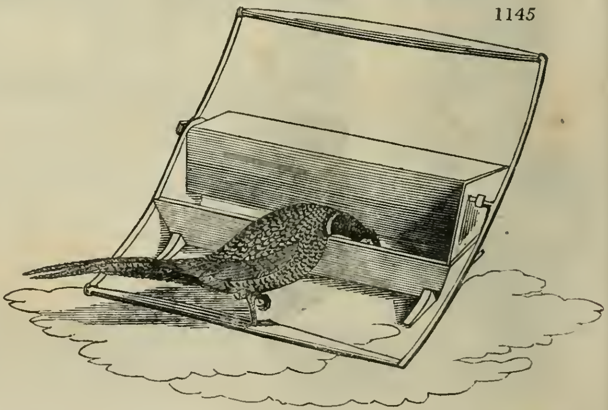

7548 *a*. *The pheasant-feeder*. (*fig.* 1145.) This ingenious invention is manufactured of iron by Messrs. Cottam and Hallen, and seems the best utensil of the kind that we have seen. There is one of tin, lighter and cheaper (see *Gard. Mag.* vol. v. p. 589.), sold by Messrs. Bailey, 272. High Holborn, and by Weir in Oxford street, but it is by no means so durable.

THE END.

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FIRST ADDITIONAL

SUPPLEMENT

TO

LOUDON'S ENCYCLOPÆDIA OF AGRICULTURE;

BEING

NOTICES OF ALL THE PRINCIPAL IMPROVEMENTS

WHICH HAVE TAKEN PLACE IN AGRICULTURE IN BRITAIN,

WITH HISTORICAL NOTICES OF ITS PROGRESS IN OTHER COUNTRIES SINCE THE PUBLICATION OF THE SECOND EDITION OF THE ENCYCLOPÆDIA OF AGRICULTURE, IN JANUARY, 1831.

BY J. C. LOUDON, F.L., H., G., AND Z.S., ETC.

AUTHOR OF THE ENCYCLOPÆDIA OF COTTAGE, FARM, AND VILLA ARCHITECTURE, ETC.; AND CONDUCTOR OF THE GARDENER'S MAGAZINE, THE ARCHITECTURAL MAGAZINE, AND THE MAGAZINE OF NATURAL HISTORY.

THIS Supplement is published in conformity with the intention expressed in the Preface to the second edition of the *Encyclopædia of Agriculture*, p. v. The additions, corrections, or variations, are given in paragraphs, each preceded by two numbers. The first of these numbers is a continuation of the series given in the second edition (which terminates with 7980.), for the sake of reference; and the second number is that of the paragraph, in the second edition of the Encyclopædia, to which the correction, addition, or variation refers; to which paragraph, in future impressions, a star will be affixed, in conformity to the plan laid down in p. v., above referred to.

In the compilation of this Supplement we have been guided by the same principles which influenced us in the composition of the original work; namely, that of laying before the reader a great variety of opinions and practices, and leaving him either to generalise on them for himself, or to particularise them, and to adopt such of them as may appear to him most suitable to his individual case. If we had adopted a different mode of proceeding; viz., that of generalising the opinion and practices of others, and giving the result as our own, our work must necessarily have exhibited our own opinion only; whereas, the former mode exhibits all the most valuable opinions and practices, on every subject that it treats of, which have hitherto been published, more particularly in Britain. The young reader is thus induced to think for himself, and to refer his opinions and practices to fundamental principles; while the experienced practitioner may adopt the opinions and practices of those authors in whom he has most faith.

A little reflection will, we think, convince every unprejudiced mind that this method of compilation is calculated to be the most useful in all general works on the practical arts; and, that it is more especially so in the arts of agriculture and gardening will be at once allowed, when it is considered how much the practice of these arts must vary with variations of climate, soil, and other geographical circumstances. How, for example, on any other plan than that which we have adopted, could we have treated on the culture and management of plants and animals, so as to have rendered our Treatise alike suitable for England and Scotland: or how else could we so easily have enabled the reader, who inhabits neither England nor Scotland, to deduce from the practices of those two countries a practice suitable to his own country; say, for example, North America? All knowledge, to be truly useful, must be gained by experience; and the next best thing to gaining experience from personal practice, is to observe and reflect on the practices of others. Our great object throughout, both in the Encyclopædia and in this Supplement, has been to instruct—not to lead.

J. C. L.

Bayswater, Sept. 14. 1834.

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A Dissertation on Soils and Manures, 8086. Lond. 1816. 8vo.

An. de Chim. et de Phys., 8059. Annales de Chimie et de Physique. A French periodical, published in Paris, and continued monthly. 8vo.

Annales des Sciences Naturelles. 8454. Par MM. Audouin, Ad. Brongniart, et Dumas.

Arch. Mag., 8347. The Architectural Magazine, &c. Conducted by J. C. Loudon, F. L. S. &c. Published monthly. London, 1834. 8vo.

Architectural Encyclopædia, 8157. See Encyclopædia of Cottage, Farm, and Villa Architecture.

Beaujour's Sketch of the United States, 8052. Translated from the French, by William Walton, Jun. London, 1814. 8vo.

Blunt's Italy, 7983. Vestiges of Ancient Manners in Italy. By J. J. Blunt. Lond. 8vo.

Brooke's Travels in Spain and Morocco, 8049. Sketches in Spain and Morocco, &c. By Sir A. de C. Brooke. Lond. 1831. 2 vols. 8vo.

Brooke's Travels in Sweden, 8031. A Winter in Lapland and Sweden. By Sir Arthur de Capell Brooke. Lond. 4to.

Brown's Supp. Prim. Flor. New Holland, 8039. Lond. 1830. 8vo.

Bulletin de la Société pour l'Instruction Elémentaire, 7988. Published monthly in Paris. 8vo.

Cadell's Travels, 8024. Cadell's Journey in Carniola and Italy. Lond. 2 vols. 8vo.

Cape of Good Hope Lit. Gaz., 8047. Published monthly at Cape Town.

Clairville, 8460. Entomologie Helvétique. 1 vol. Zurich, 1798. 8vo.

Com. Board Agr., 8028. See Commun. to Board of Agriculture, p. ix.

Conversations on Vegetable Physiology, 8056. By Mrs. Marcet. Lond. 1830. 2 vols. 8vo.

Country Times, 8390. See Country Times, p. x.

Dec., 8064. Prodromus Systematis Naturalis Regni Vegetabilis, Parts 1. and 2. Paris, 1824, 1825. 8vo.

Dec. Syst., 8058. Regni Vegetabilis Systema Naturale. By Professor Decandolle. Paris, 1818—1821. 2 vols. 8vo.

Decandolle's Physiologie Végétale, 8056. Physiologie Végétale, ou Exposition des Forces et des Fonctions vitales de Végétaux, &c. By M. Aug. Pr. Decandolle. Paris, 1832. 3 vols. 8vo.

Dom. Econ. in Lardner's Cyclopædia, 8391. The Cabinet Cyclopædia, &c. Conducted by Dr. Lardner: vol. on Domestic Economy. Lond. 12mo. 1833.

Dr. Lang's Historical and Statistical Account of New South Wales, 8036. Historical and Statistical Account of New South Wales. By Dr. Lang. Lond. 1834. 2 vols. 12mo.

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Elements of Practical Agriculture, 8104. By Professor Low. Edin. 1834. 8vo.

Emigration to British America, 8054. By John M'Gregor, Esq. Lond. 1831. 2 vols. 8vo.

Encyclopædia of Cottage, Farm, and Villa Architecture, 8321. By J. C. Loudon. Lond. 1833. thick 8vo.

Entom. Jour., 8460. The Entomological Magazine, &c. Published quarterly. Lond. 8vo.

Farm. Jour., 8599. See Farmer's Journal, p. xi.

For. Quart. Rev., 7988. Foreign Quarterly Review. Lond., Paris, and Strasburg. In quarterly Nos. 8vo.

Fraser's Persia, Edin. Cab. Lib., vol. xv. 8034. An Historical and Descriptive Account of Persia from the earliest Ages to the present Time. By James B. Fraser, Esq., forming vol. xv. of the Edinburgh Cabinet Library. Edinb. 1834. 12mo.

Graham's Mountains near Rome, 7986. Three Months' Residence in the Mountains near Rome. By Maria Graham. Lond. 8vo.

Granville's Russia, 8326. Travels to St. Petersburgh, &c. By Dr. Granville. Lond. 1828. 2 vols. 8vo.

Grev., 8064. The Scottish Cryptogamic Flora. By Robert Kaye Greville. Edin. 4 vols. 8vo.

Hayward's Inquiry into the Causes of the Fruitfulness of Plants and Trees, 8194. Inquiry, &c. arranged as a Dialogue. By J. Hayward. Lond. 1834. 12mo.

Highland Soc. Trans., 8002. See Highland Society's Transactions, p. xii.

Hist. and Statist. Account, &c., 8039. See Dr. Lang's, &c.

Hobart Town Courier, 8452. A Newspaper published at Hobart Town, Van Diemen's Land.

Introduction to Botany, 8156. By Dr. Lindley. Lond. 1832. royal 8vo.

Jameson's Journ., 7985. See Jameson's Phil. Jour.
Jameson's Phil. Jour., 8340. The New Philosophical Journal, &c. Conducted by Professor Jameson. Published quarterly. Edinburgh, 8vo.
Jour. R. Institut., 8056. Journal of Science and the Arts. Edited by W. T. Brande, &c. Lond. 1816. 8vo. Continued annually.
Journal of a Voyage from Calcutta to Van Diemen's Land, 8046. By Mrs. Prinsepp.
L., 8064. Systema Naturæ. By C. Linnæus. Gmelin's edition. Leipzig, 1788—1793. 9 vols. 8vo.
L'Agriculteur-Manufacturier, 8443. A French Periodical, published monthly. United, in January, 1834, with three others under the Title of Recueil de la Société Polytechnique. Conducted by J. G. V. De Moléon. Paris, 8vo.
L'Agronome, 7989. A French Agricultural Periodical, published monthly. Paris. Begun 1833. imp. 8vo.
L'Institut, 8057. A French Periodical published in Paris. Begun 1833.
Ladies' Botany, 8056. By Dr. Lindley. Lond. 1834. royal 8vo.
Lindley's Outlines of Horticulture, 8194. An Outline of the First Principles of Horticulture. By Dr. Lindley, Professor of Botany in the University of London, and Assistant Secretary to the Hort. Soc. of London. Lond. 1832. 12mo.
Main's Illustrations of Vegetable Physiology, 8056. Illustrations of Vegetable Physiology, &c., practically applied to the Garden, the Field, and the Forest; consisting of original Observations collected during an Experience of Fifty Years. By J. Main, A.L.S. Lond. 1833. small 8vo.
Manuel du Fontanier-Sondeur, 8340. Par M. Garnier. Paris, 1829. pamph.
Mémoires de la Société de Physique et d'Histoire Naturelle de Génève, 8070. Published periodically at Geneva. 8vo.
Moléon's Recueil Industriel, 8393. See Recueil Industriel, p. xv. United, in January, 1834, with three others, under the title of Recueil de la Société Polytechnique, &c. Paris, 8vo.
Leeds Mercury, 8395. A weekly Newspaper, published at Leeds.
National Education as it exists in Prussia, 7981. Report on the State of Public Instruction in Prussia, &c. By M. Victor Cousin, Peer of France, &c. Translated by Sarah Austin. Lond. 1834. 12mo.
On the Importance of the Decomposition of common Salt for the Purposes of Manure: whereby an Acre of Land is prepared for the Reception of any Crop, at a cost of 10*s*. only, 8085. An Address to the Owners and Occupiers of Land in Great Britain and Ireland, on the important Discovery, &c. By Henry Kemp. Lond. 1834. pamph. 8vo.
Pers., 8064. Icones pictæ Speciorum rariorum Fungorum. By C. H. Persoon. Paris and Strasburg, 1803. 4to.
Phil. Mag., 8460. See Philos. Mag., p. xv.
Practical Directions for the Cultivation and general Management of Cottage Gardens, &c., 8156. By Charles Lawrence, Cirencester. 1831. 8vo.
Present State of the Tenancy of Land in the Highlands and Grazing Districts of Great Britain, 8410. The present State of the Tenancy of Land, &c., collected from a Survey made in 1828 and 1829 by the authors, L. Kennedy and T. B. Grainger. Lond. 1829. royal 8vo.
Report of Drummond's Agricultural Exhibition, 8334. See Report of the Exhibition, &c.
Report of the Exhibition of Agricultural Productions, 8322. Report of the Agricultural Exhibition at Stirling, on the Premises of W. Drummond and Sons. Stirling, 1833. pamph. 8vo.
Report of the Stewartry of Kirkcudbright Agricultural Society, 8113. See The Stewartry, &c.
Scotsman, 8348. See Scotsman, p. xvi.
Sinclair's Hortus Gramineus Woburnensis, 8405. See H. G. Wob., p. xii.
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Stephens's Practical Irrigator and Drainer, 2d edit., 8337. The Practical Irrigator and Drainer. By Geo. Stephens, Land-drainer, &c. A new Edition. Edin. 1834. royal 8vo.
Sturt's Expedition into the Interior of Australia, 8038. Lond. 1834. 8vo.
The Printing Machine, 8057. A weekly Review, published in London. Small fol. Begun 1834.
The Stewartry of Kirkcudbright Agricultural Report of 1810, 8113. The yearly Report of the Kirkcudbright Agricultural Society.
The Times, 8461. A London daily Newspaper.
Thomson's Chemistry, 8082. A System of Chemistry. By Dr. Thomas Thomson. Edin. 1830. 4 vols. 8vo.
Trans. Agr. Soc. of India, 8035. Transactions of the Agricultural and Horticultural Society of India. Vol. I. Serampore, 1829; Vol. II. Calcutta, 1832. 8vo.
Treatise on Road-making, 8195. A Treatise on Roads; wherein the Principles on which Roads should be made are explained and illustrated. By Sir Henry Parnell, Bart. Lond. 1833. 8vo.
Treatise on Roads, wherein the Principles on which Roads should be made are explained and illustrated, &c., 8196. See Treatise on Road-making.
Quart. Journ. of Agr., 7997. See Quarterly Journal of Agric., p. xv.
Williams's Travels, &c., 8023. Williams's Travels in Italy and Greece. Lond. 2 vols. 8vo.

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To these, and to any other contributors whose names may have been inadvertently omitted, we return our best thanks; and we invite them and all our readers to send us whatever farther corrections and additions may occur to them. These will be used in a Second Additional Supplement.

FIRST
ADDITIONAL SUPPLEMENT.

PART I.

HISTORY OF AGRICULTURE.

7981. — 1. *The period which has elapsed since the historical part of the Encyclopædia of Agriculture was written*, may be described as one of general peace throughout the world. In the past history of the useful arts, it has always been observed that after nations have been for some years engaged in war, when peace arrives, their energies are directed to the useful arts with redoubled force. Accordingly, we find that in Europe those nations who were longest and most ardently engaged in arms, France and England, are now the most earnestly employed in domestic improvement. At present the attention of all ranks in France is directed to the advancement of agriculture and commerce; and this may be said, in a greater or less degree, of all the other nations on the Continent. The result is rendered evident to travellers by the improved appearance of the country, and by the numerous new buildings in the towns and cities; and to those who pay any attention to foreign politics, by legislative enactments, and by the establishment of agricultural, commercial, and statistical societies. Perhaps the most extraordinary improvement which has taken place on the Continent since the peace of 1815, is the establishment of a national system of education in Prussia in 1819; and, next to this, the attempt at the establishment of a similar system in France. (See Mrs. Austin's translation of Cousin's *National Education as it exists in Prussia.*) According to this system, all the inhabitants of both countries, without exception, would be not only taught all the most useful branches of knowledge, moral, intellectual, and physical, but even initiated into the practice of gardening and agriculture, in school gardens and fields; the boys into the practice of carpentry in school workshops, and the girls into the more useful branches of housewifery. Systems of national education, more or less perfect, have for upwards of thirty years been established in Wirtemberg, Baden, Bavaria, and Austria; but that of Prussia seems by far the most comprehensive, and equally likely to improve agriculture with the system of Bavaria, according to which system also agriculture is taught at the schools. In countries like Bavaria and France, where the farms are small, and the great mass of the population labouring cultivators, the education of all must be of greater importance, in an agricultural point of view, than in countries where farms are large; and where, if the farmer himself is enlightened in his arts, the ignorance of his labourers is of less consequence, since they act under his direction. Hence, with reference to national wealth, a national system of education would be of much greater consequence to Ireland, or any other country possessing but little capital, than it could be to England, or any other country abounding in capital. There are, however, other objects than the immediate acquirement of wealth, to be attended to by the legislator; and, taking the most comprehensive view of these objects, there appears to be no measure equal in importance to that of educating all classes, without exception.

7982. *The historical part of the Encyclopædia of Agriculture* was prepared in the beginning of the year 1829, and it cannot, therefore, be expected that we should have much to add in the way of bringing down the history of each particular country from that period to the present time. The details would be of too minute and temporary a nature to be considered as history; and they would occupy far too much space for this department of our Supplement. We have confined ourselves, therefore, to giving corrections or elucidations of former statements, whether these referred to remote periods of the agriculture of a country, or to descriptions of its present state. Among the latter, the most useful will be found the account of the Dutch dairy husbandry, from § 8001. to § 8019.

Italy.

7983. — 288. *The olive*, we are informed by Manetti, is most expeditiously propagated by cuttings, by seedlings, and by grafting. By cuttings is the most valuable mode when the soil is good, as the plants come soonest into a bearing state. Where the soil is poor, and especially if it be rocky, seedlings are to be preferred, because they send down their tap-roots into the crevices of rocks, and thus derive nourishment and support, where plants raised from cuttings would not live. In Tuscany, the olive is very generally raised from seed, and in many situations it is grafted. In Lombardy, on the Larian Hills, trees raised from cuttings are always used, and this is the reason Manetti alleges why these trees have their trunks perpendicular to the sides of the hill, instead of perpendicular to the horizon. Some interesting discussion on this very singular appearance will be found in *Gard. Mag.*, vol. viii. p. 68. to 70.

7984. — 290. *The foliage of the vines* supplies green food for cattle. Persons mount into the trees and gather the leaves into bags, exposing, at the same time, the ripening clusters to the sun. (*Blunt's Italy*, p. 212.)

7985. — 299. *The cause of malaria*, in this and other pestilential districts of Italy, has generally been supposed to be the decomposition of vegetable matter on a moist surface. This, however, is to confound the malaria with the marsh fever. The former is now thought to proceed from a very different cause, and to be analogous to what in England is called the hay fever. It is found that, while the corn or hay crop is in a growing state in the pestilential districts, they are as healthy as any part of Italy; but that the moment the crop is cut down, or withers on the ground, the malaria commences, and continues through the autumn and winter, till vegetation becomes vigorous in the following spring. The neighbourhood of Rome, where malaria is so prevalent, " is very hilly, dry, and entirely without vegetation. For days together, one sees nothing but desolate dried-up cornfields without trees, bushes, or wood of any description. In early times, Rome was surrounded by extensive sacred woods, which were not suffered to be destroyed. At that period malaria was unknown, though intermitting fevers were well known in the Pontine marshes. The avarice of the popes, however, converted these sacred woods into gold, and so desolated the region that not a tree or wood is to be met with around Rome. With the commencement of this system of extirpation the malaria appeared, and has at length reached such a height that, yearly, many are carried gradually off by it; and in the summer months strangers and respectable inhabitants quit Rome. When we take into consideration all the phenomena of marshy districts, the conclusion does not lie far distant, that the atmosphere is in different degrees rendered unfit for human organisation, not by the passage of the water to the air, but by the decomposition and solution of vegetable substances; and that thus those various intermitting fevers, and even the plague itself, are produced. In the case of real malaria, in opposition to marsh fevers, the circumstances are different. So long as the earth is covered with living vegetables, as, for example, with corn, the air of the most suspected district is pure and healthy, and no one fears being attacked by the disease; but when the prodigious crops, which in those volcanic, loose-soiled districts are speedily brought to maturity, are removed, does the surface of the earth become dead at the warmest and most energetic period of its functions? or does not rather a portion of those substances, which were consumed by the leaves and roots of plants, now go to the atmosphere, and render it unfavourable for the breathing of man, until all is again restored to an equilibrium in higher or more distant regions? That carbonaceous matter is beneficial to the vegetable kingdom, is as well known as that it is prejudicial to the breathing process in animals. No educated person in Germany doubts the organic function of the earth, to which also the cholera itself has been ascribed; and when a more general regard to nature advances to the south, the sacred woods will again gradually surround Rome, large vine branches entwine themselves round the elms, the hills be thus again covered, and the malaria reduced within limits. The fact is not without interest, that all real malaria districts are of volcanic formation, and that they are often to be found at the boundary of volcanic and non-volcanic rocks." (*Jameson's Journ.*, vol. xvii. p. 167.) In several districts in England, the country people are liable to attacks of fever immediately after the removal of the hay crop, some individuals much more so than others. This may be considered as a species of malaria of a comparatively mild description.

7986. — 301. *Lupines* are here (Vale of Poli) chiefly sown for the sake of manuring the land. When they are full grown, they are ploughed into the earth and left to rot. On some occasions they are boiled, and laid to the roots of orange and lemon trees, and even to those of olives and vines. (*Graham's Mountains near Rome*, p. 46.)

7987. — 302. *The single stale* or *funis* of the Roman plough is invariably adopted; the *binæ aures*, which are two strips of wood attached to the share (which also is often made of the same material), about eighteen inches long, diverging a little from each other, and inclined to the earth at a convenient angle for laying open the furrow. (*Blunt's Italy*, p. 205.)

France.

7988. — 380. *The backwardness of agriculture in France* " is mainly attributable to the very partial spread of education in the rural districts, there being out of 40,000 communes, according to M. Dupin, 15,000 destitute of teachers; and out of 25,000,000 inhabitants who have reached a teachable age, 10,000,000 only are able to read. Now as the small independent proprietors of land amount to 4,000,000, and their families to 12,000,000 or 14,000,000 more, it is obvious that this state of ignorance must, under such circumstances, be attended with far more prejudicial effects upon production than if it existed in England, where the labourers are under the orders of about 32,000 large proprietors, and the success of cultivation consequently does not so mainly depend upon the general diffusion of knowledge. It is gratifying to find, however, that the large proprietors in France are universally desirous for the instruction of the rest, and that societies, rural schools, and model farms have been established under very favourable auspices." (*For. Quart. Rev.* 1829.) A national system of public instruction was established in 1832, and the various details will be found in the *Bulletin de la Société pour l'Instruction Elémentaire*, for that year.

7989. — 381. *Present state of French agriculture.* In *L'Agronome*, a monthly agricultural journal published in France, at the low price of five francs a year, it is stated in the first number, published in January, 1833, that in France " the colonies afford no longer the means of making a fortune; the convents do not provide a remedy for the want of foresight of parents; the system of peace, which is every day procuring more advocates among the most highly civilised of the people, no longer offers a brilliant prospect in the profession of arms; commerce and manufacture suit only particular characters; the sciences and the professions only minds privileged by nature; while agriculture alone offers unlimited scope for employment and for improvement." After enlarging on this subject, the writer goes on to state, that the business of a farmer must no longer be that of men who are not fit for any thing else; but it must be adopted by men of education, and pursued assiduously and systematically. It appears, from this and other French publications, that extraordinary exertions are making in France for the territorial improvement of that country. Among other points to which the attention of the cultivator is directed, is the necessity of feeding his men well, no less than his horses. As a proof of the advantages of doing so, it is stated that when Messrs. Manby and Wilson, from England, established their iron works at Charenton, the French workmen were not able to support labour for the same number of hours as the English did, till they adopted, like them, the practice of eating butchers' meat. Exactly the same thing has been proved respecting the Irish labourers, as compared with the English.

7990. — *Agricultural Societies in France.* This, and some of the following paragraphs are taken from a very interesting article, understood to be by Professor Macculloch, which appeared in the *Foreign Quarterly Review*, just after the historical part of our 2d edition of this Encyclopædia was printed. "The Agricultural Society of the Seine and Oise, which comprises many extensive landed proprietors, bestows, annually, medals and prizes on the small cultivators who turn their hereditary estates to the most profit, and upon the hired labourers and servants employed in large farms, who perform their work with the greatest intelligence and fidelity. A model-farm has been lately established at Roville, in the Valley of the Meurthe, about six leagues from Nancy, by M. de Dombasle, a skilful practical agriculturist. It comprises clay, sand, and gravelly soil; and the proper modes of culture are applied to each. By the improvements in ploughs and instruments of husbandry, five horses and nine oxen now accomplish at Roville more work than thirty-five beasts of burthen used to do on the same ground. With the aid of the Scotch threshing-machine, M. de Dombasle beats out, with three horses, three hectolitres and a half (upwards of an imperial quarter) of wheat, and other grain in proportion. Potatoes are cultivated with attention, and a distillery has been established for extracting their spirit. M. de Dombasle has proved what will, we think, excite some surprise, that land of a middling quality, planted with potatoes for fattening beasts, will be more productive than the richest meadow. No stronger encomium can be made on the skill of M. de Dombasle, than the fact that he has more than doubled the produce of the land: the average annual return of Roville being 59 francs per hectare (of 2½ acres), while that of the rest of the department of the Meurthe is but 28½ francs per hectare. At Moncey, in the department of the Moselle, the model-farm of M. Bouchotte is famous for its breed of horses." (*For. Quart. Rev.*)

7991. "*The Agricultural Society of Strasburg* in 1828 commenced an experimental plantation of fruit and forest trees in Alsace; a want observable not merely in that department, but throughout the whole country, except, perhaps, Normandy and parts of Britany. In Franche-Comté, and the department of Doubs, the government has taken the breeding of cattle under its peculiar care, and established annual exhibitions and prizes. In these parts, as also in Montbéliard, the useless practice of feeding off the land is beginning to be discontinued, it being ascertained that a hectare of inclosed ground produces one third more if not subjected to this ceremony. The arrondissement of Montbéliard has abandoned the system of fallows in use in the rest of the department, and cultivates with success both flax and the turnip. In Franche-Comté the very beggars are becoming industrious; they go about collecting manure till they have accumulated a certain quantity, when they take it to a proprietor, who allows them in return to plant on his soil, and receive the crop of a proportionate number of potatoes. In Picardy, the increase of the sheep-flocks, and the improved system of manuring, have added to the fertility of the soil. At Nouvison, in the department of the Aisne, the farms have been ornamented by hedges and plantations, in imitation of the adjoining country of Hainault. It is here that the making of sabots, and wooden utensils called bois-jolis, is chiefly carried on; the supply sent to Paris annually is valued at 17,000*l.* At Origny, in the neighbourhood of Vervins, the children of the husbandmen are employed in fan-making, baskets, &c. of willow, to the value of 40,000*l.* per annum. In Champagne, the example of M. Richardot, a small proprietor, has given an impulse to planting, and to a systematic irrigation of the land." (*Ibid.*)

7992. — 390 & 414. "*The culture of the vine* is a department of their husbandry of which the French have, perhaps, a right to boast more than any other people. The same grape, when tried in countries under the same latitude as the south of France, has never been brought to an equal degree of perfection. The plantations of vines have been and are subject to severe discouragements, but have, nevertheless, increased very considerably over their extent in 1789. In that year their surface was estimated at 1,200,000 hectares of land; in 1808, it amounted to 1,600,000; and in 1824, it covered 1,728,000 hectares. In 1828, the vines occupied about 2,000,000 cultivators, and their annual produce was computed at 40,000,000 hectolitres; the value of which, at fifteen francs per hectolitre, is 600,000,000 francs, or about 24,000,000*l.* sterling English money." (*Ibid.*)

7993. — 391. *The olive climate.* Strabo (lib. iv.) says, that the line of the Cevennes, in Gallia Narbonensis, was the northern limit, beyond which the cold prevented the growth of the olive. The limit is still in the same position. (*Jameson's Jour.*, April, 1834, p. 233.)

7994. — 398 & 399. *The breed of cattle and sheep in France*, "with the exception of parts of French Flanders, Normandy, and Alsace, is yet very degenerate. But their improvement, like that of mankind, depends upon their rearing; and, if the example of the Roville and other studs be followed, there seems no reason to doubt that the French horses may one day equal those of England or Spain. The company lately formed for recovering the 4,000,000 hectares of marsh land now uncultivated, and converting them into pasture, will greatly further the amelioration of the cattle, as well as the augmentation of their numbers. 2,500,000 horses, 7,000,000 horned cattle, and 42,000,000 sheep and goats, are certainly not a large stock for a country covering 53,500,000 hectares of land. The most experienced of the agriculturists have shown that the fleeces may be brought to almost any desired degree of perfection. When the merinos of Spain first appeared in France, the partisans of the coarse mattress-wool were continually alleging that Spanish sheep would never thrive in the French climate; their success has, however, been complete. The celebrated M. Ternaux (deceased in 1832) imported wools of what are called the electoral race, and placed the goats of Thibet in his park of St. Ouen, near Paris. The rugged declivities of the Jura have been adorned with the magnificent naz breed of MM. Girod and Perrault, and their rams are now attesting in New Holland the march of science in the management of flocks in France." (*For. Quar. Rev.*)

7995. — 403. "*The French pigs*, although they have excited many facetious observations from travellers, and have not unfrequently been compared to greyhounds, may be fattened, we are assured, at a small expense; and the method of doing this is now beginning to be better understood. The Chinese and English breeds are also getting into use for crossing. The fact that 4,000,000 pigs are killed yearly in France, shows of how great importance they are to the small agriculturist." (*Ibid.*)

7996. — 407. *The most extensive of the branches of French agriculture, as connected with the manufactures*, "are the culture of beet-root for sugar; of oleaginous plants, particularly at Lille and Dijon; and of the mulberry for silk-worms, in Languedoc and the southern provinces. It has been the habit in England to consider the former of these as merely a fanciful amusement of national vanity; but it appears by the amount of its consumption (between 7,000,000 and 8,000,000 lbs. a year), that at all events it is become an article of some practical magnitude." (*Ibid.*)

Holland.

7997. — 426. *The greatest part of the land in Holland*, it is observed by Mr. Aiton, of Hamilton, being under the level of the sea, and of the great rivers and canals which intersect that country, and, consequently, being unfit for arable culture, is generally kept in meadow. "Part of the grass produced is cut for hay, to supply the stock in winter and spring; and the rest of it is eaten off by a few sheep and horses, but chiefly by cows. Some of the cows are fattened for the shambles, but most of them are kept as dairy stock. In those parts where the surface of the ground is above the level of the water, it is cropped with wheat, rye, rape, beans, oats, flax, hemp, and potatoes: and even where the soil is a little lower than the level of the sea and rivers, part of it is dug up in some places, and cropped with potatoes, hemp, &c. But the greatest part of North and South Holland is so often overflowed with water, as to render it improper to raise winter wheat crops to a great extent." (*Quart. Jour. of Agr.*, vol. iv. p. 328.)

7998. *The soil* "being generally rich, the herbage is luxuriant; but, owing to the moist condition of the land, which is frequently inundated in winter, the herbage it produces is rather coarse, and many moist plants arise from the richer natural grasses." (*Ibid.*)

7999. *There are few large estates in Holland*, and "but few large farms. The land being remarkably level, it is generally divided and subdivided by ditches, or narrow canals, that receive the surface water, and serve the purposes of a fence." (*Ibid.*)

8000. — 428. *The farm-houses in Holland* "are of dimensions suited to the extent of the land in the farm, and they are more or less elegant or comfortable, as the wealth or taste of the occupant may dictate; but they very much resemble each other. They are generally of only one story in height, but placed on so broad a base, as to afford accommodation not only for the boor, or farmer, and his family, but also their live stock, dairy, cheese-house, threshing-floor, the whole crop, and fodder for cattle. In short, the whole farmstead is frequently comprehended under one roof. Besides a kitchen, in which the family sit and eat, as well as cook their food, and from which they can see their cattle during winter and spring, these houses contain at least one elegant and well-furnished room, with a bed-room or two, into which they seldom enter, except on days of festivity. Their kitchens are much more tastefully fitted up than those of the farm-houses in Scotland. They have a stove of an elegant figure, which is kept wonderfully clean. The wall near to the fire-place is covered with plates of flowered earthenware; and the mantelpiece is richly, though rather heavily, fitted up. There are some concealed beds and closets in this part of the building; while a pump-well, and a horse-gin for washing and churning the butter, are both at hand, near the centre of the building. The floor of the kitchen generally consists of marble; the rest of the building is of brick. The gincourse is laid with sand, and is covered with boards when the horse is not in yoke. The whole building is roofed with tiles, and the roof rises in a somewhat pyramidal form. The walls are generally built of brick, but sometimes of mud or boards; but the roof is supported on frames of wood, round which the walls form only a covering. There is no urine tank as in Belgium. Indeed, little attention seems to be paid to manure in Holland, probably on account of the soil being naturally rich." (*Ibid.*)

8001. *The cow byre* is "paved with hard bricks, or clinkers, as they are termed, set on edge; and the stakes to which the cows are bound are made to be removed in summer, when the cattle are turned out to pasture. A passage before the cow's head is convenient for giving them their meat, and a trough of clean water is placed before the cows, from which they can drink at pleasure. The water is let off once a day by means of a plug, and a new supply from the well pumped into the trough. A passage behind the cows serves to remove the dung." (*Ibid.*, p. 330.)

8002. *Dutch cows.* "The Vriesland and Groningen cows are the largest and most esteemed races in Holland. They are short-necked, broad and deep-chested, deep-bodied, and broad-backed, with well-made limbs, fine small horns, and stand well upon their feet. The greatest number of these cows are either black or white, or dark brown and white." (*Highland Soc. Trans.*, vol. x. p. 169.)

8003. *The general practice in Holland* is, "that the cow should calve in her second year. The bull is employed when it is two years old, and is fatted and sold to the butcher when four or five years old, and the cow at seven or eight. Some cows are, however, kept for milking till the tenth year." (*Ibid.*)

8004. *The most improved method of treating the calf in Holland.* "It is immediately after its birth taken from the cow, put in a separate place, and laid on dry straw. A little salt is given, and the tongue and mouth are rubbed with it. It is also rubbed clean with straw. After the lapse of six or eight hours, the first beasting of the mother cow, diluted with one third water, is given to the calf to drink, and this treatment is continued for some days, the liquid being given thrice a day. Thereafter, during two or three weeks, they give the calf the milk as it comes from the cow, diluted with one fourth water, in which now and then a small handful of salt is put; then buttermilk is gradually given, and it is supplied with hay; at the age of ten weeks it is brought out into the meadow, where it is also supplied with skimmed milk, buttermilk, or whey. In this way each farmer raises the proper number of heifer calves to fill up vacancies; but calves fattened for sale have milk from the cow three times a day. For some days after calving the cow is milked thrice a day, after which they return to the usual practice of milking twice a day." (*Ibid.*)

8005. *Treatment of milch cows in Holland.* "The cows are turned out to grass generally by the end of March, or the beginning of April. They are, when first sent out, furnished with a very thick cloth of tow, covering the back and sides, from the shoulders to the tail, to prevent diseases from cold. They remain out, night and day, about thirty weeks. In the winter months the general food is hay, and most farmers give their cows nothing else: distillery grains are sometimes given, when they can be obtained. At the great establishment of Baron Van Palink, near Leyden, boiled beans, with rape cake, spread over the hay, were given at night, and ground linseed cake in the morning, which, it was stated, enabled the cow to give more and better milk than hay alone. Raw potatoes and dry linseed cake are also sometimes given, and most farmers give the buttermilk, either diluted with water or not, to the cows, as well as to the calves and pigs. Mangold-wurtzel is also given, but turnips never." (*Ibid.*)

8006. *The byres or cow houses in Holland* "are generally lofty, airy, paved with large square bricks [Aiton says "clinkers," *see* § 8001.], and kept perfectly clean. The roof is generally about ten feet high. There are no racks or mangers. The cows stand in two rows, generally facing the centre, and sometimes the sides of the byre, along which is a brick pavement slightly elevated in the middle. On the edges next the cows, and on a level with them, is a trough, perfectly clean, into which the meat or drink is put, and the hay laid down. Each cow has about five feet of space, and is tied to a railing of three small posts in front, which separate them from one another. There is little straw used for bedding: on the place where the cows stand, there is a hollow part at the fore feet, into which are now and then put dry horse dung and straw; at the hind feet, generally nothing is laid but a little dry sand. From the narrowness of the space divided into stalls, the back always projects so far as to cause the dung droppings to fall into a gutter about eighteen inches deep, and eighteen inches wide, which is regularly and carefully swept and cleaned, so that there is very little trouble in clearing away and collecting the manure. The cows are always kept quite clean; and, to prevent the tail occasioning filth, the lower end is always tied up by a string attached to the ceiling." (*Ibid.*)

8007. *Process of milking in Holland.* "The cows are always milked by the men, and the butter and cheese made by the women. One man is considered necessary for every ten cows. At Ter Leide, the well-managed dairy establishment of Baron Van Palink, there are ninety milch cows, nine men, and a *Boerinn* (or female farmer), the maker of the butter and cheese, who has a female assistant. At Klinkenburgh, near Sasenheim, there are forty cows; the farmer and three grown sons do all the milking, and his wife and one female servant make all the butter and cheese. At Schoote, near Haarlem, there are twenty cows; the father and son milk, and the wife and a female servant make the butter and cheese." (*Ibid.*)

8008. *Butter.* "There are three distinct kinds of butter manufactured in Holland; the butter made from the cream, when the cow is at grass in the summer, called grass butter; the butter from the whey of the new milk cheese, called whey butter; and the butter made in winter, when the cows are in the cow-houses, called hay butter." (*Ibid.*)

8009. *Grass butter.* "The cows being carefully milked to the last drop, the copper pitchers lined with brass, or pitchers entirely of brass, which contain the milk, are put into an oblong water-tight pit, which they call a *roelbak*, built of brick or stone, about six feet in length, three feet in breadth, and two feet in depth, into which cold water had been previously pumped; there being generally a pump at one end of the pit. In this pit or cooler, the pitchers stand two hours, this milk being frequently stirred. The cooling process is of great advantage in causing the cream to separate rapidly and abundantly from the milk. After this, the milk, being run through horse-hair sieves or drainers, is put into the flat milk-dishes, which are of earthenware, copper, or wood, as will be afterwards described; it remains in a cool dairy or cellar for twenty-four hours. It is then skimmed, and the cream is collected in a tub or barrel. When soured, if there is a sufficient quantity from the number of cows, they churn every twenty-four hours, the churn being half filled with the soured cream. A little boiled warm water is added in winter, to give the whole the proper degree of heat; and in very warm weather the cream is first cooled in the *roelbak* or cooler. In many small farm-houses, or when the cows give little milk, the milk is not skimmed; but the whole, when soured, is put into the churn. The butter, immediately after being taken out, is put into a shallow tub called a *vloot*, and carefully washed with pure cold water. It is then worked with a slight sprinkling of small salt, whether for immediate use, or for the barrel; there being none made entirely without salt, as in Scotland. When the cows have been only eight or ten days out, the difference between grass and hay butter is slightly perceptible; but the grass butter, after the cows have been three weeks at grass, is delicious. This new butter is highly esteemed in Holland: it is made in fanciful shapes of lambs, pyramids, &c., or stuck with the flowers of the polyanthus, &c., and sells very high. If intended for barrelling, the butter is worked up twice or thrice a day with soft fine salt, for three days, in a flat tub, there being about two pounds of this salt allowed for fourteen pounds of butter; the butter is then hard packed in thin layers into the casks, which casks are previously carefully seasoned and cleaned. These casks are always of oak, well smoothed inside; and, before being used, they are allowed to stand three or four days, filled with sour whey, and are then carefully washed out and dried. Each cow, after being some time at grass, yields about one Dutch lb. (seventeen oz. and a half) of butter per day." (*Ibid.*)

8010. *Hay butter* "undergoes the same process as grass butter; being, of course, the butter made in winter, when the cows stand in the cow-house. But, although inferior in flavour and colour, it has none of the disagreeable taste which the turnip imparts to the winter butter of Britain." (*Ibid.*)

8011. *Whey butter* "is made from the whey of the new milk cheeses. The whey, being collected from the curd and the pressed cheese, is allowed to stand three days or a week, according to the quantity; the cream is either skimmed off and churned, or the whey itself is put into the churn, and the butter is formed in about an hour. In winter the butter obtained by this process is about one lb. per cow per week; and in summer about one lb. and a half per cow per week." (*Ibid.*)

8012. *Cheese.* There are four kinds of staple cheese made in Holland: the round or bullet cheeses, called Edam (from their having been first principally made in that neighbourhood); Stolkshe (so called from the village of Stolkwyk), which are called in Britain, Gouda, and are flat, and broader and larger than the Edam, both kinds being made of unskimmed milk; Leidsche or Leyden (being so called from this kind of cheese being principally made near Leyden), which is made of milk once skimmed; and Graawshe, which is made in Vriesland, of milk twice skimmed. Both the latter kinds are called Kanter cheese in Britain, and are larger and flatter than the two first named." (*Ibid.*)

8013. *Edam cheese.* "The process of manufacture of the Edam cheese is as follows:—The rennet is put into the milk as soon as it is taken from the cow; when coagulated, the hand, or a wooden bowl, is passed gently two or three times through the curd, which is then allowed to stand a few minutes; the bowl or finger is again passed through it, and it is permitted to stand some minutes longer. The whey is taken off with the bowl, and the curd is put into a wooden form of the proper size and shape of the cheese to be made. This form is cut out of the solid wood by a turner, and has one hole in the bottom. If the cheese is of the small size (about four lbs.), it remains in this form about fourteen days. It is turned daily, the upper part, during this time, being kept sprinkled with about two ounces of purified salt of the large crystals. It is then removed into a second box or form of the same size, with four holes in the bottom, and put under a press of about fifty lbs. weight, where it remains from two to three hours, if of the small size; and four to six hours, if of the large size. It is then taken out, put on a dry airy shelf in the cheese apartment, and daily turned for about four weeks, when Edam cheeses are generally fit to be taken to market. Alkmaar, in North Holland, is the great market for Edam cheese. It is not uncommon to see 800 farmers at this market, and 470,000 cheeses for sale on one day." (*Ibid.*)

8014. *Gouda cheese.* "This kind of cheese is also made from the milk, immediately on its being taken from the cow. After gradually taking off the principal part of the whey, a little warm water is put upon the curd, which is left standing for a quarter of an hour. By increasing the heat and quantity of the water, the cheese is made harder and more durable. All the whey and water is then taken off, and the curd is gradually packed hard into a form, cut out by the turner, flatter and broader than the form for the Edam cheese. A wooden cover is placed over it, and the press, with a weight of about eight lbs., put upon it. It it here frequently turned, and remains under the press about twenty-four hours altogether. The cheese is then carried to a cool cellar, and put into a tub containing pickle, the liquid covering the lower half of it. The water for the pickle is boiled, and about three or four handfuls of salt are melted in about thirty imperial pints of water. The cheese is not put in until the water is quite cold. After remaining twenty-four hours, or, at most, two days, in the pickle tub, where it is turned every six hours, the cheese, being first rubbed over with salt, is placed upon a board slightly hollowed, having a small channel in the centre to conduct the whey, which runs off into a tub placed at the one end. This board is called the *zouttank*, and several cheeses are generally placed upon it at a time. About two or three ounces of the large crystallised salt is then placed upon the upper side of the cheese, which is frequently turned: the side uppermost being always sprinkled with salt. It remains on the zouttank about eight or ten days, according to the warmth of the weather; it is then washed with hot water, rubbed dry, and laid upon planks, and turned daily, until perfectly dry and hard. The cheese-house is generally shut during the day, but must be open in the evening, and early in the morning. Each cow at grass in Holland is calculated to give about three or four lbs. of new milk cheese per day." (*Ibid.*)

8015. *Kanter cheese.* "The skimmed milk is poured out of the stone, copper, or wooden milk dishes, into a tub or tubs, in which it remains to settle half a day. About the fourth part is gently poured over into a copper boiler; which boiler, by the most careful farmers, is oiled with sweet oil, to prevent burning the milk, or giving it a singed taste. This is heated till the hand can hardly bear the heat, and then taken out and mixed with the other three fourths, the whole being stirred about; the rennet is then put in, and when coagulated, the whey is taken out with a wooden bowl, the curd is hard worked and pressed with the hands, and then put into a cloth, the four corners being folded on the top, and the whey pressed out. The curd is next put into a broad tub, called a *porteltobbe*, and hard worked, and trodden upon by the bare feet; for although there has lately been a plan introduced to obviate this disagreeable practice, this is generally the mode used in making common or kanter cheese. The next process is to mix among the curd a shut handful of soft fine salt to every thirty lbs. of cheese. The curd is then put into a strong circular form (of staves, and hooped, about three inches thick, with holes bored in the bottom), with the cloth round it. It stands in this form twenty-four hours, the cloth being taken off and wrung dry three or four times a day during these twenty-four hours: this form is placed upon a hand-barrow, or open standard, over a tub, which receives the whey; a cross plank is laid over the lid of the cheese form, and it is frequently pressed by the weight of the body. The cheese is then taken out and put into a cheese-well, or form, equally strong, having a cover called a *volgirt*, and put under a heavy press, the weight being about 360 lbs., where it remains twenty-four hours more. After this process, or when taken out of the press, the cheese is washed, and in some places it is smoothened by rubbing it frequently with sour skimmed beastings preserved for the purpose; it is then rubbed with a reddish-coloured substance, called *kaasverf* or *kaassmeer*, which the apothecaries sell in Holland, for the purpose of giving it a smooth outside, and good colour. The cheese is then put into a cool cheese-house or cellar, and frequently turned, until brought to market. It is into this kind of common or kanter cheese that various spices are put, although few of the spiced cheeses come to this country. This operation takes place when the curd is put into the first form; the curd is put in in layers; the first layer has no spices in it, but upon it is sprinkled some cummin seed, and then follow regular layers, with cloves intermingled, until the upper layer is placed, which has no spices in it." (*Ibid.*)

8016. *Graauwshe kaas, or inferior kanter cheese.* "This inferior kanter cheese is made of milk twice skimmed, in Vriesland and Gröningen; and is prepared in a similar way to Leidsche, or the best common or kanter cheese, to which it is much inferior. The Dutch farmers reckon that thirty cows at grass will give from 100 to 200 lbs. of fine butter, and about 300 lbs. of kanter or common cheese, per week." (*Ibid.*)

8017. *Dairies, or milk-houses.* "There is great variety in the arrangements of the milk and cheese-houses; but the most frequent form is this: — Between the dwelling apartments and the cow-house, and of the breadth of the house, is a square apartment for churning and other similar operations; at one corner is the cooler, built of brick, as already described, and generally having a pump at one end, for the purpose of introducing the cold water to cool the milk. This apartment is airy, roomy, and paved with square bricks. Descending a few steps from it, is the milk-house, or rather cellar; it is always three or four steps below the level of the house, paved with brick, and having an arched ceiling, almost always of brick or stone, and two or four windows, according to size. The milk dishes, or pans, which are daily first hand scrubbed and washed with boiling hot water, and then with cold, are ranged along the floor (not on shelves), in such a way as each pan may be reached by the dairy-maid. The windows are opened or shut according to the state of the weather, to which particular attention is paid." (*Ibid.*)

8018. *The cheese-houses* are also generally cellars, and adjoining the milk-houses; but in summer the byres are used for the Leidsche or kanter cheese; the floor being kept quite clean. All the windows and doors being open, abundant air is afforded. In winter the windows of the cheese-houses are generally kept shut; and, if any intense frost exists, they put in one of the wooden boxes, containing a pan with burning turf. The cheeses are placed in rows on the wooden shelves." (*Ibid.*)

8019. "*The sweet and delicious flavour of the Dutch butter* is said to be principally owing to the excellence of the Dutch salt. The butter, though salted, is always well flavoured, and hardly tastes of that acrid quality which the muriate or sulphate of magnesia frequently imparts to butter in this country. This acridity will be found very obvious, when comparing the Dutch salted butter to the best salted butter of Britain. It appears that in the manufacture of salt more time is allowed for evaporation and crystallisation, and that the crystals are nearly an inch square. In Britain the process of evaporation is hurried on by artificial heat, so that the crystallisation is never perfect. This is owing to our excise laws, which it is to be hoped will be removed, or regulated in such a manner as to admit of applying the modern improvements in chemistry in this manufacture." (*Ibid.*, vol. x. p. 184.)

8020. *The great cleanliness everywhere observable in the farmeries of Holland* is "another cause of the general excellence of the dairy produce. This seems to be the result of a well regulated division of labour. The men attend to milking and feeding the cows, and the women to making the butter and cheese. As to cleanliness, every dwelling-house is a model and a pattern; the inhabitants seem to vie with each other on this point. The cow-house is pure and clean, not a particle of filth being to be seen in it; the cows are as clean as if they were in a dining-room; the milk and cheese-houses, and, in short, every part of the house, are free from dust and dirt of any kind; the manure is placed at a convenient distance from the cow-house, behind the house, and every particle is carefully collected together. The whole apartments, even the byre and hay-house, are generally under one roof; and the cleanly system, and the admirable arrangements, give that comfort and pleasure which are too often wanting in Scotland.' (*Ibid.*)

8021. *As an example of a Dutch dairy farmery,* we copy the plan and elevation, *figs.* 1146 and 1147. In *fig.* 1146., "*a* is the kitchen or living-room of the family, during the greater part of the year; *b*, a temporary apartment in which the family take their meals during the warmest weather in summer; *c*, the cow-house, in which the cows are seen from both apartments; *d*, a large room used for various purposes; *e*, bed-room; *f*, shed; *g*, dairy; *h*, dairy scullery; *i*, cooler; *k*, a place for drying cheese; and *l*, hay and straw room in the centre of the building." The farmeries in

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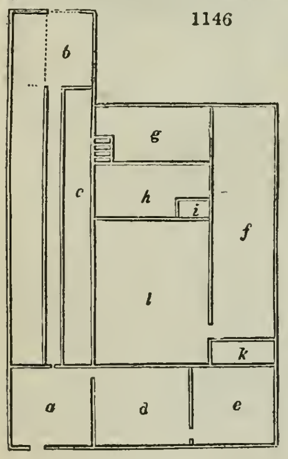

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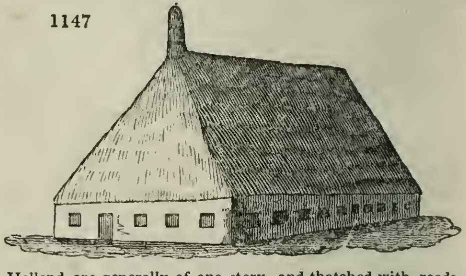

Holland are generally of one story, and thatched with reeds, as in *fig.* 1147., one immense, lofty roof covering the whole. The highest part of this roof is in the centre, over the hay and straw room. (*Ibid.*) Mr. Aiton of Hamilton, who also visited Holland with a view of studying its dairy husbandry, gives a similar account of the Dutch farm-houses. See § 8000.

GERMANY.

8022. — 567. *The Agriculture of Prussia.* The system of national education established in this kingdom in 1819 has been already mentioned, and the reader will find the details, which have reference to the manner in which agriculture is taught in the school gardens or fields, in Cousin's work already (§ 79. 81.) referred to.

8023. — 573. "*The farmers about Bonn,*" says Williams, "have neither a good plough, nor a good cart, and their hay-fork is like Neptune's trident." (*Williams's Travels*, &c.)

8024. — 624. *Screens or narrow barns* are used in many parts of Carniola for hanging buck-wheat upon. The screen is composed of two upright posts, twenty feet in height. Through holes in the upright posts, horizontal poles are placed, reaching from one upright to the other. On these poles, the buck-wheat and other kinds of fodder are placed. A narrow roof of boards covers the whole, passing from one upright to the other. The sheaves of buck-wheat are also sometimes fixed on an upright post. (*Cadell's Travels*, p. 24.)

8025. — 625. *Gourds* are cultivated in considerable quantities in Carniola and Styria: cut in slices, they are given to the hogs and cows. (*Cadell's Travels*, vol. i. p. 25.)

Russia and Poland.

8026. — 662. *Roads in Poland.* By far the best specimen of that kind of road usually called macadamised, for want of a more explicative term, is to be found between Warsaw and Kalisz, a distance of thirty-three and a half Polish, or one hundred and fifty-six English miles. Throughout this distance it is uniformly hard, level, and as smooth as a billiard table, quite straight, planted with a double row of trees on each side, and with very tolerable inns at each post station. It is doubtful whether a better road is to be found in England; certainly not on the Continent, except, perhaps, between Milan and Cremona, or even as far as Vicenza. The Warsaw road is perfectly new, and owes its existence to the grand duke Constantine, whose efforts to improve the internal communication of the country in every direction were incessant. One feature of the Polish road in question deserves notice, because it tends to give it the appearance of a carriage-road in a gentleman's park kept in the highest order; namely, the manner in which the sides are dressed all along with green turf, which looks like mossy banks, cut smooth, and perfectly level. This method of flanking a macadamised road that has been cut through hills, or prominent undulations in the ground, offers, besides its neat appearance, a great advantage; for it prevents, in a great measure, the carrying away of the loose earth and denuding of the roots of trees during heavy rains, both which inconveniences, very injurious to the road itself, takes place when the sides are not covered with turf. (*Granville's Russia*, p. 580.)

8027. *British farmers in Poland.* Since the peace of 1814, some Scottish farmers have settled in different parts of Poland, and chiefly in the neighbourhood of Warsaw. The soil and the climate are found much more favourable, both for agriculture and gardening, than might naturally be imagined. Though the winters are more severe than they are at Edinburgh, yet the summers are much warmer, and corn and fruits ripen much sooner and better. The cucumber grows freely, and bears abundantly in the open air during the summer months. The estate or farm of Wilga, on the river of that name, a view of which is given in *fig.* 1148., consists of 1600 acres, and was purchased by a near relative of the author

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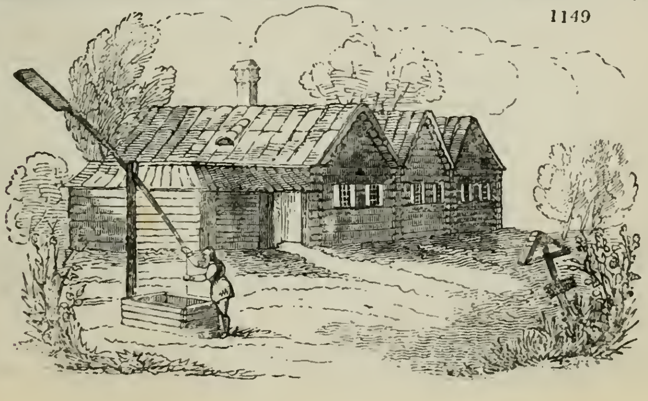
in 1832. The buildings consist of a dwelling-house (*a*), with a detached kitchen (*b*), a brewery (*c*), a distillery (*d*), a machine for raising water to supply both (*e*), a corn-mill (*f*), sheds for feeding cattle (*g*), an ice-house (*h*), in which ice is kept above ground by means of thick double walls and doors; and large barns, a threshing-machine, coach-house, stabling and all other offices, including a carpenter's shop and house, blacksmith's shop and house, bailiff's house, &c. Besides these there is a small colony of cottages for the common labourers. These cottages are generally of the kind called log houses, and, with their draw-wells attached, present the appearance of *fig.* 1149. The Germans who are settled in Poland, as agricul-

1149



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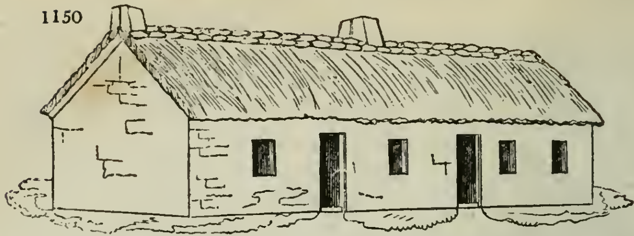
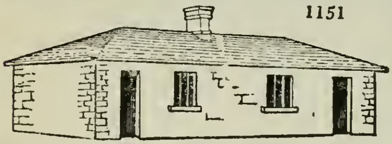


turists, generally build thatched cottages in the style of *fig.* 1150; and the English in the neighbourhood of Warsaw adopt the style shown in *fig.* 1151. Behind the house there are a large garden and orchard, with summer-house, green-house, &c., the estate having been the property and residence of a Polish nobleman, considered a man of taste. The situation of this property is about thirty miles from Warsaw, in a flat country, and there is good communication between it and that city, both by land and water. The soil is light in most places, but in others it is loamy. About half the surface is covered with wood, chiefly birch, poplar, and Scotch pine, which is felled at stated intervals, and is floated down the Wilga and the Vistula to Warsaw, where it is sold as fuel. The culture pursued on the arable land is the convertible system of— 1. turnips; 2. corn, chiefly barley and wheat; 3. clover; and 4. oats. The turnips and clover are consumed in the feeding-houses by milch cows, or cattle for the butcher. The corn is either ground into flour, or malted and brewed into beer, or distilled into spirit; for both of which there is an ample market at Warsaw. Butter and cheese are made, for which there is also a great demand. Pigs are fattened, but the Polish towns being chiefly occupied by Jews, and trade of every kind being chiefly in their hands, it is found that pigs cannot be driven to market, and sold there alive as in Britain; but the carcasses are salted, or cured as bacon, and sold in that state, to Christian consumers. The fattened cattle are sold by private contract to Jewish dealers, who dispose of them, either to their brethren in Warsaw, Cracow, and other towns in Poland, where they are killed in the manner peculiar to the Jews; or to Christian butchers either in Poland, Prussia, or Russia. Numbers are sent to Dantzic and other sea-port towns. An unlimited supply of manure may be obtained from Warsaw at present, though it cannot be expected that this will long continue to be the case; but bones are abundant not only in Warsaw but all over the country, and the supply of this manure will, probably, for many years, exceed the demand. A crushing-mill has been, or is about to be, added to the corn or flour-mill on the estate. It is also in contemplation to establish a steam-boat between Wilga and Warsaw, which will add greatly to the rapidity of conveyance between the two places. The flour might then be converted into bread, and the cattle, for Christian consumption, slaughtered on the farm; for it is chiefly by manufacturing farm produce, that it can be at all disposed of to advantage in such a country as Poland. The great drawback to farming in Poland, is the want of moral principle in the labourers, who require continual watching both to keep them at work, and from stealing and drinking; but as this has arisen from the harsh treatment to which, as slaves, they have been subject from their masters through many generations (see § 650.); it may be diminished by kindness to the adults, and the education of the children.

1151



8028. — 672. *Food of the peasantry in Russia.* Rye bread is the chief support of the peasants in the north of Russia; but, in order to save the rye flour, and to make it last the longer, the inhabitants, when compelled by necessity, mix with it fine ground oatmeal, the meal of buck-wheat, and the husks of the field mustard seed (*Sinàpis arvénsis*). Brandy is, in general, distilled in Russia from rye meal, with a more or less additional quantity of barley, oatmeal, and barley malt; but very seldom from wheat, or buck-wheat. The Russians also distil brandy from potatoes, juniper berries, and *Sórbus aucupària*, at all times with an addition of meal and malt. They distil, in Astrachan, a sort of French brandy from damaged wines, prunes, kernels of cherry-stones, and wild almonds (*Amýgdalus nàna*). Some of our distillers make use of the skin and stalks of pressed grapes, raisins, and the waste in sugar refineries, with which they make good brandy. To the worst and common sorts of brandy belongs the dram of Kamtschatka, of *Heraclèum Sphondýlium*, and another used by the Kalmucks, made from sour distilled mare's milk, which is spirituous, but rather of a disagreeable flavour. (*Com. Board Agr.*, vol. i.)

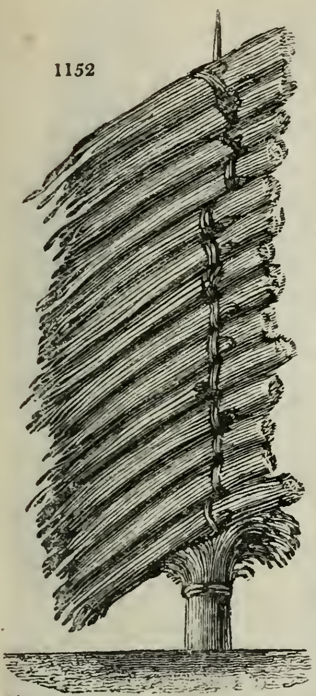
8029. *Agriculture in Livonia.* The country, before reaching Volima, offers a tolerable specimen of the present state of agriculture in this part of Livonia. Forests, both old and new, in considerable numbers, are met with here and there, succeeded by corn fields; barren heaths; farm-houses, consisting of one or two wooden buildings, and a yard, in tolerably good condition; small horses, and diminutive horned cattle; no inclosures, except a kind of palisade, marking the divisions of property or protecting the farm-houses from intrusion; and extensive buildings serving as granaries to hold the crops. These are the most prominent agricultural features of the country. The Livonians have the reputation of being good farmers. (*Granville's Russia*, p. 397.)

8030. — 673. *Agricultural products of Russia.* The hop is indigenous in the district of Petersburg; a few are also cultivated in gardens, and the crop gathered the end of September. Hemp is sown about the middle of May, and pulled up in the beginning of September. Flax is sown in the beginning of June, and pulled in the middle of August. Both these plants are grown only in small quantities for private use. Red clover is sown along with barley and oats, and cut the following year, about the end of June, and the second in September; the plants are frequently destroyed by the early frosts. The farinaceous plants grown in the district of Petersburg are the following: — Some winter wheat upon good soil, sown in the latter end of August and the beginning of September, is reaped about the middle of August. Spring wheat is sown on newly cleared lands in the beginning of May, and reaped about the middle of August. Rye is sown, more extensively than any other grain, on most descriptions of soils, and in the latter end of July and the whole month of August; it is reaped the latter end of July and the beginning and middle of August. Spring rye is sown upon high and sandy ground in the beginning of May, and reaped the latter end of August. Barley is sown in the beginning and middle of May, and reaped about the middle of August. Oats are sown the latter end of April and beginning of May, and reaped from the middle of August to the beginning of September. Buck-wheat is sown upon high sandy lands in the month of May, and reaped in the beginning and middle of September. No oleaginous plants are cultivated, except the sesamum and the white mustard in a few gardens. The following are the leguminous plants of the same district: — White and gray peas are sown in the beginning of May, gathered green the latter end of July, and ripe the latter end of August. Beans are sown in the beginning of May, and reaped in the middle of August: French beans are sown in gardens, but they seldom do much good. (*Com. Board Agr.*, vol. i.)

Sweden.

8031. — 688. *General appearance of the country in Sweden.* A bishop of Bergen is said to have given the name of Northern Italy to some districts of Norway and Sweden. The pine forests are very beautiful, especially when the pale green of the young shoots contrasts with the older foliage. From the appearance of some of these trees on lofty cliffs, it is easy to perceive how in alpine countries the descent of the roots of the pine and the mountain ash, through fissures, contribute to the splitting of the rocks. The Swedish milestones are raised on plinths to keep them above the snow. The roads, winding through extensive pine forests, are picturesque in the extreme. (*Brooke's Travels in Sweden.*)

1152



8032. — 693. *The cottages of the peasants* in Norway have double fronts. This additional protection renders them warm and secure against the blasts of winter. The manner of building these cottages is the same as in Sweden: and on the roof of each, a luxuriant crop of grass was generally growing, though some were loaded with a thick coating of pebbles, and above them were two or three large fragments of rock, to secure the whole from being blown away by the winter storms. (*Brooke's Travels*, p. 105.)

8033. — 704. *Stakes for drying newly-cut corn* are also used in Sweden. They are generally made of young pine trees, eight feet long, about one inch and a half in diameter at the top, and four inches at the bottom. Both ends are pointed, and the thick end is let into the soil by the aid of an iron crow bar. The first sheaf is put on the stake with the root ends of the corn downwards, and the other sheaves, to the number of fifteen or sixteen, are placed in an inclining position, as shown in *fig.* 1152. (*Quart. Journ. Agr.*, vol. iii. p. 638.)

Persia.

8034. — 864. *The general appearance of the country in Persia* is characterised by its chains of rocky mountains, its long arid riverless valleys, and its still more extensive salt or sandy deserts. The northern provinces form an extensive table land, which rises from a lower plain, and is interspersed with numerous clusters of hills, chains of rocky mountains, and barren deserts. The lower ground, under the name of Dushtistan, or the level country, exhibits a succession of sandy wastes, where the eye is occasionally relieved by a dark plantation of date trees, and a few patches of corn, in such places as are blessed with a freshwater rivulet or a copious well. On the banks of the Tigris this tract becomes more fertile. Wherever water abounds, vegetation is most luxuriant; but the country generally suffers from excessive drought. The mountains present masses of grey rock, and the only trees that are found in abundance are the tall poplar and stately chinar (*Plátanus orientàlis*), and the fruit trees which surround every hovel. These hovels are clean and comfortable; and wages are high, while food is cheap. (*Fraser's Persia, Edin. Cab. Lib.*, vol. xv.)

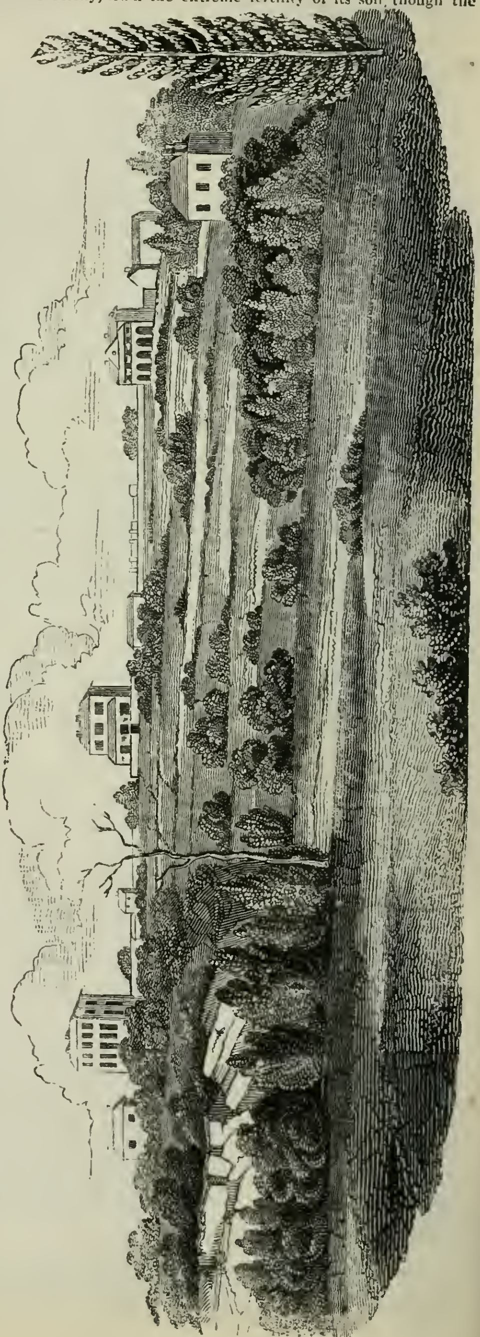
India.

8035. — 893. *To give some idea of the present state of agriculture in India*, Mr. W. Carey, one of the missionaries, states, in the *Transactions of the Agricultural and Horticultural Society of India*, vol. ii. part I., 1832, that, in many parts of the country, the same crop is invariably raised on the same ground year after year; hay is never cut till the grass has died or withered on the ground; scientific rotation of crops is a subject to which Indian cultivators are strangers; and the manure produced by animals is generally consumed for fuel. No attempt to improve stock appears ever to have been made in India; though there is every reason to believe that all the animals used in the husbandry of Europe are capable of as high a degree of improvement in India as they are in more temperate regions. The quantity of waste lands in India is said to be so large as almost to exceed belief. Extensive tracts on the banks of numerous rivers are annually overflowed, so that they produce little except long and coarse grass, seldom turned to any useful account. During the rainy season, these tracts are the haunts of wild buffaloes, which in the night come up from them and devour the crops of rice on the high lands. In the cold season, wild hogs, tigers, and other noxious animals, unite with the buffaloes in occupying these extensive tracts of alluvial soil; which, though now so pernicious, might, by embanking and draining, become the richest lands in the country, and contribute greatly to the improvement of the climate. Similar observations might be made respecting immense tracts now wholly covered with wood, and producing nothing whatever to civilise man, but, on the contrary, proving a nuisance to the surrounding districts by affording a shelter to noxious animals. The oppression of landowners, and petty officers, on the cultivator is so great, that in some parts of the country no farmer can reasonably promise himself security for a single night. " Thus," concludes Mr. Carey, " one of the finest countries in the world, comprising almost every variety of climate and situation, diversified by hills and valleys, intersected in every part by streams (most of which are navigable six months in the year, and some of them through the whole year afford every facility for carrying manure to the land, and every part of the produce to market), is, as far as respects its agricultural interests, in a state the most abject and degraded." (p. 10.) This is a most forbidding picture; but it is incident to all countries in a particular stage of their progress in civilisation. Time was when the low districts of England were ravaged by the wolves and bears from the mountain forests, and when the crops on the alluvial vales of her rivers were annually swept away, or at least greatly injured, by floods. As to oppression by superiors, and thieving from others, there will always be abundance of such evils, till mankind are brought to something like equalisation in point of knowledge, and consequently power; till, in short, the mass of society become fit for self-government. (*Trans. Agr. Soc. of India.*)

Australia.

8036. — 1037. *The whole territory of New South Wales*, Dr. Lang, writing in 1834, informs us, "is divided, like that of Great Britain, into counties and parishes; but these divisions are scarcely ever referred to in the common intercourse of colonial life. Except in government deeds or legal documents, the grand natural divisions of the country are the only ones recognised by the colonists." These divisions are the districts of the Hawkesbury, of Hunter's River, of Bathurst, of Illawarra, and of Argyle. The district of the Hawkesbury, which is let out in small farms of from 30 to 100 acres each, has been long considered the granary of the colony, from the extreme fertility of its soil, though the system of agriculture practised in it is as slovenly as can be well imagined. The surface of the ground is "for the most part merely scratched; and nothing like a proper rotation of crops is ever dreamt of. Wheat, year after year, for twenty years together, and sometimes wheat and maize in succession off the same ground during the same year, is the Sangrado system of husbandry that prevails on the Hawkesbury." The district of the Hunter's River is let out in farms of from 500 to 2000 acres each. "Dairies are frequent throughout this extensive district; and large quantities of butter and cheese, of superior quality, are forwarded regularly by the steamboats to Sydney." The vast plains of the Bathurst are chiefly tenanted by black cattle and sheep, and the farms are generally 2000 acres each. This may be considered the wool district. The cultivated land of the Argyle district is almost all in pasture, but there are interspersed extensive tracts of the most barren country imaginable. The district of the Illawarra consists of a narrow strip of arable land of the first quality, let out to "small settlers, who cultivate grain, potatoes, pumpkins, &c., for the Sydney market, their produce being conveyed to the capital by water in small coasting vessels." This is also the timber district, great numbers of the red and white cedar trees growing here, and that wood being generally used for cabinet and joinery work all over the colony. Besides these there are several large tracts of pastoral and alluvial land, which cannot be properly classed in any of the above-named districts; and a very great extent of country remains unexplored. The rich alluvial land on the banks of rivers is called interval land. It is very productive, but is difficult to clear. Norfolk Island, has a soil of the richest vegetable mould, even to the tops of the highest hills, and appears well adapted for the culture of coffee, if not sugar. It is now (1834) occupied as a penal settlement for the colony of New South Wales. (*Dr. Lang's Historical and Statistical Account of New South Wales*, vol. i.)

8037. *General aspect of the country.* The principal town, Sydney, is beautifully situated on Sydney Cove, one of the romantic inlets of Port Jackson, about seven miles from the entrance of that harbour, the headlands at the mouth of which constitute one of the grandest and most interesting features in the natural scenery of the country. Many of the most interesting localities on the shores of Port Jackson, between Sydney and the headlands, are in the hands of private proprietors. On Woolloomoolloo Hill (*fig.* 1153.), which is an elevated projection of the land, about a mile from Sydney, most of the officers of the colony have houses. The second town of the colony is at present Paramatta; but Maitland will, probably, soon supersede it, as the latter place is situated at the head of Hunter's River, in the centre of the most extensive agricultural and grazing district in the colony. Between Sydney and Maitland there are two steam-boats, and a company has lately been formed, called "The Hunter River Steam Navigation Company." With the exception of the large open plains in the interior of the country, the territory of New

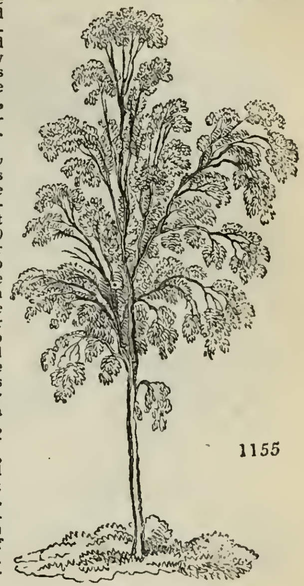


South Wales is, in its natural state, one vast forest. On the banks of the rivers, and especially on the alluvial land within the reach of their inundations, this forest becomes what the colonists call a thick brush or jungle. Immense trees of the genus Eucalýptus, such as the stringy bark (*fig.* 1154.), the Blue gum, E. piperìta (*fig.* 1155.), and the Iron bark, E. resinífera (*fig.* 1156.), tower upwards in every direction, to the height of 150 or 200 feet; while the cedar, and other trees of inferior elevation, with innumerable wild vines and other parasitical plants, fill up the interstices. In the sterile region, the trees are stunted in their growth, and of a most forbidding aspect; their trunks and naked branches being frequently blackened by the action of fire, as in the Eucalyptus (*fig.* 1157.). The soil of these regions is a white sand, and nothing can exceed the loneliness and desolation of the scene. (*Ibid.*)

1154

STRINGY BARK, 60 FT.

1155



BLUE GUM, 50 FT.

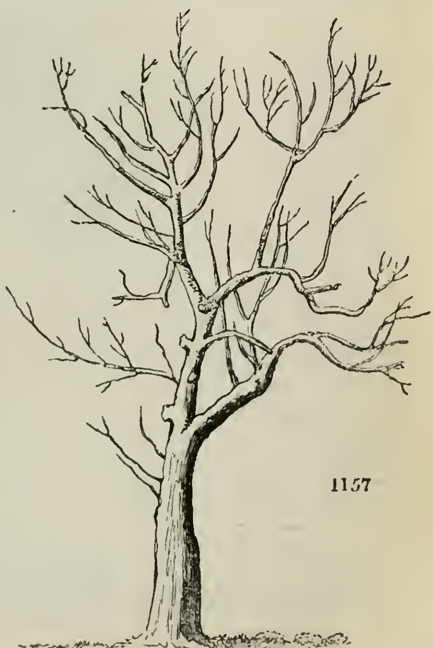
8038. *The settled portion of New South Wales*, in 1833, Sturt tells us, extended from the 36th to the 32d parallel of latitude. The population of the colony is said to consist of 45,000 free settlers, and 25,000 convicts. Its imports, in the year ending January, 1833, amounted to 602,032*l.*, of which 144,793*l.* was the value of commodities imported from foreign states, the rest being the produce of Great Britain and her colonies. The exports amounted to 384,344*l.*, of which 81,969*l.* consisted of British and foreign merchandise re-exported, and the remainder was the produce of the colony, the New Zealand fisheries, and the South Sea Islands. The chief articles of export, which were shipped to the mother country, were:— New Zealand flax, 806 tons, value 15,393*l.*; sperm and black oil, 3186 tons, value 142,921*l.*; and wool, 1,515,159 lbs., value 73,559*l.* In 1831, no less than 150 vessels entered the harbour of Port Jackson from foreign ports, the amount of their tonnage being 31,259 tons. (*Sturt's Expedition into the Interior of Australia.*)

8039.—1038. *The mineral productions.* Marble of a good quality, and which takes a beautiful polish, has been obtained in Argyle. In one part of its course, Hunter's River flows for a considerable distance over

1156

IRON BARK, 200 FT.

1157



OLD GUM, 70 FT.

rocks of jasper; and beautiful agates, opal, and chalcedony, besides innumerable petrifactions, are found on its banks. (*Hist. and Statist. Acount, &c.*)

8040. — 1040. *Natural productions of New Holland.* A peculiar character is given to the woods of the extratropical parts of New Holland, and to the woods of Van Diemen's Land, by the species of trees of the order Proteàceæ. These are numerous, and the leaves of the generality of them have a vertical position, and a similar aspect on both surfaces. These surfaces, a close inspection teaches, are distributed, by a reticulation of the fine veins of the leaf, into numerous small compartments or areolations, within each of which, on one face of the leaf, and very generally on both faces, is lodged a minute gland. (See *Brown's Supp. prim. Flor. New Holl.*)

1158

HONEYSUCKLE.

1159

APPLE TREE, 60 FT.

8041. *The vegetable productions of New Holland.* Some of the most common trees in the neighbourhood of Sydney are several of the different kinds of Eucalýptus (*fig.* 1154. to 1157.); what is there generally called the honeysuckle (Bánks*ia* integrifòlia) (*fig.* 1158.), the apple tree (Angóphora lanceolàta) (*fig.* 1159.), the forest oak (Casuarìna torulòsa) (*fig.* 1160.), and the grass tree (Xanthorrhæ'a arborescens) (*fig.* 1161.). The last is particularly beautiful. There are also the broom (Jacksòn*ia* scopària) (*fig.* 1162.), which is called the dogwood at Port Jackson, and the wood of which is very difficult to burn, and the tea tree (Melaleùca

1160

FOREST OAK, 30 FT.

1161

GRASS TREE.

linariæfòlia) (*fig.*1163.). The name of tea tree is given almost indiscriminately to several kinds of Melaleùca, and Leptospérmum, because it is supposed that the first colonists made tea from the leaves of some of the species of these genera. The terms blue, red, or white gum trees, as applied to different species of the genus Eucalýptus, refer to the colour of the bark. The wood of trees of this genus is very durable; as a proof of which, Dr. Lang informs us that a stump of a species of Eucalýptus (blue gum tree) remained quite sound for thirty-five years in the ground, after having been cut down. When it was

1162

BROOM, OR DOGWOOD, 12 FT.

1163

TEA TREE, 20 TO 30 FT.

necessary to remove it, it took a fortnight to burn out the root. The circumstance of this trunk remaining quite sound for such a great length of time is very remarkable; and reminds us of what Dutrochet states respecting the stump and roots of the silver fir (*Gard. Mag.*, vol. x. p. 408.); viz., that they will continue to live, and even grow, during a great number of years after the tree has been felled. (*Lang's Hist. and Statist. Account.*) All these cuts of Australian trees, and also the view (*fig.* 1153.) are from drawings kindly sent to us by our friend, John Thompson, Esq. of Sydney, a gentleman whose taste in landscape is not unknown to the readers of the *Gardener's Magazine.*

8042.—1041. *Agriculture in Australia* appears to be making considerable advances, from the more frequent influx than formerly of emigrants with capital. Some Scotch farmers have settled in the interior of New Holland; a good many have located themselves in Van Diemen's Land, and there are some even on the Swan River. In 1830, the Cashmere goat was imported into the colony by Mr. Riley, and about the same time a German gardener, that Mr. Riley took with him from England, established vineyards in different parts of the country, which, from accounts received in 1834, have already produced wine. (See *Gard. Mag.*, vol. x. p. 159.)

8043. *The principal agricultural products of New South Wales* are wheat and maize. The cost of clearing heavily timbered alluvial land is about 5*l.* an acre, but sometimes a single crop of maize clears the expense. The return of wheat varies from 15 to 40 bushels an acre, and in the Argyle district it has reached 45 bushels; but the system of husbandry is, generally speaking, wretched in the extreme. The staple article of Australian produce is wool, of which Dr. Lang says, 1,515,156 lbs., and Sturt, 2,500,000 lbs., were exported in 1833. It is generally supposed that John Macarthur, Esq. was the first to introduce fine-woolled sheep into the territory; and, though the honour is also claimed by another individual, there is no doubt that Mr. Macarthur had the merit of having demonstrated their adaptation to the climate, and the capability of the colony to produce wool to almost any extent. This has been effected in comparatively a very short space of time. About 1792, Mr. Macarthur commenced sheep-farming, and in a year or two, he had an opportunity of crossing his coarse-fleeced sheep with merino blood. So prolific was the mixed breed, that in ten years, a flock, originally consisting of not more than seventy Bengal sheep, had increased to 4000. In 1803, Mr. Macarthur went to England, carrying samples of his wool, which was so much approved of by a committee of manufacturers, that government were induced to encourage him in his attempts to produce fine wool in the colony, by directing that he should receive a grant of land for that purpose, in the low pastures, which is now named the district of Cambden. In 1806, Mr. Macarthur returned to New South Wales with two ewes and three rams, purchased by him from the merino flock of George III.; his flock was removed to the low pastures, and since that period, the wool of New South Wales has been rapidly increasing in value in the home market. (*Dr. Lang's Hist. and Statist. Account*, and *Sturt's Exped. into the Interior of Australia.*)

8044. *Fruits and other vegetable products cultivated in the colony of New South Wales.* Vines, which are the most important of the fruit-bearing plants to a young settlement, have only been cultivated a few years to any extent. "There are now, however, many acres of vineyard throughout the country;" and wine and brandy have been manufactured from grapes grown by Mr. Macarthur's sons at Cambden. The wine is very similar to the light wines of France and Germany. Tobacco has been grown to great extent, particularly on the rich alluvial lands, and is only inferior in point of manufacture. Olives, hops, indigo, and opium, are beginning to be cultivated: the castor-oil tree (*Ricinus commùnis*) grows luxuriantly, and oranges and all the genus *Citrus*, and figs and peaches, bear abundantly. The hedges to the fields are generally formed of quince or lemon trees. There are several orange orchards, producing annually from 12,000 to 20,000 dozen each. The fruit of the loquat (Eriobótrya japónica) is sold in great quantities in the Sydney market. Cotton, coffee, tea, and sugar have been tried, and found to answer, though their cultivation has not yet been attempted on a larger scale. (*Hist. and Statist. Account*, vol. i. p. 375.)

8045.—1042. *As a country for emigrants.* During Sir Thomas Brisbane's administration, any respectable person, who pledged himself to government to maintain and employ ten or twenty convict servants, could obtain 100 acres for each such servant. This occasioned a great demand for convict labourers; and, instead of government being obliged to establish penal settlements in order to employ them, there was, during the government of General Darling, "applications for no fewer than 2000 convicts lying unsatisfied at the office of the principal superintendent of convicts." There is no doubt that New South Wales is an excellent country for the agriculturist; but it is subject to some drawbacks. A season of drought, which continued three years, began in 1827, and it appeared from the statements of old natives, that the country was subject to periodical visitations of that nature. It is also subject to inundations, particularly from the Hawkesbury River. From the imperfect state of husbandry throughout the country and the fertility of the soil, much may, however, be done by an experienced agriculturist. For eight months in the year, from March to November, the climate is delightful; but during the Australian summer, the heat is considerable. The most unpleasant part of the year is during the prevalence of the hot winds. "These winds occur on an average four times every summer, and continue from twenty-four to thirty-six hours at a time;" the atmosphere feeling like a current of heated air from a furnace, and the thermometer generally standing at from 90° to 100°, and sometimes even reaching 112° of Fahrenheit. The extreme dryness of the air, however, prevents this degree of heat from being so intolerable as it would be in a moist climate like England. The hot wind is generally succeeded by a violent gust from the southward, and very often by a shower of hail. (Vol. ii. p. 186.) Very few persons live to attain old age; but they generally enjoy excellent health and spirits while they do live. In short, observes Dr. Lang, "the lamp of life in the salubrious climate of New South Wales is like a taper immersed in a vessel filled with oxygen gas; it burns more brightly than in the common air, but it is sooner extinguished." To persons possessing property to the amount of from 2000*l.* to 5000*l.*, "New South Wales presents a most eligible prospect for effecting a comfortable settlement. They may put out part of their capital at interest for ten per cent. on excellent security, and 1000*l.* will not only purchase 1000 acres of land at 5*s.* an acre (the selling price in 1833), but will be amply sufficient to stock it." (*Lang's Hist. and Statist. Account*, vol. ii. p. 200.)

8046.—1044. *Van Diemen's Land.* This colony may be considered as the most prosperous in Australia, and the suitableness of its climate for Englishmen is every year more and more confirmed. "The colony," Mrs. Prinsep observes (*Journal of a Voyage from Calcutta to Van Diemen's Land*), "contains every source of wealth and health, in short, every thing but money. Interest on mortgages, with the very best securities, is 15 or 20 per cent. Bank shares pay 16 per cent. There is no immediate prospect of any check to that rise in the value of land which is now observable. Money well invested in land here, and allowed to accumulate, will be tenfold its original value in fifteen years. 200*l.* would purchase a noble property here. 1000*l.* will buy a fine, healthy, and beautiful estate of 1200 acres, 200 of them already in cultivation, and the whole becoming more valuable every year. Corn and potatoes are exported to Sydney; and wool to England. Wool averages 6*d.* per pound. The whole colony is on the advance, and its resources remain to be developed. Fresh lands are granted in square miles, in the proportion of the square mile, or 640 acres, for every 500*l.* sterling of capital; which is the largest grant that is made to any settler without purchase, as the smallest is 320 acres. The total territory in acres is 15,000,000, of which about one half is rocky, or thickly wooded; the rest arable and pasture: the proportion of arable being as one to six of pasture. The total number of acres granted to individuals, up to December, 1829, is 1,323,523; consequently, there are 13,676,447 unlocated acres."

8047. *The wool of Van Diemen's Land* is of peculiar softness, and, from the greater attention now paid to cleaning and packing, the price is rising. Wheat is of a very superior quality, weighing generally about sixty, and sometimes as much as sixty-five pounds per bushel. Oats are beginning to be raised; barley has not yet succeeded; peas, and other species of pulse, are plentiful. Skins are also valuable; seal-skins the most so, being worth about 25*s.* each in England. Kangaroo skins are essentially useful in the colony for hats, and also for shoes, which are remarkably durable: when well packed, and of a good size, these skins fetch nearly 6*d.* a pound in London. Shoemakers make 100 per cent. on the raw material. (*Cape of Good Hope Lit. Gaz.*, vol. iii. p. 187.)

Egypt.

8048.—1077. *Egypt, under the government of the present pasha*, is undergoing extensive political improvements, among which agriculture, Mr. St. John observes, is not altogether forgotten. The culture of cotton has been commenced on a large scale by government; and an extensive tract of country round Cairo, which was long rendered useless by prodigious mounds of rubbish, many of them exceeding seventy feet in height, has been cleared, the mounds having been levelled, and planted with olive trees, which bore fruit the second year. The teak tree has been introduced from India, and is found to thrive near Cairo as well as in its native country. The mango, the pine-apple, and other tropical fruits, have been tried; and there is an English garden of naturalisation, under the direction of Mr. Trail, an English botanist. On the whole, there can be no doubt, that, if the present comparatively liberal policy of the Egyptian government be continued for another generation, the face of the country, and the condition of its inhabitants, will be entirely changed. Nature has supplied an excellent soil, and abundance of water, under a climate sufficiently hot to produce the produce of tropical countries, and yet not so much so as to prevent the grains of temperate regions from being profitably cultivated. (*Egypt and Mohammed Ali*, p. 443.)

Morocco.

8049.—1098. *Agriculture in Morocco.* The farmers plough and sow at the same time. The ploughing is performed by one man, who, while he guides the plough, which has a single handle, with his right hand, holds the reins, which are made of the palmetto twisted, and a long, thin, pointed stick to goad the oxen, in his left. When he sows, he leaves the plough, scattering the grain very sparingly with his right hand, and harrows it in by passing the plough again over the surface, the furrows being straight, narrow, and very shallow, without any ridge. The ploughshare has merely a simple tip of iron, which is taken off when the husbandman ceases to work, to prevent its being stolen. (*Brooke's Travels in Spain and Morocco*, vol. i. p. 303.)

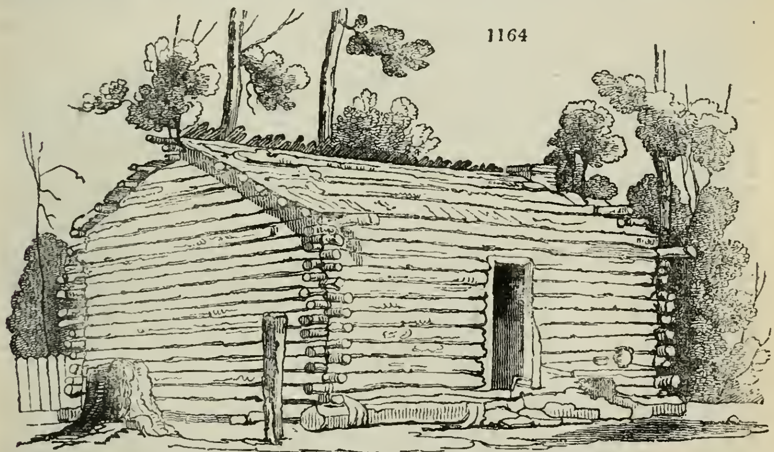
Cape of Good Hope.

8050.—1133. *Albany.* At the close of 1824, when this new settlement was hastening to dissolution, the commissioners of enquiry removed certain political evils, and the country at once commenced a march of success, which John Centlivre Chase believes "the most unparalleled in the history of colonisation." In August, 1833, the Caffre trade, chiefly in ivory, amounted to about 34,000*l.* annually; and the exports increased from 32,273*l.*, their amount in 1829, to 51,290*l.*, their amount in 1832. Hides, horns, skins, tallow, butter, salted provisions, and ivory, formed the principal items. Cultivation is extended. Oats, barley, and oat-hay are the chief commodities; wheat has also been raised, and Indian corn, fruit, and vegetables grow most luxuriantly. Cattle, sheep, and horses are abundant, and every necessary of life is extremely cheap. There are about 26,000 sheep, the wool of which sells at upwards of 1*s.* per pound. Graham's Town has increased from 22 houses to 600; and eight villages, eleven places of worship, and fifteen schools have been built. Hat, blanket, and tile manufactories, numerous limekilns, three water and six wind mills, two tanneries, and two breweries, have been established. There is an infant school, a savings' bank, a public reading room, and a commercial hall. A newspaper was commenced in January, 1832, and it is prospering. The population, in 1833, was 9913; and, as a proof that the country is favourable to human life, only 24 out of 248 persons, who landed in 1820, had died in 1830. "Such," says Mr. Chase, "is the result of thirteen years' settlement, nearly five of which were those of failure and distress. From what has been related, it may be seen, whether success has attended the efforts of the immigrants or not, their only difficulty, in as far as my own knowledge goes, is that of a want of additional labourers to gather in the harvest of growing prosperity; and, as a proof of this want, I refer to the many and frequent appeals to the home government, successively made since 1825, for a new emigration." (*The Cape of Good Hope Lit. Gaz.*, vol. iii. p. 182.)

America.

8051. — 1153. *Climate of North America.* Over the whole extent of North America, it is universally admitted that the clearing of the country has modified the climate; that this modification becomes every day more manifest; that the winters are now less severe, and the summers less hot; and, in other words, that the extremes of temperature observed in January and July annually approach each other. (*Jones's Jour.* Ap. 1834.)

8052. — 1159. *The soil of the United States* is adapted to almost every species of culture. Wheat grows everywhere; and tobacco, hemp, and flax between the Potamac and Roanoke and Mexican Gulf. All the grains flourish in the valley of the Mississippi; but it is particularly in the delta of that river (which, like that of the Nile, is the work of the waters) that the sugar-cane and indigo succeed best. Almost everywhere, the earth abounds in pasturage, but is not adapted to the growth of fruit trees, or only produces fruit tart and without flavour. The most productive kinds of culture are those of colonial articles and vegetables; a species of cultivation for which the Americans are indebted to the French of St. Domingo, who have taken refuge among them. They are also indebted to them for some seed and kernel fruits. The territories of the United States, with regard to agriculture, may be divided into two parts, perfectly distinct from each other. The lands bordering on the Atlantic are generally bad or middling; but those on the other side of the Alleghanies, in the basins of the St. Lawrence and the Mississippi, are not exceeded by the best lands in Europe; and have, besides, the advantage of being nearly all virgin, and easily cultivated. Vegetation is hardy, but prompt, which is occasioned by the humidity of the soil. (*Beaujour's Sketch of the United States*, p. 81.)



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8053. — 1192. *Climate of the Canadas.* John Young asserts, "that, 2000 years since, the climate of Europe was precisely similar to that of British America at the present day; in support of which he quotes many authors of antiquity. He attributes the change, first, to the extirpation of the forests and the draining of the morasses; secondly, to the increase of population, and consequent evolution of animal heat, and the warmth communicated to the atmosphere by the fires within the houses; thirdly, to the extension of tillage, the process of putrefaction alone generating considerable heat." (*Brit. Farm. Mag.*, vol. vi. p. 196.) *Fig.* 1164. is a specimen of the Canadian log houses, which have been well represented in the *Sketches*, &c., of Captain Hall, from which our cut is taken.

8054. — 1195. *Emigration to British America.* Mr. Ferguson, who visited Canada in 1831, says, "that Upper Canada certainly is blessed with all the solid appearance of human happiness, independence, and comfort." The notes of this gentleman are given at length in the *Quarterly Journal of Agriculture*, vol. iii., and well deserve to be consulted by all emigrants. In a work on *Emigration to British America*, by John M'Gregor, Esq., published in 1831, the British possessions in North America are stated to be the Island of Newfoundland, Cape Breton, and Prince Edward Island; the province of Nova Scotia, New Brunswick, and the Canadas; the region of Labrador and the territory west of Hudson's Bay. Newfoundland bears a striking resemblance to the Western Highlands of Scotland, and is chiefly adapted for the rearing of cattle and sheep. Prince Edward Island possesses an excellent climate and soil, and is, taken altogether, a most desirable spot for emigrants. "The society in the island is good, and the inhabitants consist of Europeans from all nations, but particularly from Scotland. Cape Breton is a small island, peopled by between twenty-five and thirty thousand souls, chiefly from the Western Highlands of Scotland." The climate, though humid, is salubrious; the general aspect of the country romantic and mountainous, and covered with forests; and the valleys contain extensive tracts of excellent soil. Nova Scotia is an extensive country, fitted to receive "thousands, perhaps millions, of emigrants." The winters are severe, but the air at that season is generally dry. This peninsula abounds with extensive fields of coal, with ironstone, with gypsum, and, it is believed, with rock salt. New Brunswick has a climate particularly suited to the constitution of Britons. The country is covered with immense forests of evergreen and deciduous trees, and it is everywhere intersected by rivers fit for navigation. Coal, iron, gypsum, and sandstone abound. The Canadas include an extensive territory, with a climate which is on the whole salubrious. The thermometer, in summer, rises as high as 80° in the shade, and in winter sinks below zero. The winter in Lower Canada is two months shorter than that of Upper Canada. The geology of Canada is little known; the principal rocks appear to be trap and limestone. There are soils of every description, but the largest tracts are either alluvial, or of a lighter character, approaching to sand. Labrador, and the territory west of Hudson's Bay, Mr. M'Gregor does not consider as suitable to emigrants. We can only refer the reader, who is desirous of emigrating, to Mr. M'Gregor's book; or to a very copious abstract of it which will be found in the *Quarterly Journal of Agriculture*, vol. iii. p. 880. to 924.

PART II.

AGRICULTURE CONSIDERED AS A SCIENCE AND AS AN ART.

8055. — 1285. *In the arrangement* of this division of the Encyclopædia of Agriculture, we endeavoured, in the first three books, viz., those on plants, animals, and the soil, to establish the science of agriculture; and in the succeeding two books, on the mechanical agents of agriculture, to describe the tools, instruments, machines, and other engines, and operations performed by them, which constitute the art. In this Supplement the chief additions to the scientific part will be found to be some paragraphs on mildew; some on the new theory of the rotation of crops (according to which plants are supposed to injure the soil by their excretions, instead of exhausting it of specific kinds of nutriment, as was heretofore conjectured); and some on humin, and on the management of manures. The additions to the mechanical part, or the art of agriculture, include a number of new implements or machines, and buildings; among which are, one of the most complete threshing-machines that has ever been erected; a very superior description of farmery; a hop kiln of a new and superior contruction; and some excellent designs for labourers' cottages.

8056. — 1294. *A plant*, Dr. Lindley observes, "is to be understood as a mass of individuals, each having its own peculiar system of life, growing together in a definite manner, and having a common organisation, but nevertheless capable of vegetating independently, and not unfrequently separating spontaneously from each other. These individuals are buds, each of which is perfect in itself, and exactly the same as all the others of the same plant. They are combined by means of a fibro-cellular substance called bark, which is to be understood as being composed of the cellular integuments of as many individuals as the plant may have developed buds. As the act of vegetation consists in the developement of a germinating body in two opposite directions; the one upwards, as stem, the other downwards, as root; every bud, when it begins to grow, must be subject to this law, provided it is the independent being which it has been represented to be. And, in fact, if a bud is separated from the system to which it belongs, it does follow this law of developement, as is well known to gardeners from their practice of propagating plants by buds and eyes. Now, if buds, when in a state of combination, undergo the same kind of developement as when isolated, as it is reasonable to suppose they do, it will be found that the fibrous and vascular tissue of the wood and bark, which always descends from the buds, really constitutes their roots; and that, consequently, the concentric circles of the wood and bark of dicotyledonous trees are congeries of roots formed by the annual developement of buds upon the surface of the plant." (*Jour. R. Institut.*, May, 1831, p. 479.) To those who are desirous of keeping up their knowledge of the physiology of plants, with the rapid progress making in that department of science, we would strongly recommend, as scientific works, *De Candolle's Physiologie Végétale* and Lindley's *Introduction to Botany;* and as popular works on the same subject, Mrs. Marcet's *Conversations on Vegetable Physiology, Main's Illustrations of Vegetable Physiology*, and Lindley's *Lady's Botany.*

8057. — 1515. *Influence of temperature on the germinisation of seeds.* Seeds in general will not vegetate in a temperature of 9° or 10° above zero. But, from some experiments lately related to the Royal Academy of Sciences at Paris, it appears that seeds of wheat, barley, rye, and beans, have been submitted for fifteen minutes to the temperature of the congelation of mercury, and yet germinated afterwards. The same seeds which lost their germinating power at 122° in water, preserved it to 143° in vapour, and 173° in dry air. The limit of germinisation varies with the duration of immersion. Thus, not more than one fifth of the seeds of wheat, barley, and rye would germinate after being kept for three days in water at 95°; the same seeds will germinate in sand slightly moistened at 113°. The germinative principle of cerealia and legumes is destroyed at 173° in fifteen minutes. In most seeds 122° will destroy the vital principle. In hot countries where the temperature of the soil is as high as 118°, and even 122°, the cerealia disappear; first the barley, then the wheat, and finally the rye. (*L'Institut.—The Printing Machine*, vol. i. p. 107.)

8058. — 1526. *Nitrogen gas.* Cruciferous plants exceed all others in the quantity of azote (nitrogen) which they contain; and, on account of this quantity of azote, ammoniacal principles are frequently obvious in their fermentation or putrefaction. To the same cause are, perhaps, to be attributed these two phenomena; first, that the cruciferæ yield more of nutritive matter than most other esculent vegetables; and, secondly, that they require, to produce them in perfection, a soil well imbued with animal matter, or a station contiguous to the residence of man. (*Dec. Syst.*, vol. ii. p. 142.)

8059. *Presence of azote in seeds.* M. Guy-Lussac remarks, "that some seeds contain azote is a well-known fact, since a substance of an animal nature may be extracted from them, as gluten from wheat flour; but he observes that he has nowhere seen it stated that all seeds contain animalised matter. To be satisfied that this is the case, however, it is requisite only to submit any seed to distillation, either in its natural state, or, what is better, deprived of its ligneous envelope. Nevertheless, ammoniacal products are not always immediately obtained by distillation. Rice, for example, gives a very acid product; but the presence of ammonia is easily proved by the addition of lime. Kidneybeans and many other similar seeds give a very ammoniacal product. In general, any grain, deprived of its envelope, may be considered as composed of two parts; one vegetable, which gives an acid product by distillation; and the other animal, yielding ammonia; so that the acid or alkaline character depends upon the predominance of one or other of these matters. M. Guy-Lussac submitted all grains which came in his way to distillation, and all of them gave ammonia, the greater number immediately, and the others after the addition of lime; and he considers that this circumstance will explain the nutritive quality of grain, and the astonishing fertilising property of seeds as manure, after the oil has been extracted from them." (*An. de Chim. et de Phys.*, May, 1833; and *Phil. Mag.* for May, 1834.)

8060. — 1534, 1535. *Fertility of soils.* The theory promulgated in these two paragraphs is, to a certain extent, at variance with the new doctrine of soils becoming poisonous by the deposition of excrement, which will be found given at length, in the section on the rotation of crops, § 2217. in the *Encyclopædia*, and § 8069. in this *Supplement.*

8061. — 1694. and 1708. *Blight and mildew.* The term blight is indiscriminately employed by empirical cultivators, and by the unscientific public generally, to plants injured either by fungi, or by insects, and sometimes even to diseased plants. If it is to be used at all, it would be more correct to use it adjectively in connection with the cause of the injury; as, for example, blighted by insects, by fungi, or by disease.

8062. *Mildew*, one of the greatest enemies that the agriculturist has to contend with, is nothing more than several species of parasitical fungi, which attack different kinds of plants, varying in their nature and appearance, according to the plants attacked; or, in technical language, being specifically different on different plants. The fungi, commonly called mildew, are divided into three classes: 1. Those which grow, or rather lie, on the surface of leaves, and which, perhaps, do not derive nutriment from the plant; 2. Those which are formed in the interior of the stem or leaf, and protrude themselves from it when ripe; and, 3. Those which only attack the roots. All are extremely simple in their organisation, and very minute in their forms; they seldom appear in the open air, but in autumn.

8063. *The first class, or mildew composed of those fungi that live on the surface of leaves*, injure a plant by preventing its respiration, but do not appear to draw any nourishment from it. One of the most common of these fungi is that called Sporótrichum, from *sporo*, a sporule, and *thrix*, hair, in allusion to the filamentous nature of its sporules. This is a very destructive parasite, and it is found upon a great variety of plants. The leaves and even fruit of peach trees are often attacked by it, and it is frequently mistaken by gardeners for an insect. Another very destructive superficial fungus is called Acrospòrium moniliöides (*fig.* 1165.), and it consists of a number of globules, attached to each other, which, when magnified, appear like the beads of a necklace, and in many cases are found standing upright. When ripe, these globules fall; and, taking root, form fresh strings, or necklaces, like the first. Sometimes little tufts of these globules appear fixed to stalks; and, from some fancied resemblance to the brushes used for sprinkling holy water, are called Aspergíllus. (*fig.* 1165.) The superficial mildew which infects the onion, and is very fatal to that plant, is called Bótrytis. Its name signifies a bunch of grapes; and it is thus called from a fancied resemblance between that fruit and its clusters of little globular seeds and seed-vessels. All these and many other superficial mildews are known by gardeners by the popular name of blight, and their devastations are frequently mistaken for those of insects.

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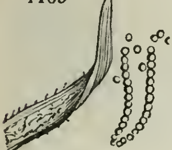

8064. *The second class of fungi, viz., those which spring from the interior of leaves and stems, are by far the most fatal.* These fungi generally appear in a sort of bag or case, which is supposed to be formed of the cuticle of the affected leaf; and they may be called hypodermous fungi, or internal mildew. One of the most common of these, is that which attacks the common cabbage (*fig.* 1167.), Cylindrospòrium concéntricum *Grev.* These very destructive fungi have the appearance of small white patches, or specks, of frosty incrustation, which, when magnified, are found to consist of a number of small cylinders, lying end to end, or across each other. These cylinders are all filled with seed, and burst when it is ripe, scattering it in every direction: wherever it falls upon the leaf it takes root, and thus the fungus spreads rapidly. The mildew which attacks rose trees and many other flowering shrubs is a kind of *Ur*èdo. This name, derived from *uro*, Lat., to burn or scorch, is applied to those occasional discolorations of the surfaces of plants which were formerly attributed to blights, or injuries from the atmosphere, and which have the appearance of a brown powder. *Ur*èdo effùsa *Grev.* (*fig.* 1168.) generally shows itself on the under sides of the leaves of the *Ros*àceæ, and spreads rapidly. *Ur*èdo *R*òsæ *Pers.* is another kind, which also attacks rose trees. The bean and pea are affected by a kind of mildew (*Ur*èdo *F*àbæ *Pers.*, *fig.* 1169.), which spreads along their leaves, like white roots curiously interlaced. From these roots spring a number of branch-like shoots, each bearing a ball-like head or brown berry, which, when ripe, bursts and discharges seed. An internal mildew, which infects corn, is highly injurious to the farmer. It is vulgarly called the pepper brand; and, when corn is attacked by it, it gradually consumes the substance of the grain, leaving in its stead only a dark powder, which has a very offensive smell. This fungus is found only on barley, and in this respect differs from the *Ur*èdo *S*égetum, or smut, which is destructive not only of barley, but also of wheat and oats. The *Ur*èdo *S*égetum, or smut, has been the subject of many interesting experiments by Mr. Bauer of Kew, whose discoveries will no doubt throw very considerable light upon the subject. It not only destroys the grain, which it converts into a kind of jelly, but it attacks the leaves and stems, always forming in the interior of the plant, and bursting forth when ripe. Corn is also attacked by a species of Puccínia; a very fatal kind of fungus, which always appears divided into cells. Puccínia Gráminis (*fig.* 1172.), which attacks corn, forms in the interior of the stalk; and, when ripe, bursts forth in clusters, like bunches of grapes, of a dark brown colour. Puccínia *R*òsæ *Grev.* (*fig.* 1173.) appears on the leaves of rose trees in little brown tufts, which, when opened and magnified, are found divided into extremely minute cells. The ergot on the rye (Spermœ'dia clàvus *Fries*) is a well known and very destructive species of internal mildew. It partakes of the nature of the truffle, and grows out of a spike of corn like a prolonged kernel. It is long, horny, and cartilaginous; and it consists of fibres closely interlaid. This disease evidently originates in the centre of the stem. It affects maize, various species of corn, and grass, and is often found in plants of yellow gentian, &c. Hawthorn trees are attacked by a species of Æcídium, which at first appears merely a point made by an insect; but afterwards looks like fungi (Æcídium laceràtum *Dec.*, *fig.* 1170. *d*). The sycamore fungus is a black spot consisting of oblong purplish bodies, yellow inside, and containing tubes filled with seeds. Æcídium Grossulàriæ *Dec.* (*fig.* 1170. *b*) attacks gooseberry bushes, and Æcídium cornùtum (*fig.* 1170. *c*), the mountain ash: both spread rapidly, and are very difficult to cure. The oak is attacked by a species of Æcídium, different varieties of which are found on many kinds of forest trees. The Æcídium *P*ìni (*fig.* 1170. *a*), found on pine trees, has, when magnified, the appearance of a number of ninepins. When ripe, the cuticle which covers the fungus bursts, and emits a powder of a bright orange colour, which is the seed. It is a vulgar error to suppose that a berberry tree (*Bérberis* vulgàris *L.*), if planted in a cornfield, will, if infected with mildew, communicate the disease to the corn. This cannot be the case, as the mildew which attacks the berberry (Æcídium *Berbéridis* Pers., *fig.* 1170. *c*) is quite different from any of the fungi which are found on corn. The berberry mildew, when magnified, is found to consist of a number of small orange cups with white films over each. When ripe, these lids burst, and the top of the cup assumes a ragged uneven appearance, like white fungi. Each cup has within it a number of little boxes containing seeds. The mildew on the pear tree is called Æcídium cancellàtum,

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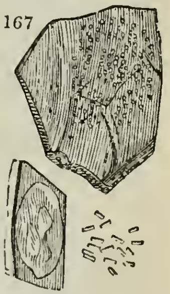

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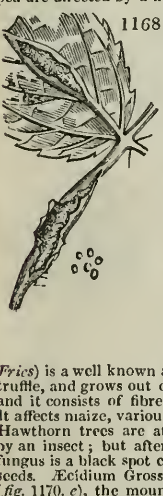

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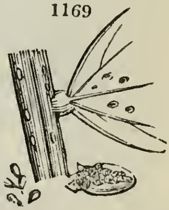

(*fig.* 1171.) In this figure, *a* is a leaf with the Æcidium becoming developed; *b*, a leaf bearing the Æcidium fully developed; *c*, portion of a leaf with the Æcidium farther developed; *d*, section of a

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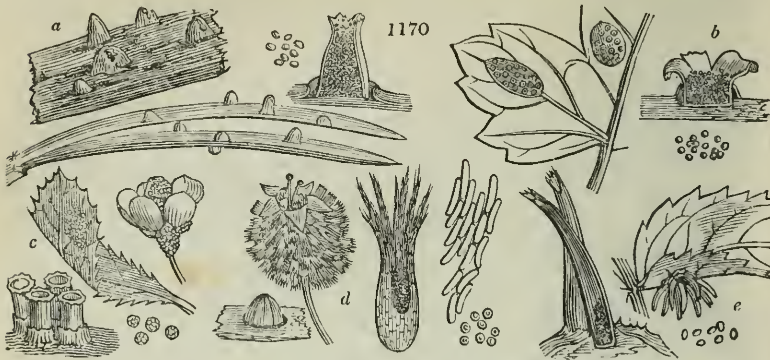

leaf, to show the fleshy thickening that accompanies the developement of the Æcidium; *e e*, seeds of the Æcidium: a seed is called a sporidium; in the plural, sporidia; *f f*, plants of the Æcidium: each is

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called a peridium; in the plural, peridia. The Æcídium cancellàtum first appears like mucus, but consists of a number of hairy substances. These hairs, when magnified, appear like a collection of granules of a bulbous shape, each containing a number of balls connected by strings. The balls, though so minute as to be scarcely perceptible by the eye, are yet only receptacles for seed. This is a most destructive fungus: it always seizes on the veins of the leaves, which afterwards turn yellow, and fall off; the branches next wither, and in two or three years a whole orchard is destroyed. Mr. Knight, in 1832, suffered severely from this fungus, and has tried many experiments respecting its cure.

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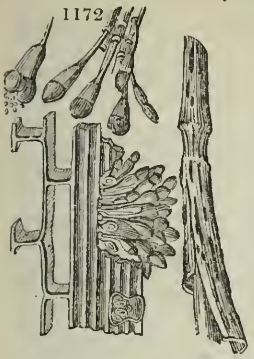
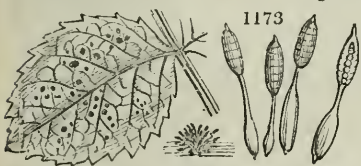


8065. *The principal fungi of the third class, or those which attack the roots of plants*, are two; and both closely resemble truffles. One of these (Rhizoctònia Crocòrum, *fig.* 1174.), which is of a brownish yellow, attacks crocuses; and, in those countries where the crocus is cultivated for its saffron as an article of commerce, it makes great ravages. It is called by the French *la mort du safran*, and soon destroys a whole crop. The other fungus (Perìola tomentòsa) is found on the potato, lucern, &c. It turns the roots, which are naturally white, of a purplish hue. Its ravages are often attributed to grubs. Both these fungi appear to be propagated by spawn, or fibres which spread through the earth, and cling round the roots which they find in their way.

8066. *Remedies for mildew.* All these mildew fungi are very easily propagated, from the rapidity with which they arrive at maturity, and the immense numbers of seeds which they produce. Most of them require only twenty-four hours from the first springing of the plant to the ripening of its seed; and the number produced by each may be guessed from the circumstance of one mushroom being sufficient to propagate 250,000,000. The extreme minuteness of the mildew fungi renders them still more numerous. The first class, or the superficial mildew, appears to be communicated by the air, the seeds when ripe being carried by it from one plant to another, and establishing themselves wherever they touch. They destroy a plant by covering the surface of its leaves, and thus preventing respiration. Plants are generally most affected by superficial fungi after a long drought, when the fibres of their roots are unable to imbibe sufficient moisture from the soil, and the plant thus becomes debilitated, and affords an easy prey to the parasite which attacks it: as a proof, in Scotland, where there are heavy night dews, this fungus is unknown. The cure for this species of mildew seems evidently to be abundant watering. Some onions attacked in a dry season by Bótrytis were nearly cured by abundant watering; and the progress of the disease was effectually checked. The internal mildew requires diametrically opposite treatment. This mildew evidently cannot be communicated by the air, since it always appears to spring from the interior of the plant, and to be at first covered with a thin skin, from which it does not burst till it is ripe. It is impossible, therefore, that this kind of mildew can be communicated externally, and yet the fact that it is contagious is so clear as not to admit a doubt. The only manner in which it appears probable that it can reach the interior is through the roots. The seeds, when ripe, fall upon the earth, which becomes contaminated by them, and they are sucked up by the spongioles of the roots. The correctness of this hypothesis is proved by sowing clean seeds in infected soils; and the young plants from these seeds springing up with the disease upon them. The circumstance of its always attacking the most vigorous plants is thus also explained, as it is evident that, the more rapid the circulation, the greater is the probability of extraneous substances being drawn up with the moisture imbibed by the roots. It is also clear that, in this case, water must aggravate the disease; as, by exciting the plant to suck it up, it would increase the danger of the seeds of the fungi being drawn in with it. The only cure for this fungus seems to be that adopted by Mr. Knight with his pear trees; viz., taking them up, washing the roots quite clean from every particle of soil, and then replanting them in quite a different part of his grounds. Red plants are said to be more liable to mildew than any other. Red is, indeed, supposed, by some, always to indicate a morbid action, as it shows that the plant is unable to absorb carbonic acid gas from the atmosphere, which is necessary to its perfect health; at all events, it is a proof of disease when leaves, or any other parts of a plant, not naturally red, assume that colour. Other experiments have been made for curing, or at least preventing the spread of, the internal mildew; and Mr. Bauer has found that steeping grains of corn in limewater will produce the desired effect. There appears no cure for mildew in the roots, but by cutting a deep trench round the infected plants, and cutting off all communication between them and the rest of the field. (*Gard. Mag.*, vol. ix. p. 332.)

1173



1174

8067. — 1732. *Elevation*, by occasioning a material difference in atmospheric pressure, has a considerable effect on mountain plants; and, according to Professor Dobereiner, is the chief cause of their diminutive size. Experiments have been made to prove this by placing seeds of barley in vessels, containing soil, water, and air, under different degrees of atmospheric pressure; and the result has been, that, where the pressure was greatest, the vigour of the plants was greatest also. (*Ency. of Gard.*, edit. of 1834. § 1746.)

8068. — 1832. *Cross impregnation of the different kinds of corns is an important operation with a view to produce new varieties.* It is thus performed with the gramineous plants: — The first day "that wheat, oats, or barley comes into ear, let the farmer select a few stalks, as breeders; and, with the forefinger of his left hand, pressing gently on the point of the chaffy cover, let him force it open; and, with a pair of small pointed scissors in the right hand, let him cut out the three yellow anthers, not yet opened, and let the chaff spring back to protect the stigma and embryo grain. After four days, let him return to the same stalks with the male flowers, or parts of the flowers, of the variety with which he means to cross, open up the glumes as formerly, and dust the stigma gently with the pollen. One stalk of barley, oats, or wheat, treated in this manner, and the grains carefully sown, may produce several new improved varieties. Peas and beans, too, have their parts of fructification concealed by the papilionaceous corolla, and by similar treatment may produce similar results." (*Quart. Jour. Agr.*, vol. iii. p. 666.)

8069. — 2217. *A new theory of the rotation of crops* has recently been promulgated by M. De Candolle and others. The originator of this theory appears to have been M. Brugmans, who, having placed some living plants in dry sand, saw some small drops of water exude from the extremity of the radicles. It appears that exudations of this kind are, if not always, at least frequently, excretions, or parts of the juices, which, not having served for nourishment, are rejected by the inferior parts of the vessels of plants. This idea first suggested to M. De Candolle a new theory of the rotation of crops, which has been confirmed to a certain extent by the experiments of M. Macaire. M. De Candolle assumed it as highly probable that the exuded matter from the roots of plants may be considered as their excrement, and that it would be as unreasonable to feed plants on their own excrements, as to feed animals on theirs. The particles which have been deleterious to one genus of a tribe or family of plants, cannot, he thinks, but prove injurious to all the individuals composing that tribe or family; while at the same time he thinks it probable that these excrements might not only be innoxious, but even nourishing, to others. If this opinion be founded on fact, it will easily account for the circumstance of one kind of corn crop being injured by immediately succeeding another.

8070. *M. Macaire*, to subject these theoretic views to the test of experience, has made many experiments to prove that vegetables exude matter from the roots; and these are related by him in a memoir inserted in the *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève.* (See *Edin. New Phil. Jour.*, No. xxviii. p. 215.) After various attempts to raise plants in pure siliceous sand, pounded glass, washed sponge, and on white linen, he decided upon pure rain water. After cleansing and washing the roots thoroughly, he placed them in vials with a certain quantity of pure water. After they had put forth leaves, expanded their flowers, and flourished for some time, he ascertained by the evaporation of the water, and the use of chemical reagents, that the water contained matter which had exuded from the roots. He satisfied himself that this is the fact with respect to nearly all those plants which display their flowers. Several plants of Chondrílla murǎlis, perfectly clean, were placed with their roots in pure water. At the end of a week, the water was yellowish, it emitted an odour like opium, and had a bitter taste. Subacetate and acetate of lead produced a brownish flocculent precipitate, and a solution of gelatine disturbed its transparency. As a proof that this matter was an exudation from the roots, it was found that neither pieces of the root, nor of the stem, when macerated in the water during the same time, occasioned either taste, smell, or precipitate. To prove that plants employ the excretory power of their roots, in order to get rid of hurtful substances which they may have imbibed, the following experiments were made:— Some plants of the *Mercuriàlis* ánnua were washed in distilled water, placed so that one portion of their roots dipped into a weak solution of acetate of lead, and another branch of the same root into pure water. Having vegetated in this manner very well for several days, the water was tested by hydrosulphuret of ammonia, which proved, by the black precipitate which it formed, that a notable portion of the lead had been absorbed, and deposited by the branch which dipped into the water. Groundsel, cabbage, and other plants, gave the same results. Some plants grew very well for two days in acetate of lead. They were then withdrawn, their roots well washed with distilled water, which, being afterwards tested, was found to contain no lead, and then placed to vegetate in rain water. In the course of two days this water was found to contain a small quantity of acetate of lead. The same experiments were made with limewater, which, being less injurious to plants, is preferable to lead. The roots being partly placed in limewater and partly in pure water, the plants lived well, and the pure water soon showed the presence of lime by the oxalate of ammonia; and the plants which had grown in lime, and then been transferred with every precaution to pure water, soon disgorged into it a portion of lime. Similar trials were made with a weak solution of marine salt, and with a like result. There can be no doubt, then, that plants have the power of rejecting, by their roots, soluble salts which are injurious to vegetation. Experiments also proved that the roots exuded a greater excess of matter during night than in the day. As it is well known that the light of day causes the roots to absorb their juices, it is natural to suppose that, during the night, absorption ceases, and excretion takes place.

8071. *The inferences which M. Macaire would deduce from his experiments*, are, that the greater number of vegetables exude by their roots substances unfit for their nourishment; that the nature of these substances varies according to the families of plants which produce them; and that some being acrid and resinous may be injurious, and others being mild and gummy may assist in the nourishment of other plants. (*Quart. Jour. Agr.*, vol. ii. p. 320.; *Gard. Mag.*, vol. x. p. 12.)

8072. *The reasonableness of this theory of the rotation of crops* seems to be generally allowed by vegetable physiologists; and it is even alleged that it had occurred to the mind of Lord Kaimes, who remarked that plants exhaust or defile the soil chiefly when forming or ripening their seeds. "Culmiferous plants," this writer observes, "when not allowed to come into flower, draw little nourishment from the soil; but by the time they have begun to ripen their seeds, all their leaves are withered, and they depend entirely upon the soil for a supply of nutriment." Mr. Towers, an English writer on gardening, seems also to have hit upon something like this theory, when he noticed that two crops of raspberries, in immediate succession, cannot easily be maintained, even with the assistance of abundance of manure. An ingenious writer in the *Quarterly Journal of Agriculture* (vol. iv. p. 880.) is inclined to think that plants exude matter from their roots only when they display their flowers, when they form or ripen their seeds, or when they die. Onions, he says, and all garden vegetables which are not permitted to produce seeds, may be cultivated in the same plot of ground year after year, without the assistance of manure; but not peas, beans, kidneybeans, &c., because they are required to form their seeds. This writer accounts for the raspberry defiling the soil from its wood dying every year after having yielded its fruit. However, there are difficulties in the way of this theory when it comes to be applied to trees and shrubs, and such plants as the saintfoin and lucern, that it will require time to overcome. (See *Gard. Mag.*, vol. x. p. 12.) We are informed, that Professor Daubeny of Oxford is engaged in a series of experiments on this subject; and, from the acknowledged eminence of that philosopher, both as a chemist and as a vegetable physiologist, the result to which he arrives will probably determine the value of the hypothesis, for theory it can hardly with propriety be called, since it has not yet been proved to be generally applicable. Notwithstanding this, however, a writer in the *Quarterly Journal of Agriculture* (vol. v. p. 1.) has endeavoured to explain the advantages derived from fallowing, paring and burning, irrigation, and draining, on the principle of freeing the soil from the excrementitious matters deposited in it by plants; an hypothesis too absurd to need contradiction.

8073.—2226. *A new theory* of the operation of animal and vegetable manures has lately been promulgated by some German philosophers. According to this doctrine, before putrescent manure can be absorbed by the spongioles of the roots of plants, it must become *humin*, which appears to be carbon in a particular state of decomposition.

8074. *Humin.* Of all the different ingredients of which manures are composed, carbon is supposed to be that which holds the first rank as a food of plants; but it is only in a state for this after it has united with the carbonic acid of the air, and the compound so formed, on being dissolved, is taken up by plants as food. This substance was called *ulmin*, on account of its being first found in the diseased part of an elm; but M. Sprengel gave it the more general term of *humin*, because he found it to exist in soils. Humin is a substance not unlike carbon, for which it has hitherto been mistaken. It is very soluble in spirits of wine, concentrated sulphuric acid, ammonia, and by heat in acetic acid; but it is insoluble in water, and water throws it down in all its solutions. It combines with all the salifiable bases, and forms the *humic acid*: but it has no acid taste; does not redden vegetable blues, &c.; like the gallic acid, it contains only carbon and water, without excess of oxygen. There is a strong analogy between humin and other nutritive substances, such as gum or fecula. It forms a humate with an alkali, which is very soluble in water. All substances which contain carbon are dissolved in the water of vegetation, through the means of humin; and the dissolved mass is taken up by plants as food. Humin in combination with lime, ammonia, or potass, also becomes soluble in soils or dung. (*Quart. Jour. Agr.*, vol. iv. p. 260.)

8075.—2241. *Noir animalisé.* The charcoal obtained from wood, coal, or peat, by burning in close vessels, after being powdered, is found to act like chloride of lime in absorbing bad smells. In consequence of this, it has been mixed by the French with those descriptions of manures which give off the most offensive odours, and the manure so formed, which is said to be highly fertilising, is sold under the name of *Noir animalisé*. This discovery was made by M. Salmon in 1831, who has obtained a patent for it, and manufactures it on a large scale. M. Bella, of Grignon, an eminent French agriculturist, tried this manure against the *poudrette* (dried night soil), and found it one fifth part more powerful. (*L'Agronome*, vol. i. p. 126.) An improvement has been made in this manufacture by M. Damart-Vincent, by which it is sold cheaper than the *poudrette*, or at about five francs for nearly two cwt.. (*Ibid.* p. 251.)

8076. — 2243. *Dutch ashes* are procured by burning bricks made from the mud found at the bottom of ponds, from which peat has been dug. According to an analysis by Professor Brande, they contain, in every 100 parts, siliceous earth, 32 parts; sulphate of lime, 12 parts; sulphate and muriate of soda, 6 parts; carbonate of lime, 40 parts; oxide of iron, 3 parts; and impurities, &c., 7 parts. These ashes are extensively used in Flanders, especially as a top-dressing for clover, at the rate of nineteen bushels per imperial acre. They are also sown on wheat and pastures in March and April; on oats and beans in the beginning of May; on rye in October and November; and in gardens at most seasons. A bushel of these ashes weighs forty pounds; and, as they can be sold in British seaports at *3l.* per ton, the expense of manuring an acre with them will not exceed *1l.* (*High. Soc. Trans.*, vol. x. p. 110.)

8077. — 2248. *Bone dust* is usually applied at the rate of two quarters per imperial acre; but by mixing it with finely sifted coal ashes one quarter per acre, it is alleged, may be rendered nearly as effective. When bone dust is used in any quantity above two quarters per acre, it does not produce a corresponding increase in the bulk of crops. The energies of bone dust as a manure is thus explained. The decomposition of the dust in the soil, which is rapid, disengages the phosphoric acid, and the lime and animal carbon is left to be acted on by the air; and these substances being converted into humin readily form a soluble mass, which is taken up by the water of vegetation, and becomes the food of plants.

8078. *Bone manure as compared with stable manure.* By an experiment conducted on a soil somewhat clayey, it appears that, while a Scotch acre manured with sixty bushels of crushed bones produced twenty-four tons of Swedish turnips, an adjoining acre manured with thirty cart-loads of stable manure produced twenty-nine tons. (*Quart. Jour. Agr.*, vol. iv. p. 636.)

8079. — 2270. *Application of recent manure.* The opinion and practices of British farmers have always been at variance with the theory of Sir Humphry Davy on this subject; though it would appear that Sir Humphry believed the farmers to have been converted. " Many," he says, " who have doubted, have been lately convinced; and perhaps there is no subject of investigation, in which there is such a union of theoretical and practical evidence." (*Lect.* VI.) It appears, by two articles lately published in the *Quarterly Journal of Agriculture*, that the Scotch farmers are as much opposed to Sir Humphry's theory as ever. " In theory," it is there stated, " dunghills should be kept dry and cool till they are applied to the land; because, if dung cannot be immediately applied to crops, the destructive fermentation should be prevented very carefully; and, if dung has been fermented till it becomes a mere soft cohesive mass, it has generally lost from one third to one half of its most useful constituent elements. In practice, on the other hand, dunghills are quite exposed to the weather, because all dry litter which has been even decomposed a little, such as that under sheds, in which the cattle are accustomed to lie all night, or an unmixed mass of horse dung, is found to be of itself a worthless application to any crop. These substances should be mixed by turning them over among the wetter cattle dung, so that the whole mass may be fermented to an equable consistency. Practice has also discovered, that the crop of turnips will be risked altogether, if well-fermented dung be not employed. Indeed, many farmers maintain that it cannot be too much fermented for the turnip crop. Two years' fermented dung is kept on purpose, by many who have abundance of straw, to apply to the raising of Swedish turnips; and, certainly, the shorter the dung is, the more quickly will the plants push through the ground, and the more healthy and heavy are the turnips likely to be. Fermented dung is more and more applied every year, even to the potato crop, which was for a long time supposed to do best when immersed among rank dung. In true potato soils, the crop is decidedly better when it is raised with fermented dung. Fermentation is also found useful in killing the vegetative power of the seeds of weeds, or grains of corn, that may have passed away among the straw. 'Thus we see from the evidence' which we have adduced, that there is not only no 'union,' but a decided opposition between the theoretical and practical methods of treating and applying putrescent manures." (Vol. iv. p. 78.)

8080. *There are other objections to the use of recent farmyard manure*, of a less important nature: such as the difficulty of burying it, and, when buried, its liability to be dragged up by the harrows; but principally the tendency which littery dung has to render the land on which it is laid too open, and thus subjecting it to the danger of being burnt up in dry weather. (*Quart. Jour. Agr.*, vol. iv. p. 78.)

8081. *The practical farmer*, in consequence of these reasons, and notwithstanding the experiments made by Sir Humphry Davy, and detailed in § 2238. and § 2239., continues to prefer using manure in a highly fermented state, so as to be what in practice is called short muck. In defence of the practical man, it is contended, that the decomposition of a dunghill does not throw off the most valuable and the most efficient parts of the dung, but chiefly vapour of water. It is allowed by those advocates, that when the texture of the fibrous part of farmyard manure begins to decompose, there will be an evolution of some of the gases which constitute the food of plants: " but what harm," it is asked " occurs to the dung as a manure from the escape of these gases? None whatever. We are told that the gases constitute the food of plants; and that, if they are permitted to be dissipated by decomposition, the quantity of nourishment in the heap of manure will of course be so much diminished; and that, if the bulk of the dunghill be lessened one half, or one third, by excessive fermentation, the quantity of nourishment to the crops will be diminished in a greater ratio." Still it is contended, that, though some of the gases which constitute the food of plants are disengaged from fermenting stable manure, yet that it does not follow that plants will receive them as food directly that they are disengaged. On the contrary, it is considered that they would either reject food in that state; or, if they could not avoid taking it in, that they would be injured by it. " Accordingly, we invariably find that plants suffer from their contact with fermenting dung, and it is this well-known fact, more than any other circumstance, which deters farmers from applying dung in an unprepared state." What has experience determined as the least injurious state in which dung can be applied to any crop? The cultivator answers, in the state of short muck, that is, " a soft cohesive mass," capable of being cut with a spade. What state has the cultivator determined to be the best for putrescent manure to be in when applied to soil not under crop, but which is to be sown or planted some days or weeks afterwards? A determinate answer to this question, founded on experience, has not yet been given. Farmyard manure is sometimes applied to fallows in an unprepared state, but always a considerable time previously to the seed being committed to the soil.

8082. *The propriety of the farmer's practice in applying dung in the state of short muck* is thus given in the work above quoted: — " In 1802, the celebrated Klaproth received from Palermo a substance which exuded spontaneously from the bark of a species of elm, and to which Dr. Thomson gave the temporary name of *ulmin*. It dissolves speedily in a small quantity of water, in which respect it is like a gum: but when the solution is very much concentrated by evaporation, it is not in the least mucilaginous or ropy; nor does it answer as a paste, and in this respect it differs essentially from a gum. When a few drops of nitric or oxymuriatic acid are added to the solution, it becomes a gelatinous mass; which, when slowly evaporated to dryness, and heated with alcohol and again evaporated, leaves a light brown bitter and sharp resinous substance. Thus it appears that ulmin, by the addition of a little oxygen, is converted into a resinous substance. In this new state it is insoluble in water; and that a substance soluble in water should assume the resinous form with such facility, is very remarkable." (*Thomson's Chemistry*, vol. iv. p. 696.) " Berzelius has found this curious substance in all barks; Braconnot, in sawdust, starch, and sugar. But, what is more to our purpose, Sprengel and Polydore Boullay have found it to constitute a leading principle in all soils and manures. Sprengel appropriately calls it *humin* from its existence in all soils, *ulmin* being given to it by Dr. Thomson as a temporary name." (*Quart. Jour. Agr.*, vol. iv. p. 620.)

8083. *Humic acid and carbonic acid gas*, mixed with water, constitute, according to this discovery, the chief food of plants. Every description of manure is only valuable in proportion as it contains these substances. Humic acid is found in abundance in putrescent manure when it is so far rotted as that it may be cut with a spade. It has been proved that rotted dung contains much more carbonic acid gas and humic gas, weight for weight, than fresh dung. Fresh dung is injurious to vegetation in consequence of its ammonia; which, from its acridity, in practice is said to burn plants. Ammouia becomes concentrated in stale liquid manures, and such manures are, therefore, mixed lightly with water, " in order to dilute the ammonia, and allow the proper action of the humic acid, which exists in large quantity in them." Covering a dunghill with soil in hot weather " is now explained, not as it has hitherto been, viz. by asserting that the earth absorbs and prevents the escape of the carbonic acid gas, which it could no more do than a balloon made of gauze could prevent the escape of hydrogen gas (*Grisenthwaite*); but that a violent fermentation in the dung is checked by the earth partly excluding the atmospheric air and rain water, the oxygen in either of which is indispensable to continue the process of forming carbonic acid gas by uniting with the dung. With regard to composts, it is found that to mix lime with fresh or rotten dung is to waste it; because the lime takes up and renders useless the carbonic acid gas which it contains. In like manner, a compost of fresh dung and weeds, green leaves, grass, turf, and green vegetables, without lime, is valuable; because all these substances supply abundance of *humin*. On the other hand, lime promotes the fermentation of peat earth, dry leaves, and every thing which contains hard woody fibre and supplies *humin* in quantity." (*Quart Jour. Agr.*, vol. iv. p. 623.)

8084. *Such are the two leading theories* of the operation of putrescent manures; in the application of which, the farmer must take especial care not to err on the side of over-fermentation. It is a fact well known to gardeners that the black spit dung of old hotbeds, however moist, is not nearly so powerful a manure as dung in a comparatively recent state from the farmyard. For our own part, we are inclined to place the happy moment of application in a middle point between littery dung, which can only be lifted with a fork, and rotten dung, which can be easily cut with a spade. It will thus appear that we neither agree entirely with the theory of Sir Humphry Davy, which is also that of M. Chaptal in the edition for 1820 of his work entitled *La Chémie appliquée à l'Agriculture*, nor with the theory of *humin* of Klaproth, Sprengel, Thomson, and others.

8085. — 2306. *Common salt as a manure.* Much as has been written on this subject, a pamphlet has recently appeared by Mr. Kemp, *On the Important Discovery of the Decomposition of Common Salt, for the Purposes of Manure: whereby an acre of land is prepared for the reception of any crop, at a cost of* 10*s. only.* The author states that, while farmyard dung produces twenty bushels of wheat per acre, decomposed salt will produce from thirty-five to forty bushels. He anticipates the whole produce of the kingdom increased fully one third by his discovery; but, before he makes it known, he expects to be remunerated by a handsome subscription, or by parliament. (See *Gard. Mag.*, vol. x. p. 233.)

8086. — 2307. *Universal compost.* The following ingredients and quantities, it is said, will afford a sufficient dressing for an acre of land: — Fifty pounds of vegetable alkali, viz., English, Russian, or American potash; thirty-six pounds, viz., four gallons of oil of any kind; one hundred and twelve pounds, viz., two bushels of common salt; fifty pounds, or about a bushel, of quicklime. Mix the whole together, the alkali and salt having been previously dissolved in water, and reduce the whole to such a degree of liquidity that it may be poured from the rose of a watering-pot on as much light porous soil as will absorb it. After this compost has lain some time, it may be carted out, and spread over the acre to be manured; but if there is a proper water cart (*fig.* 348.), this manure may be sprinkled over the land in its liquid state. (See *A Dissertation on Soils and Manures.*)

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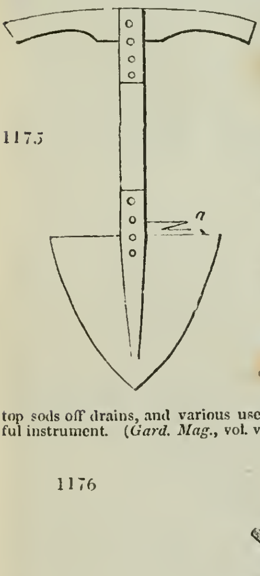

8087. — 2308. *Saltpetre* has been tried on wheat, grass, and oats at the rate of $1\frac{1}{4}$ cwt. per Scotch acre. It was sown on grass land, on the 28th of March, 1829; and in ten days afterwards the grass was of a deep green, and was fit for pasturage before the rest of the field. It appeared also to improve the quality of wheat and oats by producing the more green vegetation. It ought to be applied when the land is moist. (*Highland Soc. Trans.*, vol. viii. p. 195.)

8088. — 2444. *The under-foot spade* (*fig.* 1175.) should be made very strong; the shaft, or handle, should be square, with the angles rounded off, and strongly plated over where it is joined to the cross-angle at top, and to the blade below. The blade is about fourteen inches across, and twelve inches deep; quite perpendicular, with sharp cutting edges, and a hilt or piece of iron (*a*) riveted on for the feet. For the stuffing up of hedges, taking the top sods off drains, and various uses where strength is wanted, this spade will be found a most powerful instrument. (*Gard. Mag.*, vol. vii. p. 86.)

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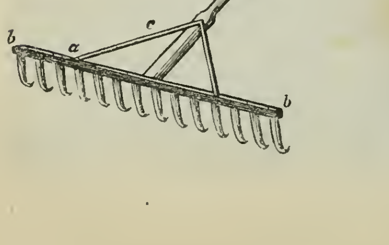

8089. — 2452. *The corn rake* (*fig.* 1176.), for using after the scythe, differs from the common rake both in form and dimensions. The head (*a*) of the corn rake should be made of fine ash; as light as possible, but strong enough to bear the driving in of a number of iron teeth; and it should be at least five feet in length, and feruled with iron at both ends (*b b*). The teeth should be seven inches in length, and four inches apart, and so curved at their points, that the weight of the rake may rest upon the curve, with the points of the teeth quite free of the ground, when the rake is held in a working position. The points of the teeth should be thin and broad. The handle of the rake may be of light fir, and it should be full six feet in length. An iron (*c*), passing from the handle on each side to the head, will prevent the latter from being twisted out of its position. A short handle, *d*, like the left handle of the scythe, and fastened at a convenient spot on the shank with an iron wedge, will facilitate the passage of the rake over the ground. (*Quart Jour. Agr.*, vol. iv. p. 363.)

8090. — 2462. *The Spanish hoe.* A modification of this instrument has been made by Lord Vernon, to which he has given his name. (See *Gard. Mag.*, vol. ix. p. 508.) The hoe is manufactured at Sheffield of different sizes, and is an excellent implement for stirring the soil; because, from the pointed form of its blade, it goes much deeper with the same exertion of force than any of the thrust or draw hoes. It is, in fact, a kind of pick, like the hoe picks used in France and Spain in stirring the soil among vines.

8091. — 2481. *The reaping-hook.* It is observed by the author of an excellent article on reaping with the scythe, published in the *Quart. Jour. of Agr.*, vol. iv. p. 350., as a remarkable circumstance in the history of mechanical science in Britain, that the art of cutting down corn crops should be so inadequately supplied with instruments. The reaping-hook, unlike every other mechanical instrument, depends entirely for its efficacy on the physical powers and dexterity of the labourer. The knife and the spade are as simple in their forms as the reaping-hook; and yet the former has been displaced by many mechanical contrivances, while the reaping-hook remains in all its primitive simplicity. Its continued use in the field is attended with immense loss of time and money; and, therefore, till an efficient reaping-machine is invented, it is proposed to substitute, in many cases, the scythe in its stead. The scythe is used, for this purpose, in France, Switzerland, and in many parts of Aberdeenshire, and it appears to be gaining ground everywhere.

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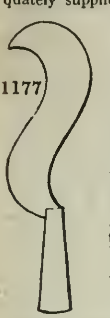

8092. — 2489. *Howden's two-edged bill-hook.* (*fig.* 1177.) This hook is something like the letter S; it is all round sharp, and combines the powers of the carpenter's axe, the gardener's knife, the hedger's hook, the Highlander's broadsword, and the joiner's chisel. The blade is twelve inches in length, and three inches broad; the socket is eight inches long, and serves instead of a wooden handle when the instrument is used as a knife, bill-hook, or axe; when it is to be used as a chisel, it must be placed on the end of a long handle; and will then, either by pushing or drawing, remove small branches from the stems of tall trees. The long socket is made a little oval in the direction of the two edges, in order to let the operator feel where the edges are. The chief use of this instrument, however, is for dressing hedges, and for that a wooden helve, or handle, of about two feet in length, is best. (*John Howden, April* 30. 1830.)

8093. — 2551. *A press for compressing flour or meal into casks* is employed in North America, and it will be found described in the *Quart. Jour. of Agr*, vol. iii. p. 559.

8094. *A machine for compressing peat* (*fig.* 1178.) has been invented by Mr. Walter Tod, of Longhope, near Hawick. The same machine might also be employed for compressing earth for building walls, and

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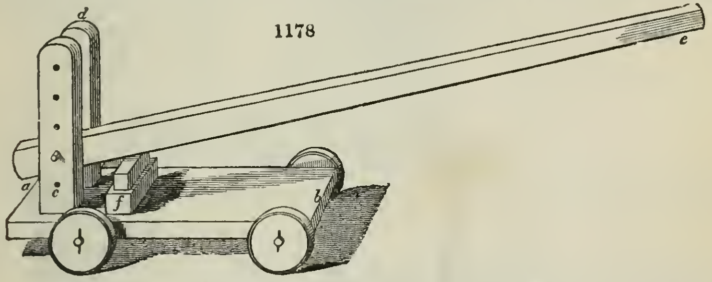

for other purposes. A more powerful and elaborate machine has been invented by Mr. Slight, the Curator of the *Highland Society's Museum of Models*, and figured and described in the fourth volume of their *Transactions*; but the simple machine of Mr. Tod, we think, will be more useful in countries where the fuel is peat; and in new countries, where the emigrant might think it advisable to build the walls of his house of dry earth. This machine consists of two strong planks of wood fixed together at each end by cross bars, and mounted upon four wheels. Two pieces of wood (*c*, *d*) at the distance of two inches from one another, are mortised into the plank (*a*, *b*) at the end *a*, and at right angles to *b*. Between the upright posts (*c*, *d*) there is inserted a strong beam (*a*, *e*) twelve feet long, and secured with an iron bolt passing through the pieces (*c*, *d*), which have numerous holes to admit of raising and depressing the beam (*a*, *e*) at pleasure. Two boxes are then made, one of wood, and one of sheet iron fourteen inches in length, three and a half in breadth, and three and a half deep. These boxes have lids which just fit them, about three inches in thickness, to allow them to sink in the boxes by the pressure. Each box is to be alternately filled with peat newly dug, the lid adjusted, and the box placed in the machine at the point *f*; a man stands at the end (*c*) of the beam (*a*, *e*); and, as each box is placed in the machine at the point, *f*, he bends his whole strength and weight upon the end of the beam. By this means, an immense pressure is applied to the box by a single effort, and in an instant of time. Two women may fill and remove the boxes. In this way a man and three women could compress about eight cart-loads of peat in a day. One man digging, and a woman throwing out the peats, could keep the machine in full operation. The peats, when taken from the machine, are built up like small stacks of bricks, but so open as to admit a free circulation of air. The stacks put up in this way become perfectly dry, without being moved till they are taken home. If the machine just described were to be adopted for compressing earth, boxes of cast iron, full of small holes, would answer the purpose best. The pressure is so great, that the wooden boxes frequently give way, though strongly made, and secured with iron at the ends; and even the one of strong sheet iron has been bent. (*Highland Soc. Trans.*, vol. ix. p. 374.)

8095. — 2560. *Slight and Lillie's straw-cutter* (*fig.* 1179.) is considered to be the most perfect machine of this description that has hitherto been invented. In most of the other machines, the oblique position of the cutters, relatively to the hay or straw which they have to pass through, is found to be attended with difficulties to the workmen when replacing them after they have been taken off for sharpening. Messrs. Slight and Lillie have obtained the advantages of passing the knives in an oblique direction through the body of hay, without occasioning the slightest difficulty when these knives are removed to be ground. This is done by elongating the cutting-box into a nozzle, which is twisted until its orifice assumes an angle of about thirty degrees. By this arrangement, the entire efficiency of the machine is retained, while its construction and keeping in order are simplified, and its price is proportionately reduced. The framing is made entirely of cast iron: *a* is the feeding-trough, the rollers being only partially seen; *b* is the nozzle or cutting-box; *c c*, the cutting bearers, with the cutters attached by their bolts; *d* is a lever and weight, which, through the medium of the bridge *e*, keeps a constant pressure on the feeding-rollers to counteract any inequality of feeding; *f* is the fly-wheel for equalising the motion; and *g*, the handle to which the power is applied. The small pinion on the fly-wheel shaft gives motion to the spur-wheel, which is mounted on the shaft of the lower feeding-roller, and carries also the lower feeding-pinion. This last pinion works into the pinion of the upper roller; and, both being furnished with very long teeth, they thereby admit of a limited range of distance between the rollers according to the quantity of feed. With one of these machines, a man, assisted by a boy to feed in the hay or straw, can cut at the rate of eight stones per hour; and that quantity of cut hay is found to be sufficient for sixteen horses for twenty-four hours. (*Quart. Jour. Agr.*, vol. iv. p. 349.)

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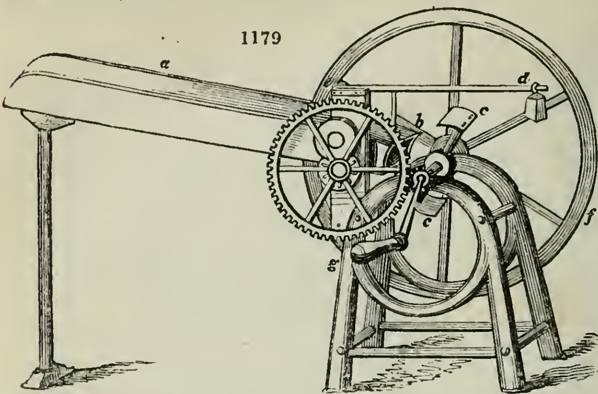

8096. — 2568. *Taylor's tub for measuring and weighing corn* represented in *figs.* 1180. and 1181. The tub (*a*) has a movable bottom (*b*), which, when it is desired to let the corn drop out, is raised by putting the foot on the pedal (*c*), which operates on the lever (*d*). The valve is worked by a spindle, which passes through the collar (*e*). The angles at the bottom of the tub are bevelled off to allow of the free egress of the corn into the sack below it. Of course the tub should be suspended high enough above the floor to allow the corn to escape; and for this purpose a platform (*f*), ascended by steps, is required, which may be either fixed or movable. Up this platform the man walks who bears the sack of corn; and, the mouth of the sack being previously

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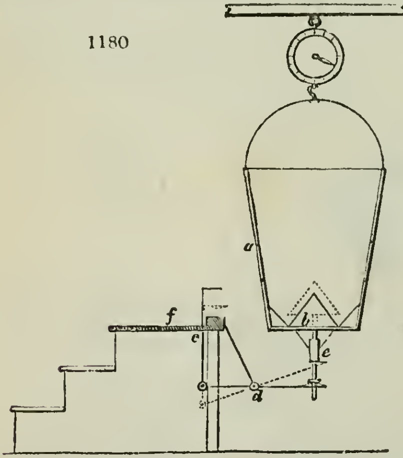

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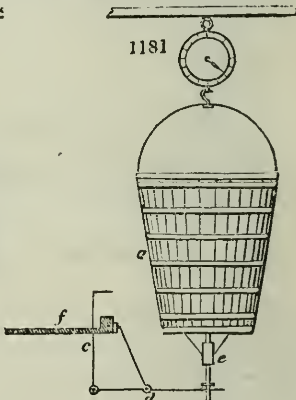

untied, he shoots the contents very gently and gradually into the tub. The precaution of shooting the corn into the tub gently and gradually is essentially necessary, as otherwise there will not appear to be full measure. The mode of weighing may be either by Marriott's dial engine, or by a steelyard beam; the former is the most simple. This tub was invented by Mr. Samuel Taylor, and is used in the extensive malting establishment under his care at Stokeferry, Norfolk. (*Gard. Mag.*, vol. viii. p. 467.)

8097. — 2571. *Baird's turnip-slicer. Fig.* 1182. is considered one of the best turnip-slicers in use in Scotland. It is made, when of full size, entirely of cast iron, and consists of a standard or frame to which is attached a hopper; the frame bearing a circular plate of cast iron mounted on a horizontal axis, to which the winch-handle is attached. This plate is cast with a thickened edge or rim, which gives it, when in motion, the effect of a flywheel. It carries two thin cutters or knives, set parallel to the face of the plate, and radiating from the centre. The thickness of the slices is regulated by the distance of the knives from the face of the plate. Each knife is preceded by three or more lancet-pointed studs, which, by slitting the turnips in passing, prepare the slices for falling in pieces when they are detached from the knives, at each revolution of the plate. This process goes on so long as the hopper is replenished with turnips, their own weight being found sufficient to hold them within the stroke of the knife. When potatoes are to be sliced, the disc above described is to be removed, and another substituted, differing from the first in having the cutting studs set closer together. In the figure, A represents the hopper filled with turnips; B, the disc of cast iron that carries the cutters; C, one of the cutting knives, the opposite one being concealed by the framework; D, the lancet-pointed studs; E, the winch-handle, partially seen from behind the machine; F F, the framework of the machine; G G, two bars which slide into staples, and serve as handles by which it can be removed from one place to another. (*Highland Soc. Trans.*, vol. x. p. 51.)

8098. — 2578. *A turnip-sowing machine*, which sows two rows at a time, and deposits along with the seed a regular train of bone dust, is described in the *Quarterly Journal of Agriculture*, vol. iii. p. 718.

8099. *A machine for sowing carrots* was invented in 1833, by Mr. Daniel M'Naughton, farmer, near Irvine, in Ayrshire. *Fig.* 1183. exhibits the general appearance of the machine, which is similar to those in common use for sowing turnips; the essential difference lying in the apparatus adopted for discharging the carrot seeds from the seed-boxes. To the lower part of the framework is attached, in the usual manner, the great roller (*a*) serving to compress the prepared ridgelets, and also to communicate motion to the other parts of the machine. This is effected by means of a leathern belt or a pitch chain, passing over a pulley at the extremity of the roller, and another of the same diameter at the extremity

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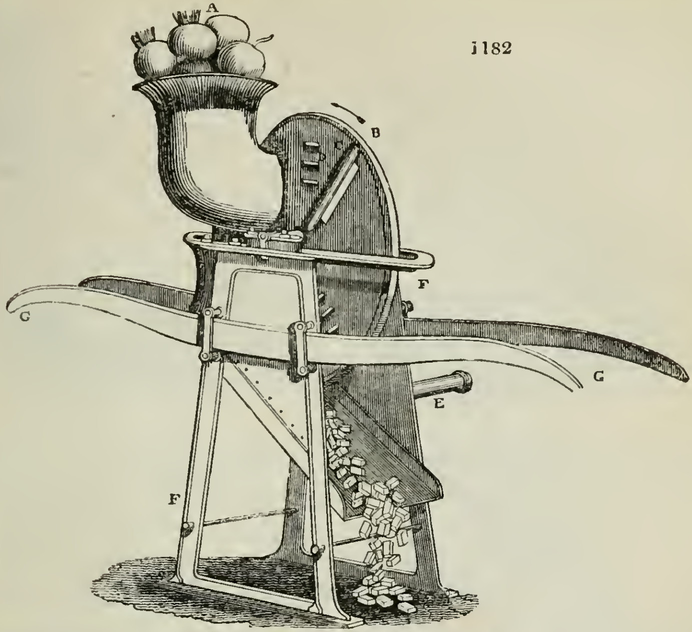

of the axle (*b*); which last, in the common machines, always carries the seed-boxes, but in this performs a double purpose. The first of these purposes is, that by means of two pulleys, which are

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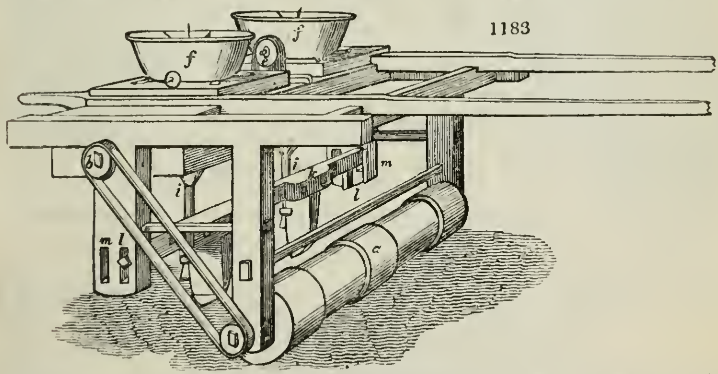

not seen in the figure, it gives motion to two other pulleys (*e*) of the same diameter, mounted on small axles, which pass through the seed-boxes, and are each mounted with three plain wooden pulleys; the middle one is about six inches diameter, one inch thick at the centre, and is diminished to about half an inch thick at the edges; the other two are three inches in diameter, and of proportional thickness. The middle pulleys, unseen, are armed with six stout wire prongs, the extremities of which describe a circle of twelve inches in diameter; while the smaller pulleys (at *e*) are similarly armed with five prongs, extending to seven inches in diameter. The revolution of these armed pulleys keeps the seeds in continual agitation preparatory to their being propelled from the box. The second purpose to which the axle (*b*) is applied is, to carry a small wooden cylinder, placed immediately under each seed-box, of five inches in length, and three inches in diameter, armed with four prongs or claws, extending to a radius of three inches. In the revolution of these claws they penetrate successively into the orifice of the seedbox, and perform an operation of picking or scratching out the seeds in a regular succession. The seeds are received into the funnels (*i i*), and pass from thence down the tubes in the usual manner to the ground, where a rut is prepared for them by the coulter. The seed-boxes are made of sheet iron, or of tin plate of an elliptical form in the mouth; the diameter being about eighteen inches and twelve inches, with a depth of twelve inches; the cross section, taken either longitudinally or transversely, being also elliptical. The bottom of the box terminates in an oblong orifice of about six inches long by half an inch wide in the clear; the latter dimension being capable of extension, or diminution, by means of two pinching screws. Each box is covered with a movable lid, to prevent the seeds from being thrown out by the agitators. The funnels, with their seed tubes, are attached to the hind part of the coulters, and are provided with an adjustment, by means of the slits and pinching screws in the collar bar (*k*) of the framework, enabling the operator to regulate the distance between the rows, while, by means of the slits and pinching screws (*m m*), he can regulate the depth of the rut for the seed-bed. The machine is convertible into a turnip drill by a very simple alteration. The seed-boxes and the claw cylinders are removed; and, in place of the latter, two barrel-shaped seed-boxes of the common construction are substituted upon the axle (*b*). It is then a complete turnip drill-machine. When, again, it is required for sowing onions, the turnip seed-boxes are removed, as also the collar bar (*k*). The axle (*b*) is then mounted with five barrel-shaped seed-boxes, similar to, but smaller than, those for turnips. A collar bar, with five permanent coulters, is placed in the slits (*ll*) of the frame. The coulters are perforated from top to bottom for the passage of the seed, terminating in the hind part of the lower extremity. Five funnels, corresponding to the seed-boxes, are inserted, one into the upper orifice of each coulter, and thus the machine is prepared for sowing five rows of onion seed. (*Highland Soc. Trans.*, vol. x. p. 203.)

8100. — 2581. *A moletrap in use in the north of Scotland* (*fig.* 1184.) consists of a block of wood (*a*)

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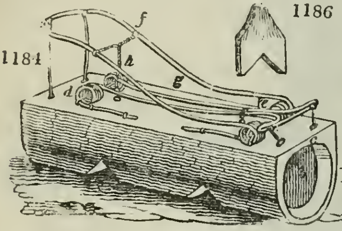

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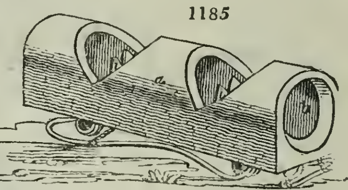

ten inches long, three inches broad, and three inches and a half deep; with a hole (*b*) two inches and a half in diameter, bored lengthwise through both ends. In the inside, half an inch from each extremity, is a groove for a wire loop to fit into, as in the common moletraps, only that the grooves are here cut quite through, having a small nail or pin of wire driven in through the middle, to keep the wires from rising above the wood. In the upper side of the hole, close by the grooves, three blunt-pointed pikes of wire (*c*) are fixed, so as to stand a quarter of an inch out of the wood. The holes for the triggers are bored in the centre of the upper side three inches from each end: in the lower side, opposite each trigger hole, is a small piece cut out, as in the common trap. The springs are made of iron wire, of about one eighth of an inch in diameter (*d* and *e*); and are exactly of the same form as those of the common mouse-trap, having a cross wire fixed one inch and a half from the top of each spring (*f* and *g*); from which the catches, which are likewise made of wire, are suspended. These catches are retained by the plug or trigger (*i*) till it is displaced by the mole. *Fig.* 1186. shows the trigger separately. (*Gard. Mag.*, vol. viii. p. 209.)

8101. — 2691. *Mr. Small*, in the county of Berwick, and who removed to the Lothians, improved considerably on the English or Rotherham plough. But Mr. Wilkie, in the vicinity of Glasgow, has made far greater improvements on Small's plough, than Small did on the English one, or than that was an improvement on the old Scotch plough. The ploughs are now all constructed of iron in the western counties of Scotland, and are beginning to be made there by many country smiths, who always form them on Wilkie's, and not Small's model. (*Brit. Farm. Mag.*, vol. vi. p. 304.) In the *Mechanics' Magazine*, vol. xxi. p. 283., a table is given showing the mechanical analysis of a ploughing match held at Aylesbury in Buckinghamshire, in May, 1834; by which it appears that a furrow nine inches broad, and four inches and a half deep, required a power of draught of six cwt. and three quarters. The plough was the common sowing-plough of Buckinghamshire, called the foot plough, with a wooden mould-board, and drawn by two horses; and the soil was a stiff clay. The horses walked at the rate of two miles an hour. Now, with one of Wilkie's iron ploughs, the same furrow would have been turned over with a drawing power of four cwt. or less; and the horses, if of the proper kind for farm labour, would have walked at the rate of two miles and a half an hour.

8102. *The universal adoption of the common two-horse plough throughout England* would, Laidlaw asserts, add more than 3,000,000 quarters of wheat to the resources of the country. (*Quart. Jour. of Agr.*, vol. iii. p. 713.)

8103. — 2616. *The subsoil plough* (*fig.* 1187.), as designed and used by Mr. Smith on the farm of Deanston,

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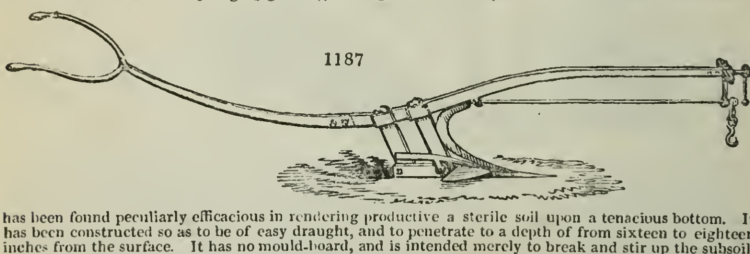

has been found peculiarly efficacious in rendering productive a sterile soil upon a tenacious bottom. It has been constructed so as to be of easy draught, and to penetrate to a depth of from sixteen to eighteen inches from the surface. It has no mould-board, and is intended merely to break and stir up the subsoil, without bringing it to the surface, or mixing it in the first instance with the incumbent soil. It is, in fact, a *horse-pick*, and readily loosens and throws out all stones not exceeding seventy pounds weight. It is drawn by four horses, two and two abreast, and it is held in the usual way by one man. In working, the common plough goes before it, taking a furrow ten inches by six inches, the subsoil plough following in the bottom of that furrow, and going deeper by ten or twelve inches. When this plough is applied on a tenacious bottom, and in conjunction with parallel drains about two feet and a half deep, and distant from twelve to twenty feet from each other, it produces wonderful effects in attaining a deep and dry soil; and, even on gravelly and sandy bottoms, its effects are considerable, and are especially apparent in the succeeding pasture. The cost of such a plough, with a soam, or main chain for the leading horses to draw by, is about 9*l.* The ordinary swingle-trees and harnessing suit, with straps over the quarters of the leading horses to bear up the swingle-trees to their buttocks, and a chain from the collars of the hind horses to bear up the soam-chain. This plough, with four horses, a ploughman, and a lad to drive, will do about an acre imperial per day, at a cost of about 1*l.*; no charge being made for the common plough, as the land would require a furrow at any rate. Such ploughs are made by Robertson Smith, at Drip (by Stirling), on the estate of Blair-Drummond. (*Highland Soc. Trans.*, vol. viii. p. 206.)

8104. — 2637. *Wilkie's improved friction wheel plough for two horses.* The invention of the friction wheel plough is claimed by Mr. Morton, an implement manufacturer of Leith Walk, Edinburgh, who "conceived the idea of introducing a wheel into the body or bosom of the common plough, about fifteen inches in diameter, to act as the sole," so far back as 1813. The average draught of the ploughs when the wheel was applied was reduced about one fifth, or to about two cwt. and three quarters. He manufactured a number of these ploughs both for home and foreign use; but in a short time, the farmers in the neighbourhood of Edinburgh left them off, giving as a reason for so doing, that they required more attention from the ploughman to grease the axle of the wheel, than the latter were willing to give. (*Gard. Mag.*, vol. vi. p. 209.) We may notice it, as a remarkable circumstance, that Professor Low, in his *Elements of Practical Agriculture*, published in 1834, describes only Small's plough, without mentioning Morton, Wilkie, or any other improver, and without once introducing the subject of wheel ploughs of any kind. The invention of the friction wheel is also claimed by Mr. E. Elliott, who lately managed a farm near Shepperton, in the county of Middlesex. In the *Farmer's Journal* for August 1. 1831, an account of an experiment is given in which Wilkie's improved plough without a friction wheel, was tried against the same implement with a friction wheel, and both against the common swing plough in use in Middlesex. Wilkie's plough, without the friction wheel, required four cwt. two quarters; with a friction wheel, three cwt.; and the common Middlesex swing-plough, six cwt. Notwithstanding experiments of this kind, it is an undeniable fact, that the old, heavy, clumsy Middlesex plough, which it appears requires twice as much strength to draw it as Wilkie's friction wheel plough, is still that commonly used in the county! We cannot suppose that any class of men would persist in a practice which they knew to be decidedly opposed to their own interest, and therefore we unavoidably conclude that in ignorance, or prejudice, or both, we must seek for the cause of these men so obstinately adhering to the practice of their forefathers. The truth is, as we have elsewhere observed, the farmers are the only class of Englishmen who do not read.

8105. — 2655. *The grubber, as compared with the plough,* Professor Low observes, will go over five or six times more ground in the same time; and to this extent there will be a saving by the use of it, where it can be substituted for the plough. It will go to the depth to which the land has been originally ploughed, or to any lesser depth which may be required. (*Elements, &c.*, p. 99.)

8106. — 2709. *Crosskill's clod-crusher roller* (*fig.* 1188.) is intended to effect the same objects as the

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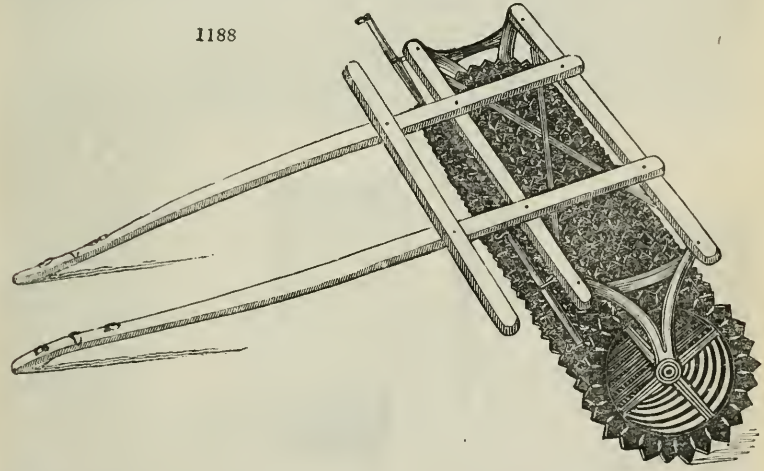

spiky roller. It consists of a number of segments, a perspective view of which may be seen *fig.* 1190., and a vertical elevation of the same segment *fig.* 1189., fixed on an iron axle six feet six inches long. Ploughed land once rolled by this machine is said to be reduced to a finer state than by two or three rollings and harrowings with the ordinary machines. It is drawn by three horses, and cleans itself, even when land is in the very roughest state. A number of these machines have been manufactured by the inventor at Beverley, and used by the farmers of the surrounding country. The price of a machine, including two iron road wheels to attach to it when not in use, is from 17*l.* to 19*l.* delivered in Hull.

1189

8107. — 2711. *A cheap and useful watercart* is thus described by Mr. Donaldson in the *Farmer's Magazine*, vol. viii. p. 81.: — A barrel, holding 100 to 200 gallons, is placed on a pair of wheels and shafts in the usual way. A pump, three inches in diameter, is placed close by the side of the barrel; and to the under end of the pump is made fast a leather pipe of indefinite length, with a rose copper end, and in the pipe small copper or tin rings are placed, two inches distant, to prevent the external air from pressing together the sides of the pipe, and thus excluding the water. The cart being placed on the bank of a river, brook, or pond, and the pipe thrown into the water with the rose end immersed, a man will pump 150 gallons in ten minutes, without the trouble of having a road into the bottom of the river, and with the great advantage of the horse standing dry, and not plunged into three feet of cold water on a winter day, in the usual way of filling by ladle and standish. A stopcock is fixed behind for discharging the water. When the cart is travelling, the leather pipe lies over the barrel, fastened by two iron catches. The barrel being filled, and driven to the place required, the leather pipe is immersed in the barrel by a hole in the top, sufficient to admit the rose end. A small iron rod screws down by the side of the piston rod, upon the upper valve, and shuts in fast. A rising main, with a check valve, is opened between the two buckets in the pump, upon which is screwed fast a leather pipe with a copper tube on the end. One man directing this pipe, and another pumping, converts the cart into a sort of fire engine, that may be

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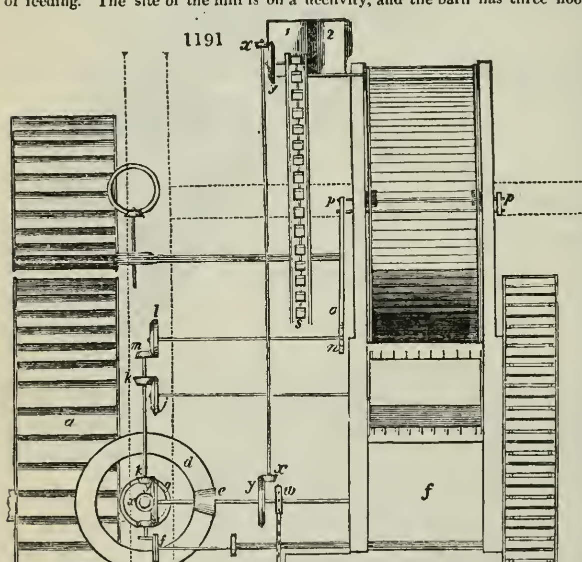
very useful in cases of emergency, throwing the water forty feet horizontally, and over any house of two stories, any haystack or corn-rick; it is also very useful for garden walls and fruit trees. By increasing the size of the barrel, and by applying more power, a very sufficient engine may be made, and answering othe purposes at the same time.

8108. — 2731. *Mann's reaping machine* was invented in 1820, but neglected till 1826, when it was improved; and in 1832 it was exhibited at an agricultural meeting at Kelso. It differs from Bell's reaping machine in being drawn instead of being pushed, and in depositing the corn in a continuous swathe nearly at right angles with the line of direction, and on the side opposite to the standing corn. Both these are advantages which we hope will not be lost sight of by the mechanist who may at some future time make such a reaping machine as shall come into general use. An engraving, with descriptive details, of Mann's reaping machine will be found in the *Quart. Jour. Agr.*, vol. iv. p. 250.

8109. — 2773. *The construction of threshing machines* is everywhere very imperfect, even in Scotland, where they were first invented, and where machines of the largest power, impelled by water or steam, are erected at great expense. The editor of the *Quarterly Journal of Agriculture* has the following judicious observations on this subject: —"Were threshing machines constructed on correct and unerring principles, like the machinery of a timepiece or of a steam-engine, or even of a flour-mill, the advantage to the farmer would not only appear in the shape of cleaner threshed straw, and of economy of time and labour, but the millwright himself would derive great advantage in the certain possession of *materials*, which would enable him to erect threshing machines that would suit the particular localities in which they were to be placed. There is no way of arriving at this perfection, but by the institution of experiments to ascertain what may be the simplest construction of the threshing machine, and the best mode of applying the least quantity of moving power to execute the desired work satisfactorily. These desiderata would produce the advantage of threshing the corn at the least cost. Threshing machines are of so durable a nature that they are not often renewed; but for that very reason they should be constructed in the best manner at first. A set of patterns could be made from the results of these experiments, and lent out to those makers in the country who could grant security that they would only erect machines which were conformable to these patterns. In the course of time the country would be stored with efficient and easily moved threshing machines. The ill-judged desire of the farmer to have a machine that will not cost much money often leads the millwright to adopt expedients in its construction which he is conscious are not suited to work well together. This is one reason, among many others, to prove the propriety of landlords erecting threshing machines at their own expense, upon their farm-steadings, and of giving the tenants the use of the mills, as well as the steadings, and of obliging them to keep the machines in repair, as in the case of the buildings." (*Quart. Jour. Agr.*, vol. iii. p. 986.)

8110. *The threshing machine at Wynnstay*, the seat of Sir Watkin Williams Wynn, Bart., is considered one of the most complete in Britain. It was erected by the late Mr. John Gladstone, of Castle Douglas, Kirkcudbrightshire, about the year 1812. This machine separates the corn from the straw, and delivers both straw and corn into their proper places, without the assistance of manual labour, with the exception of feeding. The site of the mill is on a declivity, and the barn has three floors or stories; the uppermost of which opens into the stack-yard, making it very convenient for carrying in the sheaves: the second one contains the first winnowing machine; with a chaff-house, partitioned off under the stair, and descending to the floor below, with a door into the straw-house, and one into the cattle-yard. When the corn is only to be passed through the first winnowing machine, the corn elevators and second machine are thrown out of geer, and the corn delivered on the second floor, where the bruising machine is fixed. The under floor contains the second winnowing machine with the lower end of the corn elevators. If necessary, the clean corn may be delivered on this floor, instead of into the elevator trough: the ends of both machines are inserted in the chaff chamber. The corn is put between two grooved rollers, when the grain is beaten out of the ear by four beaters fixed on the threshing cylinder, and thrown into the rake or first shaker, when it falls through the sparred bottom into the winnowing machine hopper, while the straw is raked forward and thrown upon the travelling shaker, where it is thoroughly shaked, and conveyed into the straw-house. The corn passes through the first winnowing machine, when it is cleared of its chaff, short straws, &c.: the latter is thrown into a set of elevators which carries them up to the feeding-table, to be

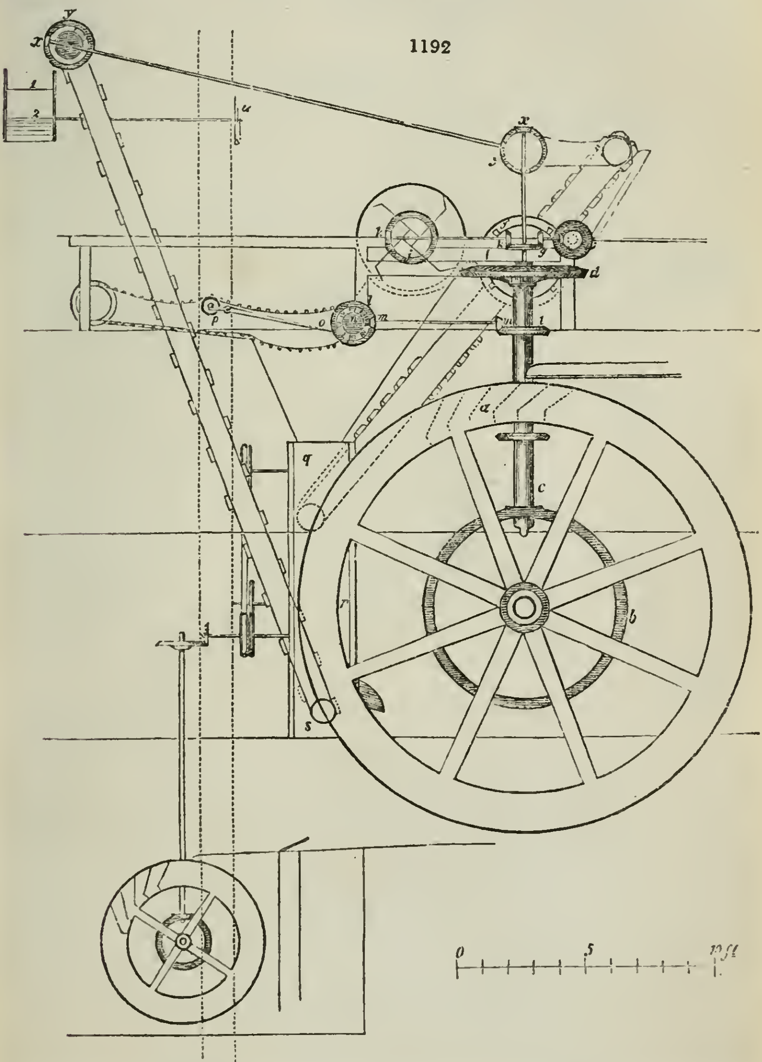
1191



threshed over again with the unthreshed corn. This is a very useful appendage to a threshing-mill; it takes all the refuse from the fanners, which generally accumulates about a barn floor (or is carried up by hand), whereas the elevators carry all away, and thereby leave a clean barn. The corn passes through another pair of fanners, and from thence into the corn elevator trough, and is carried from thence into the granary and thrown into the weighing machine, which is connected with an index in the barn on the partition walls facing the man at the feeding-table, which shows the quantity threshed very nearly. The machine occupies part of three floors. The water-wheel is in a house beside the barn, and in a room above the wheel is a Scotch barley-mill, and beyond it is a very complete saw mill, both driven from the same wheel, which can be detached when the threshing part is at work, and the threshing part, when the saw or barley mills are wanted. In the middle floor is an oat bruiser driven from the upright shaft: it can be put out of geer if wanted.

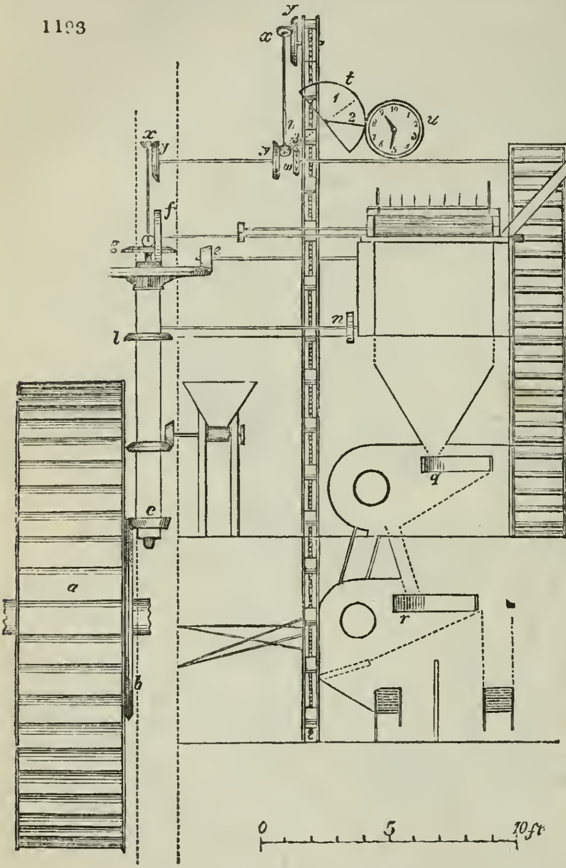
8111. *Description.* In *figs* 1191, 1192, 1193., *a* is the water-wheel, eighteen feet in diameter by four feet wide; *b*, a pit wheel, eight feet in diameter, which works into a pinion, *c*, of fifteen inches in diameter fixed on the upright shaft; *d*, a bevel wheel, five feet in diameter, which turns the drum pinion, *e*, of nine

1192



inches in diameter; *f*, the drum, or threshing cylinder, three feet four inches in diameter outside of the beaters, and four feet and a half long, with four beaters turning upwards with a velocity of 300 revolutions per minute; *a*, a bevel wheel, twenty-one inches in diameter, turning a pinion of five inches and a quarter diameter, on the axle of which is another pinion five inches in diameter, working in the face wheel, *i*, with two rows of teeth, one of thirty and the other twenty-four teeth; this pinion slides along its axle into either sets of teeth; for instance, into the one of the smallest number if the straw is long, and into the other if it is short, loose, and irregular. The rollers are about three inches and a half in diameter; the wheels *g* and *j* are each twenty-one inches in diameter, working into the pinions *k k*, five inches and a quarter in diameter, which gives motion to the rake or first shaker at the rate of forty-five turns per minute: it is four feet in diameter to the extremity of the teeth; *l l*, two wheels, each twenty-one inches in diameter, with pinions, *m m*, five inches and a quarter each, which drive the travelling shaker that receives the straw from the rake, and conveys it into the straw-house. This shaker is composed of two endless pitch chains, worked by two stud wheels ten inches in diameter, with eight studs on each, on the same shaft as the wheels *m* and *n*, revolving at forty-five times per minute. These chains are kept stretched by two smooth wheels at the farther end in the straw-house: between the chains are fixed round wooden rods about two inches apart. *m* is a wheel with large teeth on its circumference, which, as it turns round, depresses the point of the lever *o*, and raises the end *p*. The lever is fixed on an axle which passes through to the other side of the shaker, with a short lever fixed on it to correspond with the lever *p*; on these levers, *p p*, rests a small shaft, on which is fixed on each end, under the chains, a small drum four inches in diameter, which supports the shaker in the middle, as the wheel, *n*, moves round. The point of the lever, *o*, strikes from tooth to tooth, and thereby keeps the small shaft, at *p p*, in motion up and down, which shakes the loose corn out of the straw, which is drawn back by the under returning rod into the winnowing machine hopper; *q* is the first winnowing machine; *r*, the second winnowing machine; both driven by a small water-wheel, six feet in diameter, and four feet wide: the water from the large wheels supplies this one. The motion of the machine requires to be uniform, which cannot be the case if connected with the threshing part. It answers better to have a separate wheel for the machines. The clean corn passes into the elevators *s*; from thence it is carried up into the granary, and delivered into the weighing machine, *t*, by small elevators made of sheet iron, with wooden backs and bottoms fixed to a pitch chain, revolving round a studded wheel ten inches in diameter, and with eight studs at the upper end, and a small wooden roller at the bottom, at eleven turns per minute. The corn is delivered into the weighing-machine box, 1, and accumulates until there is the weight of a measure, when the box turns on its axle, and the corn is emptied into the spout which conveys it into whatever binn it may be wanted in. At the same time the part 2 turns up, and is filled as the other, and, when full, descends as the other, and so on, while the threshing is going forward: 3 is a weight which slides up and down a rod fixed at right angles from the bottom of the weighing machine: if the corn is heavy, slide this up until it will balance a bushel of corn similar to what is to be threshed; if light, slide it downwards. From the axle of this box, a small rod proceeds to two small wheels behind the index, *u*, which turns two fingers that revolve round the face of this index; it is figured from 1 to 10. For every movement the weighing bucket makes, the longest finger moves over the space of one, and for every ten, the other finger moves one. At the end of the threshing, this finger will denote pretty accurately the quantity threshed: for instance, were the long finger at 5, and the short one at 9, there would be ninety-five bushels of corn in the binn; *x x x* are pinions five inches and a quarter in diameter, each working in wheels (*y y y*) twenty-one inches in diameter each, which give motion to the corn elevators, and likewise to the tail elevators by a pitch chain revolving round the stud-wheel *w w*, giving motion to the shaft of the elevators at eleven times per minute. The buckets are made of thin boards fixed on two pitch chains turned by two stud wheels ten inches in diameter at the upper end, and a wooden roller at the lower. (*J. Gladstone, Lead-works, Chester, Oct.* 29. 1831.)

1193



8112. *Mr. J. Gladstone, civil engineer, Chester*, to whom we are indebted for the foregoing plans and description, with reference to the improved form of the threshing machine, says, " I have always understood that it was to my father we are indebted for it in its improved state. In 1788, Mr. Andrew Meikle produced the first machine of the kind, for which he took out a patent. (See *Repository of Arts*, vol. x. No. 58.) This was simply a threshing cylinder with the beaters turning downwards, throwing straw and corn into a moving screen, which separated them in a very imperfect manner; so much so, that I have heard the machines were given up, or going into disuse, simply on account of the beaters striking downwards; if the ears escaped the beaters immediately on passing through the rollers, they were bent under them, and laid close to the interior of the cylinder case, and thereby evaded the stroke of the beater. In 1793, my father made his first machine, similar to that of Mr. Meikle, with this difference, that the threshing cylinder turned upwards, and as the corn came through the roller, it lay upon the cylinder, and, being exposed to the stroke of each beater, none escaped being threshed." (See *The Stewartry of Kirkcudbright Agricultural Report of* 1810.)

8113. *The late Mr. Gladstone, of Castle Douglas*, added the shaker to the threshing machine in 1794, and what he called a fetterer, for breaking off the awns of barley, soon afterwards. In 1798, he made a threshing machine, to be driven by windmill sails. In 1799, he invented the draught chains used in threshing machines, to equalise the pressure of the draught on the horse's shoulder. In 1805, he added a travelling shaker to the threshing machine, and soon after, a contrivance for conveying the corn from the fanners into the granary, and weighing it at the same time. By another piece of machinery the corn may be accurately measured. "On reviewing the whole," the writer, in the *Report of the Stewartry of Kirkcudbright Agricultural Society for* 1810, observes, "it is impossible not to perceive how vastly superior the machines of Mr. Gladstone are to those first contrived by Mr. Meikle, and what distinguished services he has thus rendered to the interests of agriculture. The machine is now competent to the threshing not only of one, but of every, species of grain. It is adapted of itself to separate the straw from the corn, and convey it perfectly shaken into the straw-house; to clean the corn effectually, to weigh and measure it accurately; and to lodge it securely in the granary. If driven by water, the adoption of the chain bucket outer wheel saves an inner one, formerly deemed indispensably necessary, and simplifies the machinery; if by horses, the person feeding it can manage without a driver from within, and assign to each horse an equal share of the draught, or such a proportion of it as may be supposed adequate to his strength. Much diminution in the expense, as well as much improvement in the mode, of farm management has thus taken place. What was the work of several months, can be performed more perfectly, and with more ease, in as many weeks; and the labour of the winter season can now be devoted to more valuable purposes, to the collecting and formation of manures, and the better preparation of the land for the reception of the seed."

8114. — 2811. *Edifices in use in agriculture. In the Encyclopædia of Cottage, Farm, and Villa Architecture*, we have gone into this subject in greater detail than could with propriety have been done in a work embracing so extended a view of agriculture as the present volume. In that work we have not only given a great variety of the very best plans for farmeries, or farm-houses, which have been executed in Britain within these few years; but we have given detailed plans, sections, and specifications of all the component buildings of a farmyard, and of their fittings-up, fixtures, and furniture. In the *Architectural Magazine*, which may be considered as a perpetual supplement to the *Encyclopædia of Architecture*, all the improvements which may be made in architectural buildings will be recorded as they occur. We have given in this Supplement, § 8157., a plan of a farmery from the former work, which embodies all the latest improvements.

8115. — 2847. *Barn floors*, to be proof against the ascent of rats from beneath, should be formed of wood. "The sleepers upon which the floor is laid, should rest upon stone and lime building, raised two feet from the ground, close to the barn wall; and the mortar and stones must be packed close to the upper edge of the sleepers, up to the deals of the floor. According to the width of the barn, the sleepers should rest also upon one or two supports of stones, so hewn as to permit no footing to any vermin; and which will support the middle of the floor. By this contrivance, the space from the floor to the ground is made too deep to permit any small animal standing on its hind legs and gnawing the floor, while dogs or cats can easily pass under it." (*Quart. Jour. Agr.*, vol. iii. p. 995.)

8116. — 2876. *Labourers' cottages.* Having entered on this subject at length in our *Encyclopædia of Cottage, Farm, and Villa Architecture*, and there given numerous plans, accompanied by descriptions, specifications, estimates, and critical remarks, we shall not here repeat any thing which has appeared in that work. Nevertheless, as the improvement of the dwellings of country labourers is what we have most at heart, next to the education of their offspring, we cannot let pass this opportunity, without contributing something farther to the subject: we shall, therefore, give one article, entitled the *beau idéal* of an English labourer's cottage, by a most benevolent and enlightened clergyman, who adopts the signature of Selim; and another on building cottages with mud walls, by a professional man, Mr. Wilds, of Hertford, who, having been in North America, is deeply impressed with the importance of this kind of knowledge to emigrants, who, at present, too frequently build their houses of wood, and who, consequently, sooner or later, suffer from accidents from fire, or, what is almost as bad, live in continual fear of doing so. To these we shall add the design of a stone-walled agricultural labourer's cottage, recently built, along with a number of others of the same kind, on the estate of William Lawrence, Esq., in Gloucestershire.

8117. *The beau idéal of an English labourer's cottage.* The leading feature in the exterior of a labourer's cottage, should be a picturesque simplicity, which is a sort of medium between superfluous decoration and unmeaning plainness. This appears to be the only character of which a cottage is susceptible; for, as plainness is uninteresting, so it offends our sense of propriety to see a building of this description bedecked with costly fantastic ornaments, which are evidently unsuited to the simple unrefined habits of humble life. But a picturesque simplicity is seldom the pervading character of modern ornamental cottages. They are often decorated with turrets and battlements in the castellated style of Gothic, or in the monastic style, with elaborate painted windows, crosses, and pinnacles; nay, instances have occurred where the two styles have been united in the ornaments of a cottage dwelling. It cannot be denied, that a picturesque effect is produced by this mode of embellishment; all I contend for is, that such ornaments are altogether unsuited to a dwelling of the lowest order. Should it be objected, that, if we reject this mode of decoration, we must have recourse to ruin and decay to produce a picturesque effect; I answer, that as much of this effect as we may require may be produced, I think, by irregularity of form and outline; and irregularity is, in fact, the only effect aimed at by the use of Gothic ornaments. But as my object would be only a picturesque simplicity, I should discard useless and inconvenient irregularity. In so small a building as a cottage, a slight irregularity would be sufficient to give it a picturesque character, and the simplest embellishments would give it an ornamental effect; and this, I conceive, is all we require to produce what I understand by picturesque simplicity. Though I am an advocate for simplicity, however, in cottage architecture, I would in some measure sacrifice even simplicity to the picturesque; because the beauty of a neighbourhood frequently depends upon the style of the labourers' dwellings. These are the prevailing buildings in all rural scenery. They are occasionally so placed and associated with surrounding objects, that they present the most striking features in the landscape; and the effect of particular scenes is not unfrequently produced by the forms and situations of the cottages. Hence, a picturesque exterior is one of the chief requisites in an ornamental cottage; but it should be a simple pleasing style of picturesque, which does not interfere with internal comfort and convenience; produced by slight irregularity of form, and by unobtrusive and appropriate ornaments. I am not at all disposed to sacrifice internal comfort to outward effect. I think a picturesque exterior may always be united with a comfortable interior; and I now proceed to give the description of a cottage in which I shall endeavour to exemplify the union above alluded to.

8118. *Site of the cottage.* As the comfort of the inmates and the general effect of a building depend materially on its site, the situation of a cottage is the first thing connected with it that requires consideration. A general rule for the situation of a cottage is, that it should be properly supplied with water; be dry, airy, and sheltered; and admit of a sufficient allotment of garden ground adjoining the house. And I am an advocate for rather a scattered village, because, among other advantages, it affords an opportunity of erecting the cottages in proper situations. A damp situation is the principal thing to be avoided. It is a nuisance in all cases; but especially to a labouring man, who cannot afford to spend any thing in draining, or much in fuel; whose health is his only source of wealth, and to whom it is necessary, both for health and comfort, that he should have a dry home to come to, after long exposure and severe exertion in the open air. Besides being dry, the site of a cottage should be airy and sheltered. Every dwelling should have a proper circulation of air around it, or it cannot be dry; and a cottage should be sheltered, that it may be warmed with less expense of fuel: the shelter should be so placed, however, as not to interfere with a full exposure to the sun. We will, therefore, suppose our cottage placed on a gentle eminence in the neighbourhood of other dwellings; and sheltered, in part, by higher ground at a distance, by a wood, or by groups of trees, and in part by its own orchard and outbuildings; some of these so placed as to appear above the roof, but leaving it fully open to the south. The situation would be more desirable if a stream of water happened to run near, or if it adjoined a common, or a public road; and it would thus possess the advantages of dryness, shelter, and cheerfulness, besides others which are of consequence to the general effect of the building to be erected upon it.

8119. *Style of the cottage.* Having fixed upon the site of the cottage, the next thing to be considered is, in what style is the building to be erected; for even a cottage, I think, should present some appearance of architectural style. I have already contended that the Gothic is inappropriate to a dwelling of this description, and a building in the Grecian or Roman style, upon so small a scale as a cottage, must be plain and formal, and deficient in picturesque effect, unless it be an elegant and costly edifice. There remains, therefore, only what is called the old English style, which is, I think, the proper style of architecture for an ornamental cottage. It admits of great irregularity and variety of form; and is suited to houses of all dimensions. Its ornaments may be adapted to the smallest dwellings; the irregularity it allows in the exterior, may be made conducive to internal convenience; and it has this peculiar advantage, that we have many beautiful models of old English cottages in all parts of the kingdom. It has, also, this additional recommendation, that it is not an expensive style, and may be executed in almost any kind of material. A cottage in this manner may be built of stone, brick, flint and chalk, or even of wood and plaster; and the building may be so formed, and the materials so disposed, as to give a picturesque and decorated effect, without the use of any expensive ornaments. The desired effect will be given by the tall chimneys; by the high pointed gables, with, perhaps, small pinnacles at the angles; by the mullioned windows and the labels over them; by a projecting porch of one or two stories; and by the stringcourses round the building. In this style much of the ornamental work might be of wood. For instance, the whole of the upper story might be formed of a wooden framework, filled in with brick or plaster. This wooden framework would project beyond the wall which supported it, and produce a pleasing effect of light and shade, and a variety of ornament might be given by the form of the frame itself, which shows on the outside, and by the arrangement of the bricks, or by the patterns impressed upon the plaster, with which the interstices of the frame are filled up. In these half timber houses might be introduced a kind of wooden oriel window, which is one of the most striking ornaments in many old cottages. The gables over such a building might have handsome barge boards, with carved pinnacles at the points. These pinnacles, if small and in good proportion, would be in keeping with a mode of building which admits of a great variety of embellishment, and is well suited to a district where stone and other substantial materials are scarce and expensive. As it possesses these recommendations, we will adopt the old English style for our present purpose, and suppose the cottage erected on a dry, airy site, well protected from the prevailing winds, and surrounded by its garden, orchard, and out-buildings. It would, of course, present one regular front. This we will suppose divided into two equal parts by a porch of two stories in the centre: in the ground story of the porch might be an arched entrance; in that above, a neat mullioned window of two lights, with its proper label; and over this a low gable terminating in a simple ornament. On each side of the porch might be a mullioned window of three lights, placed immediately under the stringcourse, which divides the house into two stories; the low wall above these windows would be plain, as the windows of the rooms in the chamber floor would be most conveniently placed in the gables at the ends of the house. In the centre of the roof, behind the porch, would be the stack of chimneys, which should be tall, and rather the handsomest member of the building. It is the most conspicuous part of it, and the general effect of the whole would depend materially upon the form of the stack of chimneys. This front would afford an example of what I understand by picturesque simplicity. There would be a certain symmetry and unity about it; it would present no superfluous ornaments, nor any unmeaning irregularity. But still it might be made a highly ornamental cottage, and might contain many internal conveniences which are not always found in buildings of more pretension; and it would possess enough of the picturesque character to make it harmonise with the surrounding scenery.

8120. *Interior accommodation.* Such, then, would be the exterior of the cottage: what are the accommodations it should contain within? A comfortable labourer's dwelling should, in my opinion, consist of an entrance porch, kitchen, washhouse, pantry, and small cellar, a parlour or spare sitting-room, and at least three bedchambers. These apartments are all necessary for the comfortable accommodation of a family, even in humble life; and, as we are attempting to describe the *beau idéal* of a cottage, we must suppose it to contain all these conveniences, which we proceed to describe in their order. A porch, besides being an important ornamental appendage to a cottage, is necessary for the comfort of the inhabitants, to which it contributes by sheltering the entrance from wind and rain, and thus assisting to warm the interior. A cottage porch should be of small dimensions, the floor on a level with the rooms within, and raised a step or two above the surrounding surface. It should be paved and ceiled; and if it had a seat on each side, it would form a kind of summer-house, where the females would often sit at work in fine weather. Over the seats might be shelves, on which small tools might be put away, and seeds, onions, &c., placed to dry. There should, of course, be a scraper at the steps, and a mat within the entrance.

8121. *Kitchen.* From the porch you should pass through a small lobby to the kitchen, or common sitting-room of the family, which should be a sufficiently spacious, light, and airy apartment. The object of the lobby is, that there may be two doors between the living-room and the outer air, which will assist in keeping the room warm with a less expense of fuel. There are some defects, usually found in the interior of old cottages, which ought to be avoided when new ones are erected. I allude to the lowness of the rooms and doorways, damp floors, and smoky chimneys. If we were to judge of the people by the houses they inhabited, we might suppose the former generations of our "bold peasantry, their country's pride," to have been absolutely a race of dwarfs. For, if you would avoid a broken head, you must actually creep through the doorways of ordinary cottages; and, after escaping the perils of the doorway, a man of good stature can seldom stand upright in the house without being in danger of knocking his head against the bare rafters of the floor above, or against the bacon-rack, the scythe-blade, the reaping-hooks, and twenty other things commonly suspended from the ceiling. Now, these low rooms and doorways must be a continual source of annoyance to the inhabitants; and, therefore, I would lay it down as a general rule, that no cottage kitchen should be lower than eight feet, and every cottage doorway above six feet. Another common defect in cottages is, the dampness of the ground-floor. In the case of old cottages, the ground-floor is usually much below the level of the surrounding surface, and you generally descend into the house; and, even in modern cottages, the floors of the lower apartments are seldom sufficiently elevated. The consequence is, that, in many situations, the cottages are damp and uncomfortable for five or six months in the year; indeed, I know several cottages in which springs of water regularly break through the kitchen floors during the winter season. To avoid this inconvenience, I would propose, as another general rule, that the ground-floor of every dwelling of this description should be eighteen inches or more above the surface, and that the earth on the outside should be the same distance below the level of the floor. Under every brick or stone floor there should be a substratum of broken stone or flints, varying in thickness according to the nature of the soil and situation. On a damp site, it may be necessary to have this substratum two or three feet deep, with drains and air passages through it; and the earth should have a good slope from the walls on every side, so that the water from the roof may escape rapidly, and not sink into the foundation. Another prevailing misery in cottages is, a smoky chimney. This is a proverbial nuisance to every one; but it is especially so to a cottager, because, over and above the dirt and discomfort occasioned by the smoke, half the fuel is wasted in a fireplace which has not a proper draught. This nuisance in cottages generally arises from the large size and straightness of the flue, and from the lowness of the chimney on the outside, or from the currents of air occasioned by the bad positions of the doors and windows, which seldom fit close. From whatever cause it arises, a smoky chimney is a prevailing misery in labourers' dwellings, which a judicious builder may generally contrive to avoid; and I refer the reader to some sensible observations upon this subject in the *Encyclopædia of Cottage, Farm, and Villa Architecture.* After this digression, let us return to the cottage kitchen. As this is the common sitting-room of the family, in which most of the household operations are to be performed, it should be a light warm apartment, of a good size. We will suppose it sixteen or seventeen feet square, and eight feet high, having a window in the east and one in the west side. It would thus have the benefit of the morning and midday sun; an important advantage to a cottager, in whose domestic expenditure coals and candles are considerable articles. Stone is, I believe, the best material for the floor, as being most durable and easily kept clean, and in these respects greatly to be preferred to brick. Boards, besides that they are liable to occasion accidents by fire, could scarcely be kept clean in a cottage living-room, and would soon be worn out by the iron-bound shoes of the inhabitants. Of course the walls and ceiling should be neatly plastered and whitewashed, and there should be a proper skirting-board round the room, and attached inside shutters to the windows. The fireplace should be so situated as to be well lighted by one of the windows; and it might be a close or open fireplace, according as wood or coal happened to be the common fuel of the district. I observe that the old-fashioned open fireplaces are generally preferred by cottagers, on account of the snug warm seats they afford in the chimney corner, as it is called, and which is too often the only warm place in the house. I am aware that these fireplaces do not economise fuel, or afford the best means of warming the room; but they present some advantages to the cottager; that is, they are capital places to dry bacon in, and wet clothing. Either wood may be burnt in them on the hearth, or coal in a movable grate; and, as the fire is on or near the ground, it certainly diffuses a considerable heat around it. The mouth of the brick oven also generally opens in the back, or side, of the chimney, so that all the ashes and litter, together with the heat produced, are confined to one place; and, should this place be near the centre of the building, the mass of warm masonry must have the effect of raising the general temperature of all the apartments. In the coal countries these open fireplaces are not usually met with; but, where wood is the principal fuel of the peasantry (as it is in the district from which I write), I would indulge their prejudice in favour of an open chimney, and will suppose one in the cottage kitchen, with the mouth of the oven on one side of the back, and on the other a small copper set in an arch, having a flue through the arch by which the steam might escape up the chimney. It would be tedious to describe minutely the various articles of useful and ornamental furniture found in the kitchen of a thriving cottager; indeed, to those unacquainted with rural life it would be difficult to convey an idea of the multifarious collection often displayed in a room of this kind. A tidy labourer's wife is sometimes as fond of knick-knacks, and as proud of displaying her various stores, as the richest lady in the land. The peasantry have, in fact, many of the prevailing tastes of their superiors in wealth and refinement, and love to ornament their houses with plants and flowers, prints, and plaster casts, and ornamental china. The kitchen is frequently as much crowded with useful and ornamental furniture as a modern drawing-room. The mantel-shelf displays a range of flower vases, images, and painted busts of the favourite heroes of past and present times, mixed with some of the bright cooking utensils. The walls are sometimes thickly hung with coarse engravings, ballads, and printed papers, moral, religious, and political, and with various other things; among which are conspicuous the labourer's club rules, and his staff, or some peculiar implement denoting his occupation, such as the polished head of the shepherd's crook, the market-day carter's whip, or the spare flail of the thresher. The window is seldom without its collection of exotics, thriving surprisingly, some of them in spoutless teapots and other discarded vessels; and on the window seat, or on a shelf near, a little heap of books; the bible, in a neat cover, reverently placed apart from the rest. Even the ceiling is usually furnished with that desirable ornament, a well-stored bacon-rack, shoes, tools, bags of seeds, and a host of other things. But the pride of the cottage housewife is her dresser and shelves. Here she displays her little store of glass and earthenware of the better kinds, with her best plated spoons, her bright pewter plates, and clean wood trenchers, frequently arranged with considerable taste and effect. Some of the conspicuous articles will not, perhaps, bear a close examination; and are, in fact, useless; though "wisely kept for show:" but she contrives to hide defects, and the shelves often exhibit specimens of old glass and china, which a collector of such rarities might covet. There are, indeed, few more picturesque interiors than that of the well-kept kitchen of a thriving labourer who happens to have a tidy wife; and I have often been much pleased at the air of decent comfort, and at the decorated effect produced by the miscellaneous collection seen in a room of this description.

8122. *Furniture of the kitchen.* Among the more prominent articles of furniture in a thriving labourer's kitchen, the clock, I think, takes precedence of the rest in the owner's estimation, and its well-polished case is generally a conspicuous object. Next to this we may rank the best dining-table, often one of those interesting old oak tables with rounded leaves, and as many curiously-turned legs as a spider. The best tea-table, turned up, with its pillar and claw, in a corner; and the dough trough, with its clean white cover, would next attract attention. To these we may add the great arm-chair, with a patchwork cushion in the bottom, for the *man*, as he is emphatically called here, in which he sits in the evening in a sort of rustic dignity, surrounded by his wife and children, forming, in many cases, a happy, interesting group: the wife and elder girls at work, perhaps, while one of the boys is standing by the father, reading, or repeating what he has learnt at school during the day. I hope there are many such evening groups still to be found in our cottages, in spite of politics and the beer-shops. This reminds me of another piece of furniture which I should wish to see in every cottage; I mean, a shelf of useful and instructive books. You seldom enter a cottage without finding some books; indeed, as far as my observation extends, I should say that a taste for reading is becoming more general among the labouring classes; and it ought to be encouraged, as a source of instruction and enjoyment, which has a tendency to improve the morals and better the condition of the peasantry. What a wide field of knowledge and enjoyment is cut off from the labourer who is unable to read, or who has no taste for reading! Half the leisure time of such a person must be spent in drowsy indolence, or in the debasing scenes of the alehouse, to which he is almost driven in self-defence, to relieve the tedium of idleness and the oppressive vacancy of his mind: the want of this resource and comfort is severely felt by the uneducated labourer in times of sickness and old age, when a long active life is necessarily exchanged for a state of total inactivity. There are few of the rising generation entirely without education. The stores of knowledge will therefore soon be opened to all the labouring classes, and they should be encouraged to use them to their own advantage, by having their attention directed to useful and improving books. "A little learning," if not properly directed, "is a dangerous thing."

8123. *Back-kitchen and washhouse.* Besides the kitchen, or common living-room of the family, every complete cottage should have a small washhouse, in which the brewing and washing, the dirty and all work of the family, may be done. Here I would have shelves for the saucepans, and other unsightly articles, used in cooking; also a set copper; and a proper sink, communicating, by a drain, with the dung pit or a cess-pool. Most cottages are without a washhouse; but a small place of this sort is absolutely necessary to every dwelling; as, without it, the living-room can never be tidy or comfortable, and, I may add, wholesome. For want of a washhouse, the cottager is compelled to hang up his dead pig, and even to salt it, in the living-room; and as there is no other place in which to do the dirty work, and put away the dirty things which must be used in every family, the room is generally in a litter, and has an unwholesome, disagreeable smell, which must be prejudicial to the health of the inhabitants. But what I would chiefly insist upon in the washhouse is a proper sink to receive the slops and dirty water. Very few cottages have any convenience of this kind; and consequently all the slops are thrown out at the door; and, you can scarcely approach a cottage, in many cases, for the abominations that surround it. Besides this, the entrance is commonly surrounded by a sort of impure air, which is extremely offensive and must be injurious to the inmates. No cottage, therefore, should be without a sink, communicating with a drain, which may carry the dirty water to a sufficient distance from the house. Even a pretty cottage will have a squalid, miserable appearance, when the door is surrounded by filth; and I have seen villages, with the houses built on each side of a narrow road, which were absolutely disgusting in consequence of the nuisance referred to.

8124. *A small larder or pantry*, having a window in the outer wall, should communicate with the kitchen or wash-house. This is a necessary convenience not often found in labourers' dwellings, in which the provisions are generally kept in nasty close cupboards, or on shelves in the living-room, where they are liable to get spoilt, and are exposed to dust, smoke, and all sorts of impurities. For want of a better place, even the beer or cider barrel is kept in the warm kitchen, and in such a situation the liquor, of course, soon becomes sour and unfit to drink. No cottage, therefore, should be without a cool airy larder; and a small place of this kind might be easily contrived in every dwelling, with little or no addition to the cost of building. As I am describing the *beau idéal* of a cottage, the owner of which might keep a cow, I will, in the present case, suppose the larder of a sufficient size to contain both the milk and provisions. We can scarcely expect a distinct place for each in a labourer's cottage, and it would be unnecessary. There might be separate shelves for the milk and provisions, &c.; hanging shelves for the small cheeses, which a managing woman would of course make during the summer season, even from her single cow.

8125. *Cellar.* If the floor of the larder were sunk the depth of a yard below the surface, the beer might also be kept in it; but a cottage would not be quite complete without a small cellar, to contain the beer, and the potatoes and other roots. A cottager with land would grow a large supply of potatoes and other roots, for his cow and pigs; and it would save a great deal of time, and prevent waste, to have the roots always at hand in the cellar, instead of burying them out of doors in pits, which, when once opened, are not secure against frost and wet. I would also recommend a cellar in every new cottage; because I look forward to the time when every labouring man will be able to brew his beer at home. A hard-working labourer requires a certain quantity of wholesome beer; and if he has not this at home, he is sure to go to the alehouse, where he gets into the worst company, spends in intemperance what is required for the maintenance of his family, and in many cases becomes a confirmed drunkard. It would be a work of charity, therefore, to encourage brewing among the labourers; and, as a means of promoting it in country villages, I would suggest a plan of having a small set of brewing utensils, for the use of the cottagers, in the care of a fit person, who would lend them, in the parish, under proper regulations. The cost of the tubs &c., would be inconsiderable, and might be easily raised by subscription among the wealthy inhabitants, or even among the cottagers themselves. A penny or two paid for the use of the tubs would be sufficient to keep them in repair. The want of tubs is one of the chief obstacles in the way of cottagers brewing, which this plan would remove. And I am persuaded it would succeed, as I find that even a whitewashing brush, kept to lend out, has been a great promoter of cleanliness.

8126 *The parlour.* Should this paper ever fall into the hands of a labouring man, he would probably smile when he came to this part of it, in which I am to speak of the parlour. Many persons will consider a parlour an unnecessary luxury in a labourer's dwelling: it would be seldom used perhaps as a sitting-room, but as a spare room it would be a great convenience in the case of a large family, and should not be omitted in an attempt to describe a complete cottage. Most thriving labourers are in the habit of receiving their distant friends and relations, at certain seasons, such as the village feast, at "the tides," at christenings, &c. The parlour would be useful on such occasions, both as a sitting-room and additional bedroom, as it would be also in case of sickness, or death. If for no other reason, I should be an advocate for a spare room of this kind in every cottage, as a receptacle for the dead. As cottages are at present, there is seldom any possibility of separating the dead from the living, when one of the inmates dies: when such a calamity occurs, the corpse must be placed either in the sitting-room or bedroom; and I have known instances of a large family sleeping for several nights together in the same room with a corpse, even when death has been occasioned by an infectious fever. To my feelings there is something unspeakably terrible in this dreadful mixture of the living with the dead; and if the idea be so appalling what must the reality be to those who suffer it! A small parlour, therefore, containing an occasional bed, would prevent the necessity for this most disgusting consequence of death in a labourer's family; as, with the possibility of making up an extra-bed for some of the inmates, one of the bedrooms might generally be appropriated for the reception of the body, between the death and the funeral. I would have the parlour a plain comfortable room, ceiled and plastered, with a stone or boarded floor. It should, of course, have a small fireplace, and attached inside window-shutters. Besides the chairs and table, the furniture should comprise a closet bed complete, as the room would probably be more used as a bedroom than as a sitting-room. A corner cupboard to receive the best china and glass, a few groceries, &c., would also be useful; and a chest of drawers for the linen of the family would not be out of place. I should whitewash the walls, because it could be done by the cottagers themselves when requisite, and colour-washing is, of all things in this way, the most difficult to do well to the uninitiated. The cottager's wife would decorate the walls and the room generally with some of her best knick-knacks, books, flowers, &c.

8127. *Staircase.* As we proceed to the upper story, we must say something of the staircase. This, in old cottages, is generally the most awkward thing possible, and placed in the most awkward situation; a narrow, twisting, dark, and, to a stranger, a dangerous ascent, compared with which a common ladder would be luxurious, and usually leading into a bedroom which is a passage room to another, when there happens to be two. Our cottage must have a proper light staircase, ending above in a small landing, to which all the bedroom doors should open.

8128. *Bedrooms.* Every cottage for a family should have at least three bedrooms, so that the parents, and the children of each sex, might sleep in separate apartments. The rooms need not be large, but they should be light, airy, comfortable, each having a window that will open. They ought to be ceiled, plastered, and whitewashed; with boarded or plaster floors; and, if possible, a fireplace in each, in case of sickness, or merely for ventilation. I am rather an advocate for the plaster floors used in the north of England for cottage bedrooms, as they are a security against accidents by fire; and, when properly made, are more comfortable, and have a more cleanly appearance, than the rough ill-joined boards commonly found in cottage chambers. I have seen these floors nearly as hard as stone, and, when washed over with pipeclay, they have a very neat effect. It is unnecessary to describe the furniture, which, of course, should comprise the requisites for comfortable repose and cleanliness in a humble way. You seldom find bed-curtains in a cottager's chambers; I have heard them express a dislike to bed furniture; and, in a tolerably warm room, it is, I think, a luxury we might all dispense with, as being rather prejudicial to health than otherwise. Cottagers generally use stump bedsteads, with head-boards; and I have observed in cottages ancient specimens of oak bedsteads, with curiously carved head-boards and legs. Old carved oak clothes-chests are also frequently met with, which would be valued by the antiquary. There are few things connected with labourers' dwellings which so much need reform as the bedrooms. In this neighbourhood half the cottages have only one chamber, and this sometimes a low miserable apartment in the roof, open to the thatch; with the walls unplastered, and without a window that will open; in fact, a place little better than a hay-loft. And here the whole family sleep; old and young, married and single, without even a curtain to separate the sexes. Can we wonder at the gross immorality which is so lamentably common among the young peasantry, when the sense of delicacy is destroyed even from infancy? I would therefore press this subject on the attention of all benevolent owners of cottages, and especially on our great landed proprietors, who are generally well disposed to contribute to the improvement of the peasantry. The first step towards the improvement of their morals must be to increase the number of bedrooms in cottages. Let me then urge this upon those whom it concerns, in the words of "Nature's sternest painter, yet the best," the poet Crabbe: —

> "These thoughtless people part,
> Nor let the ear be first to taint the heart."

8129. *General remarks on the interior.* Having described the interior of the cottage, let me pause and enquire, whether there is anything in the description which can be justly considered superfluous, and not absolutely necessary for the comfortable accommodation of a labourer with a large family. I am not aware of any thing to which a reasonable objection can be offered, unless it be the parlour. The idea of a cottage parlour may lead some to exclaim, "The man must be a fool! Who is to do the work, if labourers are to be fine folks, and sit in parlours?" My friend, are you not offended at a name? Let us change the high-sounding title of this room of all works, and perhaps you will not object to it. Call it the spare room, for instance; a place to be used for all sorts of purposes: for such it would be, in fact. Unless when the wife was confined, or any of the family happened to be recovering from illness, I will answer that it would not be used as a parlour above six times in the year. It would frequently be let as a lodging to an occasional labourer in the parish. In rainy weather, it would be degraded into a drying-room, and be filled with wet linen; and the floor would often be found half covered with onions and seeds laid there to dry. Do not the various uses to which such a room may be applied make it a desirable addition to a cottage, even though it may be called a parlour? If such an apartment would have a tendency to give the peasantry fine notions, I should be the last to recommend it. For I hate fine people of all sorts, and fine *poor* people above all others, because they have not even an excuse for finery. But though I would not give them notions unsuited to their station, I should be glad to see their habitations improved, and I know, from painful observation, that our cottages stand in need of improvement. They are, in fact, behind the times; and while the houses of every other class of society have been gradually increasing in comfort and convenience, the dwellings of the labourers are little better than they were a hundred years ago. Many improvements and conveniences in cottages have been suggested by others, which I forbear to notice; for this reason, that, while such conveniences are unattainable by persons of small independent property, it is in vain to expect that they will be provided for cottagers. My object has, therefore, been to describe the accommodation required in what would be called a comfortable labourer's dwelling, and to suggest practicable improvements which are likely to be effected; and I hope that there is nothing in the foregoing description which can be considered impracticable.

8130. *External appendages to a labourer's cottage.* I am next to speak of the external appendages to a complete labourer's dwelling, including the yard and outbuildings, the garden, orchard, and allotment of land. To account for some of the outbuildings which will be mentioned in the following description, I must remind the reader that, as I am speaking of a cottage of the first class, I must, of course, suppose the cottager to keep a cow; and that, besides a quarter or half an acre of land, for spade husbandry, (the quantity should be proportioned to the spare time of the labourer, and the quantity of manure he can collect), he would also be the occupier of about three acres of pasture. I am of opinion that it would have a beneficial effect upon the general conduct of the agricultural labourers, if there were a certain number of cottages, with land attached to them, in every parish, to act as a sort of stimulus to industry and frugality. Formerly the small farms presented this stimulus. The industrious, saving cottager had then a chance of rising a step above his original station in society; and a natural desire to improve his condition would act as a constant inducement to carefulness and activity. But now he has no such inducement. In most parts of England, parishes which were once divided into ten or twelve farms, of various extent, are now thrown into two or three large ones; the waste lands are enclosed or appropriated; and even the bare-worn common is, in many cases, denied to the hard-working frugal labourer, who happens to have saved enough money to set up a cow. How can we wonder, then, at the careless, improvident habits of the peasantry, when they have scarcely an inducement to be otherwise? But, under all their disadvantages, there are still a few labourers who save money; and is it not rather hard that they should be deprived of the opportunity of employing it profitably in the only business with which they are acquainted, that is, agriculture? Let us suppose a working man to be possessed of 50*l.* Almost the only way in which he could invest it safely, would be in a savings' bank, where it would produce him an interest of about 2*l.* a year. Now this is all very well; the principal sum is secure, and a certain 2*l.* a year is a desirable addition to a labourer's income. But it would take nearly his whole life to save up 50*l.*; and half that sum would produce a much greater income, and much improve his condition, if employed in some sort of business. In short, though the savings' banks have been a great benefit to the working classes, the small income produced by a sum of money placed there does not afford a sufficient stimulus to frugality. The interest upon their savings can add little to the comforts of the depositors; and, as to having a sum of money against the time of sickness or misfortune, they know that the parish must then support them; and though they might be induced to save, if by saving they could materially improve their condition, we must not expect them to save for the relief of the parish. But let us suppose a man to have saved only 25*l.*, and to have an opportunity of taking a cottage, with land enough attached to it to support a cow. He would probably invest his little capital in a cow, a couple of pigs, some poultry, perhaps, and a hive or two of bees; and, if he had tolerably good luck, and were a good manager, he would soon be placed in circumstances of comparative affluence, and would be infinitely better off with his 25*l.*, *thus invested*, than the other would be with his 50*l.* in the savings' bank. The great improvement in his condition would also be apparent to all around him, and would act as a general spur upon the carefulness and industry of his neighbours. Money in the savings' bank would not produce this consequence, because its effects are less apparent; in short, its effects are unimportant when compared with the comforts derived to a labourer's family from keeping a cow. But, besides being prizes to excite the diligence and reward the good conduct of the labourers, a few cottages, with land attached, would be a general convenience to the villagers, as a means of supplying them with milk; a luxury which, in my neighbourhood, is seldom tasted by the poor. Though living in the country, they are worse off than townspeople in this respect, as they cannot get it for money, unless on some particular occasion. The cause of this inconvenience is the large farms, and the want of cottagers' cows. A rich farmer is, of course, above selling milk, and there is no one else to sell it, unless there happens to be a small farmer in the parish, or the rich farmer lets his cows to the farmer or dairyman. It would not answer to sell milk in small quantities, and, as we have no cottage cowkeepers, the peasantry are deprived of a nutritious article of food, which it is almost impossible to do without. Wherever there are no cottagers' cows, the peasantry in general must be ill supplied with that important necessary, milk. I offer these reasons for the opinion I have ventured to advance, that in every village a few cottages, with land to keep cows, would be desirable on many accounts. I do not say that every cottager should have a cow. Perhaps it would be better if all had them who can manage them; and it would be found, upon trial, that the number of these would not be large. A cow would be thrown away upon dirty, indolent cottagers, and there are many respectable ones so situated, that it would be more an inconvenience than an advantage to them to keep a cow. But I think there should be a few cottages with land in every parish, that the steady and industrious, and those who have an opportunity, may at least have a chance, of improving their condition.

8131. *The yard.* After this long digression, let us proceed to speak of the yard, a very necessary convenience to a labourer who keeps a cow. The wash-house should have a door opening into the yard, which ought to contain the pump, dung-pits, and all the out-buildings. The pump I would place as near the washhouse door as convenient; the dung-pit in the corner of the yard, farthest from the house; and to this pit the surface of the yard should have a gentle fall. It should, of course, be properly drained.

8132. *The fuel-house.* The first out-office to be mentioned is the fuel-house, a place in which the coals and dry wood may be kept, if necessary, under lock. The tools, and hogwash tubs, and many other things, may also be placed in this building, which is a necessary appendage to every cottage. It would be most conveniently placed joining the back part of the house, so that it might be approached under cover from the washhouse door.

8133. *The cowhouse and pigsty* should be near the dung pit, that the drains from both may be laid into it at little expense, and to save the cottager's time in cleaning out the cow stall, &c. The cowhouse need only contain one roomy stall and a calf-pen, with a small loft over both for the hay brought in for use. The pigsty to a cottage where a cow is kept should be divided into two, that the store pig, which a good manager would never be without, might be separated from the fatting pig.

8134. *If a poultry-house* should be required, I would place it either over or adjoining to the cowhouse, for the sake of warmth. But I am not sure that it would answer to a cottager to keep much poultry, unless in situations where there is a ready sale for eggs and chickens, and where poultry can be kept without being a nuisance to the owner and his neighbours. In a widely scattered village this may sometimes be the case, but where the houses are near together, the cottager's fowls are a continual source of dispute and annoyance. They are ill fed at home, and cannot stray anywhere in search of food without trespassing upon a neighbour's ground, where, in the absence of the family at work, they may devour or destroy half the produce of the garden. Where the houses are scattered, and a cottager has land of his own, or is near a common, on which they could have a run without trespassing upon others, perhaps it would answer his purpose to keep a few fowls; that is, if he can keep them out of his garden, but not otherwise. If water is near, ducks would be most profitable to a labourer, and more easily managed than hens.

8135. *Privy.* I do not recollect any other outbuilding actually necessary for the cottager's convenience, unless it be the privy, which might be either in the yard or in the garden, and, if desired, I see no objection to one in each place. But it is useless to talk of a separate convenience of this kind for males and females, till every labourer's dwelling has one. I believe that nearly half our cottages are without any place of the kind; at least it is so in my neighbourhood. For instance, out of sixteen dwellings near me, six only have the convenience alluded to, and three of the six conveniences have been erected within these two years. The want of such places must be a terrible nuisance to the cottagers; and I particularly recommend the subject to the attention of cottage owners.

8136. *General observations on exteriors.* As the fence of the yard and the outbuildings would add something to the cost of the cottage, I choose here to meet objections that I suppose, and recommend only the least expensive outbuildings, such as the cottagers, with trifling assistance, would very frequently erect themselves. The cowhouse would be the chief expense, and that would be little better than a common shed, walled up with any thing on three sides, and open to the south. But I would have a strong fence and gate to the yard, to be fastened well at night, that all the stock may be secure, as it would probably cost the owner at least a day's work when his cow or pig happened to get astray. I do not mention any place for pigeons in the yard, because a cottager could not keep them without constantly trespassing on his neighbours. There is an increasing prejudice against pigeons, which are certainly very troublesome to the farmer at certain times in the year. Dovecots are now much less frequently seen in farmyards than they were formerly, at least in the corn-growing districts: and if the farmers can no longer keep pigeons, of course the labourers must not. Where the cottage stands near a common, or among open green lanes, it would answer the cottager's purpose to breed a few geese, which are a profitable kind of stock, because, after a certain age, they almost take care of themselves. They would require to be secured at night; and, if the cottager keeps geese, he must add a house for them to his outbuildings in the yard.

8137. *The garden,* if well managed, is commonly the most striking feature about a labourer's dwelling, and there are many reasons why it should adjoin the house. In the present case we will suppose the cottage to be surrounded on two sides by the garden, and I would approach the front of the house through a narrow part of the garden which divides the house from the road; and this part of it I would devote chiefly to flowers and shrubs. I would train some ornamental climbing plants against the walls of the house, and a vine or pear trees, if there were proper situations for them, where the fruit would ripen and be out of the reach of the children. I observe, however, that excepting vines, fruit trees seldom thrive much against the walls of cottages; there are few labourers who know any thing of the art of pruning, and, being improperly pruned, the trees bear little, and seem not worth the time and trouble they require. Vines, however, do remarkably well against the cottage walls in this neighbourhood, and bear profusely in many situations, apparently with very little care or pruning. I am not qualified to lay down rules for the management of a cottager's garden, but I would venture to suggest, that it should not be too large; a small garden, well cultivated, being more profitable than a large one half cultivated. In fact, if he have an allotment of potato ground elsewhere, the cottager has no use for a large garden, as he grows and uses none but the commonest vegetables, which take up little room. He does not ever cultivate much small fruit. Strawberries and raspberries are very seldom seen in a cottage garden; and currants and gooseberries are not often abundant; so that a large garden is not requisite. I used to wonder formerly why the cottagers did not cultivate the small fruits in greater abundance, as they require so little trouble, and are so extremely useful. The reason for this neglect, given me by several labourers, is, that the children devour the fruit before it comes to perfection; in fact, they begin upon it as soon as it is formed, and very little is left to ripen. As cottage children are, of course, left a great deal to themselves, I believe it would be useless to attempt growing fruit where there is a large family, or in a closely built village. Where a cottager, therefore, cannot grow fruit, he ought, I think, to keep bees as a substitute for the profit of fruit. Indeed, no cottage garden should be without bees, placed in some warm retired corner, at a short distance from the house, for they are not agreeable neighbours. Bees are, I believe, the most profitable of all stock for a cottager, as the whole of their produce is valuable, and, except at swarming times, they are no trouble.

8138. *Orchard.* Besides the garden, it is desirable that every cottage with land should have a small orchard attached to it, especially in the cider countries; and, in extensive allotments of land, there are generally rough places, which, being of little value for any other purpose, might be converted into small orchards. Where there is no waste place of this description, I would plant the orchard immediately behind the garden, and contiguous to the house, that it may be easily overlooked by the owner; I would also rear a good hedge round it to keep out intruders, for young cottagers are as fond of sour apples as they are of sour gooseberries; and though they can scarcely clear an orchard of apples as they would a garden of small fruit, they will do a great deal of mischief, if not guarded against. As it is scarcely possible to have too much fruit, and a peasant's orchard is not likely to be large, I would plant some fruit trees in the hedges of the garden and fields. Damsons and cider apples, and other common fruit trees, would do very well in the hedgerows, and would be very ornamental. I think a cottage orchard should produce apples, pears, and plums of various kinds, but chiefly apples. Fruit will sell every where; and it is desirable that a cottager should have as many ways as possible of making a little money. The landlord ought to furnish the cottage grounds with fruit trees, and a gentleman of landed property would do this at a very trifling expense, by having a small cottage nursery, in which his gardener might graft, and rear fruit trees of good kinds, to transplant, when fit, into the cottagers' gardens and orchards. Many labourers are fond of grafting; and, if the ground were planted with fruit trees at first by the landlord, the tenants would generally keep it stocked. I wonder our landowners do not see the advantages of planting their cottage grounds with fruit trees; by which they would increase the value of them, and place in the hands of the tenants the means of paying the rent. They would also give their cottagers an additional comfort, and greatly increase the beauty of our villages, by surrounding the houses with fruit trees, which are the most interesting of all trees. What can be more beautiful than a handsome apple tree covered with rosy blossoms in the spring, or loaded with golden fruit in autumn? It is picturesque even in winter, when its rugged massy stem and irregular branches are exposed to view. Indeed, a village with many small orchards about it is generally a pretty village.

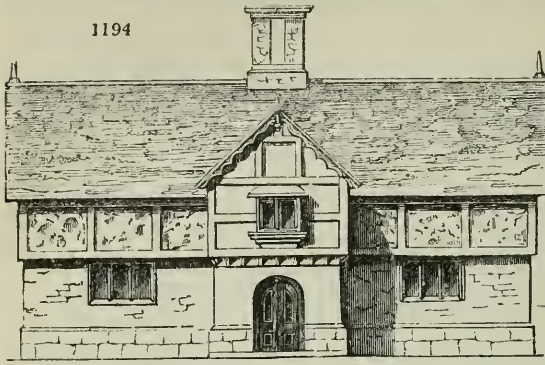
8139. *Potato-ground.* The next thing to be spoken of is the allotment for potatoes, &c., without which no cottage would, in these days, be thought complete. But, of course, this allotment would be much smaller in the case of a cottager keeping a cow, than in that of a labourer with only a garden to attend to The cowkeeper would have many little odd jobs to do connected with his cow and land, which would leave him not leisure enough to cultivate an extensive potato-ground besides his garden. Nothing pays a labourer so well as working for a master; consequently, a garden cannot answer to a cottager if he is obliged to lose time, as they express it, in order to cultivate it. A cowkeeper's ground for potatoes, &c. should therefore be smaller than that of another labourer, because the man will not have much leisure, and the wife will have less, as she will have the produce of the cow to manage, in addition to the ordinary cares of the family. But if the cowkeeper have not constant employment with a master, the case would be altered, and he would require as large an allotment as other labourers. He would probably cultivate his ground on a different plan from that followed by ordinary cottagers. He would not have space for a plot of corn, and it would answer his purpose better to grow cabbages, Swedish turnips, mangold wurtzel, or something that would be useful for the cow, on that part of his ground not occupied by the potato crop; indeed, a man who has a cow and pigs should consider their wants in his gardening almost as much as he does those of his family, and his pigs should nearly live on vegetables during the summer.

8140. *Grass land.* We conclude with a few observations upon the grass land which the cottager is to occupy for the use of his cow. This should be about three acres, divided into two enclosures. I believe three acres of fair grass land are generally considered the quantity required to summer and winter a cow; but, if a less quantity would be sufficient, of course the cottager would not desire more, as it would cause an unnecessary addition to his rent. He had better have rather too much land than too little, as the profit of a cow depends in a great measure on its being well fed. He would probably mow his fields for hay alternately, as he would not be able to manure very freely. He must, however, manure a portion of his grass land every year, or it would go back; and, if he were a good manager, he would be able to do this; for it is surprising what a heap of compost a managing person will collect who keeps a cow, and two or three pigs, and gathers every thing that can be converted into manure from the garden, the yard, the drains, and the roads about the premises. If he had not too large a potato-ground, a cottager, situated as I have described, would not be a good manager if he could not contrive to dress over an acre of his grass with compost every year; and this would be sufficient to keep it in heart if it were mowed every alternate year. There is one thing connected with allotments of land to labourers, which I would press on the attention of cottage owners, that whatever land is let to a labourer should be adjacent to his house. It should be remembered that the cottager's land is to be cultivated during the leisure time he has after having done an honest day's work for his master. His land, therefore, should be near his abode, that he may make use of all his time, half of which would be wasted in walking backwards and forwards if his land happened to be at a distance. If, also, his land were at home, he would spend many a half hour spudding thistles, or spreading dung in the field, or doing many little odd jobs, which would be left undone if the field were some way off. Moreover, it works a man too hard to have to walk a quarter of a mile, or more, to his extra-labour, after, perhaps, walking a much greater distance from the place where he works for a master. He would do half as much more work, and do it with more pleasure to himself, if he could do it at home, where he could immediately retire into the house when he felt fatigued. In short, if a cottager is to do any good with land, it should be within an easy distance of his home. Imagine the extra-labour occasioned to the cottager when he has to wheel out the manure, and bring home the produce of his land, distant, perhaps, a quarter of a mile from his house. Where the cottages belong chiefly to one proprietor, who is the principal landowner in the parish, it may generally be contrived that the allotment of land may adjoin the cottage, or be at least a convenient distance from it. A cottager can generally afford to pay as good a rent for land as an ordinary farmer; and, if he can afford to pay for it, he may reasonably expect to have it conveniently situated.

8241. *General observations.* I believe I have noticed most of the conveniences, internal and external, which in these times would be thought requisite to form a complete labourer's cottage. I am aware that the description given goes very far beyond the ordinary run of cottages, as they are at present. My aim has been to make it so; but I hope I have suggested nothing but what is absolutely necessary for the decent comfort of a family. My aim has also been to speak of practical improvements; and to show how the domestic accommodations of the peasantry may be increased at a moderate expense. There are many desirable improvements and luxuries suggested by writers on cottage architecture, which I have forborne to mention for this reason; because costly improvements are not likely to be applied to cottages; and it is useless to recommend luxuries for labourers' dwellings, which are not found in the houses of wealthy farmers and tradesmen, and even in those of the smaller gentry. Our peasantry, however, have no desire or taste for luxurious habitations. They wish for comfortable cottages; that is, dry, warm, and, above all, sufficiently roomy dwellings, in which their families may be conveniently accommodated, without violating the common decencies of life. If they had houses of this description, they would have every reason to be satisfied, and would be so, without unnecessary luxuries. And I hope the time is fast advancing, when the improvement which has taken place in the habitations of all classes above them will be extended to labourers' cottages.

8142. *As an example of an English labourer's cottage*, applicable to the above description, our correspondent has sent us the design shown in *figs.* 1194. to 1196. *Fig.* 1194. is the elevation; *fig.* 1195. the ground plan; and *fig.* 1196. the chamber plan. In *fig.* 1196. *a* is the oven; *b*, a small boiler; *c*, a closet for bacon or other things which require to be kept dry; *d*, stairs; *e*, a lobby; *f*, kitchen fireplace; *g*, parlour fireplace; *h*, washhouse; *i*, dairy; and *k*, shed for fuel, hog tubs, &c., opening into a yard, *l*. In *fig.* 1196., *m* is the parents' bedroom; *n*, spare bedroom, or bedroom for young or sick children; *o*, bedroom for girls; *p*, bedroom for boys; and *q*, a closet entered from the landing-place, *r*. The lower story of this cottage is supposed to be built of stone, or of brick with stone mullioned windows. The upper story to be a wooden framework, filled in with brick or plaster ornamented. The framework projects at the ends, and the gables have ornamented barge-boards. The window in the porch gable is an imitation of the old projecting wooden windows, of which there is a great variety, and they are all ornamenta.. There is a window in this form (see *fig.* 1194.), supported below by an ornamental bracket, which would have a good effect over a porch. These projecting windows are generally small, but they give more light than a common window of the same size. They are only proper for wooden houses, or in such parts of a house as are built of wood. The upper story in this design is supposed to be of wood and plaster, as being more picturesque, and in some places cheaper, than bricks; but in stone countries the cottage may be altogether of stone; or, both stories may be built of brick, with string-courses and copings to the gables. The chimney-stack consists of four slender separate shafts, with plain stone or brick cornices. The roof is tile or slate stone. The side walls of the chamber floor are to be five or six feet high, and the flat part of the ceiling is to be raised still higher in the roof. The bedrooms will thus be lofty and airy. (*Selim. Wiltshire, July,* 1834.)

1194



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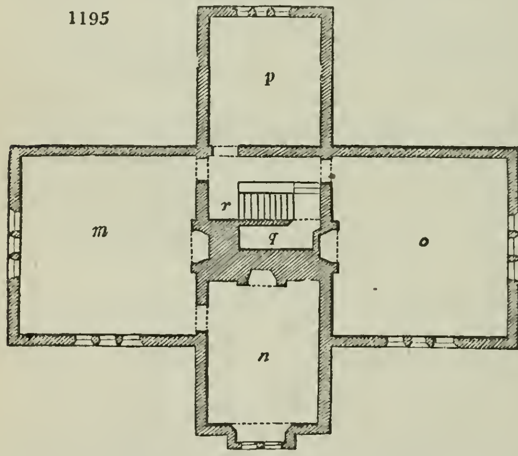
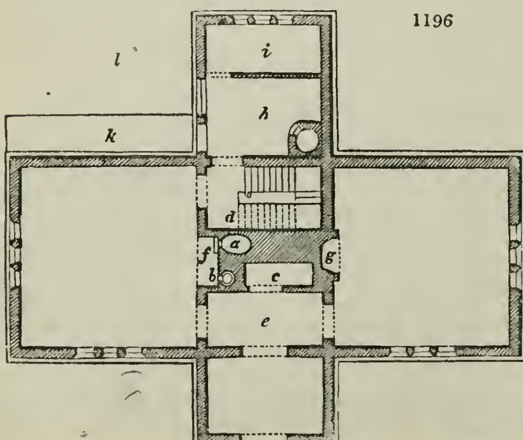


8143. *A group of four cottages* (*figs.* 1197, 1198.), represented as two, suitable for labourers with small families, comprising living-room, bedroom over, and washhouse to each. Privies are attached for the use of the two middle cottages; those of the two end ones are supposed to be detached. They may either be placed on a platform or terrace, according to the manner recommended in the *Encyclopædia of Cottage, Farm, and Villa Architecture,* or not, according to circumstances. In *fig.* 1198., *a a* are the sitting-rooms, twelve feet by ten feet; *b b* washhouse, one eight feet by six feet, and the other nine feet by six feet; *c*, water-closet; *d d*, entrance lobbies; and *e*, staircase.

8144. *Earthen walls.* It is proposed to erect the walls of these cottages with compressed earth; which method of building is termed *pisé*, and is very suitable for cottages of this description, being a very good substitute for brick, and reducing the expense of the walls one half. The chimneys must be of brick, with which the *pisé* firmly and readily unites; and, if the soil on which the cottages are to stand is not perfectly dry, the foundation must be carried above the ground-line in rough brick or stone work. I shall, however, proceed to describe the manner of executing the whole of the cottages in *pisé*, the chimneys and arches over apertures always excepted.

8145. *The sort of earth* most likely to be met with is common gravel, containing a small portion of clay; and this will answer the purpose as well as any that can be found. Where clay is not found combined in sufficient quantity with the gravel in its natural state, a small portion of common clay, or of loam, which is too

1196

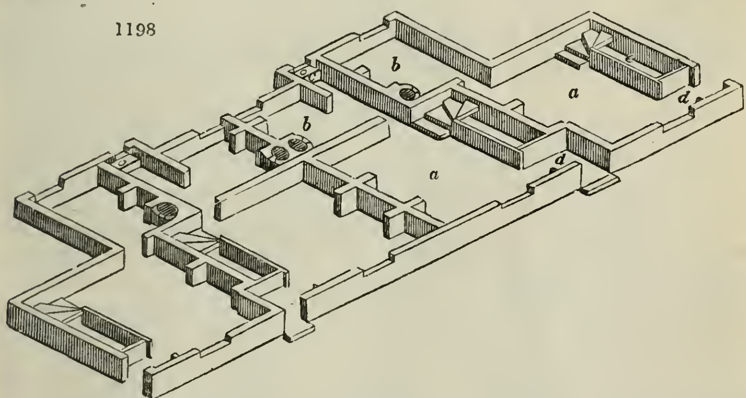


light for making bricks, may be procured, and mixed with the earth previous to its being used. On the other hand, if the clay be too strong, it will not do, but must be reduced to the proper quality by

1197

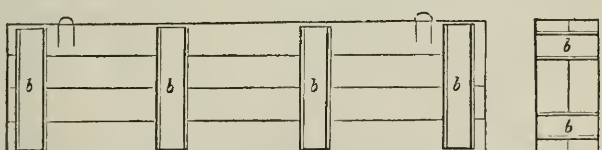
the addition of gravel or other coarse earthy rubbish; always carefully excluding all vegetable and animal substances.

1198



8146. *Mould for forming the blocks in.* For the purpose of erecting walls of this description, a mould (*fig.* 1199.) is required, which may be made by any country carpenter, being very simple, although con-

1199



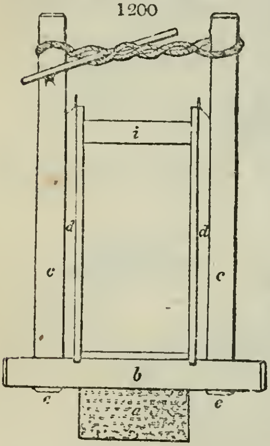
sisting of several parts. The two sides of this mould must be of one inch and a quarter of well-seasoned deal, smoothed and rabbeted, each about ten feet long and two feet nine inches wide when finished, and each having four ledges, *b*, of the same substance, nailed or screwed on the back, with iron handles to lift them by. Two heads to fit in between the sides must be made in the same way, and must be as wide as the thickness of the wall. Four bearers, mortised through at each end, receive the tenons of the upright posts. Eight upright posts stand upon these bearers, and are kept in their places by tenons at the bottom, and at the top by a line wound round each pair and twisted tight with a stick, one end of which is kept fast by being passed over a nail or peg in the post. Wall gauges, or pieces of timber cut to the width of the wall, will also be necessary to fit in between the sides of the mould, so as to prevent their coming over towards each other at top, which they will have a tendency to do during the operation. Two rammers should also be prepared, of hard heavy wood; and if formed of the root of the tree they will answer the better, being less liable to splinter off.

8147. *Mode of laying the foundation.* These things being in readiness, and the spot fixed on for the supply of earth, which should be as near to the intended building as may be convenient, the first step is to dig out the ground for the foundation in the usual manner. When trenches are opened of equal depth all round, for the outside, as well as for the partition walls, beginning at one end, fill in about six inches in depth with the ground that was taken out, and, after having trodden it well down, ram it with a heavy rough piece of timber (not with the rammers to be used in the mould), till it leaves no impression; fill in for another length; and, when the whole is covered with this first course, begin a second, and proceed in like manner till the foundation is brought up to the ground line. Large stones, or any coarse rubbish that can be conveniently procured, may be thrown into the foundation, but it should be thoroughly mixed with the earth, and, if it be very dry, a slight sprinkling of water may be given to it, from a watering-pot, before it is put in. The wall mould will not be required at this stage of the proceedings, for the sides of the trench will form a mould; but as the edges will be somewhat broken away, the ground must be well rammed up to the foundation on both sides. Having proved the work with a level, some precaution must here be taken to prevent the damp from ascending the wall, which it would otherwise be sure to do, more or less, according to the nature of the soil. In some cases, a bed of cement, spread all over the work just above the ground line, will be sufficient; in others, a course of slates must be added, and over that another bed of cement. The chimneys should be built first, and with sound bricks and good mortar, which will allow of the earth being well rammed up to the brickwork.

8148. *Mode of fixing the mould.* The bearers are now laid on at proper distances for one length of walling, level in themselves, and with each other; the sides of the mould are then set in their places, as are also the uprights, and the end and the wall gauges are put in. The line is next passed round each pair of posts, and tightly twisted with a stick; one end of which is brought over a nail or peg in one of the posts, and kept there, by which means the whole is braced firmly together.

8149. *A section of the mould as fixed*, is seen at *fig.* 1200.; in which *a* is a portion of the wall underneath; *b*, the bearer; *c c*, posts with their tenons passing through mortises in *b*, at *e e*; *d d* are sides of the mould; and *i* is the wall gauge. The twisted line and stick are also seen at top.

1200



8150. *Mode of forming the wall.* The turf having been pared off all round the spot whence the supply of earth for the walls is to be obtained, and as much immediately under it removed as is unfit for use, proceed to dig the same with a pickaxe, and throw it up in a heap, breaking the large lumps or clods, and drawing away the largest of the stones, which will roll to the bottom, with an iron-toothed rake. This rake, however, must not be too fine, as all stones not larger than a hen's egg may be used in the wall. Care must be taken to pick out every little bit of root, twig, or other vegetable substance that is to be found, and to throw them aside; for, if worked up in the wall, they would in a short time rot, and thereby affect its stability. If the earth be very dry, it should be wetted a little; but this must be done very sparingly and equally, and before it is put into the mould. Being thus prepared, the earth is carried to the wall in baskets, and put into the mould, at which there should be two other workmen with their rammers: one of these men gets carefully into the mould, and, spreading the earth evenly with his feet, treads it well down. A layer of about four inches in thickness being thus spread over the bottom of the mould, the men, one on each side, proceed to work it with their rammers, crossing their strokes in every direction. This layer being sufficiently rammed, others are added, and proceeded with as before, till the mould is filled within three inches of the top. The mould is then taken to pieces and fixed for the next length of walling, and one course is completed all round, including the partition walls up to the chimneys. Small wood-bricks for nailing skirting, linings, &c., to, should be put in vertically. Binders or ties of oak or other hard wood are put in at the angles, rough from the saw, about five feet long, an inch thick, and of such a width as to allow about four inches of earth on each side of them. One of these is put in at each angle on the top of every course, the alternate ones turning different ways, and the ends consequently crossing each other. Similar ones are put in to tie the partition walls to the front and back walls.

8151. *Laying the second course.* The first course being completed, the second should be worked the reverse way: thus, if the first was from left to right, the next should be from right to left. When the walls are built up high enough for the arches to the apertures, the skew-back of the arch may be formed by chipping away the rammed earth with a pickaxe or chisel, and the arches may be turned with sound bricks in cement or good mortar, the centres being made rather stronger than usual, as well as the supports under them; and these should be left in till the wall is completed. The lintels, joists, &c., are laid in the same way as in brick walls; and these, as well as the timbers of the roof, may be laid on immediately, which is one of the many advantages which this method possesses over "cob" or mud walling.

8152. *The roof.* The roof is intended to be slated, and furnished with eaves, trough, &c.; and the outer walls stuccoed, or a still cheaper coating may be given of roughcast.

8153. *Finishing.* The holes in the walls left by the bearers of the mould may remain open for a short time, which will occasion the walls to dry the quicker; and the plastering should not be laid on till a few weeks after they are finished, or the sweat of the walls will cast it off again. The roof, however, should be covered in, and eaves-troughs fixed as soon as possible. When the walls are ready for plastering, they should be covered all over with small holes, picked in with the sharp point of a hammer, or some such instrument, which will give a hold to the plastering; the loose dirt being brushed away with a stiff brush, and the walls then slightly sprinkled with water. The plastering is done in the usual way of rendering on brickwork; which, however, requires rather more wetting than *pisé*.

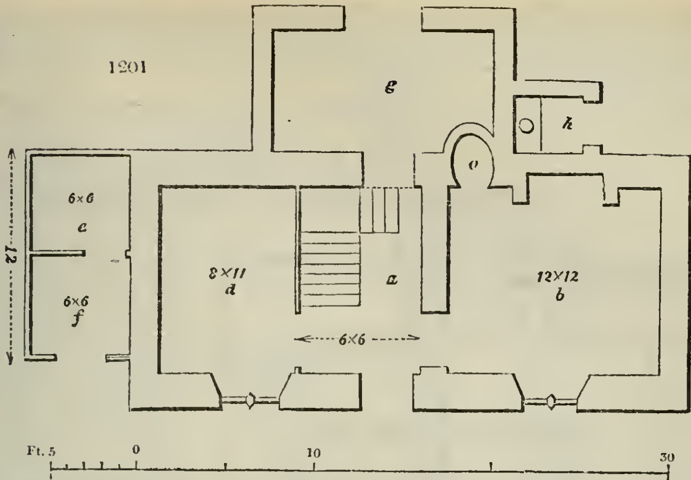
8154. *General remarks.* This will be found an economical, easy, and expeditious manner of erecting cottages, farm or other ordinary buildings, and, if properly executed and protected, will soon become as hard as stone, affording the comforts and convenience of a brick building, at nearly half less expense, and being vastly superior to those miserable hovels, put together with mud and sticks, which still disgrace many parts of the country as human habitations.

8155. *Estimate.* The expense of erecting the four cottages represented in *figs.* 1197. and 1198. according to the above plan, and finished according to the usual cottage style, will probably amount to the sum of 250*l.*, supposing the supply of earth to be conveniently placed, and of tolerably good quality.

8156. *The Gloucestershire agricultural labourer's cottage* is represented in *figs.* 1201, 1202, and 1203. *Fig.* 1201. shows an entrance, *a*, with a staircase down to the cellars, and up to the bedrooms; a living-room or kitchen, *b*, with an oven, *c*; a back kitchen or room for washing kitchen utensils, *d*; a covered pigsty, *e*; a yard to the pigsty, *f*; a shed for fuel, *g*; and the privy, *h*. There are bedrooms over *b* and *d*; and cellars under them. The lobby, and the space under the ascending stairs, are sufficiently large to admit of being used as a place for the family to sit in, in the summer season, when the heat of the kitchen might render it uncomfortable. *Fig.* 1202. is the front elevation of this cottage, and *fig.* 1203. the back elevation. These cottages, of which a number have been recently built on Mr. Lawrence's estate, by his brother, Charles Lawrence, Esq., who acts as agent for him, have each a quarter of an acre of good land attached as a garden; and, though they are well worth 5*l.* or 6*l.* a year, they are benevolently let by Mr. Lawrence for 52*s.* each. In order to teach labourers how to cultivate their gardens, Mr. Charles Lawrence has composed one of the best tracts on the subject of cottage gardens for country labourers, which has yet appeared, and has distributed it among them. It is entitled *Practical Directions for the Cultivation and General Management of Cottage Gardens*, &c.; and we would strongly recommend it to all who wish to teach country labourers how to make the most of their gardens.

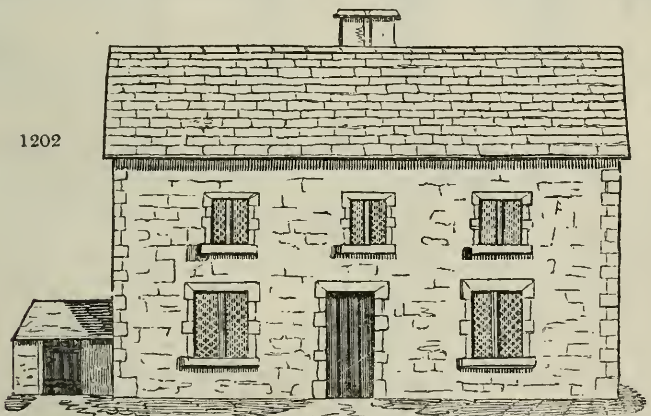
8157 — 2919. *Farm buildings.* The greatest improvement which has been made in these, since the

1201



publication of our second edition, is by W. M. Mackenzie, Esq., an architect of Perth. A number of minor improvements, by different Scotch architects, will be found delineated in that part of our *Architectural Encyclopædia* which treats of farm-houses and farmeries; but those of Mr. Mackenzie far surpass all the others. In the *Encyclopædia of Architecture*, p. 537., will be found a design for a farm of

1202



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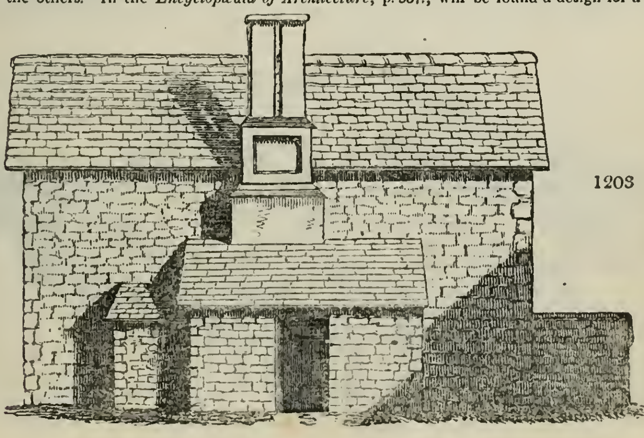
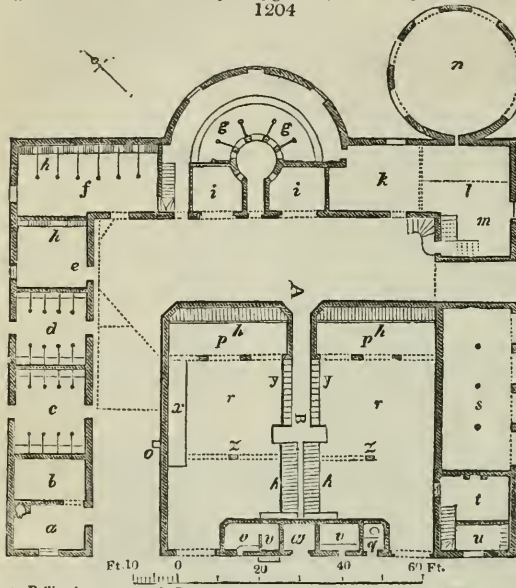


six ploughs, in which all Mr. Mackenzie's improvements are introduced, and described in detail; and in our *Architectural Magazine* (vol. i.) will be found another design by Mr. Mackenzie for a three-plough farmery; which, embodying all the improvements alluded to, and being of very general application, we shall here quote in the first place, and subsequently give two other designs, one by J. Milne, Esq., an Edinburgh architect, and the other by J. Blackadder, Esq., a land-surveyor of Berwickshire; both eminent professional men.

8158. *Design for a three-plough farmery, by Mr. Mackenzie of Perth.* *Fig.* 1204. is a ground plan; *fig.* 1205. an isometrical view; and *fig.* 1206., a vertical profile. This three-plough farmery is understood to be built upon level ground; with the straw-yard cut out hollow in the centre of a basin figure; that being the best form for retaining the moisture among the manure. In fixing the position of the different ranges of the buildings, the highest are put down to front the north and east, as best suiting the purposes to which those parts of the farmery are to be applied; and at the same time adding to the comfort of the cattle in the sheds and straw-yards, by sheltering them in the directions which are generally the coldest.

1204

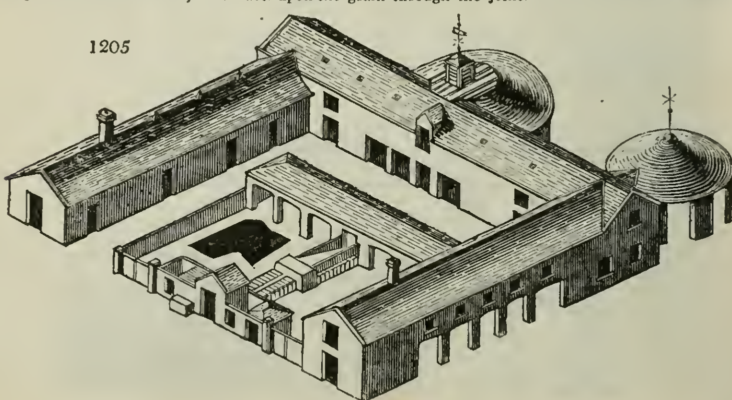


a, Boiling-house. *b*, Potato-house.
c, Cow-byre. *d*, Calf-byre.
e, Saddle-horse stable, and double stall enclosed for a mare and foal.
f, Common farm stable, with hay and straw-chamber above.
g, Feeding-byre, with straw-chambers above.
h, Racks for hay or straw.
i, Turnip-sheds: straw-chambers over.
k, Straw-house with upper floor.
l Threshing-machinery.
m, Clean corn-room, unthreshed corn above.
n, Horse-shed for threshing-machines.
o, Pump for liquid manure tank.
p, Cattle-sheds.
q, Privy. *r*, Straw-yards.
s, Cart-sheds, with granary above, carried over the carriage entrance to the farmery, and communicating with the clean corn-room.
t, Boothy for men servants, with beds in the upper-floor extending over the poultry-house.
u, Poultry-house.
v, Piggeries.
w, Water-house.
x, Tank for liquid manure.
y, Turnip-boxes.
z, Gratings over the drains leading to the liquid manure tank, to prevent the straw from the yard from choking up the drains.

8159. *The byres* (*c*, *d*), which are low buildings on the west, and the pigsties (*v*), which are on the south, do not shade the straw-yard and cattle-sheds, but admit the rays of the sun to all parts of them. The farm-house is supposed to be situated on the south-west of the farmery, with the kitchen court adjacent to the cow-byre, calf-yard, &c.; thus keeping the offices which are managed by the house servants in one division, and those under the management of the farm servants in the other division of the establishment.

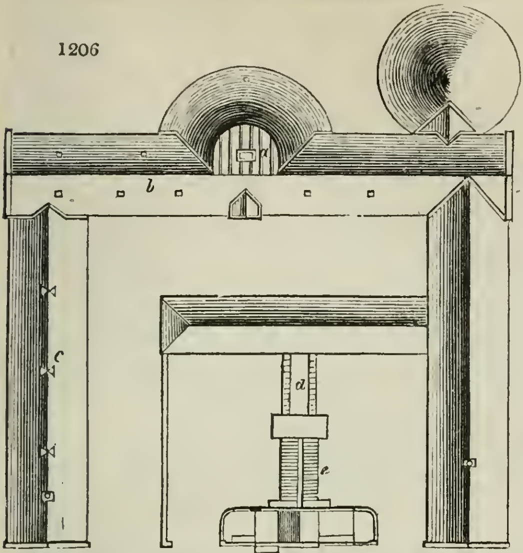
8160. *The threshing machinery* (*l*), being placed in a corner of the square, discharges the threshed corn into the clean corn-room (*m*), in the direction of the granary, which occupies the upper story of that side of the square; and the straw is thrown from it into the straw-house, which is in the direction of the straw-chambers, over the feeding-byre, stables, &c., on the other side of the square. The clean corn-room thus communicates with the granary, which extends from this point over the cart-shed. In this way the clean corn-room and granary occupy a side of the square apart from the offices allotted for the cattle, and the other apartments connected with them; and, as the corn-room can be locked up the moment the operation of threshing is finished, no opportunity is left for the grain being pilfered or injured. The granary in this situation has not only the advantage of the ventilators in the side walls, but it has also the benefit of the free air from the open cart-shed under it, which acts upon the grain through the joints of the floor. The cart-shed

1205



under the granary, besides being beneficial to it for air, is convenient, particularly where a farm is situated at a considerable distance from a market-town: or in the winter season, when the carts require to be loaded on the evening preceding the market-day; as it can be done before yoking (putting the horses in), and without moving the carts from under their cover, by means of the trap-door in the centre passage of the granary: which passage must at all times be kept clear from grain. In the straw-house, a trap-door is placed over the straw-rack; and, when the lower part of the house is packed full, this trap-door can be shut, and the straw carried along the upper floor to the straw-chambers over the stable and feeding-byre. These apartments will contain the straw of two ricks, which will enable the farmer to keep different kinds of straw under cover, and in separate divisions. A door is placed opposite the passage which extends along the centre of the straw-yard for taking out straw for the cattle-sheds, cow-byres, &c., if at any time required; but in general these are supplied from the low straw-house. The threshing-machine is one of six horse-power, and is impelled by horses; but where water can be had, it is a great improvement, as the men may be employed threshing, while the horses are resting: this is advantageous in a still greater degree at certain times, when the field operations exhaust all the horse power.

1206



a, Platform forming the upper part of the roof of the feeding-shed.
b, Ventilators to the stables.
c, Ventilators to the byres.
d, Inclined plane between turnip boxes.
e, Racks for hay or corn.

8161. *The circular byre* (*g*), which will contain ten head of cattle, is by far the most commodious and convenient arrangement; and, for a farm double this extent, the same form may be introduced, with equal advantage, by carrying the stalls wholly round the circle where the sheds are. The figure of the stalls, being broad behind, gives more space for the cattle when lying down; and, as a greater quantity of litter is requisite, more manure, of course, will be made: at the same time it admits from behind a more abundant supply of fresh air, and has also the advantage of one large ventilator in the centre of the circle serving the whole. The ten head of cattle are put up in double stalls in pairs; they are bound up one on each side of the partition, which is made high enough to prevent the horned cattle from touching one another; at the same time keeping the heads of each pair at such a distance apart, as to prevent them from injuring each other, or eating each other's turnips. The bends, or cow-ties, are fixed to upright iron rods about three quarters of an inch in diameter, which are screwed together through the partition. The lower part of the windows in the back wall of the byre are filled with luffer-boarding, which can be opened to any degree for admitting air, or shut altogether at pleasure. The feeding-ports, or openings which surround the feeding-chambers, have small doors hung with pulleys, lines, and weights, similar to those of a common window, which, by moving upwards, do not interfere with, or occupy, any part of the chamber. The wall at the heads of the cattle surrounding the feeding-chamber is built to the full height of the joists; which keeps the turnip barrow out of the view of the cattle, and does not disturb the one division of them, while the man is in the act of feeding the other. This is important, as the quieter cattle are kept the better, quietness being, no doubt, essential to quick fattening.

8162. *A commodious straw-chamber* is obtained over the byre, in a connected range with the straw or hay chamber over the stable: the roof, which is of considerable width, serving the double purpose of covering the feeding-byre, and of containing a very large quantity of straw immediately over it. Racks are placed over the several stalls, which are filled from the straw-chamber above. By this arrangement, the cattle have it in their power to eat straw and turnips alternately, if inclined. The access to the straw-chambers over the byre and stables is by a stair, which is common to both; and upon the plate (first landing-place) of this stair is placed a door, which divides the stable from the feeding-byre; the upper flight of the stair is understood to be a hanging one, having a useful space under it for holding the byre implements. By the whole arrangement much labour in feeding and attending the cattle will be saved.

8163. *The stabling* (*e*, *f*) consists of ten stalls, three of which are separated from the general farm stable, but are so situated as to admit of the racks being supplied from the general straw or hay chamber over the common farm stable. They are understood to have two sets of racks; the upper are for hay or straw, and the under one for grass. Although the under racks appear the most natural for the horses to eat from, it is found that they do not eat the straw or hay so clean out of them, as they do out of the upper racks; but these under racks are the most convenient for the grass, as it should always be put in from the stall below, without passing through the hay-chamber; being, in its damp state, very hurtful to the wood floor above. Part of the three-stall stable is set apart for a mare and foal.

8164. *The turnip-shed* (*i*), adjoining the feeding-byre, is also conveniently situated for supplying the cattle in the straw-yard; and, as it is not required for turnips in summer, it may be used for and serve the double purpose of a turnip-house and a grass-house.

8165. *Ventilators.* The cow-byres have ventilators placed over each line of heads; these cross the ridge, and are formed of lead of a triangular figure; the sill piece being overlapped by the sides far enough to prevent the rain from getting in. (See *c* in *fig.* 1206.)

8166. *The calf-house* and ward, and the cow-byres (*c*, *d*), which fall under the class of offices more immediately connected with the farm-house, have doors facing the kitchen-court, which makes the access to them convenient and clean. The opposite doors are used for driving out the cattle, and for wheeling the manure into the straw-yard. The causewayed court, in front of the byres, besides being convenient for carting in the turnips, affords space for the cows to move about in, or to stand in for a short time; and, as the cattle always dung when they are driven out, by allowing them to remain for a few minutes in this passage or court, the manure, that might otherwise be wasted on the roads, is preserved, and thrown into the straw-yard.

8167. *The several drains* leading from the byres, stables, and straw-yard, have such declivities as are sufficient to discharge the liquid manure into the tank, which is constructed on one side of the straw-yard in a central situation for the byres, stables, &c. It is thirty feet long, three feet broad, and seven feet deep; and, if the nature of the soil be porous, it should be plastered with Roman cement, to prevent the thin liquid manure from escaping. Being of this long and narrow figure, the tank can easily be covered with flagstones, which are much cheaper than arching, and take up less space. The drains should have holes fitted with cast-iron plugs, placed about fifteen feet apart; so that at these openings a jointed rod fifteen feet long could be put into the drain, with a hoe, or a piece of plate iron the shape of the drain, fixed to the one end of it. By these means the drains may be cleaned without breaking up any part of the causeway; but, if the drains are properly constructed, they will not require cleaning for several years. They should have a fall, towards the tank, of at least four inches to the ten feet, and be nine inches wide, six inches deep at the sides, and nine inches in the centre. By having this kind of triangular bottom, the smallest quantity makes a current, and forces everything along with it. The drains through the straw-yard should have openings with grates (*z z*) over them, situated in the lowest part of the straw-yard, to draw off the surplus water after heavy falls of rain or snow. When these drains are not required, the grates may be easily covered over with dung; and if, at any time, the manure is found too dry, movable spouts may be attached to the pump which is placed in the tank, by which means the liquid manure can be regularly spread over the whole straw-yard. A waste drain extends from the tank to an open ditch near the buildings; by which means, the liquid manure in the tank, if neglected, is carried off when it rises to that level, and is thus prevented from injuring the drains.

8168. *The cattle-sheds* (*p*), from their situation, face the south, which is of great advantage to the cattle, though often overlooked in laying out farm buildings, and they are divided in the centre by a passage adjoining the turnip-shed, and opposite the straw-house. This passage rises like an inclined plane four feet from A to B: the sides or parapets may be of wood, two inches thick (which forms a back to the turnip boxes), and be four feet in height, forming a fence to both yards. All the manure from the feeding-byre and stable is wheeled into the straw-yards by this passage: which, from its central situation, admits of the stable dung being equally distributed through both yards, and this by the rising passage can be done without opening a door, which prevents the one class of cattle from intermingling with the other, or getting out. Straw-racks (*h h h h*) are placed in the sheds; but, by also having them in the centre of the yard, and connected with this passage, they can be conveniently filled, and the cattle are induced to divide, which mixes the dung more generally through the yards.

8169. *The piggeries* (*v*), from their situation, may be conveniently supplied from the kitchen or boiling-house, and are in both yards. Pigs are very beneficial to the manure, from their turning it over, and mixing it; they also eat up any particles of corn among the horses' dung that may not have been digested. One small enclosure is provided with a trough for feeding young pigs, and they are thus protected from the cattle while eating; but they have no house or sty, that they may be induced to go out among the cattle, and to lie down about the sheds. By this arrangement, they have healthy exercise, and are enabled at the same time to provide a part of their food, and to be beneficial to the manure in both yards. Another sty is provided for putting up a pair to feed.

8170. *The gates to the straw-yard* may either be of the common form, or be hung, like sash windows, with stout ropes, pulleys, and weights. This last is perhaps the best plan, as it secures them from the risk of damage when the dung is being carted out of the yard; and also enables them to be raised as the straw in the yard rises.

8171. *The cistern-house* (*w*) is of such a height that pipes may be taken from it to the dwelling-house, boiling-house, calf-ward, &c. It may be either supplied from a spring, if one is to be found in the neighbourhood; or a well may be dug, and a pump placed within the cistern-house. A water-trough is placed in the division wall between the straw-yards; and a ball-cock is fixed in the centre of the said trough, and shut in by boarding, overlapped by the upper part of the wall, which thus protects it from injury by the cattle. By this self-acting supply, the cattle at all times have the command of water, and none of it is wasted: if supplied from a spring, no attention is necessary, as the supply may be regulated by having a ball-cock in the cistern. Two troughs are placed on the outside, for the horses and the milch cows, and are also supplied with ball-cocks. The roof water, in the inside of the court, is carried round with eave-spouts, and with rainwater pipes at the south extremities, leading it into drains. It is a material object to carry off the roof water, without allowing its admixture with the manure in the courts.

		£	s.	d.
8172. *Estimate.* —	Masonwork, excavations, and paving - - - -	373	0	0
	Carpenter's, glazier's, and smith's work - - -	470	0	0
	Slater's and plumber's work - - - - -	145	0	0
	Plaster work - - - - - - -	5	0	0
		£ 993	0	0

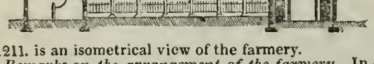
The above estimate is made out upon the supposition that stone may be got for the working, at a distance not exceeding one mile from the building; and that the land carriage of the timber (which is all foreign) and of the lime should not exceed from five to ten miles, and that of the slates from ten to fifteen miles.

8173. *Design for a set of farming offices, and farm-house, for a low-country farm, employing two ploughs, by Mr. Milne of Edinburgh.* In the ground plan of the farm-house (*fig.* 1210.), there are an entrance lobby; *a*; staircase and stairs to attics, *b*; passage, *c*; kitchen, *d*; kitchen and dairy scullery, *e*; family bedroom, *f*; dining-room, *g*; bedroom, *h*; farmer's room, *i*; coal-house, *k*; back entrance, *l*; parlour, *m*; laundry and maid-servant's room, *n*; scalding-room, *o*; dairy or milk-house, *p*; entrance to the dairy, &c., *q*. The ground-plan of the farmery (*fig.* 1209.) consists of the calf-house, *a*; yard for airing cows, *b*; dung pit and liquid manure tank, *c*; seed potato-house with hay-chamber over, *d*; stable for five horses, *e*; tool-house, *f*; cart-shed, *g*; straw-barn, *h*; house for threshing-machine, *i*; feeding-byre for eight fattening cattle, *k*; byre for ten milch cows, *l*; cleaning passages, *m m*; root and potato house, *n*; boiling-house, *o*; feeding-house, *p*; feeding-place for pigs, *q*; pigs' sleeping place, *r*; privy, *s*; pump from the liquid manure tank, in the centre of the dung-yard, *t*. The double dotted lines indicate the various drains leading to the liquid manure tank.

Fig. 1207. represents a section through the farmery offices on the line A B.

Fig. 1208. is a geometrical elevation of the front of the farm-house.

1207

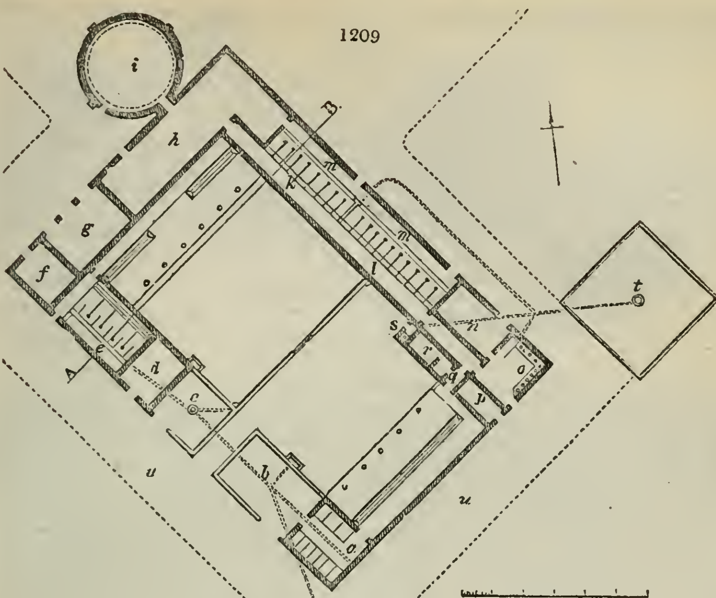


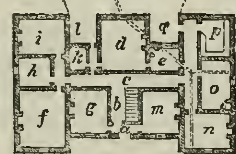
1208

Fig. 1211. is an isometrical view of the farmery.

8174. *Remarks on the arrangement of the farmery.* In designing a farmery, the object in view is to secure that disposition of the buildings which shall be the most convenient, at the least expense; and, in order to attain this object, the arrangement of the various apartments in this plan is very different from that which is usually adopted. Economy in the number or strength of the servants, together with such a plan as shall prevent the provender from being blown about by every gust of wind, and also pre-

1209

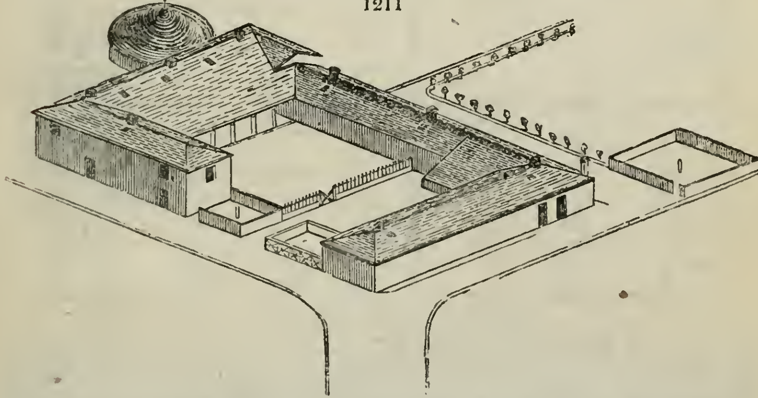




1210

vent the necessity of dragging it over urinous pools of water and wreaths of snow, and which offers a number of courts for wintering cattle of different ages, is alike profitable for the proprietor and farmer. While making a design, however, without reference to any particular farm, a considerable difficulty presents itself. By assuming only that so many ploughs are to be employed, no adequate idea can be formed of the site of the buildings; which, were it known, might lead to a difference of construction. Even a seemingly untoward piece of ground can, in the hands of a skilful architect, be turned to advantage for

1211



this or for any other purpose. The nature of the soil, too, its local situation, and capability for and extent of pasturage, would determine the number of cattle to be housed, &c., none of which data can be given on this occasion. But, assuming that a two-plough farm is capable of raising every year 67 imperial quarters of wheat, and of oats 280, of barley 67, and of peas 24 quarters; and that, collectively, these would yield about 7000 stones (of 16 lbs. each) of straw: then, for making butter and cheese for the market, there could be kept ten milch cows, five one year old cattle, five two years old, and seven three years old, to be kept through the winter, and fattened for sale in the spring; and accommodation for this number of cattle is provided in the design, *fig.* 1210.

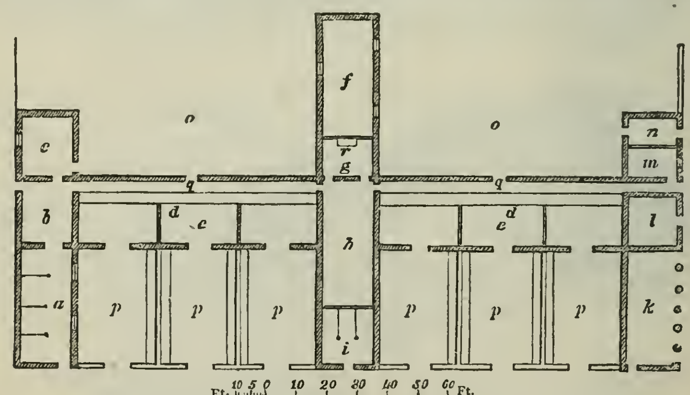
		£	s.	d.
8175. *Estimate for the farmery.* —	Masonry of the offices	172	3	2
	Carpentry	93	19	4
	Covering the roofs, slating, and furnishing lead	83	4	9
	Amount for the offices	£ 349	7	3

8176. *Farm-house.* The relative situation of the house to the offices claims particular attention. It is here placed, so that the farmer can see two sides of the farm-yard at once, and that at the greatest distance possible, without requiring an extensive paved court between it and the buildings. Where the operations of a dairy are carried on within the house, it is better to make it one story high than two: the heated vapours which ascend from the process of butter and cheese making, combined with the peculiar gases which are evolved from the apartments where such operations are carried on, render an upper story uncomfortable; and this evil is sufficiently great to counterbalance the extra expense of a little more roofing.

		£	s.	d.
8177. *Estimate of farm-house*, &c. —	Masonry	83	12	7½
	Carpenters' and joiners' work	87	18	9
	Covering of roof	35	15	6
	Amount for the house	207	5	10½
	Add amount for the offices	349	7	3
	The whole amount	£ 556	13	1½

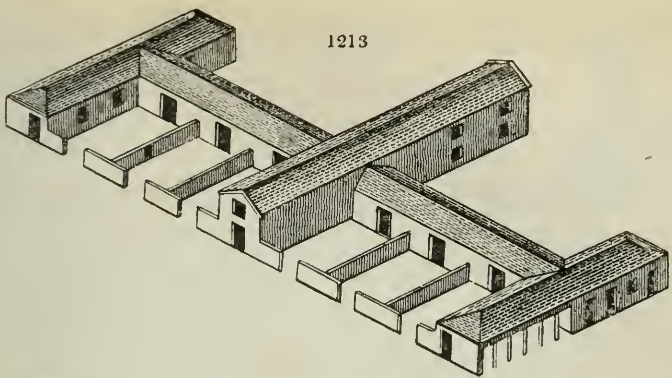
8178. *General remarks.* The practice of tossing the dung out of the byres (cow and cattle houses) through a hole in the wall should be discontinued; as by this practice the house is kept in a most unsightly state, the groop (gutter) and walls are abominably bespattered, and a current of offensive gas is continually evolved from the putrid mass at the door. It is a mistaken notion that cattle will thrive equally well in a tainted atmosphere as in pure air. The best practice is to drag the fulzie (filth) to a urinal pit at some distance, and occasionally to pump the liquid manure upon it. A horse-course is shown for the threshing machine, which almost requires an apology, as steam power is now very generally used; and the farmers in East Lothian are even said to be improving their high-pressure engines, by condensing the steam, and not using an air-pump. A valve is attached to the bottom of the condenser that opens to the outside; the effect of which is, that, when a blast of steam gets into the condenser, it pushes open the valve, thrusting out by it any air and water which had collected in the condenser during the previous stroke of the machine. As soon as the air and water have been pushed out, the jet valve is opened, the steam condensed, and the stroke effected, when the blast of steam again forces the air and water out of the condenser. The valve at the bottom shuts close by the pressure of the atmosphere, as soon as the condensation of the steam within begins to take place. By this cheap contrivance seven pounds per inch of the working piston is said to be gained. Skylights in stables and byres are preferable to windows, which are liable to be broken by the farm servants; in which cases currents of cold air enter, till they are at length closed with an old hat, or some other opaque material, by which the air and light are both shut out at the same time. When the currents of air are not stopped, they bring diseases upon the horse, which are often difficult, if not impossible, to cure; and, by excluding the light, his vision is weakened when he is taken out, and, if he is predisposed to "moon blindness," the disease is called forth. Many are the evils to which the horse is liable by subjecting him to sudden changes of light and temperature; but, by placing the windows of the stable in the roof, and by thoroughly ventilating the whole building, he has some chance of escaping from them. Indeed ventilation is essential, not only for the health of the cattle, but for the preservation of the building; yet, strange it is, that it is seldom if ever attended to. From the humid air in stables and byres, fungi may be frequently seen upon the rafters and other timbers of buildings, which are also often attacked by dry rot.

8179. *Plan, elevation, description, and estimate of a farmery, by Mr. Blackadder of Berwickshire.* In the ground plan (*fig.* 1212.), *a* is the work-horse stable, measuring eighteen feet by forty feet; *b*, stable



incidentals, places for keeping stable utensils; *c*, storehouse for turnips, &c.; *d*, straw-racks; *e*, shelter sheds, with open courts in front; *f*, is the dressing-barn (over which is the threshing machine), measuring eighteen feet by forty feet; *g*, chaff-house; *h*, straw-house, with granary above, eighteen feet by forty feet; *i*, riding-stable, with granary over it; *k*, cart-shed, eighteen feet by forty feet; *l*, wheelwright's shop and storehouse; *m*, piggery; *n*, hen-house; *o*, stack-yards; *p*, six open courts in front of the sheds, each measuring twenty-five feet by forty feet; *q*, passage through which to pass to serve the racks with straw; *r*, situation of the fanners. *Fig.* 1213. is an isometrical view of the farmery.

1213



8180. *Specifications.* The height of the side walls for the barn and straw-house to be fourteen feet, and the side walls of the other buildings to be nine feet. The dressing-barn to have seven feet, and the straw-house and riding-stable ten feet of head room. The shelter sheds to be joisted and covered with loose boards, and used as an additional straw-house. The back of the racks along the open passage to be close boarded up six feet in height, and the front laid with horizontal spars ten inches apart: the bottom of these racks to be laid with cross spars, sloping from the back down to the front, so as to send forward the straw as the rack is cleared out by the cattle; and this bottom to be laid at such a height as will allow the pigs a free range throughout the whole, and also to have liberty to go into each courtain (stall). The water to be had from the mill-head, or from pumps or wells, put down in one or two different places, according to the local situation.

8181. *The site of the farm-house* to be at any convenient distance in front of the farm-stead, allowing at least a complete cart road all round the latter; and the cottages that may be required, to be placed on the right and left side of the road opposite the cart-shed and work-horse stable. Each of these cottages to lodge two families only, and to have a pig-house and garden behind it: this will add much to the comfort of the cottager, and encourage a desire to cleanliness.

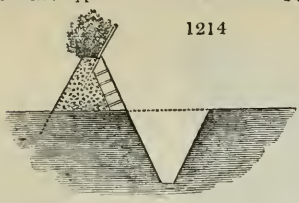
8182. *General estimate.* The walls of these buildings are supposed to be erected of stone, and the following are the estimates for Berwickshire:—

		Yds.	£	s.	d.
8183. *Rubblework.* —	Barn and straw-house	537 at 4*s*.	107	8	0
	Stable	269 at 4*s*.	53	16	0
	Cart-shed	269 at 4*s*.	53	16	0
	Shelter-sheds	355 at 4*s*.	71	0	0
	Courtain walls	320 at 4*s*.	64	0	0
	Total of the rubblework		350	0	0
8184. *Hewer's (stonecutter's) work.* — 540 feet, at 6*d*.			13	0	0
8185. *Roofing.* —	Barn and straw-house	440 at 5*s*.	110	0	0
	Stable	291 at 5*s*.	72	15	0
	Cart-shed	291 at 5*s*.	72	15	0
	Shelter-sheds	582 at 5*s*.	145	10	0
	Racks and feeding-troughs in the shelter-sheds		40	0	0
	Barn floors	188 at 5*s*.	45	0	0
	Granary floor	109 at 5*s*.	27	5	0
	Stalls in the stables	42 at 3*s*. 6*d*.	7	7	0
	Racks and mangers	30 at 3*s*. 6*d*.	5	5	0
			525	17	0
8186. *Slater's work. Pantiles.* —	Stable	284 at 2*s*.	28	8	0
	Cart-shed	284 at 2*s*.	28	8	0
	Shelter-shed	570 at 2*s*.	57	0	0
	Barn	426 at 2*s*.	42	12	0
			156	8	0
8187. *Estimate of the amount of the whole.* —	Rubblework		350	0	0
	Hewer's work		13	0	0
	Roofing		525	17	0
	Slater's work		156	8	0
	Total.		1045	5	0

East Blanerne, Jan. 1833.

8188. — 2968. *Ditches and drains.* "The bank of earth with upright facing of turfs, with a bank behind." This sort of ditch or fence, Mr. Gorrie observes, is only effective where the ditch lies between the bestial (cattle), and the faced dike (wall faced with stones), surrounding strips of plantations, orchards, or such enclosures as are not subjected to pasture. In such a case, this ditch, in waste lands, where the turf is well matted with the roots of grasses, and where the breadth occupied is not a considerable object, can be rendered a more effective fence than any other at so cheap a rate. Suppose the ditch to act in the capacity of an open drain, as well as a fence for sheep and cattle, it should be five feet wide at top, nine inches wide at bottom, and three feet deep. The turf should be cut in small squares of about nine inches, and about four inches thick, laid with the earth side uppermost, breaking joint every layer, and continued to the height of two feet nine inches, including the coping, with the green side uppermost. The faced dike (*fig.* 1214.) will require to have nearly, but not altogether, the same inclination as the sides of the ditch, and the earth taken out of the bottom must be rammed in firmly at the back of the turf in course of the work: this form of fence prevents rubbing by cattle either with their sides or horns, a practice of which they are mischievously fond, when they can reach mud fences. If sheep are to be warded off, little or no scarsement (set back) should be made, as they would get up and walk the set back, though it might be only five or six inches in breadth, and from thence they would easily effect a passage over the faced dike: in this case, a single paling rail, about nine inches above the coping, will be necessary, to serve till a hedge of plants, suited to the soil and climate, has reached the height of two or three feet above the coping and become permanently effective. A good and neat, as well as cheap, substitute for a rail, which requires sawing, posts, and nails, will be found where old larch plantations abound, and where branches about one inch and a quarter in diameter at the thick end, and six inches in length, can he got in sufficient quantities. These, having both ends sharpened, and stuck into the ground in the form of basketwork (*fig.* 1215.), will make a neat and effective fence. The larch branches so bent will last ten years, and will form an open wickerwork-like structure, which will serve as an efficient fence, impervious even to the attacks of black-faced sheep, the most troublesome dike-leapers of the breed. A fence of this nature surrounds a part of a small plantation at the west end of "Loudon's Howe" (in the parish of Kilspindie, Perthshire); so named to record the locality of some Scotch pine (*Pinus sylvéstris*), seeds of which, furnished by Mr. Loudon from the forest of Hagenau, were sown in the spring of 1829, and, having been thinned out, are now in a prosperous state.

1214



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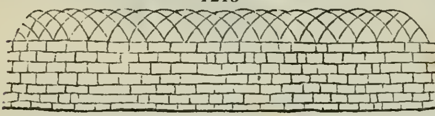
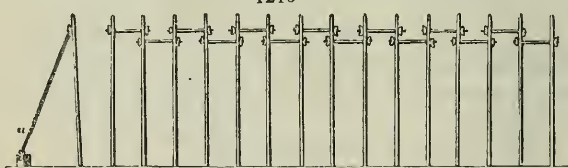


8189.—2991. *Cutting down old hedges.* In wastes, where ground is not of much value, and where it is not necessary to keep the ditch clean, a substantial hedge or live fence may be easily formed by cutting the plant halfway through, or rather more, near the root, and laying the shoots horizontally outward, at right angles with the line of fence. The side branches grow upward; and vigorous shoots spring from below the cut, forming in a short time a broad, dense, and impenetrable thicket. This practice is of advantage when hedges around plantations are necessary; and where, in the ordinary practice, they are liable to be overtopped, drawn up weak, and rendered inefficient. Some hedges have been treated in this manner by Mr. Beattie, an eminent horticulturist and forester, of extensive and successful practice, at Scone Palace, Perthshire.

8190.—3047. *Hurdle-making.* A detailed account of this operation, including descriptions of all the requisite tools, is given by Mr. Main in the *Quart. Jour. Agr.*, vol. iii. p. 647. to p. 653.

8191.—3039. *Fences composed of palings.* In the *Architectural Magazine* (vol. i. p. 79. and p. 235.) will be found two descriptions of wooden fences, which may be constructed without the use of nails, bolts, or iron, in any form. The details would occupy too much space to be introduced here; but the execution is simple enough; and the fences are suitable for countries where timber is more abundant than manufactured iron. *Fig.* 1216. is a description of fence recommended by Menteath. It consists of young

1216

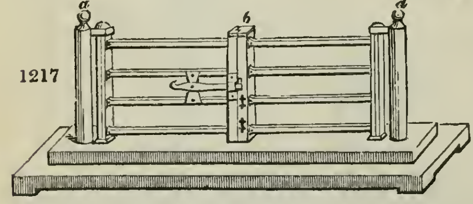


larch poles, or rods, inserted in the ground at regular distances (according to the kind of animals to be excluded or separated), and joined together at top either by wires, short iron rods, or short slips of wood. At every twelve or fifteen feet, there may be a brace on one or both sides, or alternately, as shown at *a*.

8192.—3075. *Gates.* In the *Encyclopædia of Cottage, Farm, and Villa Architecture* will be found figured and described at length, some gates of a very superior description. That called Buchanan's Gate, which is formed entirely of iron, is remarkably strong and cheap; and Cottam's Gate is equally cheap, and nearly as strong. There are several gates for park entrances, with machinery attached for the gate-keeper to open them in the night-time without getting out of bed.

8193.—3088, *b* (3088, *a*, is a gate-stopper given in the first Supplement). *Russell's gate-stopper* is thus described in the *Highland Society's Transactions*, vol. xi. p. 236. *Fig.* 1217. is a view of two leaves of a gate fixed in the pivots *a a*. The centre, *b*, is formed of two uprights, checked into each other, and fixed together by a latch, and perpendicular bolt, which is drawn up by the hand. On the gate being opened, one of the uprights, *a*, having communication with a cast-iron box (*fig.* 1218.), gives motion to the connecting rod between *a* and *b*. When the leaves of the gate are opened, the connecting rod is shortened by means of the crank at *a*; and, when shutting, it is lengthened hy pushing an inclined plane, or wedge, under the stopper, which is thus raised above the surface when the leaves are closed, and depressed when the leaves are opened. The iron box is intended to be sunk a few inches under ground, and covered with gravel. The posts and gate may be wholly of iron, or

1217



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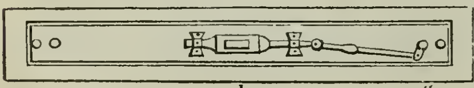
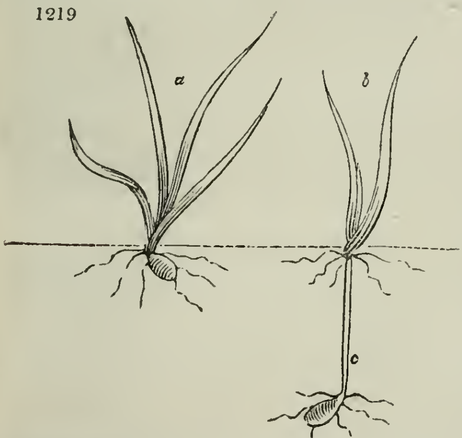


of stone and wood. The advantage of this construction is, that the danger and annoyance resulting from a raised stopper in the middle of a pathway are obviated; for the moment the leaf of the gate is opened, the stopper begins to be lowered, and when the gate is wholly opened, it is level with the ground. (*Highland Soc. Trans.*, vol. xi. p. 236.)

8194. — 3148. *The due depth at which seeds should be deposited in the soil* is a very important subject, which has been discussed by Baron Voght, of Flotbeck, near Hamburgh, in the *British Farmer's Magazine*, vol. iv.; and the following comment has been made on his paper by Mr. Main:—"If seeds be placed by accident or design at such a depth in the earth as to be out of the influence of the air, and though they may be surrounded by the requisite degrees of heat and moisture, they will nevertheless remain dormant. We have many instances of the truth of this in every-day practice, and of the imperishable properties of some kinds of seed when excluded from the influence of the air. If seeds are dropped on the bare surface of the ground, they will remain uninjured and unaltered so long as the air is perfectly dry; but in moist air germination commences, and the point of the root will quickly be protruded and find its way into the soil. This is the ordinary process of nature; but experience has taught us, that though nature distributes grain and other seeds generally on the surface of the spot where produced, yet there is a proper depth at which all seeds should be deposited, and which is specially suitable. This depth is obviously that which, while it yields the necessary degrees of heat, moisture, and darkness, is yet within the requisite influence of air. In the ordinary proceedings of farmers in the business of sowing, our implements, more than any thing else, regulate the depth at which we lay in the seed. The drilling system is approved, not only from its equal distribution of the seed, but because by it seeds are also laid in at an equal depth; this last circumstance being regarded as one of the principal advantages of the machine. Now our author has endeavoured to show that seeds may be deposited too deep even by the drill; and in all cases when seed is sown before harrowing, much of it will be laid deeper than it should be. Of this there can be no doubt. Every one acquainted with sowing must allow that seed may be buried; and every body acquainted with the structure of culmiferous plants, and their manner of growth, must be convinced, by what the Baron has shown, that, if seeds are but just covered, so as to be sufficiently shaded from the sun's rays, it is enough. As proof of this, our author quotes several eminent authorities, who argue from the physical structure of the plants, as well as from the qualities contained in the seed, and which submit to the chemical action of the elements in the act of germination, that deep sowing is highly detrimental, and opposed to the provisions of nature. Explanatory of these assertions, the Baron has appended to his paper figures of five different kinds of corn in five different states of growth, caused by the different depths at which they had been deposited in the earth. Two of these are given in the annexed cut. (*fig.* 1219.) The dotted line is the surface of the ground: *a* represents a healthy plant of wheat from a seed laid in at the proper depth, viz. one inch beneath the surface; *b* shows the growth of a plant from a seed which has been laid in too deep. This last, it will be observed, vegetated, although two or three inches under the surface; threw out its seminal or first roots, and sent up its first shoot, bearing two leaves, into the air; but, as the first joint of the culm rises therewith, and remains near the surface, it also throws out roots, and entirely supersedes those that were first produced from the grain. Now, as this is only a provision of nature to accommodate herself to circumstances of accidental position, many cultivators have been of opinion that the placing of the seed at irregular depths makes but little or no difference to the ultimate strength of the plant, or to the crop. To this the Baron is decidedly averse, affirming that this unnecessary waste of vegetable power is both hurtful and unnatural. We think, and indeed we may venture to say we know, that he is right: for, without mentioning the needless waste of vigour, the young plant must be more liable to accidents from the changes of the weather, slugs and insects, during the ascent of the first shoot, and before the principal roots are formed, than if it started from its natural position at once. To guard against over deep sowing, therefore, the Baron advises to sow nothing before harrowing; and, moreover, that great pains should be taken to pulverise the surface with fine harrows before the seed is sown, lest the corn should rise in rows, which, in broadcast husbandry, he condemns. Very different this from the custom of sowing wheat in this country, where the dexterity of the ploughman is often judged of by the regular exactness in which the ranks of corn appear on first coming up. This idea of the Baron's, though it be condemnatory of the drilling system (unless the machine be made to deliver very thinly), is, notwithstanding, very reasonable. The numbers of inferior ears, and the inequality of our samples of wheat, is mainly owing to the plants being too much crowded together in the dips between the furrows. Admitting that the principle of shallow sowing and equal distribution on a well-harrowed surface is in general right, still, as we have in this country very often a showery seedtime, it would be running a great risk on a clayey soil to harrow it down so finely as Baron Voght advises; and if a naturally loose and dry one, such an operation would probably bring up such a crop of weeds as would greatly injure, if not destroy, the crop. But on early-sowed fallows, all kinds of lent corns and small seeds, we think, from what we know of the nature of seeds generally, as well as from this writer's opinions, that the farmer cannot do wrong in following the Flotbeck manner of sowing broadcast." (*Brit. Farm. Mag.*, vol. iv. p. 290.) On the subject of this paragraph, and generally on all that respects the operations of agriculture considered scientifically, we would recommend to our young readers the careful study of the following cheap works: viz., *Mrs. Marcet's Conversations on Vegetable Physiology; Main's Illustrations of Vegetable Physiology, Lindley's Outlines of Horticulture;* and *Hayward's Inquiry into the Causes of the Fruitfulness and Barrenness of Plants and Trees.* The advantage which we propose to be attained by the study of such works, is the power of independent thinking, and of proceeding farther in scientific knowlege by observation and reflection. Many excellent practical agricultural works have a tendency altogether to preclude reflection, by describing and recommending only one practice, which has been found successful, without assigning any reasons why it has been so: instead of either assigning the reasons as the foundation for the practice; or giving different practices, and leaving the reasons to be discovered by the reader.

1219



PART III.

AGRICULTURE AS PRACTISED IN BRITAIN.

8195. — 3385. The principal addition which we have made to this part of the work, is an abridgment of Sir Henry Parnell's *Treatise on Road-making;* which it was the more necessary to give, since, in the body of the work, the system of M'Adam may be considered as placed in a more prominent point of view than is warranted by its merits. There is also a valuable article on the frequent-drain system, and the plan and description of a machine for draining fen and other low lands by steam by Mr. Capper, Engineer, of Birmingham; and the engravings and description of a very complete apparatus for steaming food for cattle, by Mr. Mallet, of Dublin.

8196. — 3523. *Formation and management of roads.* The whole subject of road-making, road management, and road repairs, has lately been discussed by Sir Henry Parnell, in a *Treatise on Roads, wherein the Principles on which Roads should be made are explained and illustrated, &c*, as practised by that distinguished engineer, the late Mr. Telford. In this *Treatise*, a number of received opinions which we had adopted are controverted, and we have therefore thought it advisable to give the essence of the work in a continued series of paragraphs.

8197. *In the introduction*, the author, after setting forth the advantages of good roads, describing the roads of the Romans, and noticing the present state of roads in the principal countries of Europe, speaks of those of England. Little attention was paid to English roads previously to 1629, when a proclamation was issued for preserving roads by limiting the weights to be drawn over them. The first turnpike road was established by law in 1653, through Hertfordshire, Cambridgeshire, and Huntingdonshire. Nothing, however, of importance was done to raise the character of English highways, till after the peace of 1748. In Arthur Young's *Six Months' Tour*, published in 1770, a frightful picture is given of the roads in Lancashire and Cheshire, and travellers are cautioned to avoid them "as they would the devil, for a thousand to one they break their necks or their limbs, by overthrows or breakings down." The ruts on these roads are described as in some places four feet deep, filled with floating mud, with here and there a loose stone, which serves no other purpose than that of jolting a carriage in a most intolerable manner. Between 1760 and 1764, 452 turnpike acts were passed; and in twenty-four years, from 1785 to 1809, upwards of 1000 have been passed, and nearly 20,000 miles of road formed, or improved. But, notwithstanding this progress, the operations have been directed with such negligence or ignorance, "that at this moment there is not a road in England, except those recently made by some eminent civil engineers, which is not extremely defective in the most essential qualities of a perfect road." (p. 26.) The crookedness and steepness of almost every great road, is owing to its being made on the lines of the footpaths of the aboriginal inhabitants, which afterwards became the horse tracks; and, finally, as society advanced, the only legal line left for carriages. This state of things is not only dangerous, but "disgraceful to the national character." (p. 26.)

8198. *The true principles of road-making* have not yet been followed in this country. "The breadth of a road is seldom defined to a regular number of feet by straight and regular boundaries, such as fences, footpaths, mounds of earth, or side channels. The transverse section of the surface, when measured, is rarely to be found of a regular convexity. The surface of all the roads, until within a few years, was everywhere cut into deep ruts, and even now, since more attention has been paid to road works, though the surface is smoother, the bed of materials which forms it is universally so thin, that it is weak, and consequently exceedingly imperfect. Drainage is neglected; high hedges and trees are allowed to intercept the action of the sun and wind in drying the roads; and many roads, by constantly carrying off the mud from them for a number of years, have been sunk below the level of the adjoining fields, so that they are always wet and damp, and extremely expensive to keep in order, owing to the rapid decay of the materials which are laid upon them." (p. 27.)

8199. *Road-makers in England* have hitherto been wholly ignorant of the scientific principles on which the making of good roads depends. Even government is ignorant on the subject, as appears evident from recommending the M'Adam system as the perfection of road-making. Notwithstanding the extent to which science is displayed in our canals, docks, bridges, and other public works, it was not till 1830 that land proprietors began to understand the value of good roads, and to be aware, that large funds, considerable science, and constant attention, are necessary to bring them into, and keep them in, a perfect state. (p. 29.)

8200. *In Scotland and Ireland*, however, a better system has been followed for some time. In 1790, Lord Dacr introduced the practice of laying out roads with a spirit level, and having no greater inclination than one in forty, even in the most hilly country; and this practice has been generally followed. In Ireland, the system of statute labour was abolished in 1763, and, the business of making roads being committed to the grand juries, improvements soon became so general, that Arthur Young, about 1777, found everywhere better roads than in England. The British legislature made a great effort for improving the roads of the Highlands of Scotland in 1803; and 875 miles and 1117 bridges, were constructed under the direction of Mr. Telford.

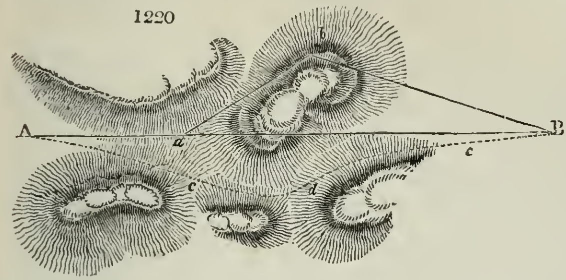
8201. *In England, a great advance in road-making was made, in* 1815, by the employment of Mr. Telford, by parliament, to improve the Holyhead road, which is now "acknowledged, by all persons competent to form a correct judgment on works of this kind, to be a model of the most perfect road-making that has ever been attempted in any country." (p. 35.) The following passage at once points out the use of the treatise, and the grounds on which the practice recommended are founded.

8202. *The obvious utility of a work on road-making*, "explaining the principles on which this business should be carried on, and containing an illustration of those principles by a reference to the plans, specifications, and contracts which have been made use of in constructing this extent of new road, through a country presenting every kind of difficulty, has suggested the present publication. The object of it is to point out, in a clear and concise manner, the best method of tracing out and constructing roads, under every variety of circumstances; and it is confidently expected, that the course which has been pursued of proceeding on experience by referring to the identical plans, specifications, and contracts by which so great an extent of perfect road has been successfully made, will be found to have attained this object."

8203. *Rules for tracing the line of a new road.* Surveys and levels should previously be made, and plans, and vertical sections, transverse and longitudinal, should be laid down on paper. The scale for the plan should be sixty-six yards to an inch, and for the sections, thirty feet to an inch. The depth of rivers to be passed, and the height of their highest floods; the depth of bogs or morasses; the natural drainage;

situation of gravel-pits or quarries, should all be marked on the plan. As a general rule, a straight, level, and cheaply executed line is the best; subject, however, to modifications arising from the comparative cost of annual repairs, and present and future traffic, &c. When a deviation is made from a straight line, proceed in a direct line from a new point, and if another interruption occurs, again change the direction, always keeping in view the imaginary straight line between the extreme points of the road, so as to deviate from it no more than is absolutely necessary. "Thus, for instance, if it be decided to have no greater rate of inclination than one in thirty-five, on a new line of road, from A to B in *fig.* 1220., and the surveyor, when he arrives at the point *a*, finds a greater inclination than this, he must incline from the direct line to *b*. Having then gained the summit of the hill, he does not endeavour to get back into the original straight line A B, but pursues the direct line *b* B, unless he is again obliged, from a similar cause, to deviate from it. This part of the survey being accomplished, it will then become necessary to examine the practicability of making a direct line of road, between A and *b*, instead of going to the point *a*. When hills are high and numerous, it sometimes appears, from a perambulation and inspection of the country, to be advisable to leave the straight line altogether from the beginning, in order to cross the ridges, at lower levels, by a circuitous course, in the way represented by the dotted lines A *c d e* B, in the above figure."

1220



8204. *The saving of perpendicular height to be passed over by a road* has not received that attention from engineers which it deserves. When the inclination of a hill is not greater than one in thirty-five, it may be driven down with perfect safety at the rate of twelve miles an hour; but if the road is so steep as not to admit of going faster than six miles an hour, there is a loss of half a mile in distance for every half mile down the hill; besides rendering necessary the use of the drag, which is at all times more or less dangerous. "An inclination of one in thirty-five is found by experience to be just such an inclination as admits of horses being driven in a stage coach with perfect safety, when descending in as fast a trot as they can go." (p. 45.) "A perfectly flat road is to be avoided, if it is not to be raised by embanking, at least three or four feet above the general level of the land on each side of it, so as to expose the surface of it fully to the sun and wind; for if there is not a longitudinal inclination of at least 1 in 100 on a road, water will not run off." (p. 47.) The great fault of all roads in hilly countries is their constant ascent and descent before they gain the highest point of the country they have to traverse; by which the number of feet ascended is increased to an extent far greater than would have been the case, if each height when once gained were not lost again by the succeeding descent. Thus a horse must ascend upwards of 1300 feet between London and Barnet, though the latter is only 500 feet higher than the former, while a horse going from Barnet to London must ascend nearly 800 feet, instead of descending 500 feet. (p. 48.) In carrying a road across a deep valley, the descent and ascent, and the quantity of material wanted, will be diminished by inclining the line upwards, where the bottom of the valley rises, rather than downwards where it falls. Where valleys are narrow and steep, the road may be more economically carried across on viaducts; some of the finest of which in Britain have been erected by Mr. Telford, at Mousewater, Birkwood Burn, the Menai Straits, &c. Hills may sometimes be passed through by means of a tunnel instead of deep cutting.

8205. *Rivers have been allowed to direct the line of a road too readily*, from timidity about incurring the expense of bridges, &c.; but if even a quarter of a mile of road be saved, by expending several thousand pounds on a bridge and its embankments, the saving to the country in annual repairs and horse labour will soon pay off the original cost.

8206. *Bogs and marshes* being elastic, the foundation of an intended road over them requires to be drained and loaded with earth to destroy the elasticity of the subsoil; which, by destroying the momentum of a carriage passing over it, greatly increases its draught.

8207. *A proper exposure to the sun and winds* is of great importance to a road. The north side of a valley running east and west, ought always, if possible, to be preferred, and trees, high walls, and every thing on the south margin of a road, which obstructs the united action of the sun and wind, removed. Damp roads, of whatever material they may be composed, wear away rapidly under the weight and pressure of heavy carriages. Open roads afford free respiration to horses, in consequence of which they can perform much more work; a fact which those farmers are well aware of, that have confined horse-tracks for their threshing mills. The expediency of causing a road to deviate from its straightest direction, in order to pass through a town, must depend on the principal object of the road. In general, little attention should be paid to the opposition of inhabitants of towns to new roads, and still less to the proprietors of parks and gardens.

8208. *Principles of road-making.* A beaten track of knowledge is but a bad guide, when, amongst several ways, the best is to be preferred. The most important, and the most obviously correct principle of road-making is, that it should be of such a degree of substance as to bear the weight and number of the carriages that are to pass over it. This principle is almost universally violated, and the crust of roads will be found generally not to exceed more than three or four inches, instead of a coating of six inches, of the hardest kind of stone, broken into small pieces, and laid on a regular foundation of rough pavement. The external forces which counteract the momentum of carriages passing over roads are collision, friction, gravity, and air.

8209. *Collision* is produced by protuberances, and friction by a soft or elastic surface. Smoothness and hardness, therefore, are the chief qualities of a perfect road. That a road may be hard, it is not sufficient to lay upon a prepared bed of earth merely a coating of broken stones, for the carriages passing over them will force those next the earth into it; even if a coating of from sixteen to twenty inches were laid on. Mr. Telford's plan, of making a regular bottoming of rough, close-set pavement, and covering it with six inches of broken stones, secures the greatest degree of hardness that can be given to a road. "By laying the stones in making the bottoming with their broadest face downwards, and filling up the interstices closely with stone chips well driven in, the earthy bed of the road cannot be pressed up so as to be mixed with the coating of broken stones. This coating, therefore, when consolidated, will form a solid uniform mass of stone, and be infinitely harder than one of broken stones when mixed with the earth of the substratum of the road. It is by proceeding in the way here recommended that the friction of wheels on a road will be reduced as much as possible."

8210. *Friction.* "Experiments have proved that, on a well-made pavement, the power required to draw a waggon is 33 pounds; on a road made with six inches of broken stone of great hardness, laid on a foundation of large stones, set in the form of a pavement, the power required is 46 pounds;

on a road made with a thick coating of broken stone, laid on earth, the power required is 65 pounds; and on a road made with a thick coating of gravel, laid on earth, the power required is 147 pounds." These experiments, it is shown, correspond with results deduced from the laws of science, and are in direct opposition to the doctrines laid down by Mr. M'Adam, viz.: "That a foundation or bottoming of large stones is unnecessary and injurious on any kind of subsoil. That the maximum strength or depth of metal requisite for any road, is only ten inches. That the duration only, and not the condition of a road, depends upon the quality and nature of the material used. That freestone will make as good a road as any other kind of stone. That it is no matter whether the substratum be soft or hard."

8211. *As gravity* acts in a direction perpendicular to the plane of the horizon, it neither accelerates nor retards the motion of a body moving on a road which is perfectly horizontal. When, however, a road is not horizontal, the action of gravity becomes a positive impediment.

8212. *The resistance of air* to a body moving along a road is variable, and has no relation to the state of the road. Wind travelling at the rate of fifteen miles an hour has a force of one pound per square foot; at twenty-five miles an hour, or a very brisk gale, three pounds; at thirty-five miles per hour, or a high wind six pounds; at fifty miles an hour, or a storm, twelve pounds. A very little reflection will show, that the resistance offered by wind to any body moving against it will be as the motion of that body, and that driving stage-coaches at a rapid rate against high winds is attended with a ruinous waste of horse labour.

8213. *Forming a road.* The great art, in carrying a road over a high elevation, is to lay it out so as to prevent it having any fall from the point of departure to the highest point. This can only be done by lowering heights and raising hollows, and the engineer will show his skill in effecting this by the least quantity of cutting and embanking. In cutting through hills, the slopes of the banks should in general not be less than two feet horizontal to one foot perpendicular; but on the south side of a road which runs east and west, the inclination may be three to one, in order to secure the action of the sun and wind from the road. No person should be intrusted to form high embankments who has not had considerable experience as a canal or road maker; "for, if the base of an embankment be not formed at first to its full breadth, and if the earth be not laid on in regular layers or courses of not exceeding four feet in thickness, it is almost certain to slip. In forming high embankments, the earth should be laid on in concave courses; for, when laid on convexly, the courses are for ever slipping." (p. 83.) "In forming embankments along the sides of hills, or what is called side forming, the rule that should be followed is that the slope to be covered should be cut into level slips to receive the earth, otherwise it will be very liable to slip down the hill: in such cases, the earth should be well compressed, and great care should be taken to interrupt all the land springs about it by proper drainage. For this purpose, a drain should be cut on the upper side of the road, and open drains should be made on the side of the hill above the road, to catch the surface water of the hill." Rocks of different kinds, and chalk, will stand at a steeper slope than common soils; chalk or chalk marl will stand at one to one; hard sandstone at a quarter to one, or nearly perpendicular; while plastic clay requires a slope of three to one.

8214. *Drainage.* On flat and wet surfaces, there should be a drain at each side of the road, at least three feet deep below the substratum of the latter. Where main drains cannot be formed, as on the side of a hill, near houses, &c., then covered drains, substantially built of stone or brick, must be resorted to. If springs rise in the centre of the road, drains must be made to them so as completely to dry the bed of the road. In cuttings, that is, where a road is cut through or along the side of a hill, it becomes necessary, in almost every case, except that of solid rock or gravel, "to make drains of small dimensions from the centre of the road to the side drains. These drains should form an angle in the centre of the road, in the shape of a V, technically called mitre drains: the angle or splay of these drains should depend upon the inclination of the road; it should not make the inclination of the drains exceed an inch in 100; for if it be greater, the run of the water will undermine the sides, and injure them. These mitre drains should be 9 in. wide at bottom, 12 in. wide at top, and 10 in. deep. These drains should be placed at about sixty yards from each other, or about thirty in the mile; but if the soil be wet, this number should be considerably increased. They are to be filled with rubblestone, or cleansed gravel. If gravel is used, a draining tile should be laid along the bottom before the gravel is put in. The upper part of these mitre drains should communicate with the road materials, so as to draw the water from them. According to the inclination of a road, and the form and wetness of the country through which it passes, cross drains of good masonry should be built under the road, having their extremities carried under the road fences. One of these drains should be made wherever the water would lie on one side of the road, and can only be got rid of by carrying it to the other side. When the road passes along the slope of a hill or mountain, a great number of these drains are necessary to carry off the water that collects in the channel of the road on the side next the high ground. They should be placed at from 50 to 100 yards' distance from each other, according to the declivity of the hill; so that the side channels may not be cut by carrying water too far. In these situations inlets should be built of masonry, to carry the water from the side channel of the road into the cross drains." After every precaution in respect to draining has been taken, injury from water should be farther secured by convexity of surface, and by side channels. "These side channels will be formed by the angle where the slope of the side parts of the surface of the road abuts against the edge of the footpath, or other defining bounds of the roadway. They will be capable of carrying off a great quantity of water, without being made into the form of a square-sided drain." The reduced particles of the materials of a road, when wet, assist the wheels in rapidly grinding down the surface, in the same manner as a lapidary cuts his jewels with the powder of the same kind of stone mixed with water.

8215. *Different kinds of roads, and modes of constructing them.* — *Railways* of wood were first introduced about 1602, and cast iron seems to have been first employed in them in 1667. A railway with a declivity of 1 in 96, or 55 feet in a mile, will admit of one horse drawing from 12 to 15 tons down the declivity, and 4 tons up it. On a level railway, a horse can draw 12 tons. In some situations, where all the traffic is one way, the loaded carriages descend by their own gravity, and pull up the empty ones. In others, the loaded waggons drag with them another waggon or truck, containing the horses which are to pull up the empty waggons. This is the case on the Darlington railway, where the rest which the horses receive while riding from one point to another, is found to renew their vigour. (p. 105.) "The expense of constructing railways depends upon the nature of the ground they are made over, and the purpose for which they are intended. In many situations, where the trade is altogether a descending one, and water scarce, they are preferable to canals, and may be constructed cheaper; but for general traffic, over a wide extent of country, they do not afford as cheap a means of conveyance as canals. The expense of carrying goods by locomotive engines on railways much exceeds that on canals, or on railways with horses."

8216. *The plan of constructing a railway* "should be arranged so as to be adapted to the purposes for which it is intended. If for local or private purposes, the same expense is not necessary as when the railway is for general and public traffic. In the former case, the rails should not be so heavy, so strong, or so expensive, as when employed for the latter, and the blocks may be of much less weight, and the fastenings less perfect. To form a perfect railway for general traffic, on which locomotive engines are to be employed, the surface of the ground over which it is to be made should be reduced, by cutting, filling, or tunnelling, to rates of inclination not exceeding 1 in 300. The rails should be of wrought iron, of not less than fifty pounds to the yard, and they should be laid on blocks of hard solid stone, each of not less than five cubic feet. These blocks should be set on a firm, solid foundation of hard broken stones, at least two feet thick, technically called ballasting. The space between the blocks should be filled up with rubble stones, and the whole should be covered with gravel up to the level of the bottom of the rails

What has been said relating to the draining of a turnpike road, should be strictly attended to in constructing railways. Railroads on which locomotive engines are employed should not be carried across a turnpike road on the same level with the road, but by tunnels or viaducts. When horses are employed, it is not so objectionable to cross roads on the same level; it should, however, if possible, be avoided: when it is impossible, great care should be taken to keep the top of the rails on a level with the surface of the road, or rather below it, and the space between the rails should be kept always filled to the same level. Notwithstanding it seems to be universally believed that the practicability of making use of locomotive engines on railroads has been established by what has taken place on the Manchester and Liverpool railway, there are many competent judges who are of opinion that it would not have succeeded had it not been for the peculiar circumstance of its forming a direct communication between two such very populous, opulent, and enterprising towns as Manchester and Liverpool." (p. 116.)

8217. *Paved roads*, where there is much traffic, will be found better for conveying goods than turnpike roads, constructed as they usually are. "On a smooth, well-made pavement, quite horizontal, it appears, from the experiments made with Mr. Macneill's machine, that the resistance to draught is not more than the hundredth part of the weight of the carriage and its load, when the carriage is properly constructed, and mounted on straight and cylindrical axles. According to this, a horse of great power would be able to draw on such a road, if horizontal, 6¾ tons; and if with no greater inclination than 1 in 50, 2¼ tons. A common opinion prevails, that because paved streets have almost everywhere been suffered to be rough and imperfect, all pavements must necessarily be rough and bad; but a slight degree of consideration will show that this opinion is without foundation, and that, in point of fact, the cause of rough and bad pavements is bad management, arising from the ignorance of those employed to make them, or the want of sufficient funds for executing good work." (p. 120.)

8218. "*The first object to be secured is a good foundation.* For this purpose, a bed should be formed with a convexity of two inches to ten feet, so as to admit of twelve inches of broken stones being laid upon it. These should be put on in layers of four inches at a time. After the first layer is put on, the street should be kept open for carriages to pass over it. When this first layer has become firm and consolidated, then another layer of four inches should be put on, and worked in as before, care being taken to rake the ruts and tracks of the wheels of carriages, so that the surface may become smooth and consolidated. The same process should be repeated with the third layer of stones, by which means a solid and firm foundation will be established, of twelve inches in thickness, for the dressed paving-stones to lie upon. The next thing to be attended to, is to provide proper paving-stones. These should be cut into a rectangular shape, and of the hardest quality that can be procured; granite is the best, but whinstones, some descriptions of limestone and freestone, will answer the purpose." (p. 133.)

8219. *With regard to the size of the stones*, that should be regulated by the intercourse. The streets should be divided into three classes, according as the thoroughfare is greater or less. For streets of the first class, or greatest thoroughfare, the stones should be ten inches in depth, from ten to fifteen inches in length, and from six to eight inches in breadth on the face. For streets of the second class, the stones should be eight inches in depth, from eight to twelve inches in length, and from five to seven inches in breadth on the face. For streets of the third class, the stones should be six inches in depth, from six to ten inches in length, and from four to six inches in breadth on the face.

8220. *After having prepared a proper bottoming*, the greatest care must then be bestowed in setting the stones. Fine gravel must be provided, cleansed from all earth, to form a bed over the bottoming of two inches thick, for the stones to be set in. Strong mortar must also be provided; and, besides the common tools, each pavior should have a wooden maul, the head of which should be made of beech or elm, and should weigh about fourteen pounds. The stones should be selected so that they may be laid in even courses, and so as to match, as nearly as possible, in each course, with regard to breadth and depth.

8221. *In paving*, the pavior should first set a stone on the gravel bed, by striking it strongly downwards with the maul, and then on its sides. Then he should lift it out of its berth, and put mortar on the sides of the two adjoining stones; after which he should again place the stone in its berth, and strike it as hard as he can, downwards and sidewise, with the maul, till it is fastened in the position in which it is to remain. Each stone should be set in this manner; and, when the pavement is finished, it will be so firm as not to require ramming.

8222. *The crossings for foot passengers* should be raised above the level of the pavement, by giving a moderate convexity to the bottoming. They should be made with stones of the size for streets of the first class, more accurately dressed.

8223. *The pavement should be formed with a regular, but very moderate, convex surface*, by giving the bed for it the convexity already mentioned. There should be no gutter or other channel but that which will be formed by the angle made by the surface of the pavement abutting on the kerbstone. The kerbstone of the pavement should be made of long blocks of stone, of a quality sufficiently hard to resist the shocks of wheels striking it. These blocks should be bedded in gravel, and joined with cement: they should be sunk four inches at least into the ground, and be six inches above the pavement.

8224. "*The foot pavements* should be made of well-dressed flags; each flag to have its sides rectangular, and to be set in mortar, with a very close joint, upon a strong gravel bed, of six inches in depth. The flagstones should be at least two inches and a half thick; the surface of the foot pavement should have a declivity at the rate of one inch in ten feet, towards the street."

8225. *The paving and repairing of paved streets* should be done by the superficial yard, and by contract; the specifications ought to be drawn up with the greatest care, and accompanied by all necessary plans and sections. Repairs require to be made the moment they are discovered to be necessary. As soon as a single stone gets out of its proper bearing, it should be taken up, and relaid with new bottoming; and a complete bottoming should always be laid down over pipes when the pavement is broken up in order to get at them. The paving-stones should be laid on loose at first, and left till the bottoming is consolidated, and then they should be taken up and carefully set in mortar.

8226. *Paved streets have been objected to*, on account of the noise made by carriages passing over them. The noise chiefly arises from the boxes of the wheels striking the arms of the axle-trees; and, therefore, when a paved street is exceedingly rough, the strokes of the axles are frequent and violent. But when a paved street is properly made, the surface of it will be comparatively smooth, and then both the number and force of the strokes of the axles on the boxes will be greatly reduced, and consequently the noise made by carriages. When a carriage passes from a rough to a well-made pavement, the difference of sound is immediately perceivable. It is supposed by some persons, that, if the streets were paved in the way proposed, their surface would be too smoooth for horses to go safely over them; but this supposition is not well founded, except when that kind of stone is used which becomes polished by wear. Scotch granite and some other kinds of stone do not become polished, and, therefore, pavements made with them will never have so smooth a surface as to be unfit for horses. A horse properly shod will seldom slip on a pavement, or fall, unless when thrown down by being turned too short, or other careless management. The enormous expense which has been incurred by adopting the plan of broken-stone streets in London, in place of pavements, is fully established by the returns which were presented to the House of Commons in the year 1827. By this return it appears that the first cost of converting 1 mile 250 yards from a pavement into broken-stone road was 12,842*l.*; and that the annual expense of maintaining this 1 mile 250 yards has been 4003*l.*, being at the rate of 1*s.* 9*d.* per superficial square yard.

8227. *Roads partly paved, and partly made with broken stones.* "Whenever the traffic of a road is so great as to wear down three inches of hard broken stones in a year, the middle part of it should be paved. At this rate of wear half a cubic yard of materials will be requisite for every lineal yard of eighteen feet of the breadth of the road. This will make the expense of new stones alone, for a road thirty-six feet wide, per mile, per annum (supposing the cubic yard of broken stones to cost 12*s*.), amount to 1056*l*. If the middle twenty feet of the broken-stone streets in London, where the traffic is very great, were paved, a great expense would be saved; at the same time that the convenience of broken-stone roadways would not be taken away." (p. 146.)

8228. "*A road with a foundation of pavement, and a surface of broken stones.* The following specification of the manner of constructing a road of this kind, of thirty feet in width, is taken from a contract for making a part of the Holyhead road. Upon the level bed prepared for the road materials, a bottom course or layer of stones is to be set by hand in form of a close firm pavement. The stones set in the middle of the road are to be seven inches in depth; at nine feet from the centre, five inches; at twelve from the centre, four inches; and at fifteen feet, three inches. They are to be set on their broadest edges lengthwise across the road, and the breadth of the upper edge is not to exceed four inches in any case. All the irregularities of the upper part of the said pavement are to be broken off by the hammer, and all the interstices to be filled with stone chips firmly wedged or packed by hand with a light hammer; so that, when the whole pavement is finished, there shall be a convexity of four inches in the breadth of fifteen feet from the centre. The middle eighteen feet of pavement is to be coated with hard stones to the depth of six inches; four of these six inches to be first put on, and worked in by carriages and horses, care being taken to rake in the ruts until the surface becomes firm and consolidated; after which the remaining two inches are to be put on. The whole of this stone is to be broken into pieces as nearly cubical as possible, so that the largest piece, in its longest dimensions, may pass through a ring of two inches and a half inside-diameter. The paved spaces on each side of the eighteen middle feet are to be coated with broken stones, or well-cleansed strong gravel, up to the footpath or other boundary of the road, so as to make the whole convexity of the road six inches, from the centre to the sides of it; and the whole of the materials are to be covered with a binding of an inch and a half in depth of good gravel, free from clay or earth." (p. 150.)

8229. *The work of setting the paving-stones* must be executed with the greatest care, and strictly according to the foregoing directions, or otherwise the stones will become loose, and in time may work up to the surface of the road: when the work is properly executed, no stone can move. If the work be executed by contract, the inspector should see all the operations as they are going on; he should walk over the pavement when it is completed, and try whether the stones be firmly fixed; and he should not allow any broken stones to be laid on over the pavement till it has undergone an examination of this kind.

8230. *In breaking stones*, the workmen would be required to break them as nearly cubical as possible: when this rule is not attended to, a great quantity of materials is wasted by first splitting the stones into thin slices, and then breaking them into pieces that are too small and too thin. If the stones or top metal are not broken very small, the proper degree of smoothness of surface will not be obtained. When stones are very hard, they never make a very smooth surface; limestone will make a much smoother surface than whinstone and other harder stones, but they should not for this reason be preferred to harder stones; for these will wear longest, carriages will run lighter over them, and the expense for scraping and repairing will be less. All the soft kinds of stones make heavy roads in wet weather; and in dry weather there will be more friction upon roads made with them, because there will be more dust on their surface.

8231. *With respect to the convexity of a road*, it should be so arranged that it should be slight in the middle. In giving a convexity of six inches to a road of thirty feet in breadth, the convexity at four feet from the centre should be half an inch; at nine feet, two inches; and at fifteen feet, six inches. This will give the form of a flat ellipsis.

8232. *The binding*, which in the foregoing specification is required to be laid on a new-made road, is by no means of use to the road, but, on the contrary, injurious to it. It is, however, unavoidable, when a long piece of new road is to be opened; for, without it, the wheels, by sinking into the new materials, would make the draught of the carriages much too heavy for the horses. This binding, by sinking between the stones, diminishes the absolute solidity of the surface of the road, lets in water and frost, and contributes to prevent the complete consolidation of the mass of broken stones. In a district of country where any sort of coarse stone can be got for making a pavement, it will be cheaper to make a road with a pavement and six inches of broken stones, than with ten inches of broken stones without a pavement.

8233. *Roads made with foundations of rubblestones, and a surface of broken stones*, will answer for cross roads and others, that do not communicate between large towns, collieries, or quarries. The rubblestones should be reduced so as none of them exceed four pounds in weight; they should be laid in a regular bed, seven inches deep in the middle of the road, and four inches at the sides, and a coating of small broken stones, not exceeding an inch in diameter, should then be laid over them.

8234 *A road made wholly of broken stone*, of twelve inches in thickness in the middle, and six inches at the sides, may be found suitable for light carriages and little traffic. The stone should be laid on in layers, allowing each layer to be worked in and consolidated, before a fresh one be laid on. " This plan of road-making, however, having of late been recommended, as greatly superior to all other plans, by persons who profess to be experienced and scientific road-makers, a number of turnpike trustees have adopted it; but experience has fully established its unfitness for roads of great traffic, in comparison with roads made with a proper foundation. In point of fact, there is nothing new in this plan; for all the roads of the kingdom have been made in this way, and the universal defect of them, namely, their weakness, is the result. A road made on this plan will require, for two or three years after it is said to be finished, the expending of large sums in new materials, to bring it into anything like even an imperfectly consolidated state; and, after all that can be done, such a road will always run heavy, and break up after severe frosts; for as the natural soil on which such a road is laid is always more or less damp and wet, it will necessarily keep the body of materials, of which the road is made, damp and wet; in consequence of which, the surface of the road will wear down quickly. Hard frosts will penetrate through the materials into the under-soil; and, when the thaws take place, will break up the whole surface. It is in this way that the ruinous state of most roads, after severe frosts, is to be accounted for."

8235. *Roads made with gravel.* The bed being prepared, a coating should be laid on four inches thick, and carriages allowed to pass over the road, the ruts being filled in as soon as they appear. When the first coat has become firm, a second coat once screened, that is, freed from the larger stones and the smaller gravel, should be laid on three inches thick, and treated as before. A third coat of well-riddled gravel should afterwards be put on, taking care to break all pebbles exceeding an inch and a half in diameter; and this process of putting on layer after layer, allowing a considerable interval between, should be continued till there is a body of gravel on the road sixteen inches thick, declining convexly towards the sides, where the thickness may be ten inches. The strongest and best part of the gravel should, of course, be put in the middle part of the road. A road made with gravel in the way here recommended will be much stronger than gravel roads usually are; but it will be much inferior to one made with stone materials. The roundness of the gravel stones prevents them from becoming consolidated by pressure, so as to form a perfectly hard road surface; and when the gravel consists of limestone, flint, freestone, sandstone, or other kinds of weak stone, it is so rapidly pulverised that the friction produced by wheels passing over it adds greatly to the labour of horses."

8236. *Fences.* Walls are preferred to hedges, because they require less room; and at once give a neat and finished appearance to a road. Hedges are to be planted on banks, and the ditch is always to be on the field side of the bank. All road-fences should be kept as low as possible, in order that they may not intercept the sun and wind. Hedges should be trimmed every year, in August and September, applying a line and templet (mould) to insure regularity.

8237. *Road masonry.* — *Bridges* ought to be placed in a direct line with the road which is to pass over them, and, if possible, at right angles to a straight reach of the river or stream. The width of bridges on turnpike roads near large towns should not be less than forty feet, and on other roads thirty-six, thirty, twenty-four, or twenty feet. The inclination of the sides of bridges should never exceed one in thirty. The waterway of the bridge should be ample, so as to allow the highest floods to pass away freely.

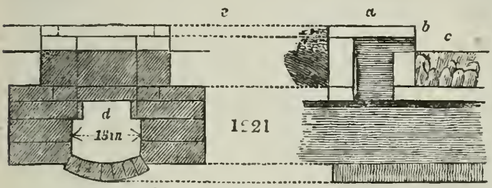
8238. *Retaining walls*, or those which are built on the hill side of a road in a rugged and precipitous country, require to have a secure foundation, and to be carried up with a curved batter (slope) on the face or side next the road, at the rate of one inch and a half of curve for every foot in height.

8239. *Breast walls*, or those which support a road on its lower side, should be built in the same manner as retaining walls; and, like them, they should increase in thickness downwards, at the rate of two inches and a half for every foot in depth, by a regular slope on the outside.

8240. *Fence-walls* may be built without mortar if the stones are flat-bedded.

8241. *Cross drains* should be built of good masonry, eighteen inches in the clear.

8242. *Inlets* or openings for the water from the side-channels of a road should be in stone masonry, ten inches by sixteen inches, covered with sound flagstones, the top of which would be at least six inches above the level of the channel, as in *fig.* 1221., in which *a* is the flagstone, *b* the opening for the water, *c* the channel of the road, *d* the cross drain, and *e* the surface of the footpath. Inlets may likewise be made along the channels, and should be covered with iron gratings.



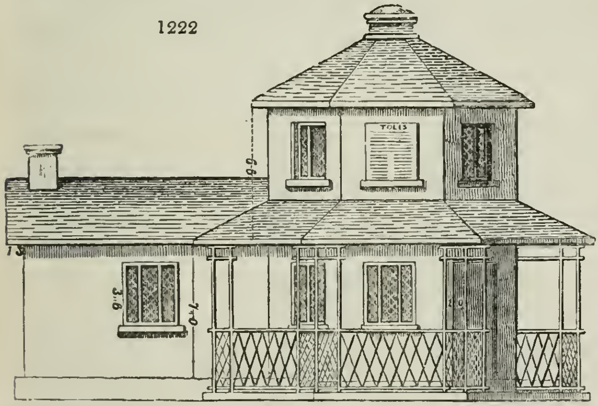
1221

8243. *Outlets* may be built of brick or stone, about a foot square, for the purpose of carrying the water from the channels under the footpath or fence into the outside drains, or to the cross drains, as the case may be.

8244. *Depôts* are made along roads for holding materials for repairs; they are rectangular recesses, with back and side walls, the former twelve, and the latter each two yards and a half in length. This space will hold twenty-five cubic yards of materials; and four depôts on a mile, at 428 yards apart, will contain 100 cubic yards. Depôts should never be farther apart than a quarter of a mile, so as to admit of the materials being moved from them in barrows.

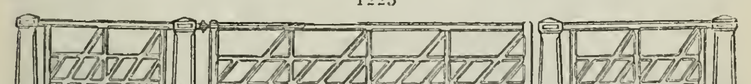
8245. *Toll-houses* are recommended to be built in a strong substantial manner, and to be made suitable and comfortable for the persons who are to inhabit them. " Many instances might be mentioned, in which the tolls on a road have been much increased by building good houses." (p. 212.) *Fig.* 1222. is the elevation of a toll-house at Llanfair, in Anglesea, built by Mr. Telford.

1222



8246. *Tollgates and bars* should never be placed on the summit of a hill, or at the bottom of one, for obvious reasons. Gates should be painted white, and not made higher than four feet six inches. The width of the carriage-way may be sixteen feet or more. The toll gates at South Mims, and on the Coventry road (*fig.* 1223.), are hung on " Collinge's patent hinges, which are particularly fit for this purpose: they run about five feet along the upper and under rail of the gate, and are connected by a diagonal piece of metal, carried from the bed of the lower hinge to the point of the upper one, in order to prevent the gate from sinking. The balls of the hinges are cast, with the caps and plinths of the posts, so that the posts are not weakened by holes or mortises, as in the usual manner of hanging gates. The caps and plinths of metal are also a great security to the posts by preserving them from the effects of the weather, and by preventing the wheels of carriages from chafing their angles.

1223

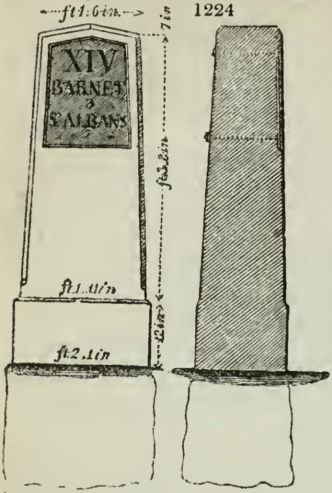


8247. " *Flapping-posts* are set in the ground at proper places, to prevent the gates from opening too far, and straining the hinges; these posts are about two feet and a half above the ground, and two feet in it. Catches or clicks are let into these posts, to hold the gates open when thrown back: these catches project about two inches from the side of the posts, and turn on a pin within the post; the inner end of the catch being made heavier than the outer, it always throws that end up, and by that means it takes hold of the bottom of the lower bar of the gate, by a notch cut in it for that purpose: by making the catches in this way, they are out of the reach of injury. In the common way they are put on the top of the posts, from which they project six or seven inches; in consequence of which they are frequently torn off by wheels of carriages and waggons." (p. 224.)

8248. *Lamps* are required for all tollgates; they should be made similar to the best coach lamps, with powerful reflectors, and large airholes; they may be nine inches high, and six inches wide in the clear

8249. *Milestones* should be made higher than they generally are, and of very hard stone of a light colour. *Fig.* 1224. is the form used on the Holyhead road.

1224



8250. *Management of roadwork.* As soon as the precise line is determined on, the following circumstances should be attended to: — I. Drawings to show, 1st, the natural surface of the ground; 2d, the longitudinal inclinations of the proposed road; 3d, the slopes of the cuttings and embankments; 4th, the form of the bed of the road, and footpath; and 5th, the courses of materials to be laid on, and the thickness of each course. Drawings should also be made, describing the plans of the bridges, culverts, cross drains, inlets, outlets, depôts, and fences which are required to be made. II. A specification should be prepared, to explain in detail the precise method of executing every part of the work. III. After the specification has been settled, an estimate should be made of the expense to be incurred. IV. Next a contract is to be entered into, which, if the plans, specifications, &c. have been properly made, will be found the most safe and satisfactory mode of execution. Select a contractor of skill, integrity, and capital, and rather overpay than underpay him. V. In preparing a deed of contract, refer to the drawings and specifications, and provide a clause to prevent all deviations from them, except by agreement in writing. VI. Before the work is commenced, an inspector should lay out the work, settle the levels, and see that everything is done agreeably to the specifications. The inspector should be a person of considerable experience as a civil engineer; and it is on the skill of the chief engineer, in engaging men of this kind, that his success in accomplishing great works will very much depend. VII. The mode of paying the contractor should be as the work proceeds: for which purpose it ought to be measured by the inspector every fourth week.

8251. *Improving old roads.* Here nearly the same objects are to be attended to as in making new ones; "such, for instance, as the direction, the longitudinal inclinations, the breadth, form, and hardness of the surface, the drainage, and the fencifig. For the purpose of ascertaining in what respect an old road is complete or defective in these points, the following queries have been prepared. The answers that can be given to these will at once show what is the state of a road: —

1st, Is the direction of the road in the shortest line that can be found, without having to pass over steep hills, or other obstacles?

2d, What are the rates of inclination of the hills? Is there no more ascent in the road than is necessary for reaching the heights of the country which must be crossed?

3d, What is the breadth of the road? Is it everywhere the same? Is it defined by side channels, having along them kerbstones, or borders of grass sods?

4th, Are the channels on each side of the road on the same level? Is the convexity of the surface uniformly the same in every part along the whole length of the road?

5th, Is there a footpath? What is the height of it above the side of road? What is its breadth? Of what materials is it composed?

6th, Is there any waste land between the road and the fences of the road? In what state is it?

7th, Is the surface of the road higher than that of the adjacent fields?

8th, Of what materials does the crust of the road consist? What is the depth of them in the centre of the road, and at a distance of five feet on each side of the centre?

9th, Are there sufficient drains for carrying off all rain and other water?

10th, Are the fences low? Are they raised on ground of the same level on both sides of the road? Are they of the same height on both sides, and parallel to each other?

The answers which can be given to these queries will show what the defects are of any road to which they are applied, and what is requisite to be done to improve it."

8252. *Repairing roads.* This ought always to be managed on a regular plan, more especially with reference to, "1st, The quality of materials. 2d, The quantity to be put on per mile per annum. 3d, The preparation of the materials. 4th, The method of putting them on the road. 5th, The number of labourers to be employed." (p. 270.)

8253. *The materials used* should always be the hardest; for it has been ascertained by experience, that hard stones brought from a distance are cheaper in the end than soft stones got near the road at a much lower price. It is also a fact, that in proportion to the softness of the stones is the labour of the horses on the road, in working the often-renewed coatings of them into a smooth surface. The best description of stones for roads are, basalt, granite, quartz, syenite, and porphyry. Schistose rocks are rapidly destroyed, more especially when wet; and they occasion great expense in scraping, and constantly laying on new coatings. Limestone is liable to the same objection. Sandstone is very well adapted for the foundation of a road, but much too weak for its surface. Flints vary very much in quality as a road material. The hardest of them are nearly as good as the best limestone; but the softer kinds are quickly crushed by the wheels of carriages, and make heavy and dirty roads. Gravel, when it consists of pebbles of the hard sorts of stones, will make a good road, particularly when the pebbles are so large as to admit of their being broken; but when it consists of limestone, sandstone, flint, and other weak stones, it will not; for it wears so rapidly, that the crust of a road made with it, always consists of a large portion of the earthy matter to which it is reduced. This prevents the gravel from becoming consolidated, and renders a road made with it extremely defectivo with respect to that perfect hardness which it ought to have."

8254. *The quantity of materials* to be put on the road in the course of a year will be regulated by their durability, and the traffic on the road. The materials should be quarried, carted, and broken by contract, and, when ready to be put on the road, placed on the depôts till wanted.

8255. *With respect to preparation*, stones should be broken "to a size of a cubical form, not exceeding two inches in their largest dimensions." Gravel should be sifted at the pits, so that no stone larger than one quarter of an inch in diameter should be carried to the road. The road labourers should again sift it, so as to separate the pebbles that are less in diameter than the rest; and the large pebbles which exceed one inch in diameter should be broken.

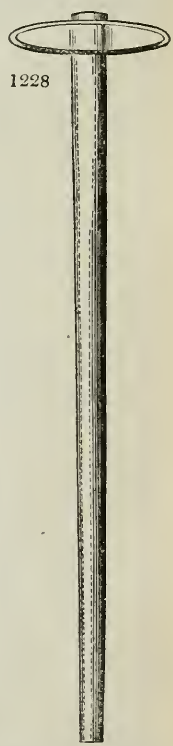
8256. *The materials should be laid on in small quantities at a time*, taking care to fill up ruts or hollows as soon as they appear. "In those places where the surface of the road has become much worn, a coating of one inch and a half of materials should be laid on: that is to say, a coating only a single stone in thickness, when stones are used; and when gravel is used, a coating not exceeding one inch in thickness. If more materials are necessary, they should be laid on after the first coating is worked in. The work of repairing roads, by laying on new coatings of materials, ought to be done between the months of October and April, and when the surface of the road is wet. By laying on the materials at this season of the year in thin coatings, they are soon worked into the surface, without being crushed into powder, and without producing any great distress to horses drawing carriages over them." (p. 274.)

8257. *In arranging the labourers* on a road, it should be divided into "districts of four miles each; and a foreman, with three labourers, should be appointed for each district. The foreman and one or more of the labourers should be daily on the road, taking care that the side channels of the road are kept clean, and making good any injury to the road, as soon as it appears. The foreman should work with the men: he should take care that the orders of the surveyor are attended to, and be able to measure roadwork." (p. 274.) The water channels and drains should be particularly attended to, and in October in every year they ought to undergo a general repair. At that season, also, the surface of the whole road should be scraped, "all ruts and hollows should be carefully filled with materials, and all weak parts of the surface coated with materials; that is to say, the road should be put, in every respect, into a complete state of repair, so as to preserve it from being broken up during the approaching winter. A road should be scraped, from time to time, so as never to have half an inch of mud upon it. This is particularly necessary to be attended to, when the materials are weak; for, if the surface is not kept clean, so as to admit of its becoming dry in the intervals between showers of rain, it will be rapidly worn away." Hedges should be kept clipped, and branches of trees lopped. The superior condition of roads which cross unenclosed lands, and of those which run south and north, rather than east and west, shows the great benefits of a free exposure to the sun and air.

8258. *The trustees of a turnpike road* should require the surveyor to lay before them, at the commencement of every year, an estimate of the work he proposes to perform in that year; and he should make up a monthly account, as well as an annual account.

8259. *Road instruments and tools.* The principal instruments are theodolites, spirit levels, and sextants, which are used in laying out roads. Road tools are spades, *fig.* 1225.; shovels, *fig.* 1226.; trucks, or small waggons, for removing earth; hammers for breaking stones, *figs.* 1227. and 1228., the handles of which should

1228



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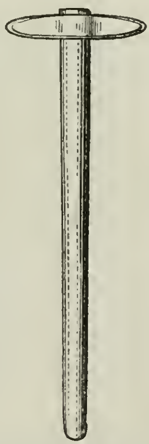


be flexible, and made of straight-grained ash; the small hammers having a chisel face, and the larger ones a convex one, about five eighths of an inch in diameter. The hammers should be made of cast steel, which wears much longer than wrought iron, and seldom breaks at the eye. Pronged shovels are useful for filling broken stones into carts or barrows: a man will not only lift more stones with them, but he will lift them without taking up earth. Scrapers for scraping off dust or mud should be made of wood shod with iron, or of plate iron, six inches deep, and from fourteen to eighteen inches long. The best scrapers are made of old saw-plates, stiffened on the back by a nib of wrought iron, or a piece of elm board. Hedging-knives are required for trimming hedges, which they do much more expeditiously than shears. Working levels, which resemble a common bricklayer's levels, are absolutely necessary in laying out new works. On the horizontal wooden bar should be placed four gauges, made to move perpendicularly in dovetail grooves, to the lower edge of the bar. Each of these should have a thumb-screw, in order that, when adjusted to its depth below the level line, the gauge may be fixed in the desired position. "Levels for laying out slopes are best made of a bar of wood, three inches deep, one inch thick, and six feet long; on the centre near the middle of the rod, a triangular piece of wood of the same thickness is nailed; the sides of this triangular piece are so formed, that when the rod is placed upon a slope of one to two, or one to three, a small pocket level placed on one side of the triangle will be horizontal, and the bubble will remain in the centre."

8260. *Ring gauges* are required for ascertaining the size of broken stones.

8261. *Road legislation.* The turnpike system is considered as so far good, as, by putting the management of roads into the hands of local proprietors as trustees, a larger road revenue has been raised than the country would have been willing to pay to government for their management. Great errors have, however, been committed in carrying the turnpike system into operation. The government is not to blame for this, because the business has not been in its hands; nor the civil engineers, because they have not been consulted by turnpike trustees. "The country gentlemen of England, in point of fact, are alone responsible for the defective state of the roads, because the business of managing them has been vested, by the legislature, exclusively in their hands." (p. 291.)

8262. *More than double the money necessary is raised*, and the works are performed in the most slovenly manner, or not at all. The trustees on each trust are by far too numerous; they ought to be reduced, and rendered responsible to a board of control, appointed by government. Under such a board, the Holyhead road was improved, and the late Mr. Huskisson, who was chairman of this board, observed, that all the roads in the kingdom ought to be placed under similar control.

8263. *Parish roads* are, in general, much worse than turnpike roads. The private interests of a vestry lead it to be satisfied with very imperfect roads. The surveyor is appointed to act only for one year; a proceeding founded on the vulgar notion that the management of roads is something that requires no education, skill, or science. These roads ought to be managed by county commissioners, as in Scotland. (p. 312.)

8264. *Scotch roads* are superior to the turnpike roads of England. The road management of every county is vested in trustees, which is attended with the following advantages: — "1st, A more efficient governing authority is provided. 2dly, The obstacle to a uniform and efficient management of the roads, which the small divisions of parishes occasion, is obviated by giving the general management of all the roads of a county to the general meetings of the trustees. 3dly, The funds for maintaining the roads are derived from a regular assessment on the lands, instead of statute labour. 4thly, The surveyors are appointed permanently, and with fixed salaries."

8265. *Irish roads* are under the management of grand juries; the defects of which plan is, that the governing authority is insufficient, because it does not represent the interest concerned in road affairs; and because there is a want of "correct moral principle" and "pure habits" among Irish grand juries. (p. 318.) The Scotch, therefore, is recommended to be introduced into Ireland.

8266. *Appendix. No. I. is a description of Macneill's road indicator*, which Mr. Telford has declared to be, "for practical purposes on a large scale, one of the most valuable that has been lately given to the public." (p. 328.) It may be described as a dynamometer of an improved description, attached to a carriage (a light phaeton), in such a manner that no part of the moving power is communicated to the carriage, except through the agency of the instrument. The indicator may also be attached to the fore part of any carriage, cart, or waggon. Besides pointing out the distance passed over, it marks the power of draught at every ten or twenty yards, and the rates of acclivity or declivity on every part of the road.

8267. *Macneill's road indicator* may be applied to the following important purposes: — 1st, It affords the means of ascertaining the exact power required to draw a carriage over any line of road. 2dly, It can be applied to compare one line of road with another, so as to determine which of them is the best, and the exact amount of the difference, as regards horse power, both for slow and fast coaches. 3dly, The comparative value of different road surfaces may be determined with great exactness. 4thly, It affords the means of keeping a registry, in a most accurate manner, from year to year, of the state of a road, showing its improvement or deterioration, and the exact parts in which such improvement or deterioration has taken place.

8268. *Practical examples explanatory of the foregoing statement.* 1st, Let it be required to determine the expense of working a four-horse coach over the line of road from —— to ——, at a velocity of ten miles an hour. Suppose the instrument has been run over the road, and that it has been found that the average power required to draw a four-horse coach over the whole line amounts to 350 lbs., and the distance equal to twelve miles. Let the average power which a horse should exert for eight miles a day, with a velocity of ten miles per hour, be assumed equal to 60 lbs.; then $160 \times 8 = 480$ lbs., raised one mile in the day; and taking the daily expense of a horse equal to six shillings, we have 480 lbs. : 6*s.* : : 1 lb. : ·15, the expense of horse power exerting a force of 1 lb. over 1 mile. Thence $350 + \cdot15 + 12$ miles $= 630$ pence, or 2*l.* 12*s.* 6*d.*, the expense of horse power required to work a four-horse coach per day over such a road.

8269. *The most important and useful application of the instrument* is, perhaps, that of being able to ascertain with accuracy and precision the state of any road, from time to time, as regards its surface; and the state of repair in which it has been kept.

8270. *The public advantages* to be derived from such a system of road inspection would probably be very great. It would show not only where the best plan of repairing roads has been followed, and point out where there are good and bad surveyors, but it would also show if the money of the trust is improperly applied or wasted on any line of road; and it will enable trustees, who let the repairs of their roads by contract, to determine whether or not the contractors have done their duty, and kept the road in the same state of repair as at first, or whether they had improved it, or suffered it to become defective."

8271. *Appendix II. contains a report respecting the street pavements, &c. of St. George's, Hanover Square*, in which the present system of macadamising streets is condemned as in every respect bad.

8272. *Appendix III. is a notice of Mr. Walker's plan of paving roads along the sides*, by which the carmen on footpaths or sides of the roads could be close to their horses without interruption, or being in danger of accidents from light carriages; and the unpaved, being the highest or middle part, would be more easily kept in repair. This plan was adopted in the Commercial Road, Middlesex, in 1820, and has been subject to the heaviest traffic ever since: it has cost very little for repairs, and is now, 1834, in excellent order.

8273. *Appendix IV. Report respecting the expense of the Holyhead and Liverpool roads.* It occupies a number of pages, and will be useful to young engineers, by showing them the forms in which business is transacted, and assisting them in committing their ideas to paper.

8274. *Appendix V. The principal clauses of a Scotch act of parliament respecting roads*, which it is thought might be imitated in English and Irish acts.

8275. *Appendix VI. Tables respecting turnpike road trusts*, extracted from the reports of the Lords' Committee on that subject.

8276. *Note A.* Investigation of the best plan for improving the road through Stowe Hill Valley. By John Macneill. This is a most valuable paper for the young engineer; it contains arguments, comparative views, specifications, and estimates, full of instruction.

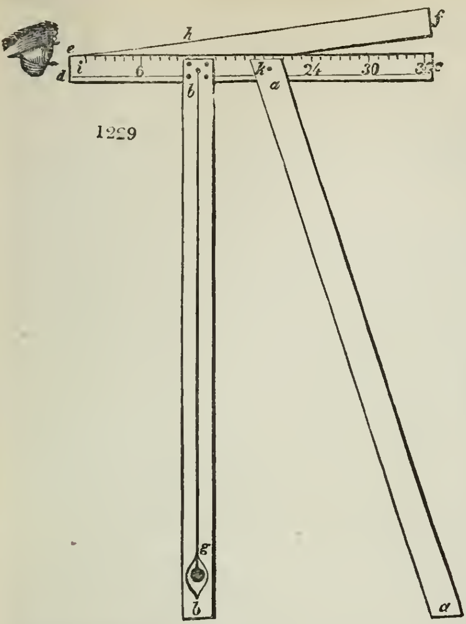
8277. *Note B.* Proofs of the resistance produced by collision.

8278. *Note C.* Proofs of the resistance occasioned by friction.

8279. *Note D.* Proofs of the resistance from the force of gravity, when a road is not horizontal. We have already occupied so much space, that we cannot afford room to give the substance of these notes; but the book itself will soon find its way into the library of every civil engineer, road-maker, and country gentleman. We need hardly say that it is by far the best work on the subject which has appeared in England.

8280. *An instrument for measuring the inclination of roads* (*fig.* 1229.) is thus described in *Trans. Highland Soc.*, vol. viii. p. 62.: —" A slip of wood must be procured, measuring three inches broad by half an inch thick, and sixteen feet nine inches long, which must be cut into four lengths of five feet three inches, five feet, three feet three inches, and three feet three inches, marked as follows:—*a a*, five feet three inches; *b b*, five feet; *c d*, three feet three inches; *e f*, three feet three inches: six thick screw nails are also required, one inch long. Join *c d* and *c f* by a screw nail, inserted about two inches from the end of each, and exactly one inch from their upper surfaces, as marked *a*. From the point *a*, upon *e f*, draw a line, measuring thirty-six inches, towards *f*, and exactly one inch distant from the upper surface, and divide this line into thirty-six parts or inches. It is self-evident that each of these points, when elevated above *c d*, will show a rise of one in fifteen, twenty, thirty-four, &c., as the case may be, provided *c d*, which should be divided into inches numbered on the upper edge, shall be horizontal; and *e f* shall point to a pole or mark, as high above the ground as *c d* is; this is effected by fixing *b b* firmly upon *c d*, at right angles, and either having a plummet *g* suspended, as in the figure, or a spirit level fixed on the top of *c d*. I prefer the plummet made of bobbin or small cord, with a pierced bullet at the bottom. The instrument is retained in a level or horizontal position by the assistance of *a a*, which is upon a movable pivot, made by one of the screw nails at *b*. The distance of *a a* from *b b* is immaterial. A small stop is fastened at the back of *b b*, for the purpose of preventing *e f* from falling below *c d*. The rise of a road is shown by looking from *e* towards *f*; the fall of a road, of course, by looking from *f* towards *e*, and, if great correctness is required, the observation should be reversed."

1229



8281. — 3862. *Burning of lime, and making of bricks.* A variety of forms of limekilns, and of kilns for burning bricks, will be found described in the *Encyclopædia of Cottage, Farm, and Villa Architecture.*

8282. — 3918. *Succession in the kinds of trees.* "There is reason to fear that a judicious rotation of crops in arboriculture is not, as yet, well understood; doubts are entertained, for instance, that the Scotch pine, as a previous crop, is unfavourable to the growth of larch, having a tendency to produce rot at an early stage of growth. It is well known that the Scotch pine is an excellent preparation for the oak, producing rapid growth where that plant would not previously have prospered, although it may be injurious as a foregoing crop to other resinous plants; and as the Scotch pine and the larch, as a mixture (3958.), are known to prosper tolerably well together without engendering disease from their proximities, it may be inferred that it is not so much from the excrementitious matter exuding from the growing roots of Scotch pine that larch receives injury, as from the poisonous matter, absorbed by the spongioles of the growing larch, proceeding from the decaying roots of Scotch pine in the soil. It therefore becomes a matter of importance for the forester to consider how far it may be advisable to mix larch with Scotch pines in plantations (a practice of frequent occurrence); as, in the process of thinning, a process more or less necessary in every plantation, many roots will be left to rot in the soil, and these, in a state of decomposition, may prove seriously hurtful to living plants on the same spot. It may be safer practice to plant each sort in masses (4012.), observing not to plant larch on an open dry loam, incumbent on a ferruginous subsoil." (*A. G.*)

8283. — 3923. *A new guard for single trees in parks and in lawns* is described in the *Gard. Mag.*, vol. vi. p. 48. It consists of low stakes with rails nailed to them in such a manner as to form a hexagonal platform of paling, ten feet in diameter, and about eighteen inches high, round each tree, or group. The advantage is, that it keeps horses and cattle off as effectually as a high paling, and yet is not offensive to the eye. This invention has been termed a dendrophylacton; its vertical profile is seen in *fig.* 1230., and its elevation, or rather section, in *fig.* 1231.

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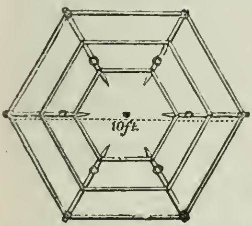

1231

8284.—3928. *Disposing of trees in plantations.* Mr. Lawrence, under ordinary circumstances, prefers a mixture planted at regular distances; and he gives, as an example, a square plantation (*fig.* 1232.), formed of oak, ash, and larch. The great advantage of this regular disposition of the trees, both in regard to distance and kinds, is, that the future management of the plantations can be predetermined, and, as it grows, regulated with perfect ease and accuracy. For example, the trees in this plantation being six feet apart, no thinning will be required until the ash attains a sufficient size for hurdles, hoops, &c., which will be from twelve to fifteen years' growth, according to the quality of the land; or even eighteen years' growth, if the land is very poor. At this period cut off every other ash, in the rows composed exclusively of ash, with a blow in an upward direction, from two to three inches above the ground, in order that the stools should shoot again. The next year cut off all the ash between the larch and the oak in the same manner. The following year cut out the remainder of the ash with a downward blow, under the ground, to prevent them from shooting again. The ash left for stools will produce, in the summer after cutting, several shoots; these should be thinned out, leaving not more than three or four of the best placed for a crop. When these have attained sufficient growth to be crowded by the larch, the

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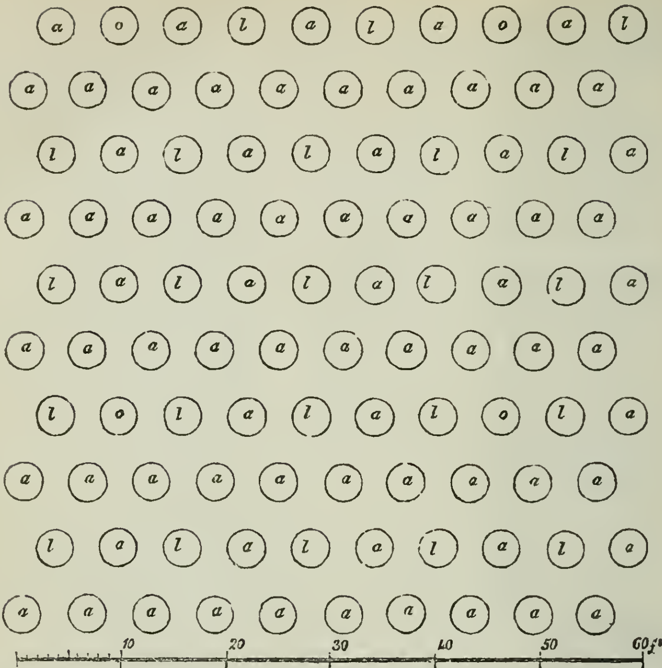

latter will be from twenty to twenty-five years' growth, and should be cut out as soon as the sap is sufficiently in action to admit of their being barked; as, though their bark does not bear a price in proportion to that of the oak, with reference to the tan it yields, it will pay for the stripping. Upon this plan it is obvious that any labourer could effect the necessary thinning without any superintendence: he could not make a mistake. If a variety of timber be desired, a sweet chestnut may be substituted for every other oak, as both thrive well, generally, on the same soil; or any other timber trees may be planted, more suitable to the particular soil, keeping them in the places assigned in the plan to the oak. The underwood may also be varied, by the introduction of the oak, wych elm (*U'lmus montàna*), *Sàlix càprea*, hazel, &c., all of which form excellent coppice wood, but they must be introduced in regular order, with reference to future thinning. (*Gard. Mag.*, vol. x. p. 30.)

8285. — 3929. *To grow the best and most valuable timber*, the trees should stand rather closely together, and be regularly pruned, from the time they are five feet high, until a clear stem is obtained of at least twenty feet. Clearness of grain, undeteriorated by knots or flaws, constitutes prime timber; and it is impossible to have it so, unless the trees be carefully trimmed when young. The leading shoot of the stem should always be allowed to have pre-eminence, by cutting off lateral branches which act as rivals; and such branches should be cut off close to the bole, when they are not more than one inch in diameter. If allowed to exceed this size, the wound made by the removal, though it will be shortly afterwards covered with new wood and bark, will always remain a flaw in the timber when cut up for use. Small spray growing on the trunk does no injury to the grain of the timber; and if all branches, as they arrive at the size mentioned, be pruned off, till a bole of sufficient length be obtained, very fine round timber will be the result. It must be remembered, however, that the trunk is not enlarged by pruning, but rather the reverse; but, as length of bole, clearness of grain, and perfect soundness, cannot be had without pruning, and paying attention to the trees in the early stages of their growth, a portion of their girth must be sacrificed for the more valuable properties of length of bole and excellence of timber. (*J. Main, in Brit. Farm. Mag.*, vol. vii. p. 162.)

8286. — 3950. *The perforator* (*fig.* 1233.) is used as a substitute for the spade, in planting young taprooted trees in rough ground. It was invented by Mr. Munro of the Bristol Nursery, and, in that

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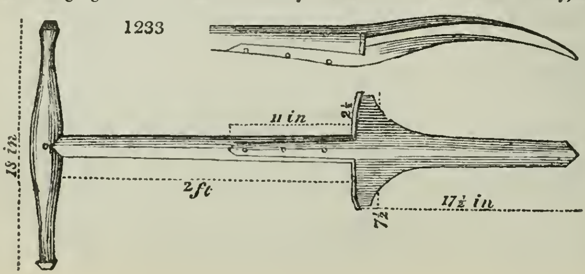


neighbourhood, in 1828, cost about eight shillings. In using it, one man employs the instrument, while another man, or boy, holds a bundle of plants. The man first inserts the instrument in the soil, holding it up for the reception of the plant; round which, when introduced, he inserts the iron three times, in order to loosen the soil about the roots; he then treads down the turf, and the plant becomes as firmly set in the ground as if it had been long planted. Two men may set from five hundred to six hundred plants in a day with this instrument. (*Gard. Mag.*, vol. iii. p. 215.)

8287. — 3954. *The subject of preparing large trees intended to be transplanted by cutting or shortening their roots* has been treated upon, in a very masterly manner, by Mr. M'Nab of the Royal Botanic Garden, Edinburgh, in the *Quarterly Journal of Agriculture*. The following is the essence of the article alluded to: — The practice of cutting the roots of large trees, at a certain distance from the stem, a year or two previous to removal, is excellent, where time is allowed for the operation, or its necessity foreseen; but the opinion, that the chief advantage derived from this operation arises from the formation of young roots, or fibres, is denied. The principal consequence of this mode of mutilation, is the check given to the growth of the tree; by which it is, to a certain extent, stunted. Every large deciduous tree receives a check when transplanted; and, by beginning the operation of checking a year or two before transplanting, it is rendered more gradual.

8288. *The economy* of Mr. M'Nab's mode is thus shown: — "Let three trees of the same kind, and as much alike as possible as to age, size, health, situation, soil, and exposure, be selected, each about three feet in circumference at about a foot from the ground, and from thirty-five to forty feet high. Let a trench, eighteen inches wide, be cut round each, at the distance of eight feet from the stem, and down to the subsoil, so as to divide every horizontal root at the inner side of the trench. Let this trench be left open round the first tree till the period of transplanting, but round the other two let it be filled again with the earth which had just been taken out of it. At the period of transplanting, let the three trees be removed with equal care, and planted in similar situations and soils, the whole operation being conducted in the same manner, with this difference only: in the first, let any new roots which may have formed at the cut extremities, in consequence of earth having accidentally fallen into the trench, be disregarded; in the second, let all the new roots which have formed in this situation be cut off; in the third, let them be preserved with as much care as possible. At the end of two or three years (and we can rarely judge sooner of the ultimate success of our operations), we shall find the whole to have succeeded alike; and it is evident that the first and second will have been removed with a saving of labour, and, therefore, at a cheaper rate, than the last. The length of time which should be allowed to elapse between the cuttings of the roots and the transplantation will vary with the season; after one wet season the trees will be as fit for removal as after two dry years."

8289. *Two bad methods of transplanting trees* are next described by Mr. M'Nab. By both these methods manure is applied to the roots of the trees previous to their removal. In the one case, the manure or compost is placed in a trench, cut round at three or four feet from the stem of the tree, and by the other it is laid on the surface of the ground all round the stem. Both methods are bad, from their producing an excess of vigour in the tree. By this, the constitution of the tree is brought into an artificial state, and therefore it is much less able to bear the shock of removal, than if it had been left alone. Enriching the soil about trees, after they have been removed, in order to assist them in regaining their previous vigour, is to be recommended; but, if this artificial enrichment is continued many years after transplanting, the tree will be thrown into an unnatural state of growth, which it could not continue without the continuation of the manuring. "There cannot be a doubt that a tree, taken up and transplanted without any previous preparation (even although the roots and branches are deficient), will make a better appearance, at the end of four or five years after removal, than one that has got the top-dressing will do in the same period, supposing all other things alike, both in transplanting and in subsequent treatment. We may be assured that it is a good practice to starve and stunt trees before removal, and to feed and encourage them, for a time, after they have been transplanted."

8290. *The truth of this doctrine* every gardener has experienced who has been in the habit of taking up plants growing in the open ground and putting them into pots or tubs. If the roots are cut at some distance from the stem some days previous to removal, the plant will receive no great check; but if, on the other hand, a vigorous plant be taken up at once without having its roots previously cut, it will suffer considerably, and, in all probability, lose a number of its leaves, and also its flowers. "Now this difference can only arise from the first plant having been checked in its growth, not from any advantage which it could derive from the formation of young roots between the preparation of the plant and its removal, because the roots are scarcely ever cut so short, at first, as to go into the pot, lest the check should be too sudden, but require either to be shortened a second time, or bent round in the inside of the pot; and, even in this last case, it is hardly possible to preserve any tender rootlets which may have been formed at or near the extremity of the old roots. The principal advantage of following this practice (which I know from experience to be a good one) must, therefore, arise from checking the plant in its growth before it is taken up. Were it necessary, other facts might be adduced to prove that, at least, one great advantage of cutting the roots of large trees previous to removal is derived from the check thus given, and, by consequence, that every measure taken to promote that vigour, previously to removal, must be injurious." (*Quart. Journ. of Agr.*, vol. ii. p. 828.)

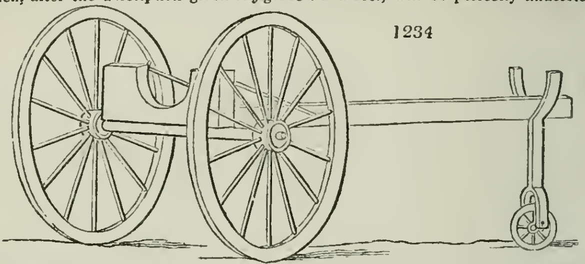
8291. *The practice of Mr. Monro of Brechin* may be adduced as confirmatory of Mr. M'Nab's theory. During the winter of 1824, having occasion to transplant a number of trees, and being dissatisfied with the mode of preparation by opening a trench round the tree and filling it with loose soil, Mr. Monro selected an oak about twenty-five years old, large for its years, and prepared it in the following manner: — He formed a circular trench round the tree, and dug out the earth; but, instead of filling the trench with loose mould, he left it empty, and roofed it over with boards, covering over any opening between them with withered grass, and then putting over the whole one inch deep of earth. The tree remained a year in this state, and was transplanted in the winter of 1825. On reducing the ball of earth to proper dimensions for removing the tree, the old roots were found furnished with fibres, matted sufficiently to retain enough of earth to protect them during removal. The object which Mr. Monro had in view was, instead of encouraging the growth of fibres at the extremities of the amputated roots, as is done when the trench is filled in with loose soil, to have them formed within the ball of earth, and not on the outside of it. This he considered would enable him to remove the tree with a ball, which he never could accomplish by the other method, though he had practised it for five years, on from three to five hundred trees annually. When the trench dug round the tree is filled with loose earth, the young roots form in clusters round the ends of the old roots, and the tree, on removal, generally loses the whole of the earth which forms the ball. (*Gard. Mag.*, vol. ix. p. 218.)

8292. *The opinion of Mr. M'Nab is farther confirmed* by the practice which prevails in Belgium and France of planting large trees by the roadside. These trees are always of considerable size, and generally between two and three inches in diameter. When planted out, the head of the tree is cut off, leaving the trunk a bare pole. This bare pole is suffered to grow untouched for one or two years, after which all the branches are cut off below the strongest leading shoot, which is left to form the head of the future tree, and which, in a few years, becomes as straight and handsome as one not headed down, and far more vigorous. (*Gard. Mag.*, vol. ii. p. 226.) The trunks of trees so treated, observes Mr. Joseph Knight, become generally as straight as the mast of a ship, to the height of from thirty to forty feet. (*Ibid.*, vol. x. p. 8.)

8293. *Our opinion on this subject* is, that the mode of previous preparation by digging a trench round the tree, and filling it with rich mould, or by manuring the surface of the soil in which the tree grows, is worse than useless; and that checking the growth of the tree a year before removal, and heading it down to the height of eight or ten feet, when removed, is the cheapest and best of all modes for general purposes where the trunk of the tree does not exceed from five to eight inches in diameter at the surface of the soil. For larger trees, or for trees which are short-lived, or for any description of tree where immediate effect is an object, we would still do nothing more than check the growth of the tree by cutting its roots a year before removal; and only make this difference after removal, that we would not cut off any, or, at all events, not many of the branches. With regard to trees which may be considered old, in the case of the beech, and in that of all the pine and fir tribe, and of most evergreens, we would cut off no branches whatever. We ground this recommendation as to old trees, the beech, resinous trees, and evergreens, chiefly on experience; it being found that these trees do not bear amputation well, either of their tops or roots.

8294. — 3957. *The machine for transplanting large trees, in general use in England*, is represented by *fig.* 1234.; which, after the description given of *figs.* 592. and 593., will be perfectly understood by inspection.

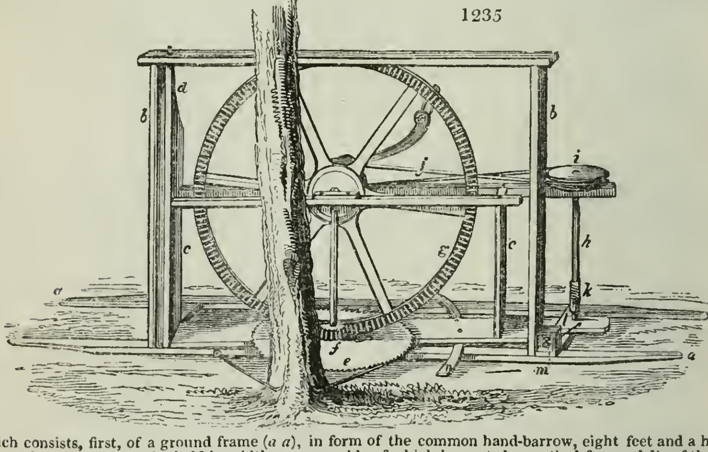
1234



8295. — 3983. *Filling up blanks in plantations.* In Cambridgeshire, where the willow is grown extensively for basket rods, deaths take place occasionally among the stools. The mode of filling up the blanks thus occasioned is not, as might be supposed, by sticking in a cutting, as in the case of new plantations, because the shoots from that cutting would soon be choked by the surrounding shoots from the stools; but by inserting a rod at its full length, and allowing it to grow undisturbed for a year or two; when, having acquired an abundance of roots and a thick stem, it is cut down. Empirical practice is here in beautiful accordance with science. (*J. D.*)

8296. — 4062. *Sawing machines for felling timber*, of four different kinds, will be found described in the *Highland Soc. Trans.*, vol. ix. p. 275. The most powerful of these appears to be a circular saw (*fig.* 1235.),

1235



which consists, first, of a ground frame (*a a*), in form of the common hand-barrow, eight feet and a half in length by two feet and a half in width, on one side of which is erected a vertical frame (*b b*), of three feet and a half in height. The second compartment comprehends a traversing frame or carriage (*c c*) about five feet in length, and two feet in height; the vertical bar (*d*) being prolonged upward, and having its top and bottom ends formed into pivots, on which the carriage, carrying all the working machinery, is made to swing. The saw (*e*), of twenty-four inches diameter, is fixed on the lower end of a vertical spindle, and immediately above it a bevelled pinion (*f*), which is driven by the wheel (*g*); the winch handle, by which the power is applied, is fitted upon the same spindle. The saw pinion and the wheel (*g*) are in the proportion of one to five, so that, when the handle is turned with the ordinary velocity of forty revolutions a minute, the saw will make 200 revolutions in the same time. In order to keep the edge of the saw in contact with the saw-draft, a vertical spindle (*h*), carrying the pulley (*i*), of one foot in diameter, is placed at the outward extremity of the carriage; the pulley (*i*) is put in motion by the band (*j*) passing over a smaller pulley on the winch axle. On the spindle (*h*) there is also fitted a small drum (*k*), capable of being disengaged at pleasure from the motion of the spindle by means of a clutch. The cord (*l*), which passes round the pulley (*m*), in the ground frame, has one end attached to the carriage; while the other end, being attached to the drum, is coiled upon it when revolving along with the spindle, thereby carrying forward the saw with a slow and uniform motion. When the operation is completed, the small drum is disengaged, and the cord is allowed to uncoil, while the carriage is moved backward to prepare for the next cut. For the support and guidance of the carriage, an iron segment (*n*) is fixed upon the lower part, which slides through eyes in the ground frame; and the machine is kept steady while at work, by two iron dogs (grappling irons), the hooks of which are driven into the roots of the tree. The certificates accompanying the model of this machine bear ample testimony to its successful application on the large scale; and show that it can be worked, and carried from tree to tree, by two men. The machine here described is calculated for felling trees from eight to twelve inches in diameter. (*Highland Soc. Trans.*, vol. ix. p. 276.)

8297. *Species and varieties of the larch.* That extensively cultivated by the Duke of Athol is the common white larch, *Làrix europæ'a Dec.*; but the following other species or varieties were tried: — 1. The Tyrol larch, with white flowers; those of the common variety being pink flowers. 2. The Tyrol larch, with white flowers; the cones also remarkable for their whiteness, and for being erect, not cernuous. The shoots of the Tyrol larch are generally stronger than those of the common larch; but the foliage of both kinds is similar. 3. The weeping Tyrol larch, a variety of the common, with pendulous branches; but distinct in botanic characters from the *Làrix péndula*, or black larch of North America. 4. The red larch of North America, or *Làrix microcárpa*. This species is remarkable for the great specific gravity of its wood, which is so ponderous that it will scarcely swim in water. Its cones are shorter or smaller than those of the common larch, its branches weaker, and its leaves narrower. 5. The Russian larch, raised from seed procured by the Duke from Archangel, about the year 1806. The bark is cinereous, not yellowish-brown; the leaves come out so early that they are liable to be injured by spring frosts. The *Làrix péndula*, or black larch of North America, and *Làrix dàùrica* of Dr. Fischer of Petersburgh, are distinct species, no examples of which exist at Dunkeld or Blair. (*Hort. Trans.*, vol. iv. p. 416.)

8298. As an *Appendix* to the chapter on Planting, we shall here give some account of the larch plantation of Athol and Dunkeld, from the *Transactions of the Highland Society*, vol. xi. p. 165. to p. 219. It appears that the late Duke of Athol planted 15,573 acres, which contained 27,431,600 plants. Of these 8,604,542 plants were larch. All these were planted in the slit manner, as by far the best. It is stated in that paper that the larch will supply timber fit for ship-building, at a great height above the region of the oak; and that, while a seventy-four-gun ship would require the oak timber of seventy-five acres, it would not require more than the timber of ten acres of larch; the trees in both cases being sixty-eight years old. The larch in the neighbourhood of Dunkeld grows at the height of 1300 feet above the level of the sea; the spruce at 1200; the Scotch pine at 700; and deciduous trees not higher than 500. The larch, in comparison with the Scotch pine, is found to produce three and three quarter times more timber, and that timber of seven times more value. The larch, also, being a deciduous tree, instead of injuring the pasture under it, improves it. It is remarkable that the woolly aphis, which affected the larch plantations in most parts of Scotland for a number of years about the beginning of the present century, never extended higher than about 600 feet above the level of the sea. The late Duke John the Second planted, in the last years of his life, 6500 Scotch acres of mountain ground solely with the larch, which, in the course of seventy-two years from the time of planting, will be a forest of timber fit for the building of the largest class of ships in his majesty's navy. It will have been thinned out to about 400 trees per acre. Each tree will contain at the least fifty cubic feet, or one load of timber, which, at the low price of 1*s*. per cubic foot, only one half of its present value, will give 1000*l*. per acre, or, in all, a sum of 6,500,000*l*. sterling. Besides this, there will have been a return of 7*l*. per acre from the thinnings, after deducting all expense of thinning, and the original outlay of planting. Further still, the land on which the larch is planted is not worth above 9*d*. to 1*s*. per acre. After the thinnings of the first thirty years, the larch will make it worth at least 10*s*. an acre, by the improvement of the pasturage, upon which cattle can be kept summer and winter. (*Highland Soc. Trans.*, vol. iii. p. 168.)

8299. *Soil for the larch.* It is an error to suppose that the larch will thrive in all soils and in all situations. There are many kinds of soils in which it will not thrive, and ought not to be planted. It has been found that, in soils which have been turned up by the plough, and which have borne white crops, the larch cankers. It cankers in wet situations also. In soils resting on a wet tilly subsoil, it decays at the heart, after arriving at forty years of age. In situations where water stands for a length of time about the roots, it becomes fogged, or covered with lichens. But in all rocky situations, and particularly those which are composed of mica slate, containing crystal of garnets, among the fissures and fragments of which they can push down their roots, larches thrive to admiration. The geognostic character of the country from Dunkeld to Blair is primitive. At Blair is gneiss, at Dunkeld clay slate, and the intermediate space is occupied by mica-slate: they lie conformably to one another.

8300. *Situation.* The advantages resulting from planting mountain ground appear at first sight, in the greater number of trees that may be supported on the acclivity of a mountain than on a surface equal to its base. Trees derive nourishment from the soil immediately around the place in which they are fixed; and, as the superficies of that soil must, of course, be greater on an acclivity than on the base, a greater number of trees will be there supported. Practically speaking, 100 trees, at six feet apart, can be planted on the hypothenuse of a right-angled triangle, whereas the base would only permit eighty at the same distance. Another and a great advantage derived from planting mountain ground is, that, on an acclivity, the trees expose a greater surface to the influence of the sun, and air, and rain, than they can do on a level surface. That trees derive much nourishment from the air, through the instrumentality of their leaves, there is no doubt. The experiment of taking the bark from fifty standing larches, in May, 1814, at Dunkeld, did not prevent their vegetation, and even forming wood for two years after. The outside trees in a forest are always the strongest. On an acclivity, they all possess the advantages of outside trees; and, at the same time, most of the shelter enjoyed by those in the interior." (*Highland Soc. Trans.*, vol. xi p. 185.)

8301. *Nurses* were not used by the late duke in his larch plantation. The gardener, in the Duke's absence, planted some acres with a mixture of Scotch pine and larch; but so far were the former from nursing the latter, that at the end of seventeen years they had not attained a height exceeding three feet; while the larches which they were intended to nurse were from fifteen to twenty feet high.

8302. *The growth of the larch.* Taking the average height of an average larch, of eight years from the seed, at eleven feet, it will be nearly accurate to allow sixteen inches as the annual growth, till the tree is fifty years old, and after that only ten inches per annum for twenty-two years longer; as the length of the tree lessens in growth as the bulk of the wood increases. These data give a larch tree of seventy-two years of age a height of ninety-three feet four inches; a fair average, agreeing with actual experiment. The shoots of larches beyond thirty-five years of age are heavier, though they are not so long as those of younger trees. The larch, like the oak, puts forth two shoots every year, the one in spring, the other in autumn. The spring shoot has no lateral branches; the autumnal shoot pushes out like the spring one; but, at the time this process is going on, the spring one is throwing out lateral branches which are firm and woody.

8303. *In regard to the growth of the girth*, a larch tree, on an average, will acquire an inch in girth per annum, till it be twenty-four years old; and, from that time, till it has acquired the venerable age of seventy-two years, it will grow one inch and a quarter in girth every year; thus: —

In 24 years, it will be	2 feet in girth, at 1	inch per annum.
48 years more,	5 feet in girth, at $1\frac{1}{4}$	inch per annum.
In 72 years, it will be	7 feet.	

8304. *The larch begins to make wood* at twenty-four years of age.

At 50 years old	it will contain	26 cubic feet of wood.
60	—	14 ditto more.
72	—	20 ditto more.

In all, 60 ditto, or one load of 50 cubic feet, and 10 feet more.

8305. *These results* correspond exactly with the quantities which the Duke obtained at these respective ages. Larch appears to be on its greatest increase for timber from fifty-seven to seventy-two years old. A larch containing fifty cubic feet, or one load of timber, is quite fit for naval purposes. At half that size it is suitable for every country purpose.

8306. *Thinning larch plantations.* The great object of the Duke, in planting the larch, seems to have been to raise timber for naval purposes; and, finding that larches grow to a great size at only twelve feet apart, he thinned accordingly. This distance gives 380 trees to the Scotch acre, or about one fifth of the 2000 originally planted. "The first thinning should consist of a light one of about one fifth of the whole, by removing only those trees that are of least value or worthless. After twenty-four years from the time of planting, the spines fall off the lower branches, which are, of course, no longer useful to the soil below. From twenty to thirty years old, then, the thinning is carried on so extensively, as to remove two thirds of that which was left standing by the first thinning. In thinning, it is necessary to observe that all the strongest and healthiest trees should be left, even if two or three of them should be closer together than twelve feet. These small clumps happening to light on a favourable situation, they will thrive well, as the air has access to each tree, around two thirds of its circumference. This thinning being delayed so long, the trees thinned out will be valuable for a variety of purposes. One of these purposes is the profitable use which may be made of the bark. The last thinning should be given when the trees are from thirty to thirty-five years old, which will leave from 380 to 400 trees per acre."

8307. *Pruning the larch.* Little or no pruning was used in the larch plantations at Dunkeld. The 380 trees left in the acre, it is observed, "will require a little pruning and trimming of the lower branches, in order to give head room to the cattle, which are to browse on the grass below. The whole prunings and thinnings will cost about 5*l.*, and their produce will fetch about 12*l.*, leaving a profit on them of about 7*l.* an acre." (*Highland Soc. Trans.*, vol. xi. p. 190.)

8308. *Thin planting the larch* is recommended by the late Duke of Athol, because it allows the lower branches to extend to a greater size; and on these depend the thickness of the base of the trunk of the tree, and the strength of its roots. He therefore seldom planted more than 2000 plants per acre, more especially in elevated regions.

8309. *The process of the thickening of the soil, and the improvement of the pasture, by the larch,* being very important in its results, it deserves to be particularly described. The lower and stronger branches meet together in six or seven years after planting, so as to form a complete matting over the ground. The air and light being excluded by them, all plants that are under them die. At the same time, the annual deposit of leaves from them, by means of decomposition, forms, in the course of time, a soil of considerable depth. At the age of twenty-four, the larches lose the spines on the lower branches altogether, and that is the natural mark of their being ready to be removed by thinning, to a considerable extent. On the air being readmitted by the removal of the trees, the surface of the new-made soil, wherever it has been formed, even among the rocks, becomes immediately covered with natural grasses, of which the *Hólcus* móllis and *H.* nàtus seem to predominate. These grasses continue to grow, and to thicken into a sward by the annual top-dressing which they receive from a continued deposition of leaves. The improvement of the natural surface of the ground for pasturage, by means of the larch, appears to be a property peculiar to this tree. This pasturage is quite capable of improving the condition of cattle either in winter or summer.

8310. *With regard to other trees effecting a change of the ground,* the following are the results of many experiments made by the Duke on the subject. In oak copses, the value of the pasture is only 5*s.* or 6*s.* per acre for eight years only in every twenty-four years, when the copse is cut down again. Under a Scotch fir plantation, the grass is not worth 6*d.* more per acre than it was before it was planted. Under beech and spruce it is worth less than it was before; but the spruce affords excellent shelter to cattle, either from the heat of summer or the cold of winter. Under ash the value may be 2*s.* or 3*s.* per acre more than it was in its natural state. But under larch, where the ground was not worth 1*s.* per acre, the pasture is worth from 8*s.* to 10*s.* per acre, after the first thirty years, when all the thinnings have been completed, and the trees left for naval purposes, at the rate of about 400 to the acre, and twelve feet apart. Nay, so impressed was the Duke of the value of larch as an improver of natural pasturage, that he makes a statement to show that the pasture alone, independent of the ship-timber on it, would increase the value of land, by increasing its annual rental, so that it itself would repay the whole outlay of fencing and planting, at five per cent. compound interest, thus:—

	£	s.	d.
3000 acres of land in its natural state, not worth above 1*s.* per acre, at 25 years' purchase, will give	3,750	0	0
Plants and planting, at 6*s.* per acre	900	0	0
2400 roods of fencing, at 5*s.* per acre	600	0	0
Sundry expenses, at 3*d.* per acre	37	10	0
	£5,287	10	0

5287*l.* 10*s.*, at five per cent. compound interest, for twenty-nine years, the period at which the land is fit to be begun to be depastured, gives 21,150*l.*; but 3000 acres, at an improved rent only of 6*s.* per acre per annum, at twenty-five years' purchase, yield 22,500*l.* (*Highland Soc. Trans.* vol. xi. p. 189.)

8311. *The value of larch wood,* exclusive of the value of the pasture under it, may be estimated in this manner:—Suppose the plantations are thinned out by thirty years to what they are to stand for ship-timber; that is, to 400 trees per Scotch acre; — suppose, after that period, the whole were cut down at the following respective ages; the value of the whole, per acre, at the different periods, would be as follows:—

	£
400 trees at 30 years old, at 2½ cubic feet each tree, = 1000 cubic feet, or 20 loads, at 1*s.* 6*d.* per foot profit, =	75 per acre.
400 trees at 43½ years old, at 15 cubic feet each tree, = 6000 cubic feet, or 120 loads, at 1*s.* 6*d.* per foot profit, =	450 —
400 trees at 59 years old, at 40 cubic feet each tree, = 16,000 cubic feet, or 320 loads, at 2*s.* 6*d.* per foot profit, =	2000 —
400 trees at 72 years old, at 60 cubic feet each tree, = 24,000 cubic feet, or 480 loads, at 2*s.* 6*d.* per foot profit, =	3000 —

The average of these prices would be 1381*l.* 5*s.* per acre; so that 1000*l.* per acre is not too high a calculation of the value of the Duke's larch plantations.

8312. *On felling large trees of larch,* care must be taken to use plenty of rope, and to take advantage of the direction of the wind; but a very windy day should be avoided. It was found, in digging the Scotch fir out by the roots from among the larch, that the ground was so much shaken about the roots of the larch, as to endanger their stability: ever after, the fir was cut over by the ground.

8313. *The seasoning of larch timber* is accelerated by stripping off the bark before felling. In May, 1815, the Duke experimented on fifty trees of larch at Dunkeld, that were growing in a situation, among other wood, that was nearly inaccessible for want of a road or path to it. In 1816 they were cut down and used for several purposes, and they appeared to be completely seasoned. They contained twenty-five cubic feet of wood each. Larch trees that had been only ten months cut down were built into a steam-boat in the river Thames, but they had not been seasoned enough, as the planks above water, near the deck, shrunk a little. In this case, however, the scantlings were made the same as of oak, which were of too slight dimensions for larch.

8314. *Uses of the larch.* These are very various. Larches have been grown by the Duke as nurses to spruce firs. The thinnings of larch plantations, "which take place from twenty to thirty years of their age, supply useful materials for various purposes. Posts and rails for fencing may be made either out of the tops or the trunks of young trees. While fir-posts and rails last only about five years, and are worm-eaten after that period, the larch-posts stand for twenty years, and never get worm-eaten.

But the trunks of young trees are preferable for this purpose to the tops, as they have less sap-wood. In 1807 the Duke fenced a nursery-ground with young larch trees cut up the middle, made into a railing seven feet high. In three years after, the sawn side assumed a leaden grey colour, and in 1817 the whole railing was quite sound. Larch tops which had lain cut for four years, and were, of course, well worn, were found useful in filling drains where stones were at a distance, and they continued sound in them for many years. The larch was used for axles to different kinds of mills, from 1793 to 1802, and up to 1817 they continued quite sound, though constantly in water.

8315. " *For buildings*, too, the larch is found equally desirable. In 1779, the Duke built the shooting-box in Glentill, called Forest Lodge, the floors and joints of which were made of larch. The wood was under forty years old, and, as an experiment, some of the deals were cut up narrow, and others as broad as they could be wrought. In 1817 the narrow boards continued quite close together. After the bridge was thrown over the Tay at Dunkeld, the Duke altered the course of the great northern road to Inverness, which caused him to build a new porter's lodge, stables, and offices to Dunkeld House, near the new line of road. The whole wood-work of these buildings was executed with larch. They were finished in 1812. In 1813, part of Athol House was burnt down, and the repairs of wood, consisting of joists, floors, doors, and windows, were all made of larch. This wood was so red in colour that it looked like cedar. Several houses were also repaired in the town of Dunkeld with larch. At Dunkeld 271, and at Blair 170, larch trees had been used by 1817 for building purposes.

8316. " *The first attempt to use the larch for the purposes of navigation* was in the construction of fishing-cobles on the Tay in 1777. In 1809, 8491 cubic feet of larch timber were sent to Woolwich dockyard. The greatest quantity which was employed was in the repair of the *Serapis* store-ship, and the state of its soundness was favourably reported on in 1817. One beam of it was put into the large frigate *Sibylle*, in 1816, after it had lain six years in the dockyard. The next trial of larch in shipbuilding was in the Sir Simon Clerk, merchant vessel, of 375 tons register, built by Messrs. Symes and Co. of Leith, in 1810. They got eleven trees, containing 1066 cubic feet, and they were formed into the first four or five planks, of three inches and a half in thickness, on the bottom of the vessel from the keel upwards. This vessel was soon afterwards taken by the Americans, and no account could therefore be got regarding the durability of the timber."

8317. *The elasticity, durability, strength, and resilience of larch timber, relatively to oak and Baltic fir*, has been determined by experiment. The details, in a tabular form, will be found in the article quoted; and the following are the general results:— The Riga timber and American white pine are about one fifth part less strong than the larch. The larch is superior to the oak in stiffness, in strength, and in resilience, or the power of resisting a body in motion; and it is inferior to Memel or Riga timber in stiffness only. The larch tree, while growing, may be uprooted by wind, but it seldom breaks over by the stem, either by wind, or a weight of snow lodging on its upper branches. The durability of the timber, in every stage of its growth, is superior to every other, even to oak itself. When speaking of all the above properties as belonging to the larch, it is always to be understood to be grown in an alpine region on dry soil. In low rich soils the wood is of a very inferior character.

8318. *The large roots of larch trees fit for ship timber* may be used as knees; and this was first done at Leith in 1811. These roots have been used for the same purpose on various occasions since that time.

8319. *The larch has been tried for masts*; but, the vessels which were fitted up with them having left the Tay, it is uncertain how far larch timber will answer for that purpose. It was the Duke's practice " to plant spruce in all the wet parts of the ground, which he planted to the amount of about one tenth, expressly for the purpose of raising masts and spars, for which he conceived the spruce peculiarly well adapted."

8320. *The larch as piles*. Two hundred and twenty-three trees, forty-two years old, were converted into piles, and driven into the river Thames in the front of the works of the Woolwich dockyard in the year 1810. A report on their state was made in 1817, when they were found to be as fresh as when they were driven in. It is impossible to peruse this paper without being strongly impressed with the patriotic views entertained by John, the second Duke of Athol. Living in a period when the country was involved in a war with almost all other countries, he dreaded, in common with other patriots and statesmen, a scarcity of timber fit for naval purposes, and he contemplated the idea of planting so extensively as to provide against this scarcity for centuries to come. In all his plans and operations we see little or nothing of the merely selfish principle at work; his great object was to provide a regular yearly supply of ship timber, the commencement of which supply could not take place till many years after he was dead. The following table shows the Duke's own calculation of the supply which would be afforded by the woods of Athol, from 1832 to 1904.

12 years cutting from	1832 to 1844	will give	1,250	loads annually from	50 acres.
10	—	1844 - 1854	—	8,000	—	300
8	—	1854 - 1862	—	18,000	—	650
8	—	1862 - 1870	—	30,000	—	1050
16	—	1870 - 1886	—	52,000	—	2000
18	—	1886 - 1904	—	120,000	—	3000

8321. *The relative duration of timber* has been thus determined by M. Hartig, an eminent German professor of forestry. Small posts of lime tree, black American birch, alder, and trembling poplar, inserted in the soil, decayed in three years; the common willow, horsechestnut and the platanus in four years; the purple beech and the common birch in five years; the elm, the hornbeam, the ash, and the Lombardy poplar, in seven years; the acacia, the oak, the Scotch pine, the Weymouth pine, and the spruce fir, at the end of seven years were only decayed a little to the depth of a quarter of an inch; the larch, the common juniper, the Virginian juniper, and the arbor vitæ, were, at the end of the same period, untouched by decay. Thin boards of the same woods decayed in the following order: platanus, horsechestnut, lime tree, poplar, birch, purple beech, hornbeam, alder, ash, the maple, the spruce fir, the Scotch pine, the elm, the Weymouth pine, the acacia, the oak, and the larch. (*L'Agronome*, tom. i. p. 315.) It thus appears that the larch, whether as posts with the bark on, or sawn up into boards, is by far the most durable of our timber trees.

8322.—4138. *Machinery and utensils necessary for cider making.* In the *Encyclopædia of Cottage, Farm, and Villa Architecture* this subject is treated at much greater length; and not only all necessary plans, elevations, and sections are given, but detailed specifications for the execution of the work, and detailed estimates of the cost of every part.

8323.—4267. *The frequent-drain system.* The great importance of thorough drainage, and deep ploughing, has lately been placed in a striking point of view, by James Smith, Esq. of Deanston, in Stirlingshire, in an article contained in a *Report of the Exhibition of Agricultural Productions*, &c., published, in 1832, by Messrs. Drummond, seedsmen, of Stirling. Mr. Smith observes, " that the practical drainers of the old school cannot see how a field should be drained, unless by deep cross drains, to cut off the springs. The portion of land, however, wetted by water springing from below, bears but a very small proportion to that which is in a wet state from the *retention* of the water which falls upon the surface in the state of rain; and a vast extent of the arable land of Scotland and England, generally esteemed dry, is yet so far injured by the tardy and imperfect escape of the water, especially in winter, and during long periods of wet weather in summer, that the working of it is often difficult and precarious; and its fertility is much below what would uniformly exist under a state of thorough dryness. A system of drainage, therefore, generally applicable, and effecting complete and uniform dryness, is of the utmost importance to the agricultural interests, and, through them, to all the other interests of the country. By the system here recommended, this is attained, whilst the expense is moderate, and the permanency greater than on any other system yet known. The drains, as applied in the carse, have been named *wedge drains*, from their form, and being filled with wedges or keys to preserve the opening in their bottoms. They are sometimes called *furrow drains*, from their being placed under the water furrows of the ridges; but these terms give no exposition of the principle upon which the effect of this mode of draining depends. The principle of the system is, *the providing frequent opportunities for the water rising from below, or falling on the surface, to pass freely and completely off;* and, therefore, the most appropriate appellation for it is *the frequent-drain system.*"

8324. *Main drains.* In proceeding to apply this system of drainage to land, the first object is to obtain a sufficient fall, or level, as it is commonly termed, for a main drain to receive the water flowing from the various smaller or ordinary drains. This drain should be directed along the bottom of the chief hollow or valley of the grounds, where the whole or greater portion of the drains can be led into it. If any lesser hollows occur in the extent of surface, they must also have their proportional mains or leaders. The bottom of the main should be at least three feet; and, if possible, three feet and a half or four feet under the surface where it passes along; and it should have throughout as uniform a fall as the nature of the ground will admit. It should be flagged at the bottom; or, where flagstones are expensive, built as an inverted arch, to prevent the possibility of rain, &c. washing away the earth under the side building. The dimensions necessary will depend on the fall or declivity, and the area of land from which the drain has to receive water. With a fall in no place less than 100 yards, a drain ten inches wide, and eighteen inches deep, will receive the rain water from 100 acres. It is of great importance to make the openings of such drains narrow and high; as they will thus require smaller bottoms and covers, and be less liable to give way; the current of water being also more confined, mud and sand will be less apt to settle in the bottom. Let the sides be smoothly and securely built with flat stones, either with or without mortar; and let strong flat covers be placed over the drain; or, where such are not to be found, a rough simple arch, with thin stones and mortar, may be built, packing the haunches of the arch well up to the sides of the cuts with earth beaten in firmly. Where lesser hollows occur, crossing the fields, it is necessary to cut submains along their bottoms, about three feet or three and a half feet deep, and having openings of suitable dimensions formed by stone couples (two flat stones placed together at the top and apart at the bottom, like the two sides of a triangle), or with drain tiles; or, where a very large flow of water has to be provided for, with inverted tiles, and covering tiles placed above the bottom one, or with larger tiles made on purpose.

8325. *Submain drains.* There should be a cross submain at the bottom of every field or stretch of drains, to receive the water from all the parallel drains; and such submain drain should always be cut six inches deeper than the drains running into it, that the water may have a free drop, which will prevent the lodgment of mud or sand at their junctions or mouths. Open cuts or ditches, either as mains or submains, should never, except from necessity, be adopted, being apt to get filled with mud and grass, by which the water is thrown back into the drains, and often chokes them; besides, the loss of land, annoyance in ploughing, constant expense of cleaning, and unsightly appearance of such drains, are serious objections.

8326. *Parallel or frequent drains.* Having thus provided a main drain, with submains flowing into it, matters are prepared for setting off and for executing parallel or frequent drains in the field. These drains can be executed at any season when the weather will permit; but spring and summer are most suitable for the work. It is best to execute the drains when the field is in grass, as they can then be cut in all kinds of weather, and in a more cleanly manner.

8327. *In setting out the drains*, the first object for consideration is, the nature of the subsoil: if it consists of a stiff strong clay, or a dead sandy clay, then the distance from drain to drain should not exceed from ten to fifteen feet; but if there is a lighter and more porous subsoil, a distance of from eighteen to twenty-four feet will be close enough. When the ridges of the field have been formerly much raised, it suits very well to run a drain up every furrow, which saves some depth of cutting. At whatever distances the drains are placed, they should be run parallel to the ridges, which is commonly in the steepest descent. They should always be run quite parallel to each other, and at regular distances, and should be carried throughout the whole field *without reference to the wet or dry appearance of portions of the field;* as uniform and complete dryness is the object, and land, which may be considered dry in its natural state, will show wet when compared with properly drained land. A three-feet drain should be carried along the ends of these drains at the top of the field, and at a distance of about nine feet from the fence, especially if it is a hedge fence. Such a drain is necessary for the growth of the hedge; but if made nearer than nine feet, the roots are apt to get into the drain, and choke it up by degrees. It is of importance to be accurate in setting out the drains as described, as it secures uniformity of dryness, and in all future operations, or at any time, it is easy to ascertain the line of any drain.

8328. *Excavation.* The lines of drains having been marked off in the field, the drainer begins by cutting with a spade on a line; then removing the first layer to the depth of a spitful of about thirteen or fourteen inches wide all along, another follows with a narrower and tapering spade, made for the purpose, taking out another layer; and, when picking becomes necessary, a third man follows with a pick; and a fourth with a large scoop shovel to cast out the earth, and a smaller scoop shovel is used to clean out the bottom, which should be cut as narrow as will allow the last drainer a footing, generally about three or four inches. From two to two feet and a half from the surface are the best depths for such drains; the latter always to be preferred. The bottom should be cut as straight and uniform as possible, so that the water may flow freely along at all places, and it is better to cut a little deeper when there is any sudden rise of the surface than to follow it; and where sudden hollows occur, the cutting may, on the same principle, be less deep: attention to this also admits of after straightening or levelling of the surface, without injury to the drains. The workmen, in cutting, should throw the earth to the right and left from each alternate drain, as that allows the plough to go regularly and fully occupied *boutings* (a Scotch term for a rotation or traverse of the plough) in filling in the earth, whilst each alternate ridge or space is left for getting in the stones free from the earth thrown out.

8329. *Filling.* The stones may either be laid down at intervals, by the sides of the drains, to be there broken; or, being broken in masses at some convenient spot, can be brought by the carts, ready to be filled in. No part of any drain should, if possible, be filled in, till the whole line is cut out and inspected, but the sooner drains are filled, after having been cut, the better. Sometimes, when there is much tendency of the sides to fall in, it becomes necessary to fill in going along. Cutting at the end of summer, when there is little water in the soil, or in a dry season, saves much of this. In soft or sandy bottoms, by cutting the drains to half the depth in the first instance, and allowing them to remain in this state until the water has drained from the upper stratum of the soil, the lower part may be cut out with more safety from falling in. The stones covering the drains should not be filled in nearer to the surface than eighteen inches, leaving sixteen inches free for deep ploughing.

8330. *Covering the stones.* The upper surface of the stones having been made straight and uniform, the whole should be neatly and closely covered with thin turfs, cut from the adjoining surface, or brought from some suitable place. Strict attention to the correct execution of this operation is of the greatest importance, as many drains are ruined at once, from the running in of the loose earth. Thick turfs are objectionable, from the difficulty of getting them to fit close. Straw, rushes, broom, whin, and other like material, are very objectionable, affording no certain or uniform security, and forming a receptacle for vermin. Peat may be used to advantage. Where the deepest ploughing has been executed, there should always remain a firm crust of earth undisturbed over the stones of the drain; and no surface water should ever have access to the free way of a drain by any direct opening, but should find its way, by percolation or filtration, through the subsoil, and should always enter by the sides of the drains. For this purpose, it may be of advantage to tread or beat down closely the first two inches of soil put over the turf, in order to form the permanent crust.

8331. *The cost of executing such drains* varies, of course, according to circumstances: the cutting cost (in 1832) from 1*s.* 6*d.* to 2*s.* 6*d.* per rood of thirty-six yards, according to the hardness of the subsoil; the stones, if collected on the adjoining fields, will cost from 1*s.* to 1*s.* 6*d.* per rood, the breaking from 9*d.* to 1*s.* per rood; about one and a half cubic yard of broken stones will fill a rood of a well-cut drain; the putting in of the stones may be calculated to cost about 3*d.* per rood, and the turfing about 1*d.*; the filling in of the earth over the stones with the plough will cost about 1*d.* per rood. The whole cost, per rood, of common drains, may be taken at 4*s.* 8*d.*, or, including a charge to cover proportion of main drains, 5*s.*

8332. *The following table* exhibits the cost per Scotch acre of draining in this method, at various distances between the drains; and as this method of draining forms a permanent improvement of the land, it is presumed the proprietor should defray part of the expense. The table is constructed to show how much it will cost the landlord in money to do the cutting, carrying, and (when necessary) breaking of stones, filling in, and turfing; and how much the horse-work, &c., which can be performed by the tenant, will cost, charged at the ordinary rates: —

Subsoils to which the Distances are applicable.	Distance between the Drains in Feet.	Roods per Acre.	Cost per Rood to Landlord.	Cost per Acre to Landlord.	Cost per Rood to Farmer.	Cost per Acre to Farmer.	Total Cost per Acre.
			s. d.	*£ s. d.*	*s. d.*	*£ s. d.*	*£ s. d.*
For stiff clay subsoil -	10	48	3 4	8 0 0	1 8	4 0 0	12 0 0
	11	43¾	—	7 5 10	—	3 12 11	10 19 9
	12	40	—	6 13 4	—	3 6 8	10 0 0
	13	37	—	6 3 4	—	3 1 8	9 5 0
	14	34⅓	—	5 14 5	—	2 17 3	8 11 0
Sandy clay -	15	32	—	5 6 8	—	2 13 4	8 0 0
	16	30	—	5 0 0	—	2 10 0	7 10 0
	17	28¼	—	4 14 2	—	2 7 1	7 1 3
	18	26¾	—	4 9 2	—	2 4 7	6 13 9
	19	25⅓	—	4 4 5	—	2 2 3	6 6 8
	20	24	—	4 0 0	—	2 0 0	6 0 0
Free strong bottom -	21	23	—	3 16 8	—	1 18 4	5 15 0
	22	21¾	—	3 12 6	—	1 16 3	5 8 9
	23	20¾	—	3 9 2	—	1 14 7	5 3 9
	24	20	—	3 6 8	—	1 13 4	5 0 0
	25	19¼	—	3 4 2	—	1 12 1	4 16 3
	26	18½	—	3 1 8	—	1 10 10	4 12 6
	27	17¾	—	2 19 2	—	1 9 7	4 8 9
	28	17	—	2 16 8	—	1 8 4	4 5 0
	29	16½	—	2 15 0	—	1 7 6	4 2 6
More open bottom -	30	16	—	2 13 4	—	1 6 8	4 0 0
	31	15½	—	2 11 8	—	1 5 10	3 17 6
	32	15	—	2 10 0	—	1 5 0	3 15 0
	33	14½	—	2 8 4	—	1 4 2	3 12 6
	34	14	—	2 6 8	—	1 3 4	3 10 0
Irregular beds of gravel or sand, and irregularly open rocky stratifications - -	35	13¾	—	2 5 10	—	1 2 11	3 8 9
	36	13⅓	—	2 4 5	—	1 2 3	3 6 8
	37	13	—	2 3 4	—	1 1 8	3 5 0
	38	12¾	—	2 2 6	—	1 1 3	3 3 9
	39	12⅓	—	2 1 1	—	1 0 7	3 1 8
	40	12	—	2 0 0	—	1 0 0	3 0 0

8333. *Remarks.* In cases where time or capital are wanting to complete the drainage, each alternate drain may be executed in the first instance; and the remainder can be done the next time the field is to be broken up. After the drainage has been completed, a crop of oats may be taken from the field; and immediately after that crop is off the ground, the field should be gone thoroughly over with the subsoil plough, crossing the line of drains at right angles.

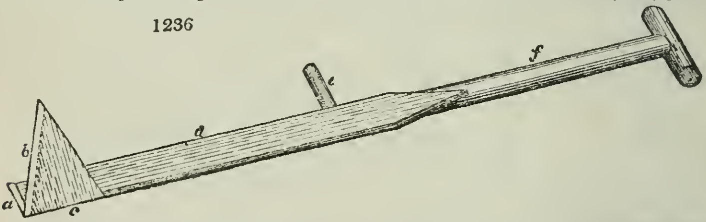
8334. *The subsoil plough* has been constructed on principles appearing the best fitted to break up the subsoil completely to a depth sufficient for most thorough cultivation, say fourteen to sixteen inches, allowing the active soil still to remain on the surface; to be of the easiest possible draught, in reference to the depth of furrow and firmness of the subsoil; and to have strength and massive weight sufficient to penetrate the hardest stratum, to resist the shocks from fast stones, and to throw out all stones under 200 lbs. in weight. All this has been accomplished, and practically proved, over an extent of at least 200 acres of various soils. This plough requires four good horses, an active ploughman, and a lad to drive the horses and manage them at the turnings. Six horses, yoked three and three abreast, may be necessary in some very stiff or stony soils. A common plough drawn by a pair, goes before the subsoil plough, throwing out a large open furrow of the active soil. The subsoil plough following, stirs up thoroughly and breaks the bottom, when the next furrow of the active soil is thrown over it; the stones brought to the surface by the subsoil plough being thrown aside, on the ploughed part of the land, by a boy or lad; and so on, till the whole field is gone over. The boy should carry a bag of wooden pins, that he may mark the site of the large fast stones which the plough cannot throw out, and which must afterwards be dug out with the pick, and, perhaps, blasted. This large plough is a sort of horse-pick, breaking up without raising to the surface the subsoil. Channels are thus regularly formed for the water to flow from all parts towards the drains. The atmospheric air being also by this means freely admitted to the subsoil, the most sterile and obdurate clay becomes gradually ameliorated, and the common plough may ever after be brought to a depth of from fourteen to sixteen inches without obstruction; and with the power of three horses yoked abreast, and managed with ease by the ploughman, without any person to drive. By being thus yoked together, and near the point of resistance, the horses have great power; and, the furrow turned over being broad in proportion, nearly as much ground will be gone over in a day, as with a plough and a half drawn by a pair of horses. The cost of subsoil ploughing an acre may be estimated at 30*s.*, being one sixth of what a similar depth would cost with the spade; and, upon the whole, as effectually done. A subsoil plough with apparatus cost, in 1832, from 7*l.* to 8*l.*

8335. *The effect of this mode of draining and deep working on close-bottomed land* is quite wonderful. After one turn of green cropping, with the usual application of lime and dung, the formerly scanty sterile surface soil becomes a deep rich loam, carrying, without fail, crops of wheat and barley, producing from nine to twelve bolls per acre of wheat, and from eight to twelve of barley; the hay and pasture following being also very fine. When fields have been thus dried and worked, it is recommended to plough them at all times without ridges, or water furrows, preserving one uniform sheet of soil over the whole field.

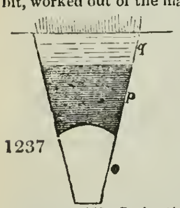
By this means every superficial inch is allowed to be productive. There is no carrying away of the surface by accumulated currents of water; and the water falling as rain, is left to percolate through the soil where it falls, thereby uniformly enriching the whole extent. There is a powerful process of nature much facilitated by complete draining and deep working, viz., the constant circulation of air to and from the bottom of the soil, produced by the constantly varying relative temperatures of the atmosphere and the earth. When heavy rain falls, the air is completely expelled from the interstices of the soil, the water taking its place. Also, when the rain has ceased to fall, the water gradually subsides to the level of the drains, or, at all events, to the level of the bottom of the subsoil that has been moved by the plough, and fresh air takes its place throughout the soil; thereby promoting doubly a chemical action vastly conducive to the decomposition of the soil and the manure it contains; and, of course, to the nourishment of plants. When land is uniformly and completely dry and deep in the soil, it is more easily wrought; it can be wrought at any time when it does not rain; it comes to a state proper for sowing earlier, and more uniformly; a circumstance of great importance in our climate: it affords a wide and uninterrupted range for the roots of plants; it resists the evil effects of long droughts, as well as of long periods of wet; it never honeycombs, as it is called; it seldom throws out plants of any kind in frosts: it never suffers from the treading of cattle in removing the green crop; for, although apparently puddled or poached on the surface, yet, being dry below, a single ploughing restores the soil to a proper tilth; and it gives an earlier harvest, and affords a dry bed for cattle when in pasture. In the conclusion of his article, Mr. Smith observes, that the subject of thorough under-draining, and of deep ploughing, is one of so much importance, and so extensive in its parts, that volumes might be written on it to the advantage of the country. (*Report of Drummond's Agricultural Exhibition, &c.*)

8336. — 4295. *Plug or clay draining* is performed chiefly in pasture land, by first digging out a drain from eighteen inches to two feet deep, two inches wide at the bottom, and about one foot wide at the top. In the bottom of this drain is placed what is called the suter, or plug, which may be two or three feet in length, one inch and three quarters wide at the bottom, and four inches wide at the top. To one end of this plug is attached a chain, about two feet in length, which is connected with a lever for drawing the plug forward. The drain being dug out, and the plug being put in its bottom, the excavated clay is then firmly rammed over it; when this is done, the plug is moved forward by means of the lever, and the same operation of ramming is repeated, till the whole length of drain is filled in. The drain is completed by replacing the surface turf as it was before the drain was dug out. This mode of draining is described in the *Quart. Journ. of Agr.*, vol. iv. p. 501., by W. J. Evans, Esq., who says " that he has executed in this manner, during three years, more than 400 miles of clay drains, to his entire satisfaction." " Pasture land," he says, " which had been before deluged by surface water, has undergone an entire change of character." The implement, *fig.* 1236, is used in clearing out the bottom of these drains; and *fig.* 1237. is

1236



a section of a drain made and filled up. Fig. 1236. is the bit or grafting-iron; *a* is the width of the bottom, one inch and three quarters; *b*, the side bit, length of cut six inches; *c* is the width of the back of the side bit, worked out of the main bit, which must be of the best tempered steel, four inches and a half; *d* is the length of the main bit from the step to the bottom, one foot six inches; *e* is the treading step; and *f*, the handle, which is about the length of a common spade handle. Fig. 1237. is a section of a main drain, two feet deep, filled up again; *o* is the waterway left open, eight inches and a half high; *p* is the rammed clay above the suter, or plug, nine inches deep; and *q* is the returned turf, with the grassy side uppermost, six inches and a half thick. (*Quart. Jour. Agr.*, vol. iv. p. 503.)



1237

8337. — 4320. *Embankments.* An essay will be found in the *Highland Soc. Trans.* (vol. viii. p. 97.), in which are enumerated all the books, or articles, which have appeared on the subject in the English language up to 1828, the period at which the essay was written. In the same work (vol. viii. p. 91.) will be found a section and description of an embankment formed by rows of piles, filled in between by furze, and employed to direct the course of a river.

8338. — 4380. *Irrigation.* An excellent practical work on this subject, and on draining, *Stephens's Practical Irrigator and Drainer*, has reached a second edition since the publication of this Encyclopædia. Any thing new in such a work was not to be expected; but, being entirely of a practical nature, and by a practical man, it may safely be recommended as one of the best books on the subject.

8339. — 4406. *Sluices, trunks, and valves for embankments* are now made of cast iron, on an improved principle; and, when properly fixed in by a mass of masonry and cement, they are found to retain the water of a pond, and admit it at pleasure, with as much accuracy and ease as a brass cock does the contents of a beer barrel.

8340. — 4485. *Artesian wells*, or those produced by boring, are so named from their having been first used in the neighbourhood of Artes in France. Upon a review of the appearances observed in these wells, it is quite evident that they must always succeed where an inclined stratum of a fissured or porous limestone, or other porous stone, is included between two waterproof beds of clay; one of which sets a limit to the sinking of the water downwards, and the other prevents it from rising above the surface. The existence of such a cover is evinced by all boring works. A waterproof stratum of clay must always be penetrated, before reaching the spring water: and it may easily be conceived that the undermost layer is never wanting. Although, for the most part, some thinner strata of limestone supply its place, yet the strata, which conduct the water, always contain it in crevices, which are much more numerous on the surface than in the centre of the beds. Thus there is a demonstration, as in a boring work at Blengel, that, even in the limestone itself, beds of clay occur. From these circumstances it is easily explained how we can never hope to sink Artesian wells in granite, gneiss, porphyry, serpentine, &c. Even in schistose mountains, it would not be advisable to sink these wells, because, if water were found there, it would be very easily impregnated with sulphuretted hydrogen, from the abundance of pyrites occurring in these strata, and thus be unfitted for many uses. Limestone, on the contrary, which is very insoluble, experience teaches us, yields a very pure water. These observations especially relate to the Pas de Calais.

8341. *Other districts*, where water has been bored for, show a similar geognostic constitution to the Pas de Calais. M. Garnier, in his *Manuel du Fontanier-sondeur, &c.*, notices this, with regard to Boston in America, and Sheerness in England. London (where many sugar-works, distilleries, and breweries have, for a long time, been principally supplied with water from Artesian wells) lies in the middle of a basin-shaped hollow, the fundamental rock of which is a limestone belonging to the chalk formation; which also forms the heights in the vicinity, and which is covered with clay, though at times not immediately. The wells, which are not sunk to this London clay, give abundance of clear, but mostly very hard, water; while those which penetrate through the London clay, into the subjacent plastic clay, a formation immediately covering the chalk, and consisting of alternating beds of sand, clay, and boulders, yield a very soft and pure water, which, on piercing this clay, often ascends with such violence that the workmen have scarcely time to escape. Here the plastic clay seems to be either the conducting medium, or the reservoir of the water yielded by the chalk. Paris is known to be situated in a district whose geognostic relations are almost identical with those of London, and therefore we cannot wonder that there, as well as in many other parts of the north and east of France, Artesian wells may everywhere be sunk; nor can we doubt of the extension of this very useful discovery. (*Jameson's Phil. Journ. for July*, 1830.)

8342. *We must not, however, expect to be able to sink Artesian wells in every description of country*, as has been thoughtlessly asserted. On the one hand, the nature of the ground sometimes absolutely prevents it, as in granite districts; and, on the other hand, it is possible that a perforation, if made too near a bored well affording water, may not yield any; should the latter, for example, be fed by a subterranean current, in place of being supplied by a sheet of water; or should the perforation be made upon the extremity of a basin with inclined strata, resting upon a formation of a very different nature. M. Garnier's *Manuel du Fontanier-sondeur* contains all that can be desired on the subject of boring these wells. (*Ibid.*)

8343. *General observations on Artesian wells.* Great subterranean sheets of water exist at various depths. These sheets are more commonly met with in the plane of superposition of strata of different formations. They, however, frequently occur at various heights in the great masses of earth; such as those of clay, chalk, and even marine limestone containing cerithia, when these masses are entire, and of great thickness. According to the slope, the undulations, or the declivities which are presented by the plane of superposition of the permeable deposits in which the waters flow between impermeable strata, these great sheets of water are met with at all depths; but it is impossible to lay down any constant rule with respect to them. (*Ibid.*)

8344. *In order that these waters may be capable of ascending*, it is necessary that the formations among which they occur be entire, in the state in which they were originally deposited; and that they be not intersected by large valleys, or deep ravines, through which the waters would find a free and easy exit.

8345. *It would be in vain to search for springs in deposits which, at no great distance from the place of boring, are intersected by deep valleys*, or when the formations are internally crooked, filled with tortuous separations, and greatly disturbed, whether by the contraction attending the desiccation of the mass, of by internal shocks, swellings, or earthquakes; or, lastly, when these Neptunian formations, such as plastic clay, chalk, oolite, and shell-limestone, are raised up, and present precipices at the surface. In such localities, we need not expect success in boring for springs, unless by penetrating deeply into the mass of the chalk, in search of the sheets of water in its lower part; or even by traversing it entirely, in order to come upon those in the clays, oolites, and shell-limestones; or, lastly, unless by penetrating deeply into the latter, when they happen to be raised to the surface, and to present cliffs, or are intersected by valleys of greater or less depth.

8346. *In a country composed of elevated plains*, if, in place of boring to the necessary depths for reaching the different water-sheets which are commonly the most abundant, and, at the same time, those which rise highest, the boring is stopped at higher levels, less distant from the surface, it is more than probable that the ascending waters will stop more or less beneath the surface of the ground, according to the depth of the borings. When this occurs, we ought to be far from considering the operation as having failed; because in this case the water does not rise above the surface, and in most instances, according to the localities and the nature of the ground, steps may be taken to remedy the deficiency. Thus, for example, when the water of a boring only rises to within a certain number of yards from the surface, but in sufficient quantity, it might be conducted from the point to which it reaches, by a small gallery, into some neighbouring well, or into one dug on purpose; and there might thus be produced a kind of artificial fall, which might be employed to make the water ascend to the surface of the ground, and even beyond it, by employing for this purpose either the hydraulic ram (bélier hydraulique), which would always give a third of the volume of water, or a wheel, which might be placed at the point of the fall, and which, working a pump suitably placed, might raise the third, or perhaps even the half, of the volume of water; or, in short, any other hydraulic machine of the kind. But these means would be practicable, only in so far as the wells into which the waters should be precipitated, might not allow them to run off into strata of permeable deposits.

8347. *Circumstances which it is necessary to examine and appreciate before resolving upon boring a well.* It is necessary to examine the physical constitution or the nature of the ground, and the disposition of the surface of the country, with reference to the mountains which overlook it, the valleys by which it is intersected, and the springs which rise in those valleys. The latter it is particularly necessary to examine, before deciding upon boring a well, as many of them are natural wells. It is of importance to select a fit person for boring; the art not being merely mechanical, and such as can be practised by *any borer*. Besides attending to these circumstances, it is necessary to be possessed of perseverance and courage, which will lead us to disregard the delays and difficulties often unavoidably connected with the operations of boring. (*Héricart de Thury, as quoted in Jameson's Journal for July*, 1830.)

8348. *Boring for water in deep sand.* Mr. David Greenley of London has been lately (August, 1834) very successful in obtaining "an abundant supply of pure water," at Diss in Norfolk, at a depth of upwards of 600 feet below the surface. A well had been previously sunk in the same place; but, in consequence of an immense quantity of sand rising whenever the pump was worked, it was almost useless. (See *Arch. Mag.*, vol. i. p. 210.)

8349. — 4524. *Rending rocks or stones.* A newly invented apparatus for this purpose has been brought into notice by Mr. D. Millar, road contractor and builder in Edinburgh. The apparatus appears to be a more efficient boring instrument than any hitherto in use. It is calculated to bore or tap to the depth of 100 feet or upwards, and may be put in operation either by manual labour or steam. (*Scotsman*, Feb. 22. 1834.) An instrument for the same purpose was invented by Mr. Mallet of Dublin in 1832. Mr. Mallet's object was to split all rocks that could be separated into laminæ, by the application of male and female screws; instead of blasting, as heretofore practised, with gunpowder. The process is as follows: — Jumper holes are formed in the direction of the proposed fracture, as at present; but, instead of filling them with gunpowder, a split female screw is inserted in each hole, and the fracture is effected by the insertion of a conical or male screw. (*Arch. Mag.*, vol. i. p. 93.)

8350. — 4541. *Draining and bringing into cultivation moss-lands or peat-bogs.* The Liverpool Agricultural Society having awarded its premium to Mr. Reed, late of Chat Moss, but now a professional drainer, we give the following as the essence of his paper. We may premise that we had the pleasure of inspecting Mr. Reed's farm at Chat Moss, near Liverpool, in August, 1831, and were much gratified and instructed by what, when there, we saw and were told by Mr. Reed.

8351. *Draining.* The water, to a considerable depth from the surface, being held in a great degree by capillary attraction, drains should be frequent, and more or less distant according to their depth. Open drains to divide the fields may be placed at any distance not exceeding 100 yards. The covered drains should run at right angles to the divisional drains. Sixty-six yards, or three chains, Mr. Reed has found the best width between the open drains; and, consequently, as the covered drains are at right angles to these, their length will be sixty-six yards. The open drains may be four feet wide at the top, from three feet six inches to four feet deep, and fourteen inches wide at the bottom. The covered drains should not be more than five or six yards apart, and three feet deep. No material is wanted to cover them but the moss itself. "The form should combine the principle both of the shoulder and the wedge drain, and the somewhat square clod, which is first taken out, when dried to a certain extent by the weather, becomes the cover."

8352. *Preparing the surface.* "Moss, or peat bog, is not a soil, but an accumulation of dead, dying, and living plants growing in water." To form a soil, therefore, it is necessary to destroy, to a certain depth, the original structure of the moss, both for the purpose of destroying vegetation, and facilitating the passage of the water to the covered drains. Digging is perhaps the best mode of destroying the structure of the moss, and afterwards, a cutting machine formed by fixing circular knives on the cylinder of a common roller, may be applied. In due time, the surface may be harrowed, and afterwards manured, and sown with a crop. Any description of earth is useful, as tending to consolidate the moss, and to facilitate its decomposition; but, to obtain a good crop the first year, putrescent manure in a considerable quantity is absolutely necessary.

8353. *After cultivation.* "Manure of some sort being applied, almost any description of crops may be had; but potatoes are perhaps the best article to begin with; 2d, wheat; 3d, clover, without grass seeds; 4th, oats. The rotation may be varied, so as to include almost every crop."

8354. *The preparation of coke or charcoal from peat or moss* has been effected in different parts of Scotland, and in Ireland, and the charcoal thus produced has been found superior to many kinds of coal for smelting iron, and the use of smiths' forges. This arises from the total absence of all sulphuric matter in the peat, which renders it almost equal to the charcoal of wood, to which it is well known the Swedish iron owes its principal excellence. The charring of peat for use in smelting iron has been strongly recommended as a means of giving employment to the labouring population. (See *Brit. Farm. Mag.*, vol. v. p. 360.)

8355. — 4557. *In improving moist lands where manure cannot be obtained,* covered drains are unnecessary; but open drains are made at distances of from ten to twelve yards. The stuff taken out of the drains is spread on the intervening spaces, on which also clayey earth is laid, in quantity varying from thirty to fifty yards per statute acre. The land is afterwards pared with a breast plough by men; or with a plough constructed for the purpose, drawn by a horse; then partially burned, the ashes distributed pretty equally over the surface, the seed sown, and ploughed in with a slight narrow furrow. Tolerable crops of oats may be obtained in this manner; and, sometimes, inferior crops of clover are made to follow the oats: in others, oats follow oats, year after year; the paring and burning being a necessary preliminary to each crop. This is certainly better than nothing, and is, perhaps, the best practice where manure cannot be made or procured at a moderate price. (*Brit. Farm. Mag.*, vol. viii. p. 42.)

8356.—4688. *The question of corn rents* has been discussed at considerable length, but nothing has been said as to the *modus operandi* of converting money into a grain rent. In a cultivated district, where the farm proceeds arise chiefly or wholly from the sale of grain, an experienced farmer, in offering for a farm, forms an estimate of the quantity of grain he may expect to raise for the market, and what proportions thereof he can afford to pay as rent, after allowing for interest on capital, profits, and expenses. In this estimate, price forms a most important ingredient; and it is the fluctuation in the price of grain which has occasioned the adoption of grain rents. From the commencement of the present century till the conclusion of the war, the generally high prices of grain produced keen competition in farm-taking, and a rapid rise of rent was the consequence; but those who, chiming in with the spirit of the times, entered into leases at high rents, between 1810 and 1815, found, by 1821, that, in reckoning on a continuance of high prices, they had calculated without their host. About that period the cry for deductions of rent became loud and general; and that cry was in many instances responded to by the landlords giving temporary relief. This relief was, however, only temporary; and, in many cases, did harm, as it tended to keep up competition in farm-taking; and though a proprietor who had acquired a character of liberality felt little alteration in his rent roll on granting new leases, yet, as that liberality formed a very prominent ingredient in the farmer's estimate, it was naturally expected to be put in requisition where other sources failed. This unsettling of all covenants between landlord and tenant soon became disagreeable to all parties. The farmer had to become a humble supplicant, and the landlord to put up with a diminished income, without being altogether certain how far the claims on his generosity were well founded, or to what extent they might proceed. It therefore became a matter of necessity to make such arrangements as would restore the farmer to his original and proper state of independence, and the landlord to a state of certainty as to the extent of his income. Those farmers who had entered on nineteen years' leases during the last years of the war, or soon after its termination, had calculated on receiving, on an average of years, 35*s.* per boll for wheat, 25*s.* per boll for barley, and 20*s.* per boll for oats; but as prices soon fell, and continued below these rates, profits on farming became extinct, and capital began to decrease. Under these circumstances, farmers petitioned for permanent reductions of rent, suitable to the low prices; or craved leave to retire. Renunciations were written out by land agents, in which terms were proffered to the tenant less favourable than if his lease had expired, connected with an offer to convert the money rent into grain rent, payable in money by the county fiars price (the average price for the year) of grain for the current crop. Thus a tenant who had entered on his farm in 1815, and who grumbled at low prices in 1821, paying a money rent of 400*l.*, agreed to pay, under the new arrangement, during the currency of his lease, money to the amount of the highest fiars per 100 bolls of wheat, 100 bolls barley, and 100 bolls oats, these three bolls at 35*s.*, 25*s.*, and 20*s.*, amounting to 4*l.*; the maximum reaching to 85*s.* or 90*s.*, and the minimum to 60*s.*; thus giving a preference to the tenant in the fluctuation. When farmers entered into leases subsequently to 1821, on money rents, 75*s.* for the three bolls became the standard of conversion, because, warned by a succession of low prices, farmers had offered lower money rents; but in either case, wherever the plan has been adopted, it has been found to work well. Where money rents still exist, they are ill paid; the partial payments are entered to account, and the arrears press as an incubus on enterprise or improvement. The situation of the landlord is not enviable, and that of the tenant is deplorable; but, with the example before them, this state of things will soon rectify itself. In pastoral districts, something, too, might be devised to produce a fluctuating rent, regulated by the average price of sheep, wool, and cattle; and thus to place the grazier and his landlord on that same safe sort of footing now enjoyed by the more reflecting portion of the landlords and farmers in the cultivated districts. (*A. G.*)

8357.—4820. *On the capital required in farming,* an excellent paper will be found in the *Quart. Jour. of Agr.*, vol. iii. p. 450. To this paper is annexed a list of the implements of husbandry, live stock, seeds, lime, and expense of labour required for stocking a farm in Scotland, in 1831, of 500 acres. The total amount required was 3569*l.* 17*s.* 11*d.* The list is given in great detail, and well deserves the study of young men intending to become occupiers of farms.

8358.—4925. *Rotation of crops.* Independently of the benefit which a rotation of crops affords to the cultivator, by the greater variety of articles which it enables him to cultivate, there is less danger of his suffering in years of scarcity; because it seldom or never happens that the seasons are unfavourable for every description of crop. Thus, a very dry season is favourable for the production of corn, while a very wet one is unfavourable for corn, but produces abundance of herbage, roots, and grasses, which directly, or by means of nourishing or fattening animals, furnish a supply of human food.

8359.—4936. *For clays and loams of an inferior description,* the following rotation is recommended in the body of the work: —

1. Fallow, with dung.	3. Clover and rye grass.	5. Beans, drilled and horse-hoed.
2. Wheat.	4. Oats.	6. Wheat.

Here barley forms no part of the rotation, though inferior loams are often well calculated to yield fair crops of that grain: such loams are to be met with in many parts of Scotland at altitudes where wheat could not succeed. Another objection to this rotation is, that wheat forms the last and also the first crop of the course, with an intervening fallow: for inferior loams, such cropping is too severe; and in any case two crops of the same species in succession should, if possible, be avoided, even although a fallow or green crop intervene. The following rotation, which is practised on poor clays in the Carse of Gowrie, appears preferable, either on inferior clays, or loams, where wheat can form part of the rotation:—

1. Fallow, with dung.	3. Drilled beans.	5. Clover and rye grass.
2. Wheat.	4. Barley, with dung.	6. Oats.

On inferior soils, five successive crops, with only one manuring, cannot be expected to reach mediocrity. The general practice is to give rather less to the fallow crop, say fifteen tons per acre, and ten tons per acre, ploughed down in the end of autumn, on the bean stubble, for the barley. The growth of this plant is so rapid, that, on strong lands, where the dung has not been incorporating with the soil throughout the previous winter months, it is found to be of little benefit to the barley crop, and is therefore seldom applied at seedtime. In this rotation, too, five years intervene between each species of crop; the only drawback is, that barley after beans or peas is darker coloured than after a fallow or a green crop; but purchasers will make allowance for this, when they perceive that such colour does not proceed from damp in the stack. (*A. G.*)

8360.—4937. *The rotation for thin clays* in the body of the work is objectionable, from the land being continued too long in grass.

1. Fallow.	3. Grass.	5. Grass.
2. Wheat.	4. Grass.	6. Oats.

On the thin clays in the Carse of Gowrie, of which there is a considerable breadth, the rotation generally followed is the same as that recommended above. Pasturing poor retentive clays will not pay. Such land is sufficiently tenacious without the tread of cattle, and the forage would be extremely scanty. Where the clay soil is so miserably poor as not to carry beans, a four-course shift might be adopted, keeping the grass only one year. On all clay lands it is often difficult to obtain sufficient mould for grass seeds in spring, among autumn-sown wheat; and, except in early situations, spring-sown wheat will not succeed on cold clays; hence a cross crop, that is, oats after wheat, is sometimes resorted to, for insuring a fair braird (sprouting, or plant) of clover and grass seeds. With this exception, the practice is not advisable. (*Idem.*)

8361.—4939. *In the "rotation for light soils,"* we have—

1. Turnips.	3. Clover and rye grass.
2. Spring wheat or barley.	4. Oats or wheat.

What I consider defective in this rotation is the possibilily (although not clearly expressed) of following barley with wheat, after only one intervening green crop. It has been found, by dear-bought experience, that wheat succeeding to barley, with only an intervening fallow grass, or other green crop, is diminished in produce, from one third to one half in quantity on light lands: on strong retentive soils, the diminution is less perceptible; but on all soils, the practice should be avoided. (*Idem.*)

8362. *The land under regular rotation of cropping all over the country* has been rendered, by frequent repetition of the same sort of grass seeds, what is termed "clover-sick;" a state of the soil, according to De Candolle and others, produced by excrementitious deposit, hurtful to clover, but favourable to the growth of the cereal crops. On many farms a seven-course shift has of late been adopted, it being found that clover succeeds better after a cross crop, otherwise an objectionable mode of farming: the land requiring, as it would appear, two successive white crops to purify it from clover deposits, and to prepare it for producing that plant in a healthy state. Aware of this, the writer of this article, twelve years since, commenced the following rotation on light dry land, which, by frequent cropping, had become so "clover-sick," as to produce little else than rye grass.

8363. *Rotation of eight years*:—

1. Potatoes and turnips.	3. Grass after barley, peas after wheat.	5. Turnips and potatoes.
2. Half wheat and half barley.	4. Oats, on both divisions.	6. Barley and wheat, as before.
	7. Grass after barley, and peas after wheat.	8. Oats.

Here the rotation is after the four-course method; only the potatoes alternate, as do the barley and wheat, and the peas and grass; so that each of these species of crops occurs only once in eight years on the same ground, with the exception of oats, for which each soil is well calculated, and which occurs once in four years. From this mode of cropping, a much heavier crop of clover is obtained from the half of the division than was formerly from the whole. The pea straw also adds to the horse fodder; and by it the dung is considerably augmented. The practice begins to recommend itself in the neighbourhood. The farm on which this course of cropping originated lies on the northern bank of the Carse of Gowrie, and at an elevation of from 400 to 500 feet above the level of the sea, consequently at the full limit where wheat can succeed. (*Idem.*)

8364.—4944. *Fallows.* It is the opinion of some, that the mere exposure of soil to the drying influence of the sun during the summer season will contribute towards its fertility; but, assuming that the land is what farmers call sweet, that is, friable, and free from weeds, it will profit more by being covered with vegetation, or otherwise shaded from the sun and drying air, than by being exposed to it. This is shown by an able article in the *British Farmer's Magazine*, vol. iv. p. 10.

8365.—4955. *Kirkwood's grubber* has, subsequently to its first being made known, been greatly improved by the inventor, an ingenious mechanic, at Tranent, in East Lothian. (See *Quart. Jour. of Agr.*, vol. ii. p. 848.)

8366.—4965. *The use of fresh or unfermented dung* for turnips has, of late, been much recommended by several agriculturists, and has been advocated by Sir H. Davy, on chemical principles. But it appears that practice does not always support it. When Davy's lecture appeared, it was sent, by the then President of the Board of Agriculture, to a friend in Tweedside, who farms to an extent of several hundreds of acres of turnips yearly. This being in the turnip season, he directed an experiment to be made in two parts of a field with fresh dung from the fold-yards against the dunghill. The fresh dung failed by thirty per cent., and similar trials made on another farm led to the same result. It may be observed, however, that, in making experiments of this kind, something may be misunderstood. If the fold-yards were kept in a rough state, the fresh dung might be little better than wet straw, and containing little or no excrementitious matter; and if it were taken from near pigsties, or a chaff house, it might be nearly as much decayed as if it had lain in the dunghill. It is a long-established opinion, that dung fit for raising turnips must be thoroughly rotten and decomposed, so as to cut like a jelly; and though in this case a loss takes place, both of bulk and matter, the quality of the manure is undoubted. Perhaps dung in a state betwixt unfermented and total decomposition is preferable to either; and this opinion the following statement appears to confirm. During two succeeding years, the dung required for turnips on a farm was laid in a moist state on a dunghill about ten weeks before turnip sowing. A short time before sowing, it was turned, carefully shaken out, and laid lightly together. When laid on the land, it appeared to be in a most excellent state; the decomposition was going on, but had not ceased. A steam arose from the heaps of dung, and, the arrangement of the carts and ploughs being very close, ten minutes did not elapse until the turnip-seed was sown, and pressed close to the dung by a roller. The braird (sprouting) of Swedes was everywhere most excellent; and, through the summer, grew with a rapidity seldom seen, and produced a crop rarely to be met with in the best turnip districts. The field was a sandy loam, of weak quality, but suitable for turnips. It is presumed that the heat which the dung possessed, and the subsequent decomposition that would take place, had infused life and vigour into the young plant, which thoroughly rotten dung does not possess; and, though it may ultimately raise us a good crop of turnips, it is at the expense of a great loss of bulk. The experience of the best cultivators in the northern parts of the kingdom is against the use of fresh dung; and neither Davy's lecture nor the recommendations of some of the greatest names of the day, have been able to alter that opinion. Fresh dung may answer on wheat fallows; but all dung will be the better for being laid together, turned, and fermented, so as to be easily separated and properly covered. (*Brit. Farm. Mag.*, vol. vi. p. 276.)

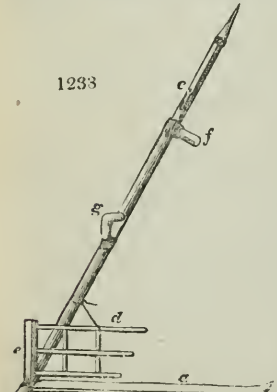
8367.—4990. *Meal from straw and hay* has been obtained by some French agriculturists, by cutting and afterwards grinding; and the meal, or rather bran, so produced, by facilitating mastication and digestion, is supposed to be better for old horses than straw or hay which is merely cut.

8368.—4992. *The advantages of cutting corn crops before they are dead ripe;* that is, when the straw immediately below the ear is just beginning to turn yellow, are thus summed up by Mr. Sheriff: — An increased quantity of grain, greater security from the weather, improved quality of straw, and an extension of the harvesting season. To these may be added, greater security against the effects of wind and rain, either as affects the shedding, discoloration, or germinating of the grain. The colour of grain which was not cut till it became dead ripe is generally of an opaque whitish hue; while that which was cut before it was dead ripe is transparent, and tinged with brown. The latter description of sample bears the highest price in most British markets. (*Brit. Farm. Mag.*, vol. v. p. 23.)

8369. *The period at which corn crops ought to be reaped* is best determined by examining the upper grains of the spikes. The cereal grasses, like all monocotyledonous plants, ripen the seeds on the upper extremity of their flowers, or even in the upper part of their seed-vessels, in the case of plants with pods containing many seeds; whereas dicotyledonous plants ripen their seeds equally throughout the seed-vessel, and in general rather ripen them first at the lower end than at the upper end. When the uppermost grain of a spike of corn has dropped out, the stalk may be considered as having stood rather too long, and the reaping point to be that when the uppermost grain is firm and plump. On the whole, the most improved practice of British farmers is in favour of reaping their crops at an earlier state of ripeness than they have hitherto been accustomed. (*Quart. Jour. Agr.*, vol. iv. p. 501.)

8370. *Cutting grain crops with a common scythe* has been generally practised in Aberdeenshire since 1818. The crops grown in this country are chiefly oats and barley. No change whatever is made in the common grass and clover scythe, for cutting heavy or lodged grain crops; but for light standing crops, a very simple addition is found of advantage. This consists of a small rod or shoot, nearly an inch in diameter, of green willow, or rowan (mountain ash), or broom, or any other flexible and tough young wood. It has its thick end twisted into the small iron rod, which aids in attaching the blade of the scythe to its handle, named provincially the grass-nail. Its small end passes over the upper side of the blade as far as the back, where it is bent upwards in an easy curve, and is brought backward, and tied with several rounds of strong twine to the handle, about fifteen inches above the blade. In cutting grain with a scythe, the swathe or cut corn is laid away from the standing corn. Every mower is attended by a gatherer; and, as the gathering is the part of the work that women can best perform, the gatherers are generally women. The grain is left by the scythe, having the stems forming an acute angle with the line of the standing corn, the root end of the stems pointing partly backwards and partly inwards towards the uncut part of the field. The gatherer places herself at the root end of the stems, so as to be able to stoop forward nearly in the line in which they are laid; and, by a succession of lifts with her hands, placing the corn on the rear over that which is more forward, stepping at the same time towards the right hand herself, she gathers into one heap what she deems sufficient for a sheaf, and, having carefully separated it with her right hand from the forward part of the swathe, then makes a band, in the ordinary way, of a part of the gathered heap, and lays the heap upon it. A binder is also attached to every mower, who is able to bind up all the sheaves cut by one scythe, and also to set them up in shocks; but there is no novelty in his operations. The gatherer and binder could generally, after a skilful mower, gather up all the corn sufficiently clean; but their labour would be greatly impeded, so as that they could not keep up with the scythe, were the cleanest gathering strictly enforced. That is, therefore, dispensed with; and a raker, generally a woman, follows the other operators, to collect the straggling ears and straws. (*Highland Soc. Trans.*, vol. x. p. 189.) The Rev. James Farquharson, speaking of this mode of reaping, says, — "In no branch of agricultural labour, not even in the substitution of the two-horse plough for the one drawn by ten oxen, or of the threshing-machine for the flail, has a more valuable advance been made, within our memory, from an old and inferior system to a new and better one, than in the adoption of scythe-reaping. It is calculated that double the work is done by the scythe, which could be performed in the same time by the sickle. It is also better performed; because the straw is cut off more closely to the ground, and consequently a better provision is made for cattle fodder during the winter, and for a larger quantity of manure. When the grain is over-ripe, much less is shaken out by the scythe than by the sickle. Another advantage, of which the magnitude can scarcely be believed, except by those who have learnt to estimate it by their own experience, is the quickness with which the mowed shock winns (drys or withers) thoroughly, and becomes fit for the stack; a matter of the utmost importance in our unsteady climate. The straws are not crushed, as they frequently are with the hand in reaping with the sickle; and the sheaf, although not more liable to break out of the band, is more elastic and open to the action of the atmosphere. It is perhaps not too much to say, that a sheaf of equal weight, cut with the scythe, becomes ready for the stack, under equal circumstances of weather, in half the time needed by one cut with the sickle. The most pleasing advantage is the total change of the character of the labour, as it affects the larger part of the workpeople. The mowers, gatherers, and rakers deem their work delightful in comparison with the labour of the sickle."

1238



8371. *The scythe for reaping corn* (*fig.* 1238.) should have its blade (*a*) of the best steel, four feet long, strengthened by a plate of iron along the back (*b*). The handle should be straight, because that gives the greatest command over the scythe. A well-seasoned young larch tree, reduced to the proper thickness, with a slight curve at the root end, for receiving the blade in a proper position, makes the best handle to a reaping-scythe. A hone, covered with fine sand, and a fine sandstone, to whet the edge of the scythe, are hooked on to the handle at *c*, near its upper extremity. There should be a cradle (*d*), consisting of three long teeth, fastened to an upright stem (*e*), formed of ash, and as light as the strength of the wood will permit. The upper tooth should be a little more than two feet in length, and the two under ones should be, the first three inches, and the second six inches shorter. The upright stem of the cradle is driven into a socket of iron. The height of the cradle is about thirteen inches; the left-hand handle (*f*) is straight, and the right-hand handle (*g*) is crooked. For the construction of this important instrument, further details will be found in the *Quart. Jour. of Agr.*, from which our figure is taken; but the above outline will suffice for any one who can construct a common scythe.

8372. *Corn of every description may be reaped with the scythe.* Oats make the most perfect work, with the greatest ease to all the labourers. Barley, with new grass, is not difficult to cut; but the clammy juice from the barley straw lubricates the scythe with a viscid coating like varnish, which must be rubbed off frequently with the whetstone. The binders have always hard work among barley. Wheat is beautifully laid in swath when mown. The takers-up and binders have less labour among wheat than the mowers, who must be powerful men to continue a length of time at the work; but there are modes of equalising the labour, and, of course, of diminishing the fatigue. For example: when a field of wheat and a field of oats are nearly ready for reaping, it is an excellent arrangement to reap the oats in the dewy mornings, before breakfast, or as long as there is any dampness on the corn, and then to go to the wheat, or to the barley, if there be little wheat on the farm, during the dry period of the day. By this plan much valuable time can be saved in reaping the whole crop. Oats are not the worse of being reaped in a damp state. It is a remarkable fact, that oats reaped in a damp state, with the scythe, will be nearly as soon ready for the stack as when reaped dry. Not so with barley. Shocks of oats which are reaped dry, but have afterwards been soaked with rain, will be longer before they are ready for the stacks than oats that have been reaped in a damp state. It is a still more remarkable fact, that damp oats reaped with the scythe will be sooner ready for the stack than would the same oats, reaped in a dry state, with the sickle. Oats reaped with the scythe will be quite ready for the stack in eight days, whereas oats reaped with the sickle require at least a fortnight. Shocks that have been reaped with the scythe will keep off much more rain than those reaped with the sickle. (*Quart. Jour.*, vol. iv. p. 366.)

8373.—5003. *Cone wheat*, a variety of *Triticum túrgidum*, has been found by Mr. Gorrie to be but little injured by the wheat-fly, as this insect appears in the fly state much sooner than the wheat blossom bursts from the spathe. The grain of this variety is coarse; but every spike generally yields from seventy to ninety grains, which is double the number of the common wheat, *Tríticum hybérnum*. It ripens about a week after the red wheat, and, when standing, is from a foot to eighteen inches taller than the common wheat. (*Quart. Jour. Agr.*, vol. iii. p. 641.)

8374. *Dantzig creeping wheat* is a variety cultivated on the borders of Scotland, which possesses the property of tillering, or throwing tap-shoots from the root in the autumn, in a remarkable degree. It originally came from Dantzig. (*Quart. Jour. Agr.*, vol. iv. p. 536.)

8375.—5042. *On the climate requisite to bring wheat to perfection.* Nothing is here said of altitude, latitude, or temperature. The highest altitude on which wheat will succeed on the banks of the Tay, is 450 feet above the level of the sea, where the mean temperature for the year is 46°. Wherever the annual mean temperature is below this, wheat cannot be raised with advantage. (*A. G.*)

8376.—5074. *Rye straw* is preferred to that of any other plant for littering horses; and rye is somewhat extensively cultivated about Newmarket for the sake of obtaining the straw for the livery stables. (*J. D.*)

8377. —5121. *The Hopetoun oat* is an accidental variety brought into notice by Mr. Sheriff in 1824. It is chiefly remarkable for its long reedy straw, which, in a crop of twenty acres in East Lothian, has averaged six feet in length, while the grain is thin in the husk, and nearly as short and plump as the grains of the potato oat. (*Trans. of Highland Soc.*, vol. viii. p. 362.)

8378. —5290. *The value of crops of Swedish turnips, potatoes, and mangold wurtzel, as food for cattle*, is not materially different, provided the crops are alike good of their kind. This is the opinion formed by an East Lothian farmer of great skill and experience, after having made a number of experiments to determine the value of these roots. (*Highland Soc. Trans.*, vol. ix. p. 273.)

8379. —5307. *Soil for the potato.* In the peninsula of Kintyre, the soil is calcareous clay, in which there is found gypsum, an earth said to be congenial to the potato; and there, Mr. Stewart states, that the potato crops far surpass any he had elsewhere seen, either in Scotland or Ireland. (*Brit. Farm. Mag.*, vol. vii. p. 479.)

8380. —5312. *Comparative produce of different modes of preparing the sets, and planting potatoes.* The following interesting experiments were made by the Messrs. Drummond of Stirling, with the Irish blue potato, on the same piece of ground, and under similar circumstances. The space which each experiment occupied was forty square yards, which were drilled and dunged at the rate of thirty tons the imperial acre. They were all planted on 28th May, and raised 12th October, 1832:—

8381. *The first plot* was planted on the plan recommended by Mr. Knight, Pres. Hort. Soc. The tubers were whole, weighing half a pound each, and were planted at the distance of six inches in the row, and the rows four feet apart, and lying north and south; forty square yards required nine pounds of sets, and produced 364 pounds of potatoes; being, per acre, 136 bushels of sets, and 550 bushels of produce: net increase, 414 bushels.

8382. *The second plot* was also planted with similar tubers to the last, at nine inches apart. The seed required weighed sixty pounds, the produce 326 pounds; being, per acre, ninety-one bushels of seed, and 493 bushels of crop: net increase, 402 bushels.

8383. *In both these plots* the plants were highly vigorous, and early in advance of others planted in the ordinary manner. The potatoes were not too large, but the crop contained a great proportion of small ones

8384. *The third plot was planted* the same as the last, but the sets were cut of the common size. The seed required weighed only six pounds, the produce, 276 pounds; being, per acre, nine bushels of seed, and 417 of produce; nett increase, 408 bushels. The plants in this plot grew fast in the autumn, and produced by much the largest potatoes; but they did not ripen well.

8385. *The fourth plot* was planted with sets cut of the common size. The seed required weighed twelve pounds, and the produce 376 pounds; being, per acre, eighteen bushels of seed, and 568 of produce; net increase, 550 bushels. The potatoes in the produce of this last lot were the most equal sized.

8386. *The result of these experiments* (which were conducted with great care) is entirely contrary to Mr. Knight's theory, and consequent practice. (*Quart. Jour. Agr.*, vol. iv. p. 411.) In the *Transactions of the Horticultural Society*, second series, vol. i. p. 445. to 456. (published in August, 1834), an account is given of a number of experiments made with the greatest care and accuracy, under the direction of Professor Lindley, in the garden of the Horticultural Society, the result of which is conformable to that obtained by Messrs. Drummond. It also appears in the same work that Sir George Mackenzie made experiments of the same kind in Ross-shire, and found the produce decidedly better from sets than from whole potatoes. (See *Gard. Mag.*, vol. x. p. 433. 435. and p. 499.)

8387. —5328. *The uselessness of earthing up potatoes* has been pointed out by Mr. Hayward; and, independently of the effect of earthing up, and other operations between the rows, in destroying weeds and loosening the soil, we should think his practice the best. He says, that a farmer who simply hoed the soil between the rows of potatoes in one of his fields, had a much larger crop than he had in an adjoining field, where the rows were earthed up with the greatest care. A potato placed an inch only under the surface of the soil will produce a greater number of tubers than one planted at the depth of a foot. "I have no doubt," says Mr. Hayward, "if potatoes are planted shallow, and placed wide enough apart to admit of the stems being laid down after the young potatoes are formed; and if the earth between them was then thrown over five or six inches thick, so as to form a flat surface, that it would increase the crop. But this is a very different operation from that which I object to." (*Gard. Mag.*, vol. ix. p. 323.)

8388. —5337. *Benefit resulting from the removal of potato blossoms.* By a well-conducted experiment on a field of two acres, for which the honorary silver medal of the Highland Society was given, it appears that one third part of the field, being those drills from which the blossoms were plucked in the bud, produced thirty bolls, two bushels. One third part from which the blossoms were plucked when in full flower produced twenty-seven bolls, three bushels; and one third part, being those drills on which the plants were allowed to ripen their seed, produced twenty-six bolls. The difference here, in favour of plucking off the blossoms as soon as they appear, instead of allowing them to remain and ripen their seed, is nearly one sixth part of the produce. (*Highland Soc. Trans.*, vol. x. p. 237.)

8389. — 5354. *Potatoes may be preserved* by being rasped or ground to a pulp, afterwards pressed into dry cakes by Bramah's or any other powerful press, and then dried like cheeses. Potato cakes of this sort have been found to keep for years perfectly sweet; and, as a great deal of nutriment is thus put into very little bulk, it is thought by some that ships bound for long voyages might find it advantageous to lay in their stock of potatoes in this form. (*Quart. Jour. Agr.*, vol. iv. p. 483.)

8390. *Potato flour* was shown at Messrs. Drummonds' exhibition at Stirling in 1832, which was thirty-eight years old. It was made from damaged potatoes, which, it seems, answer as well as sound ones, and was in the finest condition. (*Quart. Jour. Agr.*, vol. iv. p. 414.)

8391. — 5360. *Potato haum* forms a rich and excellent manure for wheat, at the rate of four acres of haum to one of wheat, ploughed in green immediately before sowing the wheat. It is found decidedly superior to stable-yard dung. The mode of preparing it is simply to pull up the stems, and to avoid burying potatoes with it, however small they may be. (*A. Gorrie, in Country Times*, October, 1831.)

8392. — 5363. *Good beer can be produced from potatoes* by grating them to a pulp, mixing it well with boiling water, and then adding ground barley malt. The liquid, being drawn off, is to be hopped in the usual way, yeast added, and fermentation induced. The liquor thus produced, after being bottled, was found greatly to resemble the Paris beer. (*Dom. Econ.* in *Lardner's Cyclopædia.*)

8393. *Beer may be made from parsneps* in a similar manner to that from potatoes.

8394. — 5364. *The distillation of spirit from potatoes is thus practised in France:* — The potatoes are boiled by means of a steaming apparatus; and, where the apparatus is good, will be prepared sufficiently in ten minutes. As soon as they are in a proper state, they must be bruised when at as high a degree of temperature as possible, and then thrown, for the purpose of fermentation, into a tub or other vessel containing, for every 1000 pounds of potatoes, 416$\frac{2}{3}$ pounds of cold water; the temperature of which, however, should not be below 14° of Reaumur (63$\frac{1}{2}$° of Fahrenheit). The whole must then be covered up, and allowed to remain. There will be 750 pounds of sediment contained in the quantity of potatoes which has been mentioned; and this proportion, with the 416$\frac{2}{3}$ pounds of water, will be quite sufficient to produce a mass, of which the consistency will be that of pap or curdled milk, and the temperature from 48° to 50° Reaum. (140° to 144$\frac{1}{2}$° Fahr.) There are then taken 31$\frac{1}{4}$ pounds of the malt of barley, which is steeped in 250 pounds of water that has been previously heated to the height of 60° Reaum. (167° of Fahr.), and the whole is allowed to remain until it shall have cooled to the temperature of 22° of Reaum. (81$\frac{1}{2}$° of Fahr.) There are then added 22$\frac{1}{2}$ pounds of yeast, which is mixed by being actively stirred, and the whole is then well covered and allowed to remain. When the mass of fermenting potatoes is cooled to the temperature of 38° of Reaum. (117$\frac{1}{2}$° of Fahr.), the fermentation is stopped by adding 416$\frac{2}{3}$ pounds of cold water, and the whole is well stirred together. This mass having fallen to the temperature of 25° Reaum. (88$\frac{1}{4}$° Fahr.), the prepared malt, which has already begun to ferment, is added; the whole is again well stirred together, the vessel very lightly covered, and the fermentation allowed to proceed. This latter operation takes place very regularly, and terminates in from forty-eight to sixty hours. The fermented mass assumes a spirituous odour, and furnishes, on distillation, so abundant a quantity of spirit, that, for every 100 pounds of potatoes, there are obtained eight French pints of spirit, in which, according to the scale of Richter, there are thirty per cent. of alcohol. If, before carrying the fermented mass to the still, it is passed through a sieve of iron wire of close meshes, the pulp of potatoes is kept back, and the spirit is then more pure, and more pleasant to the taste and smell. This will be still more the case, if there be added to this mass half a pound of potash for every 100 pounds of potatoes, before submitting it to distillation. If it is wished to have a spirit analogous to that obtained from wine, it must be rectified accordingly. (*Moléon's Recueil Industriel*, and *Quart. Jour. Agr.*, vol. iii. p. 321.)

8395. — 5377. *Dale's hybrid turnip* was originated, about 1828, by Mr. Robert Dale, of Libberton West, near Edinburgh. It is tankard-shaped, and resembles the Swedish or yellow turnip in colour. It is equal in size to the white globe, superior in size to most other varieties, whether of white, yellow, or Swedish turnips, and is found to produce a greater weight in a given space, and at a given expense of manure, than any other turnip hitherto introduced. It is not so hardy as the Swedish, and it runs to flower rather sooner in the spring; but, with these exceptions, it is the best of all field turnips. (*Quart. Jour. of Agr.*, vol. iii. p. 578.)

8396. — 5432. *Fly on turnips.* The following mode of prevention has been resorted to with success at Green Hammerton, Yorkshire. A board, about eighteen inches in breadth, and sufficiently long to cover four ridges of turnips, was made to run upon wheels, high enough to allow the board to pass over the turnips without touching the tops of them. The lower side of this board was painted with white paint, which the men provided themselves with, and took into the field, and during the night (at which time the fly is more injurious and destructive than during the day) the instrument was wheeled from one end of the field to the other. The insects, on being disturbed, of course immediately fly or jump up, and stick to the paint; and at the end of every set of ridges the board was almost covered with them. (*Leeds Mercury*, and *Report Don. Agr. Association.*)

8397. — 5453. *Carrot seed.* Messrs. Drummond, the eminent seedsmen of Stirling, state that the carrot crop in the field may almost always be insured, other circumstances being favourable, by bringing the seed to the point of vegetating before sowing. This is done by mixing it with sand or earth, kept moist, and turned occasionally for several days. They also recommend some nourishing compost to be placed under the seed in the drills, or sown along with it. They have made an experiment to prove that carrots may be grown to great advantage in peaty soil, and that they may be even grown in old worn-out garden soil, by mixing peat and dung together, and putting the compost thus formed in a gutter made by a wedge-shaped dibble, six inches wide at top, six or eight inches long, and at least a foot deep; the seed being sown immediately above the compost. (*Quart. Jour. of Agr.*, vol. iv. p. 410.)

8398. — 5516. *Sýmphytum aspérrimum*, Mr. Gorrie observes, is assuredly liked by horses and cattle, and will soon recommend itself to the cottager and dairyman as a powerful auxiliary to clover, in summer and autumn. (*Highland Soc. Trans.*, vol. ix. p. 249.)

8399. — 5527. *Trifòlium incarnàtum* is considered in Italy as the earliest of clovers; as particularly calculated for dry soils, and as preferring the mountain to the plain. It is an annual, and succeeds best when sown in the autumn, after the corn crop has been removed. (*Quart. Jour. of Agr.*, vol. iii. p. 729.)

8400. *Trifòlium élegans* is mentioned as worth culture, and seeds of it were shown at the Highland Society's exhibition in 1832. (*Farm. Jour.*, Oct. 4. 1830.)

8401. — 5550. *Clover* is dried in the hilly parts of Germany by resting it, immediately after being mown, against portable tressels, as corn is dried in Sweden and Norway. (*L'Agronome*, vol. i. p. 136.)

8402. — 5643. *Old pasture compared with new.* John Boswell, Esq. of Kingcausie, Aberdeenshire, has long been of opinion that permanent pasture, instead of being a good thing, is a bad thing. After recapitulating his experience during several years, and strongly recommending thorough under-draining, deep ploughing and manuring, he concludes thus: — "I maintain, that, except a few favoured spots, such as banks of rivers, &c., no ground can, without loss, be left long in pasture; and that it appears to me, four or five years is, generally speaking, the longest period land should be allowed to lie in grass. If pasture be the object, at the end of that time the ground should be broken up as arable land, and then returned to grass again. I maintain, that without grass severely cropped land cannot be restored to full fertility; and without cropping, grass cannot be made to continue at the maximum point of verdure and utility.

Lastly, I maintain, no land, under any circumstances, ought to be cut in hay, if intended to remain some years in pasture; and, if cut as hay, every kind of land ought to be directly ploughed, and again put through the rotation." (*Quart. Jour. Agr.*, vol. iv. p. 790.)

8403. — 5647. *The great object of mixing different grass and herbage seeds together*, is to stock the surface of the soil at once so thickly with useful plants as to prevent weeds from rising up through them. Experience has proved that this cannot be done so effectually when only one or two species of grass or herbage seeds are employed, as when a greater number are made use of: and the reason appears to be found in the diversity of soils and situations. In general, the richer the soil the smaller will be the number of species which it will require. When the selection of grass seeds is judicious, there will be a constant succession of herbage kept up by them the whole year round, as grasses of several sorts grow at all times when the temperature is above the freezing point.

8404. — 5656. *The Italian rye grass*, Mr. Lawson found to be the same variety as Stickney's rye grass. It is considered superior to any other grass in producing winter herbage, and to be more hardy than the common rye grass. (*Highland Soc. Trans.*, vol. x. p. 28.)

8405. — 5717. *Number of kinds of grasses required in laying down permanent pasture.* A judicious writer in the *Quart. Jour. of Agr.* is of opinion that more of these grasses are brought into notice than their good properties will warrant. Independently of perennial rye grass and white clover, which must always occupy a large share of every permanent pasture, perhaps five or six of the others are all that are worth cultivation. It is true, many worthless grasses will grow up among our most carefully laid down pastures, and they, no doubt, assist in thickening the sward. But this is surely no adequate reason to sow them; and if it be necessary to sow a certain quantity of seed to cover the ground, that quantity should be composed of the best kinds. One reason for sowing a number of kinds is, that more plants will thrive closely together of different sorts than of the same sort. Allowing this to be the fact, there is still no necessity for incurring the trouble and expense of sowing worthless kinds, when a variety of them will grow naturally out of the soil to form a thick sward. Should the different kinds arrive successively at their greatest vigour, seeds of the best sorts can be selected on account of their coming to maturity at the different seasons when pasturage is required. It seems that $4\frac{1}{2}$ bushels will just furnish as many fertile seeds, that is, seven to the square inch, as there are plants in that space in a natural pasture: but if even more are required to render the pasture better, more of the best kinds only should be sown to insure the requisite thickness of sward. (*Quart. Jour. Agr.*, vol. iv. p. 414.)

8406. *Kinds and qualities of grass seeds for laying down land.* The most valuable article which has appeared on this subject since the publication of Sinclair's *Hortus Gramineus Woburnensis*, will be found in the *Quarterly Journal of Agriculture*, vol. iv. p. 714—724. This article is by Mr. Lawson, an eminent seedsman in Edinburgh; who, for a number of years, has directed his attention to the subject, with a degree of success which has been acknowledged by the first agriculturists in Scotland to be pre-eminently great. After giving a short description of thirty species or varieties of proper grasses, and eleven herbage plants, of which he has seeds for sale, he enumerates six other herbage plants, all Leguminòsæ, the seeds of which are not yet articles of commerce, but which, he says, may be advantageously introduced into cultivation as soon as their seeds can be obtained. These are, *L*òtus màjor; *V*ícia *Cràcca*, sèpium, and sylvática; *L*àthyrus praténsis, and *T*rifòlium mèdium.

8407. *Sowing the seeds of grasses and herbage plants by weight*, instead of the general practice of sowing the grasses by measure, and the clovers by weight, is strongly recommended by Mr. Lawson. "For, although in grass seeds the greater weight of one variety is no criterion of its superiority over another variety of less weight, yet a greater weight in the same variety always denotes a superior quality. Thus, when seed is light, and consequently inferior, the greatest number of seeds is obtained by adhering to a given weight; and hence there is the chance of nearly an equal number of plants springing up as when the seeds are plump and heavy. But a given weight of measure of seeds does not indicate the relative number of plants that will spring up; because there is both a difference in the relative bulk and specific gravity of seeds, and there is also a difference in the number of seeds that grow from a given quantity." (p. 719.)

8408. *The weight of the seeds of grasses*, per imperial bushel, is next given by Mr. Lawson; and the differences between the seeds of different species in this respect is most remarkable. Of thirty species, the heaviest appears to be the common perennial rye grass, a bushel of which weighs from eighteen to thirty pounds; and the next heaviest appears to be the crested dog's-tail grass, which weighs twenty-six pounds. The lightest seed is that of *Av*èna [*Trisètum*] flavéscens, a bushel of which weighs only five pounds, and the next lightest is the meadow fox-tail grass, which weighs five pounds and a quarter. Anthoxánthum odoràtum, and *A*lopecùrus geniculàtus weigh each six pounds; *A*ìra flexuòsa, six pounds and a quarter; *P*òa glaùca, seven pounds and a half; *E*lymus arenàrius and *Festùca* duriúscula, each nine pounds and a half; and the remaining species weigh from ten to sixteen pounds. Rye weighs 62 pounds the bushel.

8409. *The weights of clover and other herbage plants* are much less various. Burnet weighs twenty-four pounds and a half; saintfoin weighs twenty-six pounds; *A*chillèa millefòlium, twenty-eight pounds and a quarter; ribwort, fifty-one pounds and a half; Medicàgo lupulìna (the nonsuch of English farmers, and the yellow clover of the Scotch) weighs sixty-three pounds and three quarters; and the different species of clover (*T*rifòlium) from sixty-two to sixty-five pounds.

8410. *With reference to the culture of grasses in Britain*, Mr. Lawson observes that, wherever land produces the cereal grains and other cultivated plants, the pasture and herbage grasses will grow with vigour. Plants of this kind, he observes, are improved by different kinds of soils, and more especially with relation to their states of dryness or moisture. As a convenient arrangement for practical purposes, he classes all soils under light, medium, and heavy; and he has composed twelve different tables, each containing the quantity of grass seeds, per Scotch acre, for these three divisions of soils. Whoever, whether in Britain or America, wishes to sow grasses on a large scale, will find it worth their while to correspond with Mr. Lawson, with reference to the subject of these tables; because every year he is adding to his experience, and in all probability improving the selection. We shall, therefore, not copy them into our pages in detail, but merely give their titles, with a few remarks, chiefly with a view of showing how much greater the number of species is which Mr. Lawson recommends than what is commonly sown, and yet how much smaller is the quantity of seed per acre.

8411. *Grass and herbage seeds for alternate husbandry.* For one year's hay, twenty-two pounds of annual rye grass, ten pounds of red and two pounds of white clover. For one year's hay and one year's pasture, eight pounds of annual and eighteen pounds of perennial rye grass; three pounds of *P*hlèum praténse, five pounds of red and five pounds of white clover, and two pounds of nonsuch. For one year's hay and two years' pasture, twenty-eight pounds of perennial rye grass, two pounds of *P*hlèum praténse, two pounds of red, six pounds of white, two pounds of cow clover, and two pounds of nonsuch. These proportions are for soils suited for the turnip husbandry; in heavy soils, from two to four pounds of *P*hlèum praténse may be added for one year's grass.

8412. *Grasses and herbage plants for permanent pasture.* Of proper grasses, seven species are employed; of proper clovers, three species, and also the nonsuch. The proportions are given for laying down without a crop and also with a crop; and it is worthy of remark, that in the latter case the quantity required is not much above half what it is in the former. Without a crop, seventy-five pounds are required for a light soil, and eighty-two for a heavy soil; while with a crop, forty-one pounds and a half in the one case, and forty-five lbs. in the other, only are required.

8413. *Grasses, &c., for permanent pasture in ornamental parks.* Of proper grasses, fourteen species are employed, besides the clovers mentioned in the preceding paragraph. It is added, that *A*chillèa millefòlium may be added in dry soils; saintfoin in dry calcareous soils; wild endive in neavy soils; and from one to two pounds of parsley per acre on lands where sheep are apt to get the rot.

8414. *Grasses and herbage plants for lawns, bowling-greens, &c., kept constantly under the scythe.* Of proper grasses, fifteen species are employed, together with the common white clover. On each soil, Pacey's perennial rye grass, more than one fourth part of the proper grasses, and the quantity of white clover per acre, varies from six to twelve pounds.

8415. *Grasses and herbage plants for grounds much shaded with trees.* Twelve species of proper grasses and white clover.

8416. *Grasses, &c., for heathy and moory lands which have been pared and burned, or scarified, for the purpose of producing herbage.* The following cheap mixture is recommended: — Mixed hay seeds twenty-five pounds, and white clover, six pounds, with a crop; and forty pounds of mixed hay seeds, forty-five pounds of rye, and nine pounds of white clover, without a crop. When land of this description is situated 500 feet, and upwards, above the level of the sea, sheep's fescue and the two allied species, and *P*òa glaùca, may be added, at the rate of two pounds each.

8417. *Grasses for improved deep peaty ground intended to lie in grass.* Perennial rye grass, ten pounds; *P*hlèum praténse, eight pounds; *A*gróstis stolonífera, two pounds; *A*lopecùrus praténsis, two pounds; and *T*rifòlium rèpens, eight pounds, are recommended, when they are to be sown with a crop; when without a crop, the proportions are, eighteen, twelve, three, three, and twelve pounds.

8418. *Grasses for land in preparation for irrigation.* We shall take the liberty, in this case, of copying the table verbatim: —

	Light Soil.		Medium Soil.		Heavy Soil.	
	With a Crop.	Without a Crop.	With a Crop.	Without a Crop.	With a Crop.	Without a Crop.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Perennial rye grass	10	18	7	12	7	12
*A*gróstis stolonífera	2	4	2	4	3	6
*A*lopecùrus praténsis	2	4	3	6	4	8
Festùca praténsis	2	4	2	4	2	4
*Festùca l*olìàcea	4	7	4	7	4	7
*P*òa triviàlis	2	4	2	4	3	6
*P*òa flùitans	1	2	2	4	2	4
*P*hlèum praténse	4	6	6	9	7	10
	27	49	28	50	32	57

8419. *Grasses for lands which are occasionally subject to the overflowing of lakes and rivers, or which are always in a very wet state.* These are, *P*òa aquática, six pounds; *P*òa flùitans, six pounds; *Festùca l*olìàcea, four pounds; *P*hlèum praténse, six pounds; *A*lopecùrus geniculàtus, six pounds; *A*gróstis stolonífera, four pounds.

8420. *Grasses for rabbit warrens, or light sandy soils.* These are, perennial rye-grass, fourteen pounds; Anthoxánthum odoràtum, one pound; *Festùca* duriúscula, one pound; *Festùca* ovìna, one pound; *Festùca* rùbra, one pound; Cynosùrus cristàtus, two pounds; *P*otèrium Sanguisórba, four pounds; *A*chillè*a* millefòlium, half a pound; *T*rifòlium rèpens, six pounds; *T*rifòlium mìnus vel procúmbens, two pounds; Medicàgo lupulìna, two pounds. If this mixture be sown without a crop, a bushel and a half of rye grass may be sown along with it.

8421. *For drifting sands, which are to be consolidated, and have a sward produced upon them by sowing.* These are, *E*lýmus arenàrius, ten pounds, which should be mixed with clay and straw ropes cut into pieces, and dibbled into the sand. After a sward has been produced, the mixture recommended for rabbit-warrens, or light sandy soils, may be sown.

8422. *For dry gravelly situations, which resist a sward from all ordinary means.* These soils may be sown with *A*gróstis vulgàris, two pounds; *P*òa ánnua, four pounds; *B*riza mèdia, four pounds; *A*ìra flexuòsa, one pound; *T*rifòlium mìnus vel procúmbens. We repeat our strong recommendation of Mr. Lawson, as an agricultural seedsman, to all persons residing near Edinburgh who have lands to lay down in grass. We are not less anxious to recommend Messrs. Drummonds of Stirling; Messrs. Dickson and Turnbull of Perth; Messrs. Cormack and Son, and Mr. Gibbs, of London; and M. Vilmorin, of Paris, to all those similarly circumstanced in their respective localities.

8423. *Mixtures of grasses for the alternate husbandry.* From the result of an experiment made by Mr. Shireff of Mungoswells (*Quart. Jour. Agr.*, vol. ii. p. 242.), it appears decidedly preferable to use a mixture of seeds, even where a single crop of hay, to be succeeded by a year's pasturage, is to be taken. The grasses sown were cock's-foot, hard fescue, cat's-tail, rye grass, and red, white, and yellow clover. "The rye grass was conspicuous for growing early in spring as well as late in autumn, and remaining comparatively unproductive in the summer months. The cock's-foot, throughout the season, put forth new leaves with rapidity, after being cut with the scythe, and produced culms to the hay crop only; the fescue planted thinly, and also grew rapidly after being cut; the cat's-tail was later in producing flower-stalks than the other grasses used in the experiment, and, after being cut, did not put forth new leaves so rapidly as the cock's-foot and fescue; but, in every instance, it produced numerous culms, white blossomed, at the same time as the red clover; and, where a part of the field was four times mown, yielded a rich crop of culms to the last. The produce, as compared with that of clover and rye grass only, sown in the same field in the same season, was about a ninth part greater, and the extra-expenses of the seed about a fifteenth part. Had the clover failed to grow along with the rye grass, as it frequently does, the difference in the produce would have been much greater. The great advantage of a numerous combination of grasses is, that the failure of a crop is rendered next to impossible. It is also found that a mixture of grasses is less injurious to the succeeding corn crop than rye grass only. The family of grasses, Mr. Shireff observes, forms a useful class of machinery in the manufacture of productions for the dairy, the shambles, and the manufacturer of clothing; but, in order to take advantage of the raw materials, air and moisture, so bountifully supplied by nature, the most efficient machinery must be employed. The husbandman who clothes his fields only with rye-grass and clover employs a limited machinery, the former being unproductive in summer, the latter moderately so in spring; but when he, for this purpose, uses a variety of plants, differing in their habits of growth and periods of luxuriance, a numerous and powerful machinery is kept successively in full operation.

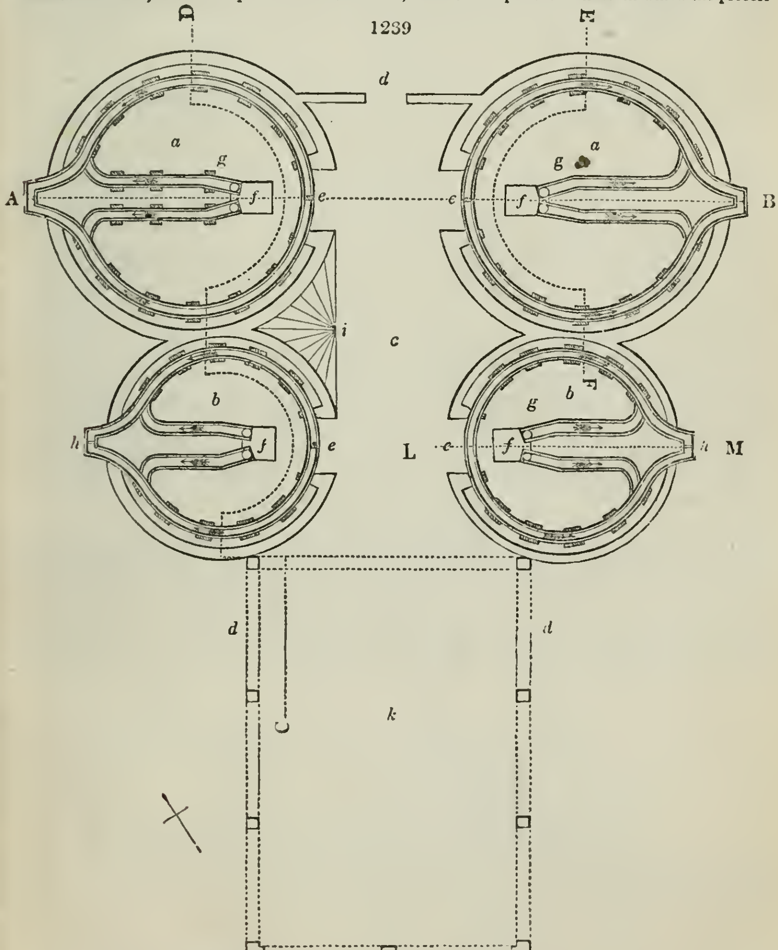
8424. *P*òa *nemoràlis* was found by Mr. Taunton to produce a thick sward in plantations where every other grass was killed. He says, "its rich nutritive quality, its beautiful and perpetual verdure, and, above all, its quality of flourishing under a dense cover of trees, appear to me to render it peculiarly valuable for the particular purpose of rendering ornamental, and also of turning to a profit, the site of grown-up plantations and thick groves, which are, usually, in a state of complete nakedness." (*Quart. Jour. of Agr.*, vol. iii. p. 413.)

8425. — 5820. *To destroy moss in old turf.* "It is a singular fact, but not generally known to agriculturists, that by merely lifting the turf of an old pasture field that is overrun with moss, and ploughing and loosening the subsoil, and then laying the same turf down again, the whole of the moss will disappear the first season, without applying either water or manure to the surface." (*Stephens on Irrigation and Draining*, p. 59.)

8426. *Renovating defective meadows.* The late Mr. Sinclair, of the New Cross Nursery, had perhaps more experience, as he certainly had more science and skill, in this department than any other man. In his excellent work the *Hortus Gramineus Woburnensis*, he recommends first ascertaining that the meadow is completely under-drained; then stirring the surface, by harrowing it, in all directions; the best harrow for which is unquestionably that of Finlayson. After this, he gives a thorough top-dressing of rich finely divided compost; he again harrows and cross harrows, and then sows from two to six pecks per acre of grass and clover seeds. For a meadow of low rich alluvial soil, he employs meadow fox-tail, meadow cats-tail, meadow fescue, rough-stalk meadow grass, crested dog's-tail grass, sweet-scented vernal grass, and perennial red clover. In two years such a meadow will be thoroughly renovated, and will bear abundant crops of hay.

8427. — 6041. *The process of drying hops* is as follows: — After being gathered from the bine, or stalk, the flowers are immediately carried in bags to the kiln, on which they are spread out to the thickness of from six to ten inches all over the surface of the kiln. The fire is then lighted, and kept burning briskly night and day, so long as there are any hops ready to be dried. It is found that a kiln of Mr. Read's construction may be charged once in every twelve hours. After the hops are dried, they are swept off the kiln into a cool ventilated loft adjoining, and generally attached to it; this loft being formed over a cart-shed, or some other building open on one or all sides. Being cooled here for a day or more, or according to convenience, the hops are bagged or pocketed; the bag weighing 200½ cwt., and the pocket 100½ cwt.; that is, packed in bags, which are suspended by a hoop from a round opening in the floor, and into each of which a man enters, to consolidate the hops by treading them down. When the bag is full, it is released from the hoop, and pulled up, still being retained over the hole, till it is beaten into shape, when it is sewn up, and let down into the shed, whence it is carried to market, or to the store loft, where it may be kept a year or more, if carefully excluded from the air. Hops dried on Mr. Read's kiln have been known to keep four or five years; but those dried by the common methods, and especially those of Farnham, seldom keep even twelve months, from the imperfect manner in which the process

1239



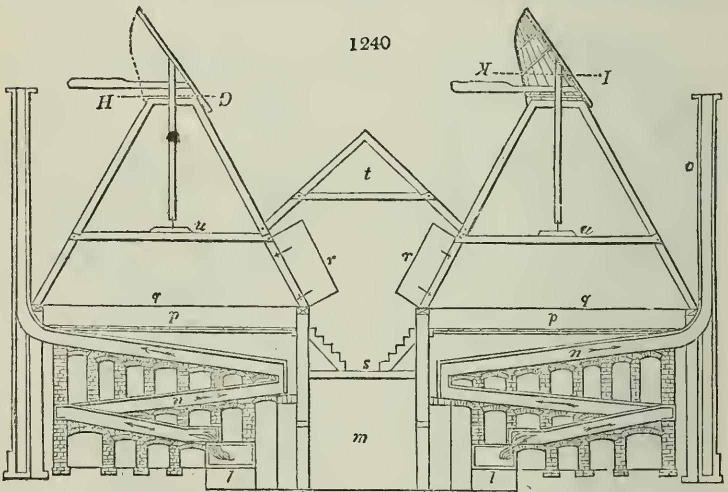
of drying has been performed. There are several excise regulations connected with the drying of hops in Britain, which we think it unnecessary to enter into a work intended for both hemispheres; more especially as we anticipate the entire removal of the excise duties, and the substitution of a graduated per centage or property tax for this and all other government taxes.

8428. *The situation of a hop-oast* ought to be airy; and the external opening to it, for the admission of the air, ought to face that point of the compass from which the wind blows most frequently at that season of the year when hops are being dried. In England, the hop harvest is in the month of September, and the wind in that month is generally in the direction of the south-west. When several kilns are built together, and not in a straight line, but so as to form two rows or a group, as in *fig.* 1239., this rule cannot be followed; but the next best rule is, to have the openings to the fireplaces facing the north-west and south-east, by which means they will catch a part of the current from the south-west as it passes.

8429. *The circular form* for the kiln has been adopted by Mr. Read, because it contains a greater area than any other figure with the same quantity of exterior walling; and, because both the walls and roof can be made stronger than they can in any rectangular form, with fewer materials. Hence, while the circular kilns possess more strength and durability than the rectangular ones, the expense of construction is less.

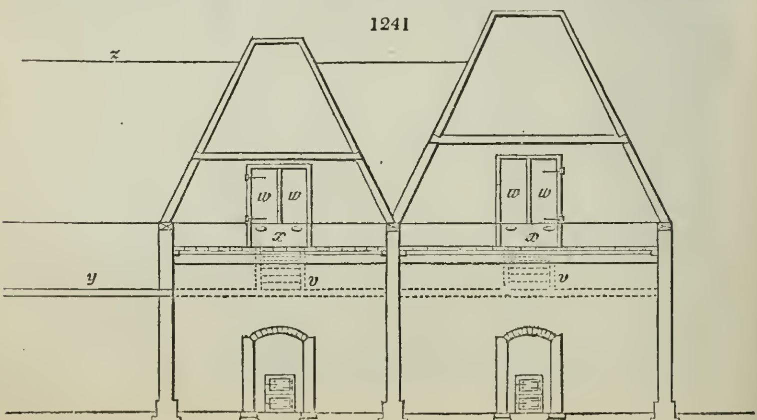
8430. *Details of the oasts* erected at Teston. Fig. 1239. is the ground-plan; in which *a a* are two kilns, twenty feet in diameter internally; and *b b* two other kilns, sixteen feet in diameter internally; *c* is an open space between the kilns, to which air is freely admitted by the openings to the south-east, south-west, and to the north-east, at *d d d*; *e* shows the openings to the dunge, and cockles or furnaces for the admission of air to the fire, and to be rarified by the flues, previously to its ascending and passing through the drying floor; *f*, the furnaces, made of cast iron, with doors to the fuel-chambers and ash-pits of the same material; *g*, termination of a portion, to the extent of one yard, of the flues next the furnaces, which ought to be built of fire brick, or which may be formed entirely of cast iron, as in this design. The remaining part of the flues to be built of common brick on edge three courses deep, and covered with bricks or tiles, twelve inches long by six inches broad; *h*, the situation of the chimney-shafts; *i*, the staircase for carrying up the hops to the drying-floor; and *k*, a cart-shed, over which is a floor on which the hops are cooled. Fig. 1240. is a transverse section on the line A B, or nearly so, in which *l* is the fuel-

1240



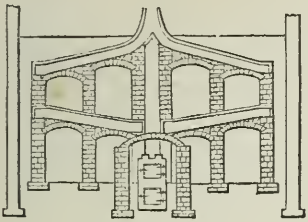
chamber, with the doors open; *m*, the thoroughfare between the two kilns; *n*, the flues; *o*, the chimney-shafts; *p*, the drying-floor; *q*, the situation of the wall-plate; *r*, the doors to the drying-floor open; *s*, the floor of the loft, with the movable stairs to the drying-floor; *t*, the roof of the cooling-loft; and *u*, collar beams for supporting the spindle of the cowl. Fig. 1241. is a longitudinal section on the line C D, in

1241



which *v v* show the situation of the movable steps from the common floor of the passage loft, and cooling-room, to the double doors, *w*, of the drying-floor; *x*, bottom boards of the doors, eighteen inches deep, which fit into grooves, and have two holes in each for lifting them up every time the drying-floor is to be emptied. While this operation is going on, the step ladders are removed, and the hops are swept through the door, and fall down into the passage loft, where they are swept along to the cooling chamber; *z* is the ridge of the roof from the cooling chamber and passage loft. Fig. 1242. is a cross section of one of the larger kilns on the line E F, for the purpose of showing the returns of the flues, from the centre to the sides in the lower part of the dunge, and from the sides to the chimney-shaft in the upper part of the dunge. Fig. 1243. is a dissected plan of the drying-floor, in which *a a* are the iron girders, the strength

1242



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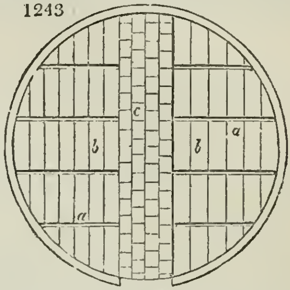
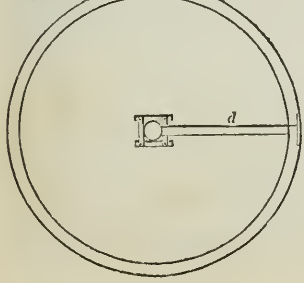


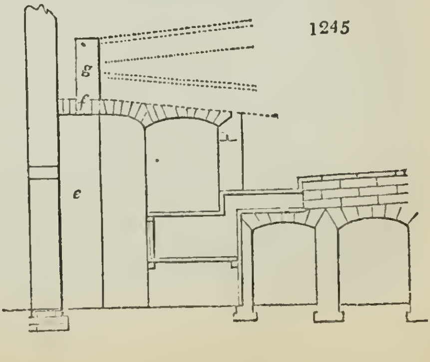
of which may either be such as to require no supports between the ends, or they may be so slight as to require one or more pillars as props between the extremities; when they are of cast iron, they may be in two lengths, four inches deep in the middle, and half an inch thick, each length of sixteen feet, supported by two iron columns: *b b* are the laths, which may be either of cast or wrought iron; when of cast iron, they are four feet long, roach-bellied, that is, forming the segment of a circle on the under side, two inches broad at top, and a quarter of an inch on the under edge; when they are of wrought iron, they are one inch and a half broad (that breadth being necessary to form a bed for the tiles), and half an inch deep; in this case the extended length across the girders is from one of the kilns to the other: *c c* are the tiles pierced with holes, in the same manner as the tiles of malt kilns.

8431. *Construction.* The exterior walls are of brick, with eighteen-inch footings, and are carried up a foot or more of the width of fourteen inches, after which their width is nine inches, up to the eaves of the roof, which are eighteen inches above the drying-floor. The rafters are four inches by two inches at the bottom; and three inches by one inch and a half at the top, where they shut against a circular curb or rim under the cowl. The furnaces or fuel-chambers are entirely of cast iron, and the ash-pits have iron doors. At the farther extremity of the fuel-chamber there is an opening six inches square at top, through which the smoke and heat ascend into the flue. The flue for the first three or four feet is either built of firebrick, or formed entirely of cast iron, six inches in diameter; after which its sides are formed of three bricks on edge, not plastered either outside or inside; and its top is covered with two courses of tiles, breaking joint, six inches by three inches. The reason why narrow tiles are chosen is, that duty is saved; and two courses breaking joint are employed, in order to prevent the risk of smoke getting through the joints into the dunge. The flues are supported by piers formed of open brickwork on edge, and joined by arches four inches in thickness, bevelled on the top, so as to form the base of the flue. Two flues proceed from each fireplace, ascending at an angle of 15°, or more if the height of the dunge will permit, in the direction indicated by the arrows, meeting at *e*, in the plan *fig.* 1239. and each there returning over itself, and again meeting at the chimney-shaft, *h*. These flues may be easily cleaned by the removal, at short distances, of some of the covering tiles; or, what is a simpler mode, by burning in the fuel-chamber a few handfuls of dry brushwood, or dried hop-bine, or any thing that will quickly create such a draught as will carry all the soot in the course of a few minutes out at the chimney top. About London the washerwomen clean the chimneys of their boilers on the same principle, by throwing in, in rapid succession, small quantities of gunpowder. The cowl should project about a foot on every side over the orifice in the summit. This orifice is, to that for the admission of air to the dunge, as one to one and a quarter. In the building of the walls of the kiln, in order to preserve them truly circular, an upright pole is fixed in the centre, and a guide-rod, *fig.* 1244. *d*, is framed on to it, of the requisite radius. The lower end of the central perpendicular pole is fixed in the ground, and the top kept steady by braces to other poles outside the circumference of the plan, so as not to interrupt the free evolution of the guide-rod. For every course of bricks laid on the wall, a course is also laid in mortar round the upright pole under the guide-rod, so that the latter is always kept level. So rapidly can bricks be laid in this manner, that Mr. Read finds such walling cost less than straight brickwork. The course of bricks immediately under the flooring tiles, twenty inches from the top, ought to project an inch inwards, for the tiles to rest on. The exterior opening to the dunge should be kept low, it being found that when this is the case the draught is always greatest; its height need never exceed four feet six inches, which is sufficiently high to admit a person to enter the dunge. When the manager of the furnace is once within, he immediately finds six feet of head-room; there being a pier, *e*, nine inches by eighteen inches, carried up on each side of the door, along with the outside wall, as in *fig.* 1245., which is a section on the line

1244

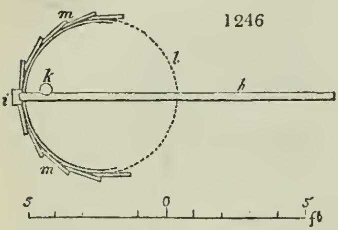


1245

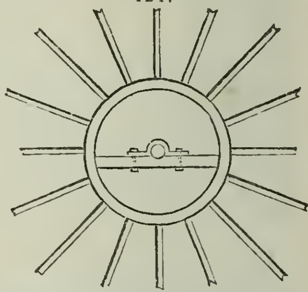


L M, for the purpose of forming abutments for the four-inch arch, *f*, which carries the double flue, the end of which, at the point where one returns on the other, is shown at *g*. The furnace and flues should be blackened exteriorly, in order to increase the radiation of heat, and the inside of the surrounding walls ought to be whitewashed, to prevent them as much as possible from absorbing it. The cowl moves altogether independently of the curb which forms the opening under it: it consists of one strong back piece, into which the upright spindle is framed, as may be seen in the section, *fig.* 1240, at I. Attached to the spindle and the back-board is the fly-board, *fig.* 1246. *h*, which serves, like a rudder, to keep the back of the cowl to the wind. The boards forming the cowl overlap each other from the back piece, or rib, towards the sides; and they are nailed to iron hoops, as indicated in the section I K, *fig.* 1246., and also in the section, *fig.* 1240. In the former section, *h* is the fly-board; *i*, the back rib; *k*, the upright spindle; *l*, the iron hoop; and *m*, the boarding. *Fig.* 1247., which is a section on the line G H, shows the

1246



1247



manner in which the upright spindle works against a collar-piece, which is fixed across the centre of the curb, at the kiln top. This piece being fixed, and the collar containing the spindle bolted on it, the bottom piece, in which the pivot of the spindle works, can, before it is fixed, be moved backwards and forwards on the collar beam, till the spindle is brought to a perfectly upright position and made to work freely.

8432. *Remarks.* The great superiority of the circular kiln to that described in the preceding design is so obvious that we only wonder, considering that it has been extensively used in Kent and Sussex for upwards of thirty years, that it has not found its way everywhere. It must be obvious that not only any description of fuel may be used in Mr. Read's kilns, but that, from the great length of the flues, a much greater quantity of heat will be rendered available for passing through the drying-floor. The circumstance of the flues ascending at a considerable slope is highly favourable for promoting a draught, and consequently for thoroughly consuming the fuel. Mr. Read informs us, that he has superintended the erection of some hundreds of these kilns; and that in one year he erected seventy, all within the counties of Kent and Sussex. This being the case, it strikes us with astonishment that Mr. Read's improvement has not been adopted by the hop-growers of either Farnham or Worcestershire, and the proprietors of malt kilns everywhere.

8433. "*Buckwheat* is ground generally into grits by means of handmills, or lever hammers, and is made either coarse or fine. The coarse sort is used for gruel, and the fine sort for cakes and biscuits. In some places they even make use of the first grinding with the bran, more or less, in addition to the finer flour, for baking household bread. It also serves to fatten hogs or poultry in a short time. The principal method to cleanse and separate the husk is, to pour boiling water on a given quantity of cleaned buckwheat, to stir the mass about with a stick, and draw the water off, then to pour cold water upon it, having first stirred it about well. In a quarter of an hour after, the buckwheat is taken out with the hands, and the water squeezed out. In the summer it is dried in the sunshine, and in winter in a warm room, and spread on the floor. As soon as it is quite dry, it is ground in a hand-mill or a stamping-machine into grits, in which state it is very clean and tasteful. The flour obtained from the sieve is dainty and very fit for cakes," &c. (*Com. Board Agr.*, vol. i.)

8434. — 6594. *A machine for fixing horses while being shod*, of a simple and effective description, has recently been invented by Mr. James Catcleugh, millwright in Haddington, a mechanic of very great genius; which will be found described and figured in the *Quart. Jour. Agr.*, vol. iii. p. 510.

8435. — 6684. *The following plan of feeding horses* has been practised by Dr. Sully of Wiveliscombe, in Somersetshire, for upwards of twenty years. In Dr. Sully's stables there are no racks for holding hay; for in his opinion a horse with a well-filled rack will consume and spoil upwards of thirty pounds of hay in twenty-four hours; whereas, if the hay were cut down, and mixed with a due proportion of cut straw, and bruised or coarsely-ground oats or other grain, ten pounds are sufficient. In the loft, above the horses, Dr. Sully has prepared proportionable quantities of the food with which his horses are daily supplied; and a very simple method has been devised to convey it, when mixed, to the manger of each horse. A wooden pipe is made to pass from the loft into each of the mangers, and close by the mouth of the pipe, in the loft, is placed a tub, of size enough to contain what is sufficient food for a horse for twenty-four hours. To prevent the horse, in searching for grain, from tossing out of the manger the mixed food which is dropped into it, oak crossbars twelve inches distant, are nailed over it; between these bars ample space remains for the horse to feed. As there can be no dependence on the measured quantities of grain or other food given to the horse, from the variation at times in the respective weights of equal quantities, Dr. Sully recommends, and, indeed, regards it as necessary, that grain of all kinds, and also the cut hay and straw, should be carefully weighed. When all the ingredients are so prepared, the proportions for each horse are allotted. From the following table will be seen the different articles of food, and the quantities and weight of each, which the horses should receive: —

	1st class. lbs.	2d class. lbs.	3d class. lbs.	4th class. lbs.
1. Farinaceous substances, consisting of bruised or ground beans, peas, wheat, barley, or oats	5	5	10	5
2. Bran, fine or coarse	- -	- -	- -	7
3. Boiled or steamed potatoes, mashed in a tub with a wooden bruiser	5	5		
4. Fresh grains (boiled barley)	6			
5. Hay cut down into chaff	7	8	10	8
6. Straw cut down into chaff	7	10	10	8
7. Malt dust, or ground oilcake	- -	2	- -	2
	30	30	30	30

with two ounces of salt for each class. By this table it will be seen that each horse receives thirty pounds of food in the twenty-four hours, a quantity that will in all cases be found to be amply sufficient. The addition of two ounces of salt is necessary to assist the digestion of the food. Of the four classes into which Dr. Sully divides his ingredients for feeding, those two which contain the steamed or boiled potatoes are the most recommended. No food conduces more to the healthy working condition of horses than the steamed or boiled potatoes; and we may observe, with relation to this, as well as to other kinds of food, that, when the horse comes in weary and hungry, after a long day's work, it is necessary to fill his manger more copiously with the ingredients prepared for him. Dr. Sully and all the other persons who have devised improved methods of feeding agree in the practices of bruising or coarsely grinding the grain and beans, of cutting down the hay and straw, of giving no hay in the rack, of allowing salt, and of weighing each article separately before mixture, instead of adopting the fallacious guide of measurement. (*Quart. Jour. of Agr.*, vol. ii. p. 727.)

8436. *Road horses*, in some parts of Scotland, and more especially in the neighbourhood of Edinburgh and Glasgow, are fed on equal parts of oat-straw and hay, cut by a machine in the lengths of from one eighth to one sixteenth of an inch. The cut straw and hay so produced are intimately mixed together, and, when musty, sometimes sprinkled with a little salt and water. The drink given to the horses is water in which oats or barley have been boiled, and the grain so boiled is found to equal double its quantity of raw grain in keeping horses in condition.

8437.— 6852. *Feeding horned cattle on raw, or on steamed or boiled, food.* Though boiled corn is found to be doubly nutritious to horses, yet, from a number of experiments made by practical farmers, with a view of obtaining the premium of thirty sovereigns offered by the Highland Society of Scotland, it has been given as an opinion, that, in the case of the ruminating animals, no advantage whatever results from cooking their food. (See *High. Soc. Trans.*, vol. x. p. 253.)

8438. — 6856. *On the treatment of cattle in winter.* An excellent paper on this subject will be found in the *Quarterly Journal of Agriculture*, vol. ii. p. 228—241. Some difference of opinion exists among agricultural writers as to whether young growing cattle ought to be fed, or pampered as Dr. Coventry calls it, with rich food, or supplied with abundance of coarser food. The writer of the article referred to inclines to the former opinion, on the principle of its being the farmer's interest to treat his cattle in such a way as shall enable him to bring them soonest to market. Coarse food, he says, ought not to be found on a well-cultivated farm. Straw and water, in an agricultural sense, are not food at all. Straw given to cattle, with a view of being consumed as their only food, is just so much straw wasted, and time lost, in the forwarding of their condition. A limited supply of turnips will keep cattle alive, and may prevent them from falling off in flesh, but it will never bring them to a state of fatness, though they were to eat in that manner for any length of time; whereas a moderate quantity beyond this limited portion would constitute abundance. Scanty food renders cattle uneasy; whereas food in abundance renders them contented and able to endure every inclemency of weather. A farmer ought neither to rear nor purchase more cattle than he has food sufficient to keep in affluence; for though this might lessen the number, both on individual farms and in the country generally, yet the quantity of butchers' meat brought to market would be greater, and its quality better, than it now is. Hence, on the score of profit to the farmer, and ease and comfort to the cattle themselves, abundant nourishment ought to be given to the latter from the earliest period of their existence, until their growth is complete. Cattle may be fed in houses, and tied to stakes, or in what are provincially called "hammels," which are small open courts, with an open shed for shelter on the north side. Twenty calves, or ten yearlings, may be put into one of these hammels. A hammel with a shed seventeen feet in width, and fourteen feet in depth, with a court twenty-one feet by seventeen feet, will contain three large oxen, or four smaller-sized cattle. Every hammel must be supplied with pure water at the command of the cattle. Before the cattle are put into hammels or byres, the floors ought to be well littered, so as to form a sort of drain to carry off the urine to an underground tank, whence it may be pumped up for use. Cattle fed on turnips eat very little straw; and therefore, the first thing that should be given to them, in the morning, is turnips; the troughs for holding them having been previously cleaned out. In the byre, the first thing to be done in the morning is to draw the dung from behind the cattle into the urine canal; and while the cattle are eating their turnips, the dung can be wheeled to the dunghill. Fresh straw, for fodder, may be given about the time that the turnips are eaten up, a small quantity being placed before each beast in the byre, and in the racks under the sheds of the courts. Oat-straw is found to constitute the best fodder for cattle; potato oat-straw is, perhaps, better than that of the common oat, as the former is always cut down before it is quite ripe. Hay is, no doubt, better than any kind of straw; and those who have abundance of that desirable fodder may give it ungrudgingly to cattle, in the certainty of being soon repaid its value. Turnips should be given again about mid-day; and about three o'clock in the afternoon the mangers should be cleared out, and straw or chaff given. In the byre, after this allowance is eaten up, the mangers should be cleaned out before giving another foddering of straw. A trowel will be found a handy instrument for this purpose. At the hammels, the last foddering of straw can be given any time after the last allowance of turnips, which should be ample, as the cattle will come backward and forward to them even in the dark, and in moonlight they will feed as well as during the day. The calves should be served with turnips immediately after the feeding-beasts; and the year-olds can also get a few at this time, to complete their day's allowance. Between the allowances of turnips, litter should be sprinkled in the byres and hammels, to induce the cattle to lie down after repletion, to chew the cud, which they will invariably do. At eight o'clock at night, the byres should be looked at with a light, and the cattle supplied with the fodder necessary, and their beds made comfortable, for the night, by drawing back any dung that may be on them, sprinkling some more litter, and shaking it well up with a fork. At the hammels, if it is moonlight, some more turnips should be thrown, even at this time of night, into the mangers. During the day, the water-troughs should be all kept full of fresh water, and any filth that may have been blown into them by the wind should be removed. When the frost becomes so severe as to harden the turnips, they should no longer be brought from the field, but from the store formed of them in the beginning of winter, for the purpose of supplying the cattle with fresh turnips during the continuance of frosty weather; nor should any more be taken even from the store than what can be consumed in a day. Frozen turnips may be thawed by being placed in a tub of cold water; but this is a very tedious and troublesome mode of obtaining fresh turnips in frosty weather, compared to the excellent practice of storing a considerable quantity in open weather.

8439. *In the feeding of cattle*, it is of the utmost importance that the man who has the charge of them should be very attentive to his duty; and, in particular, that he should be exact, even to a minute, in supplying them with turnips: cattle know perfectly well when the time arrives for a fresh supply, even though the mangers in the hammels may not be empty, which they should never altogether be. When they are supplied with food at irregular times, they will either be always craving it, or become careless about it; and their uneasiness, arising from frequent disappointments, will prevent them from feeding so pleasantly and speedily as when their food is placed before them at exact periods. When the man thus regulates his different works by time, he will find leisure moments during the day to perform many necessary acts; which, though they may appear of little importance in themselves, nevertheless contribute greatly to the appearance of neatness and comfort in the farm-yard and its inmates. Thus, he might spread the stable-litter along the edge of the turnip-troughs of the year-old cattle, to keep any turnips clean that may have been pulled over by the beasts; for, when cattle are first put up to feed, the freshness and tenderness of the leaves induce them to eat these first, and in the anxiety of each to obtain another fresh bite, many turnips are necessarily turned over. The man can also shovel and scrape together any mud about the causeways, and the places on which the turnips have been laid down from the field. He can frequently examine the skins of the cattle, and give immediate notice of any eruption; for cattle, after being a month or six weeks on turnips, get very itchy in the skin, the violent rubbing of which often causes ulcerated spots to break out, but which can easily enough be cured at first, by an application of a decoction of tobacco, with a little spirit of tar. He should rub those parts of the body which they cannot easily get at to lick with an old currycomb, and scrape off any dung that may adhere to the hair in the hinder and under parts of the body, with a large blunt knife; and this attention is more necessary at the beginning of the season than afterwards, as the freshness of the stems, and the juiciness of the roots of the turnips, and the greediness which all cattle evince for them at first, often cause a looseness in their bowels. He should observe the first indication of lice in their skins in the early part of the spring, when these may be easily destroyed, by applying to the affected parts a solution of mercurial ointment; but, if neglected, they will cause much uneasiness to the cattle, making their hair peel off, and exposing to view an unsightly skin; and he may handle them frequently on every part of their body, as they are very fond of being handled when they are rising in condition; and it is also serviceable to familiarise them with man; as cattle, when they have been accustomed to be handled, will stand better, and show themselves more satisfactorily to the buyer. There is something so winning in a gentle disposition in powerful animals, caused by good treatment, that a buyer will prefer them, when they have to be driven a distance upon the road; and the butchers in the neighbourhood will also prefer them, as they will walk peaceably to the shambles, without the risk of being raised to a frenzy. All these constitute the minutiæ of the business of feeding cattle on turnips in winter; and, trifling as they may appear, attention to them will be amply repaid, in the shape of prime beef and docile cattle. The whole may be easily accomplished by any man who regulates his movements by the watch; and the man who has the charge of cattle in winter that will do this, whether he is seen by his master or not, is an inestimable servant.

8440. *The quantity of turnips which feeding cattle will consume*, as stated by most writers, is about one ton every week, for an ox of from sixty to seventy stones, or about one acre of a fair crop of turnips in six months. Thirty-three double-horse cart-loads of turnips, each weighing from sixteen cwt. to eighteen cwt., are a good crop on light sharp lands.

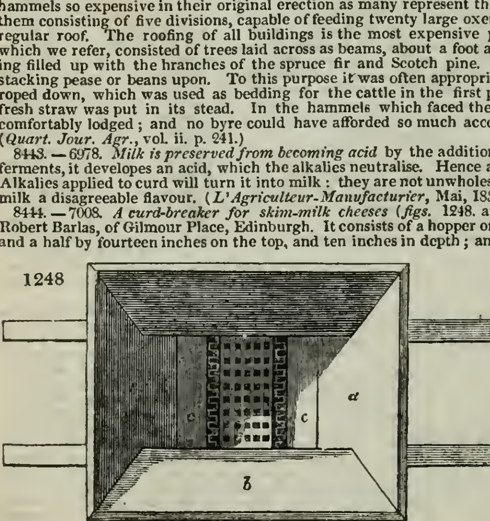
8441. *Time of putting up to feed.* If the second growth of grass has continued fresh till the latter part of autumn, cattle may be soon enough put up to feed by the 1st of November; but if the grass fail sooner, which it will in most seasons do, the middle of October is late enough for putting them up to feed. White globe turnips are an excellent juicy food for cattle till the commencement of the new year, after which should follow the yellow or green tops, for two months longer, and then the Swedish turnips will finish the season. If the Swedish turnips have been stored up before the second growth of the stem has made its appearance in spring, they may be taken out quite fresh till the beginning of June. Since the cultivation of the potato has increased so rapidly, many people feed their cattle on it in spring, either wholly or mixed with turnips. When cattle are fed on potatoes, attention ought to be paid to them after feeding, for fear of internal swelling. When observed at first, the swelling may be allayed by pouring down the throat a bottleful or less of common whale oil, which will check the fermentation, and operate as a purgative. Should any of the young cattle or the feeding beasts in the byre be choked with a piece of turnip, for those fed in hammels never or very seldom do so, the best expedient is to use the probang at once, rather than to permit the throat of the poor animal to be squeezed and consequently inflamed in attempting to push the piece of turnip up and down. The probang may be used with great success, by causing the animal to be forcibly held by superior strength, with its neck and mouth stretched forward, and while one is pushing the instrument gently down, another is directing the end of it down the gullet on the outside of the neck. When the piece of turnip is pushed down into the stomach, let the instrument be gently drawn out; and if, during the operation, the animal forcibly twists its head about, the instrument should instantly be let go. Feeding cattle will eat very little straw; but they ought to have abundance of litter at all times.

8442. *Comparative merits of feeding cattle in hammels and byres.* "Our decided predilection is in favour of hammels. In them the cattle are at perfect liberty to roam about, if disposed for exercise: they are exposed to all the sunshine there may be in a winter day; and the very rain which falls on their backs titillates the skin, and causes them to lick and clean themselves; they are comfortably warm in their sheds among an abundance of straw in the coarsest night, and cattle will never suffer from cold, when they have a comfortable shelter to which they can repair at will; they can come and go to their food whenever they please, night and day, and, their meat being constantly in the open air, it will be always fresh and sweet; and their feet and hair, when they come to travel, are quite able to bear the hardness of the road and the coldness of the air. These are all advantages which no byre can confer. Nor are the hammels so expensive in their original erection as many represent them to be. We have seen a range of them consisting of five divisions, capable of feeding twenty large oxen, erected for 20*l.*; but these had no regular roof. The roofing of all buildings is the most expensive part of them. The roof of those to which we refer, consisted of trees laid across as beams, about a foot asunder, the space between them being filled up with the branches of the spruce fir and Scotch pine. Such a place was a choice one for stacking pease or beans upon. To this purpose it was often appropriated; or it was covered with straw, roped down, which was used as bedding for the cattle in the first part of the succeeding season, when fresh straw was put in its stead. In the hammels which faced the south, the cattle were well fed and comfortably lodged; and no byre could have afforded so much accommodation at the same expense." (*Quart. Jour. Agr.*, vol. ii. p. 241.)

8443. — 6978. *Milk is preserved from becoming acid* by the addition of any alkali; because, when milk ferments, it developes an acid, which the alkalies neutralise. Hence alkalies prevent the curdling of milk. Alkalies applied to curd will turn it into milk: they are not unwholesome, but in large quantities give the milk a disagreeable flavour. (*L'Agriculteur-Manufacturier*, Mai, 1831.)

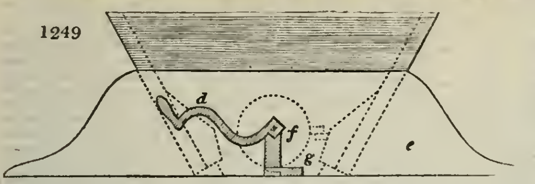
8444. — 7008. *A curd-breaker for skim-milk cheeses* (*figs.* 1248. and 1249.) has been invented by Mr. Robert Barlas, of Gilmour Place, Edinburgh. It consists of a hopper of wood (*fig.* 1248. *a*), seventeen inches and a half by fourteen inches on the top, and ten inches in depth; and a cylinder of hard wood six inches and three quarters (*b*) in length, and three inches and a half in diameter. The cylinder is studded with square pegs made of hard wood, each a quarter of an inch in the side, cut square at the ends, and projecting three eighths of an inch. There are eight teeth in the length, and fifteen in the circumference, of the cylinder, 120 teeth in all. It revolves on a round iron axle twelve inches in length, and is moved by the crank handle (*d* in *fig.* 1249.); *c c* are two wedge-shaped pieces of hard wood, made to fill up, in some degree, the space between the side of the hopper and the cylinder. These pieces rest on a slip of wood nailed to the lower

1248



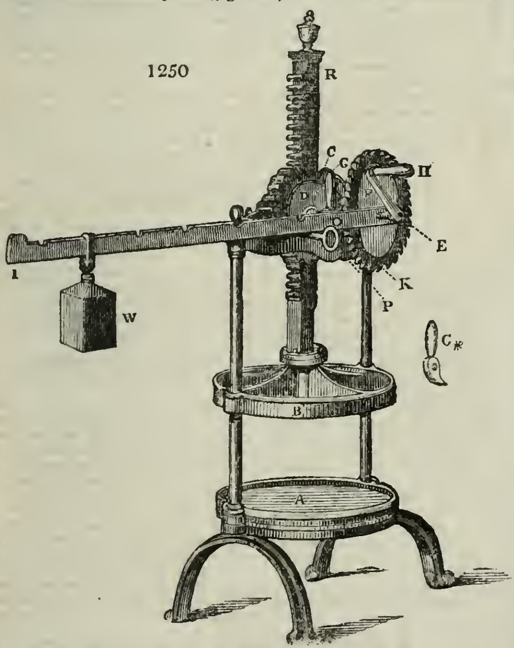
rim of the hopper, to keep them in their place. The face of these is studded with nine teeth of hard wood, similar to those on the cylinder, at opposite sides. The stand (*e*) (*fig.* 1249.) can be made of any length, to suit the breadth of the tub into which the curd is broken. The implement is used in this manner: — Place over it a tub, heap the hopper (*a*), with curd, and, on turning the winch (*d*) in either direction, the curd will fall, broken quite small, into the tub. While one hand is moving the machine, the other can press the curd gently down into the hopper. As cleanliness is a matter of the greatest importance in cheese-making, the internal parts of this machine, being loosely put together, can be easily taken to pieces to clean. The cylinder axle rests on two hard wooden blocks (*f*, *fig.* 1249), one on each side, which slip out of their groove. They are held in their working position by the thumb-catch (*g*), sunk flush with the bottom of the stand (*e*), one over each block. The wedge-shaped pieces (*c c*, *fig.* 1248.) come out. To prevent the curd working out of the sides of the axle, the cylinder is set a little at both ends into the sides of the hopper. The dotted lines in *fig.* 1249. will give an idea how the internal part of the machine is constructed. Only one tooth is represented on the cylinder by the dotted lines, to show the position of the whole. (*Quart. Jour. Agr.*, vol. iv. p. 385.)

1249



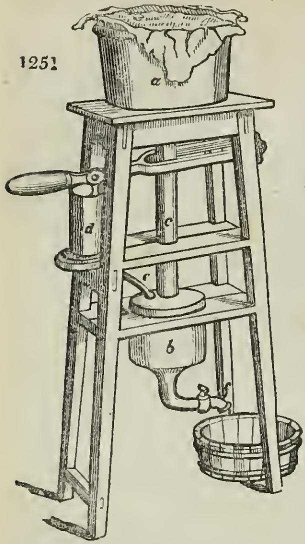
8445. *Baird's cheese press* (*fig.* 1250.) is one of the most convenient in use. "The form containing the curd is put on the bottom plate, A, and the top plate, B, is made to descend and press on it. There are two ways of doing this: one quick and easy, until the resistance becomes great; and the other slower, but more powerful, and used for the conclusion of the operation. On the axis, C, of the wheel, D, there is a pinion of eight teeth (not seen in the engraving) which works in the rack, R. On the axis, E, there is another pinion of eight teeth (concealed by the other parts) which acts in the wheel, D, of twenty-four teeth. This axis, E, may be turned by the winch handle, H, three turns of which will make the rack descend through a space corresponding to eight of its teeth. In this way the plate, B, may be lowered to touch the cheese, and to commence the pressure; but when the resistance becomes considerable, the second method of acting on the rack must be resorted to. On the axis, E, besides the pinion before-mentioned, there is a fixed ratchet wheel, F: the lever, I, forked at the end, which embraces F, is also placed on this axis, but turns freely round it. In the forked part of F, there is a pall or click, G (better seen at G*), which, turning on the pin, K, may be made to engage in the notches of the ratchet-wheel, F. By means of this arrangement, when I is raised up, and G engaged in F, the axis, E, and its pinion, will be turned round with great power on depressing the end, I, of the lever; and by alternately raising and depressing I, any degree of pressure required may be given to the cheese; after which, if it be wished to continue the pressure, and to follow the gradual shrinking of the cheese, the lever is to be raised above the horizontal position, and the weight, W, hung on, which will cause it to descend as the cheese yields. By inserting the pin, P, this effect may be discontinued, and the farther descent of B prevented. (*Highland Soc. Trans.*, vol. x. p. 52.)

1250



8446. *The pneumatic cheese press* (*figs.* 1251, 1252.) is the invention of John Robison, Esq., Sec. R.S.E. When of full size, this press may consist of a stand about three feet high, on the top of which may be fixed a tinned copper or zinc vessel, of any required capacity (say eighteen inches diameter, and eighteen inches deep), to contain the prepared curd. This vessel should have a loose bottom of ribbed work, covered with wirecloth, from under which a small tube, nearly twelve inches long, should communicate with a close vessel, capable of containing all the whey which may be drawn from the curd in the upper vessel. At one side of the stand there may be a small pump-barrel of about seven inches deep, from the bottom of which a suction pipe should terminate at its upper end in a valve opening upwards, and a piston, with a similar valve, should be placed in the pump-barrel, and be worked by a jointed lever, as shown in the model. The process is to be conducted as follows: — The curd being prepared, and salted in the usual way, a cloth is to be put over and into the upper vessel, and the curd put lightly into it, except round the edges, where it should be packed quite close to the sides of the vessel, so that no air may pass that way; the pump handle is then to be briskly worked for a few minutes, on which the pressure of the external air will force the whey to run down the tube into the whey-vessel; when it ceases to run, a few strokes of the pump may be repeated. The cloth and its contents are then to be lifted bodily out of the curd-vessel, and to be put into a mould of close wirework, with a weight placed over it until it become firm enough to be handled. The mould should stand on a sparred shelf (a shelf made of laths like a bacon rack) to allow the air free access to it on all sides of the cheeses. In *fig.* 1251., *a* is a vessel containing the curd; *b*, a vessel for containing the whey; *c*, a tube communicating from *a* to *b*; *d*, an air pump for exhausting the air in *b*; *e*, tube communicating from *d* to *b*; *f*, a tub for letting off the whey from *b*. *Fig.* 1252. is a false bottom for the vessel *a*; *g*, wood frame; *h*, wirecloth. (*Highland Soc. Trans.*, vol. x. p. 200.)

1251



8447. — 7086. *New Stilton cheeses* may be made to acquire the flavour and appearance of old ones, by inoculating them with portions of the old, containing blue mould. The little scoop which is used in taking samples of cheese, affords a ready means of performing the operation, by interchanging ten or a dozen of the rolls which it extracts, and placing them so as to disseminate the germ of the blue mould all over the cheese. A new Stilton cheese, treated in this way, and well covered up from the air for a few weeks, becomes thoroughly impregnated with the mould, and generally with a flavour hardly to be distinguished from the old one. (*Highland Soc. Trans.*, vol. xi. p. 233.)

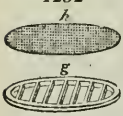
8448. — 7184. *Management of the fleece in Australia.* In order to assimilate the Australian wool as much as possible with the German, in preparing it for market, the fleeces should not be broken, but merely divested of the breech and stained locks, and so assorted or arranged that each package may contain fleeces of the same character as to colour, length of staple, fineness of hair, and general quality.

8449. *If the washing* has been performed at the same time and place, and with an equal degree of care, the colour is likely to be uniform, and it will then only be necessary to attend to the separation of the fleeces as to length, fineness, and general quality; but if a large grower has flocks of different breeds, and fed on different soils, care should be taken that the fleeces be separated, first, as to colour, and then, again, as to length, fineness, &c.

8450. *Packing.* The fleeces, being assorted as already suggested, should be spread one upon another, the neck of the second fleece being laid upon the tail of the first, and so on alternately to the extent of eight to ten fleeces, according to their size and weight. When so spread, the two sides should be folded towards the middle, then rolled together, beginning at each end, and meeting in the centre; and the roll or bundle, so formed, should be held together by a slight packthread.

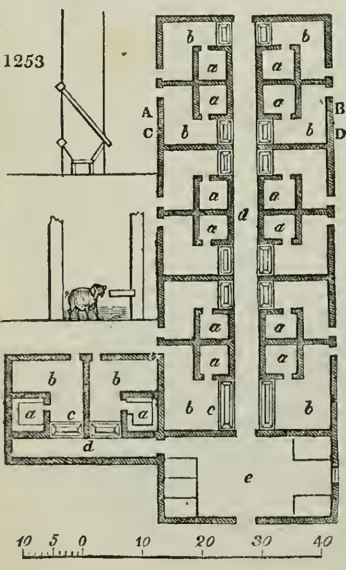
8451. *The bagging* should be of a close, firm, and tough nature. The material hitherto most generally used has been sail canvass, which very ill resists bad weather on a long voyage, and, when received here, even in favourable condition, is so dry and crisp, that it will tear like paper. A thicker, twilled, more flexible, and tough material would be preferable. The size and form of the package may be in length about nine feet, and in width four feet, sewed up on the two long sides, and at one end; the other end being suspended with the open end upwards to receive the bundles made up as before directed, which are to be put in one at a time, one of the flat sides of the roll or bundle being put downwards, and so on in succession; and the whole being well trodden down, until sufficiently filled for the mouth to be closed. This is the German mode of packing, but it is doubtful whether packages of the dimensions that have been hitherto sent from the two colonies may not be more convenient for so long a voyage.

1252



8452. *The operation of screwing* should be discontinued where it has been practised; as the pressure by the screw, and the remaining compressed during the voyage, occasions the wool to be caked and matted together in a manner that is highly prejudicial to its appearance on arrival. The practice, also, of winding up each fleece separately, and twisting a portion into a band, is productive, in a minor degree, of the same prejudicial effect; and it is to avoid this, that the making German bundles of eight or ten fleeces is suggested. (*Hobart Town Courier*, Jan. 8. 1834.)

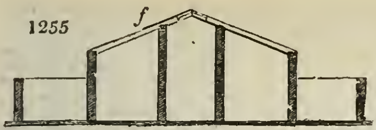
1253



8453. — 7274. *A pigsty* is a building which a general observer is in the habit of thinking requires no great care either in the plan or in the execution; but the experienced agriculturist is of a very different opinion. Pigs, to thrive, must be kept dry, warm, and clean, and this they cannot be without some contrivance. In general, a pigsty consists of two parts, a small open yard, and a small covered house, or shed; in the former, the animal eats and takes exercise, and, in the latter, he keeps himself warm and sleeps. As an example of a complete range of pigsties erected at Bagshot Park Farm, by Mr. Burness (see *Gard. Mag.*, vol. x. p. 332.), we refer to *fig.* 1253., which is a ground plan of a very complete building for breeding and fattening pigs. In this figure, *a* represents the lodging-houses; *b*, the exercise courts; *c*, the troughs into which food is put; *d*, passages for supplying food; and *e*, a house containing the food, in which there is a boiling and steaming apparatus, and three large tanks, for fermenting the food before it is used. *Fig.* 1255. is a section, on a larger scale, on the line A B, and *fig.* 1254. is a vertical profile, on a still larger scale, of part of the roof, showing the cover of one of the ventilators, marked *f*, in *fig.* 1255. *Fig.* 1256. is a section, on the line C D, on the same scale as *fig.* 1255.

1254

1255



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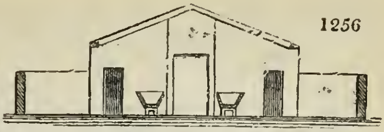
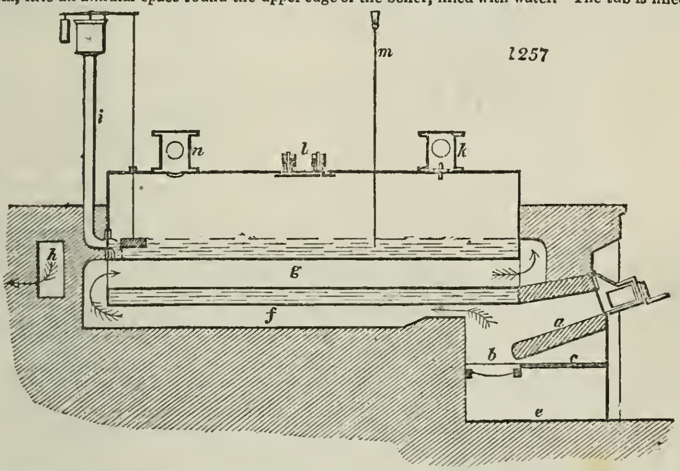


8454.—7315. *Preparation of food for swine.* Mr. Bolton, who has fattened swine to an enormous weight, has the following observations on the subject in the *British Farmer's Magazine*, vol. vii. We consider them worthy of quotation, with a view of impressing on the mind of the reader the importance of fermenting food for this class of animals:—" I always feed my pigs on sour food, which I have invariably found to feed them faster, and to make the flesh firmer and whiter, than food given in any other state. The following is my method of preparing it: — As soon as the potatoes are steamed, I have them, while quite hot, beaten to a pulp, and mixed with bran, in the proportion of twenty-eight pounds of bran to a sack (240 pounds) of potatoes, and this mixture is put into a vat for ten or twelve days, till quite sour; this food makes the pigs fat enough for porkers or small bacons. When I require them more than commonly fat, I begin with fifty pounds of barley flour, instead of the bran, to each sack of potatoes, gradually increasing the quantity of flour till it amounts to half the weight of the potatoes; when the quantity of flour is greater than the moisture of the potatoes will absorb, I add a sufficient quantity of water to make it into a thick paste: I never give it until it has fermented."

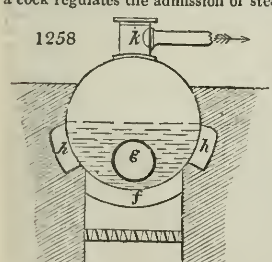
8455. *A description of Mallet's improved apparatus for cooking fodder for cattle by steam.* The simplest form of apparatus for this purpose usually met with, consists merely of a common open boiler, over which a tub, with its bottom perforated, is placed, and the junction rendered steam-tight by what is called a water-valve or water-lute joint; that is to say, by the lower edge of the tub projecting below its bottom, into an annular space round the upper edge of the boiler, filled with water. The tub is filled with

1257



the vegetable matter to be cooked; and the steam rising through the perforations of its bottom, from the water beneath (a fire having been lighted under the boiler), prepares it. This apparatus, excellent as it appears from its simplicity, has many disadvantages. The tub requires to be lifted on and off, by means of a crane, if of large size; a separate boiler is required for each tub; there is no mode of regulating the supply of steam, but by damping the fire, or urging it; and the boiler, to be supplied with the water spent in steam, needs the tub to be previously lifted off. Added to all, the boiler must be circular, and, therefore, of the worst possible form for economy of fuel. The next form is that in which several steaming vessels are supplied from one boiler, which may be of any form. Each of these vessels consists of a tub, as before, with a perforated bottom, and close but movable cover, which is placed on another shallow tub, with a close bottom, into which the steam from the boiler is conducted by a pipe from the boiler; the junction between the two tubs being made good, either by three or four thicknesses of felt, or by a gasket; a cock regulates the admission of steam to each lower tub, and a crane is provided, which commands the whole range, and lifts them on or off. The arrangement answers tolerably well, but has some inconveniences. But a comparatively small surface of the potatoes or other fodder is exposed to coction. The crane for lifting off the tubs, when each is capable of containing from four to six barrels of potatoes, requires to be a strong and rather costly piece of work; and the consumption of time and labour in lifting on and off, filling and emptying those tubs while hot, is very great, whereby a considerable loss in fuel accrues. All these considerations may be of small importance where the quantity of fodder cooked is small, and therefore the cost of labour and fuel slight; but where a large stock of cattle is to be fed with cooked food, and the apparatus is therefore nearly at constant work, every consideration of facility and economy becomes in the highest degree important. Accordingly, the following train of apparatus was designed for a gentleman, who is not only an extensive rearer of cattle, but one of the most distinguished agricultural improvers in Ireland.* It is conceived that it embodies most, if not all, that can be wished for the purpose. Fig. 1257. is a longitudinal section of the boiler, which is cylindrical, and four times its diameter in length. Witty's patent gas-furnace is applied to it

1258



* Robert La Zouche, Esq., of Harriston.

a is the inclined plane; *b*, the fire bars; *c*, the dead plate; *e*, the ash-pit. The flame and heated air passes under the boiler, through the bottom flue, *f*, thence through the tubular flue, *g*, right through the body of water in the boiler; at the extremity of which it goes off, right and left, through two lateral flues, which join at *h*, and go into the stack or chimney: *i* is the feed head, supplied either from any sufficiently elevated source, or by a pump; it is adjusted, to supply the boiler at a pressure of 1½ lb to the square inch: *k* is the safety valve, loaded to the same pressure; the steam from it blows into the flue; *l* is the man-lid; *m*, a whistle, for the purpose of giving notice when there is a deficiency of water in the boiler, should such ever take place; boilers upon this construction being much more liable to injury in this respect than those which have no internal flues: *n* is the steam-pipe and stop-valve, which is connected with the steaming vessels. *Fig.* 1258. is a cross section of the boiler: the same letters refer to both figures. The top part of the boiler, above the masonry, is covered with a wooden jacket, one inch thick, and supported by segments of angle iron, at an interval of one inch and a quarter from its external surface; and for the same reason the walls of its setting are all built hollow. *Fig.* 1259. is a side elevation of the steaming vessel for cooking potatoes, carrots, parsneps, turnips, &c., or other such things; of which *fig.* 1260. is a cross section, through the centre of its length: the same letters refer to both. *a* is the external cylinder or outer case of the vessel, formed of oaken staves, one inch and a half thick, hooped together, and having a close end, staved in at the end, *b*. The other end is closed by a movable lid (*c*) of wood, fastened by cotters driven through two links formed in projections from the adjacent hoop, and made steam-tight by a gasket, soaked in bees' wax and tallow; it is capable of being very readily put on or taken off. In the lower segment of the cylinder, an arched wooden false bottom *d* is placed, stiffened by slight cross-ribs of cast iron, and perforated full of holes, five eighths of an inch in diameter; above, and supported by this, the matters to be cooked are placed until they quite fill the cylinder. The whole thing is hung upon two gudgeons or journals, *e e*, passing through the centre of gravity of the cylinder, when loaded; so that, by the arrangement about to be described, either end of it may be elevated or depressed. One of these journals is hollow, and immediately connected with the steam-pipe from the boiler by a stuffing-box, *f*; so that the steam enters the bottom of the cylinder through this journal and the curved pipe, *g*, the former having still free liberty of motion. Both journals move in brasses, resting on strong diagonal framing, *h h*, bolted down to a mass of masonry. *i i* are two wrought-iron links, connected by joints with the hoops of the cylinder at top, and with the extremities of the equibrachial lever, *k*; the centre of which consists of a Y shaft, *l*, supported by two or three slight frames, *m m m*, and having the long vertical lever, *n*, keyed on it at one end. These frames are bolted to proper timbers in the floor of the loft above. Now it is obvious that, by means of the vertical lever, *n*, either end of the cylinder may be elevated or depressed, and that the natural tendency of the whole system, when at rest, will be to remain horizontal. From the bottom or side of the cylinder at *o* proceeds a small tube, to take away the condensed steam; so made, that it shall permit the water to pass, and yet be steam-tight; and also that it shall remain vertical, whatever be the position of the cylinder. This is shown enlarged in *fig.* 1264. The upper end of the tube works in a steam-tight joint, *a*, like the pin of a common cock; but made so that there is a free passage through in all positions of the tube: the screw tail of this joint is secured into the bottom of the cylinder by a brass nut and felt washer; the joint being placed with its axis of motion at right angles to the axis of the cylinder. The lower end of the tube, *b* (shown only in part), consists of an inverted siphon, the returning limb of which is of such a

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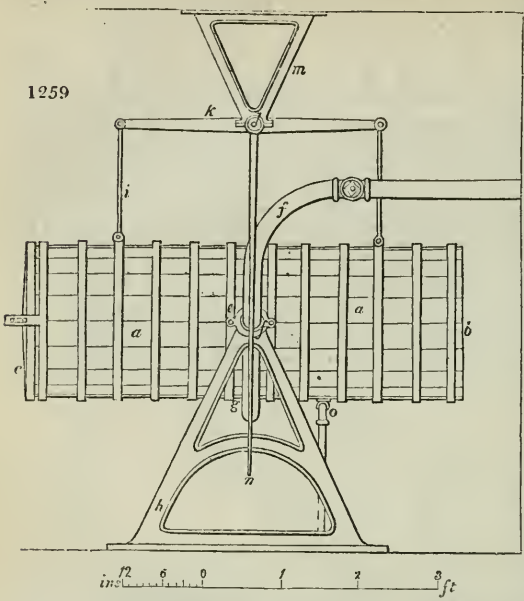

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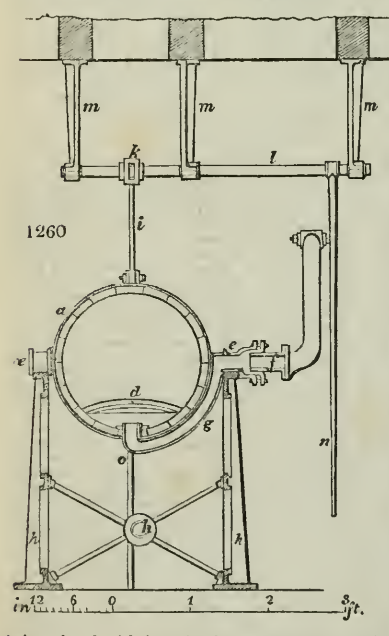
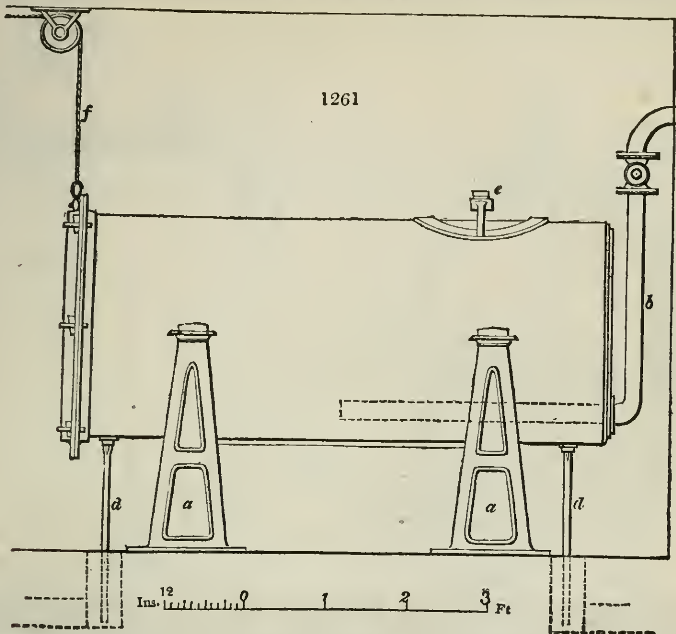


length that the column of water retained in it is equal in pressure to the density of the steam in the cylinder. The greatest part of this tube hangs freely in a square aperture, below the level of the floors

1261



in *figs.* 1258. and 1259., where it is connected with a small sewer to take away the water. It is evident that, when the cylinder is moved, the tube will rise and fall vertically in the hole or upright trunk in the floor. Now for the mode of working this steaming vessel. The steam being up in the boiler, and the lid, *c*, removed, the end, *c*, of the cylinder is elevated to an angle of about 40°, when it comes just under a large wooden shoot or hopper from the loft above, close to which is placed a slicing machine, for dividing mangold wurtzel, turnips, or other large roots requiring to be steamed; from whence they drop direct through the hopper into the cylinder until it is full. Potatoes are either shot direct from a cart (if the situation permit of it) through the hopper, or from sacks from men's shoulders, into the cylinder. When it is full, the lid, *c*, is put on, and cottered tight; the cylinder again placed horizontally, and the steam admitted. When the steaming is complete, a low capacious truck, or a large square basket on wheels, or any other convenient receptacle, is brought under the end, *c*; the lid is removed, and the end, *c*, is now depressed sufficiently to cause the vegetable matter to fall out; the steam being previously shut off: the operation is then complete. The false bottom is now to be withdrawn; and it, together with the inside of the vessel, scraped and washed: the former is only necessary when potatoes are cooked in it. The objects proposed in this arrangement are, perfect ease in filling and emptying, without the necessity of handling either the heated vessel or food; nearly a maximum capacity with a minimum cooling surface to the vessel; perfect staunchness, durability, and readiness of examination and cleansing of the interior. If there be no other elevated supply of water to the steam kitchen, a pump should be fixed in it, both to supply the boiler and to wash the vessels: potatoes, especially, leave a kind of slime upon the inside of steam tubs, which soon putrifies. It is said the cattle are sometimes choked by small potatoes, which are not sufficiently steamed; this might be prevented by the addition of a pair of rollers, into the hopper of which the cylinder might discharge its contents; and they would bruise all to a given size, and deliver into the truck before mentioned. *Fig.* 1261. is a side elevation of the cylindrical vessel for steaming hay, chaff, bran, oats, clover, &c. It is of a much larger size than the cylinder for steaming more solid matters; and, therefore, is not made of wooden staves, but of iron plate riveted together like a steam boiler. *Fig.* 1263. is a cross section of the same: the letters of reference apply to both figures alike. The cylinder is supported on four vertical frames of cast iron, *a a*, properly connected by diagonal stays; one end of it is riveted in, and through it the steam-pipe, *b*, enters. The other end is movable, and closed by a circular lid or cover, also of boiler plate, secured by six cotter bolts, as shown in elevation, *fig.* 1261.; it is strengthened round its edge by a ring of two inches and a half angle iron riveted on, and is externally slightly convex: *c* is the convex false bottom, formed of sheet iron one eighth of an inch thick, punched full of round holes three tenths of an inch diameter, and stiffened by ribs of T iron, riveted to its lower side: *d d* are two siphon tubes for emission of condensed water, as before described: *e* is a man-lid for the purpose of filling in chaff, &c., or other such matters. The large end lid has got a counterbalance weight attached to the chain, *f*. The whole of this cylinder, and all the steam-pipes, are lapped over with slight haybands, which are lapped over with thick felt or dreadnought; and this, lastly, is sewed tightly over with strong sail canvass painted. This mode of uniting, as a coating, several bad conductors having different conducting powers, is found to resist the passage of heat much more effectually than an equal thickness, of even the worst conductor of the three. This fact, which, I believe, has not been hitherto noticed, will at once suggest to the scientific reader some curious

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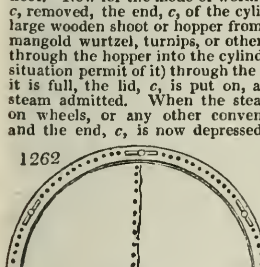

analogies to the passage of sound through media of different density; and which, indeed, caused the arrangement which has been described to be adopted. It will thus be seen that this second cylinder is

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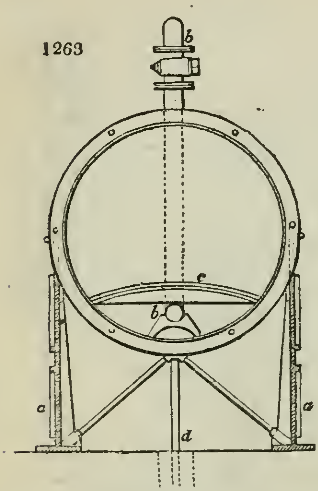
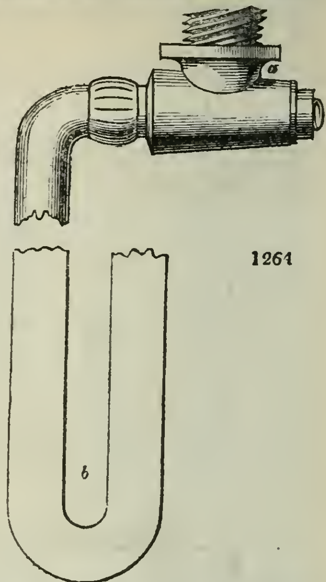




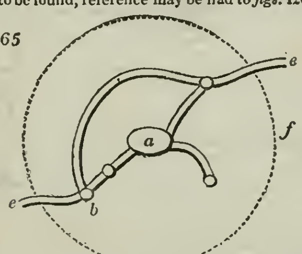
1264

very similar in its general construction to that first described, except that it is not movable; which, from its magnitude, would be inconvenient, and is unnecessary for either hay or chaff, &c. Now of the mode of working it. In the loft above, immediately over the man-lid, *e*, is placed a chaff-cutter, and also a bean and oat bruiser, which both discharge by separate hoppers into the cylinder. The end lid having been put on and cottered up steam-tight, the vessel is thus filled with the desired material, which is spread uniformly with a fork through the man-lid. Steam is then turned on; and, when the operation is complete, the end lid is loosed and thrown up by the aid of the counterbalance above the cylinder end, and the contents drawn out by forks, or by a large but light and slender instrument like the worm of the ramrod of a gun. Before being used the first time, the inside of this vessel is given a coat of drying oil, and copal varnish mixed, which prevents subsequent oxidation. The general intent of the whole of the apparatus is to save labour and fuel, which it does effectually; and that portion of it for cooking potatoes is now about being erected in the new gaol of Mayo, the largest in Ireland. In some few cases, where the extent of the apparatus would be very great, and labour dear, it might be advisable to connect a small steam-engine with it, working from the same boiler, to pump water, slice turnips and mangold wurtzel, cut chaff, and bruise oats and beans, &c. Where a high pressure steam-engine pre-exists on a farmery for other purposes, the waste steam from it may be made fully available for steam-cooking apparatus, which thus would cost nothing; it requires, however, a particular adaptation, in order that the power of the engine may not be reduced, by driving the steam through any considerable resistance. Occasionally, but rarely, fluids may require to be boiled by steam, as stirabout for pigs, or wash for calves; for these, another form and construction of vessel altogether is necessary. (*R. Mallet.*)

8456. — 7431. *Warmth* is strongly recommended for promoting the health of poultry. Cold, it is found, either produces inflammation of the lungs, or pulmonary consumption. Heat constantly prevents this, and alleviates the disease when it has taken place. (*Annales des Sciences Naturelles*, as quoted in *Quart. Jour. of Agr.*, vol. ii. p. 568.) Warmth, also, makes fowls lay. Every housewife knows that eggs are most abundant in warm weather; and all country housewives know that the only way to make hens lay in cold weather, when eggs are dear, is to feed them well and keep them warm — the latter being of very nearly as much importance as the former. Some excellent observations on the subject of rearing and feeding poultry will be found in our *Ency. of Cott. Arch.*, § 1325. to § 1329., and § 1356.

8457. — 7631. *The mole* may be extirpated without the use of traps by digging up the mole hills in the course of the month of March, which is the breeding season. In order to give an idea where the mole's nest is to be found, reference may be had to *figs.* 1265. and 1266.; the first of which is an underground plan,

1265



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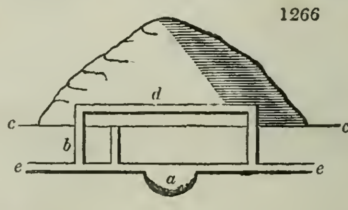

or horizontal section of a mole-hill, and the second a vertical section. In both these figures, *a* is the mole's nest; *b*, vertical tubes or runs, by which the mole ascends with the soil which it has excavated from the place forming the nest, in order to raise a hill over it to protect it from the rain; *c c* show the surface of the ground; *d*, a tunnel above the surface of the ground, in the soil of the artificial hill; *e e*, the common run of the mole extended to an unascertained length on every side; *f*, line indicating the base of the hillock. After removing the hill, and destroying the young moles, by waiting a little without making the least noise, the parent will make her appearance, and may be also destroyed. (*L'Agronome*, vol. i. p. 220.)

8458. — 7632. *A mode of catching rats* by baiting the traps with ground pale malt scented with the oil of caraway seeds, and which is said to be very effective, will be found described, at great length, in the *Quart. Jour. of Agr.*, vol. ii. p. 319. to p. 331.

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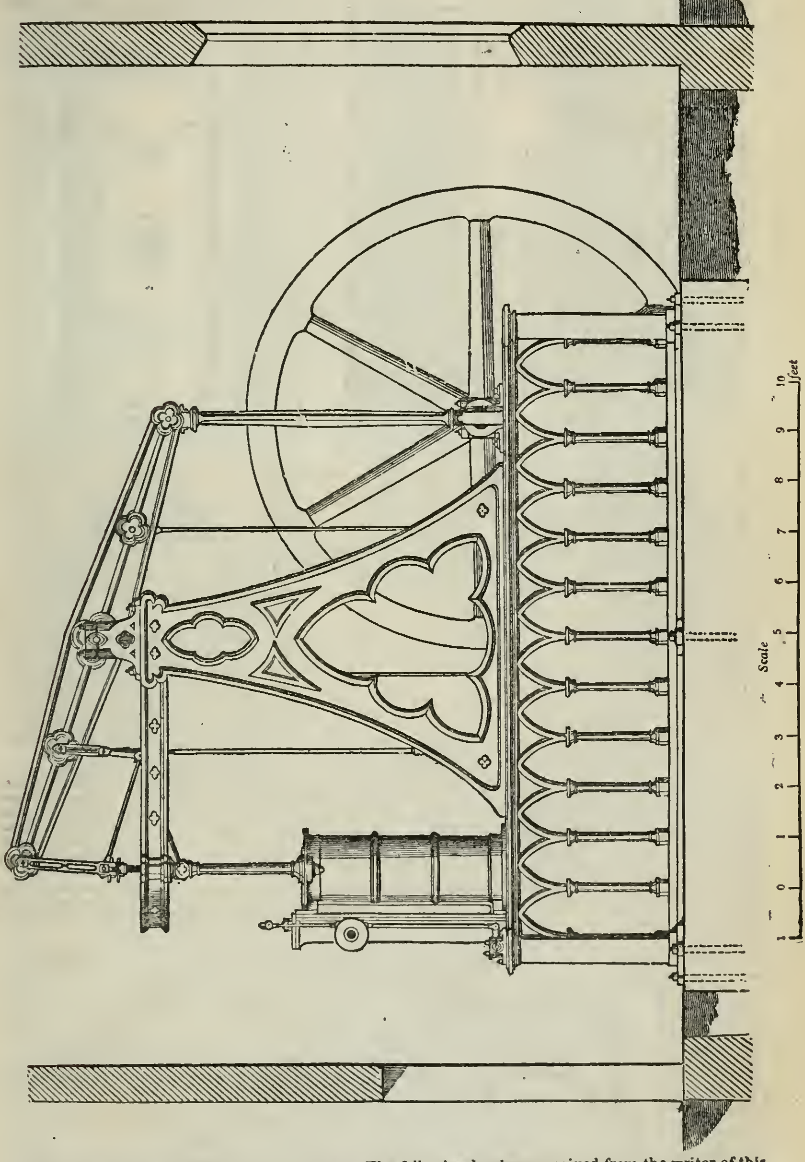
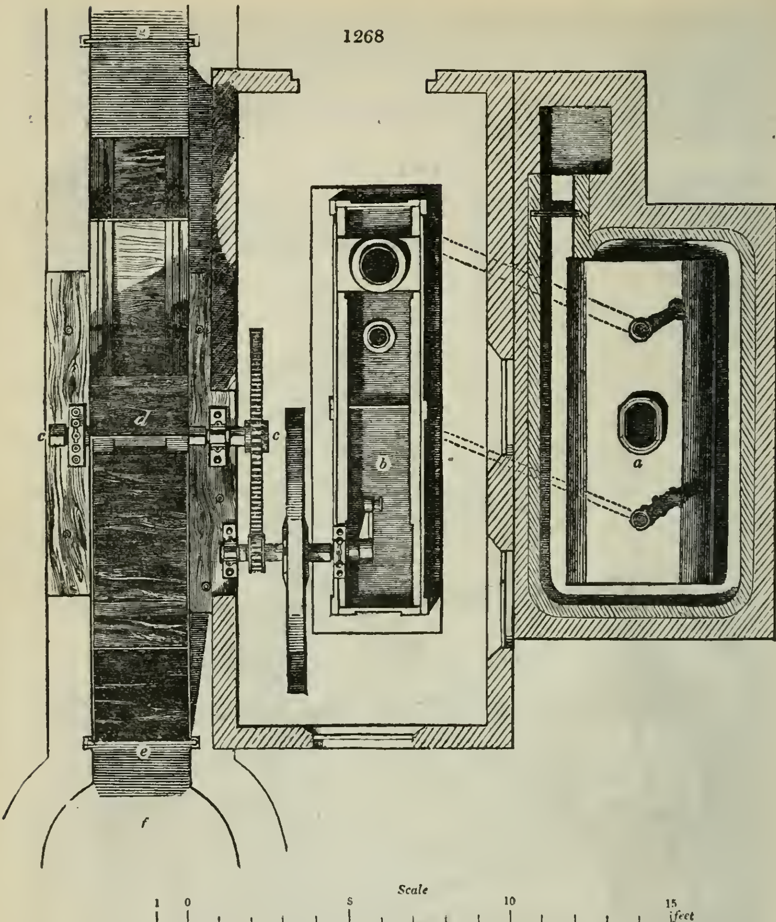


8459. — 7643. *Insects injurious to agriculture.* The following has been received from the writer of this article in the body of the *Encyclopædia*, W. Swainson, Esq. F.R.S. &c. — "Dear Sir, Although little disposed to notice the small critics, who love nothing so much as to be thought worthy of a reply, it is due to yourself that I should say something upon an attack made on the chapter regarding insects, written by myself in your *Encyclopædia of Agriculture*, and which attack I have just seen in an agricultural book,

1268



written in imitation of your excellent and useful work. It seems that I have said (p. 1113.), that, as the perfect suctorial insects (the Haustellàta of *Clairville*) 'are supported by suction alone, it is obvious that in this state they can do no injury to the agriculturist.' Yet, says the critic, 'in absolute forgetfulness of this extraordinary assertion, Mr. Swainson, in the very next pages, tells us of the extensively destructive ravages of these very suctorial insects, which he has just before pronounced to be incapable of doing any injury to the agriculturist.' So far for the charge: now for the inference. 'Such palpable blunders as these require no comment, but I (the critic) cannot help remarking that they are calculated to lead to extensive practical inconvenience, to puzzle the agricultural reader most inextricably, and to destroy very much his confidence in all book instructors.' Literary blunders are of two kinds. They either originate in the ignorance of the author with regard to the subject he is writing upon, or in the haste of composition; in which latter case they are usually, if not always, discovered on perusing the proof sheet. If, however, by any chance, the proof is not seen (and I have no recollection of this circumstance), and the mistake is a '*palpable* blunder,' it corrects itself; every one *palpably* perceives that it is an oversight, originating from the printer's omitting, perhaps, one or two words. It requires, indeed, no comment; for every one capable of reasoning sees at once that, by expatiating on the injury caused by the *Aphides*, I virtually correct the previous omission of those insects being an exception. So much for the 'palpable blunders,' the 'inextricable puzzlement,' the 'extensive practical inconvenience,' and the 'destruction of the confidence' of the agriculturist, the printer's omission has occasioned. 'The figures, indeed,' continues the critic, 'drawn by Mr. Swainson, prove his great accuracy as an artist; but the text equally proves that he knows little of insects beyond the atmosphere of cabinets and books, and that even his book knowledge is sadly deficient.' Now the figures in question *were not drawn by me*, but by Mr. Sowerby; and, in regard to the rest, who cannot help laughing at one of the oldest entomologists of England, who has, moreover, for years, lived under the temperate and tropical 'atmospheres' of both hemispheres, being gravely told that he knows nothing about insects beyond the precincts of his study! But when the same writer talks to us of the 'gross inaccuracy' of LINNÆUS, the 'credulous absurdity,' and the 'wild, mischievous, and absurd analogies' of CUVIER, the 'trash' of MOHS and HAIDINGER, the 'absurdity' of SAVIGNY, and (to crown all) the 'flimsy productions' of MACLEAY and HORSFIELD (see the *Phil. Magazine*, Nov. 1831. No. lix.)*, need I add, that, to be associated in such a list (comprising, as it does, the

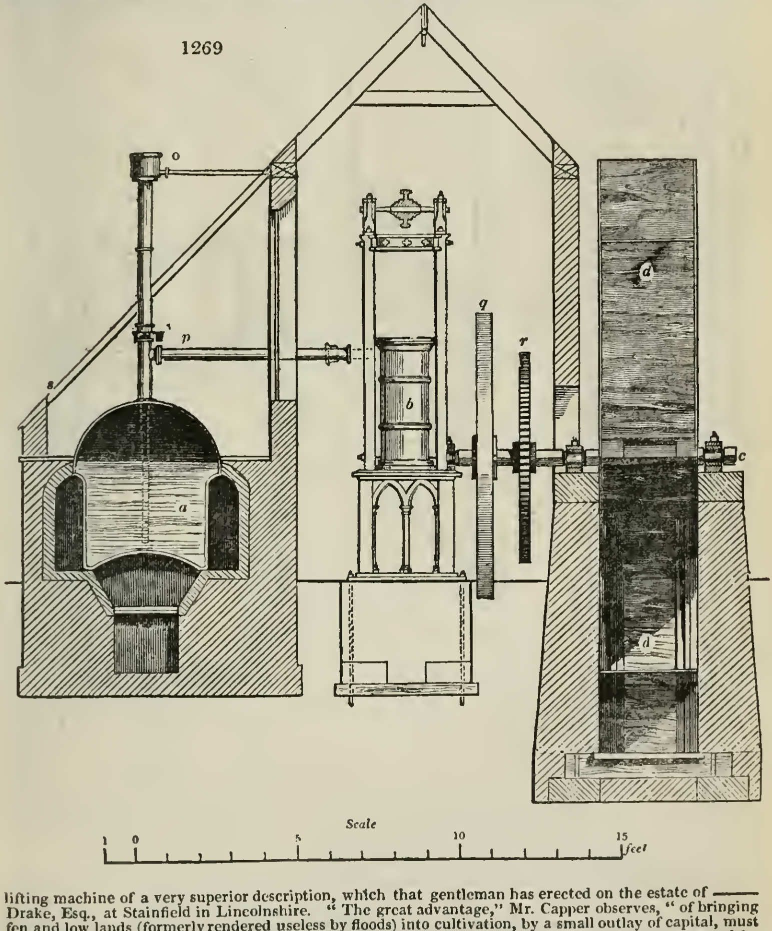
* The reader who wishes to know the entomological proficiencies of Mr. Rennie, will be greatly amused by turning to the *Entom. Journal*, vol. i.; and to the *Philosoph. Magazine*, for Nov. 1831. p. 372.

princes of science) will always be considered the greatest honour that can be conferred upon, dear sir, yours most truly.—*W. S. Tittenhanger Green, Feb.* 12. 1834."

8460.—7776. *The agriculture of the different counties* in England, Wales, and Scotland, more particularly the grazing districts, will be found treated of in a work entitled, *The present State of the Tenancy of Land in the Highland and Grazing Districts of Great Britain*, by L. Kennedy and T. B. Grainger, published in 1829. This work contains a good deal of information on the subjects of sheep and wool, the great object of which is to show the difficulties under which the landowners and farmers are placed, in consequence of excessive taxation, as compared with the German baron who cultivates his own estate, or the agriculturist of Australia who possesses for nothing the right of pasturage over thousands of acres. The result of the whole is the " necessity of a protecting duty to the wool-growers." The time for protecting one part of capital and labour against another is, we trust, rapidly passing away.

8461.—7784. 11. *The application of steam to machinery for raising the water from fen and low lands.* We have mentioned (§ 7786.), that steam had been employed for this purpose in Cambridgeshire; and we have since learned from the account of a trial, in the newspapers (see *Times* for July, 1834), that a gas engine has also been so employed in the Cambridge fens. We are now enabled, through the kindness of Mr. C. H. Capper, engine-maker, Union Foundery, Birmingham, to figure and describe a steam-engine and

1269



lifting machine of a very superior description, which that gentleman has erected on the estate of —— Drake, Esq., at Stainfield in Lincolnshire. " The great advantage," Mr. Capper observes, " of bringing fen and low lands (formerly rendered useless by floods) into cultivation, by a small outlay of capital, must be my apology for troubling you with so minute a description of the draining machine I have erected for that purpose; and, as the same may be of use to a few, I shall feel obliged if you will give it a place in your work; and at the same time add, that by the great improvements which the use of locomotive carriages has made in high-pressure engines, I am enabled to say that as effective an engine as the one described might now be completed for a much less amount,; or, if the landowners whose lands are subject to floods were to subscribe, a movable draining-machine might be made, at a very small expense."

Fig. 1267. shows the elevation of a six-horse portable condensing steam-engine, working a second shaft, marked *c*, in *figs.* 1268, 1269, and 1270. On this shaft, the large water-wheel *d d* is fixed. This wheel revolves in a brick or stone casing, similar to that formed for the wheel of a common water mill, but so accurately fitted as not to allow of any water passing by either of the sides of the paddles, or by the front; because this wheel acts by its paddles lifting the water from the bottom of the wheel race up against the breastwork, and then throwing it over the sluice *e*. This sluice is formed of movable boards, to admit of regulating the lift of water at pleasure, from 3 feet to 8 feet in height. The water, being raised and thrown over the sluice *e*, falls into the pond or receiver *f*, whence it is carried off at as high a level as it

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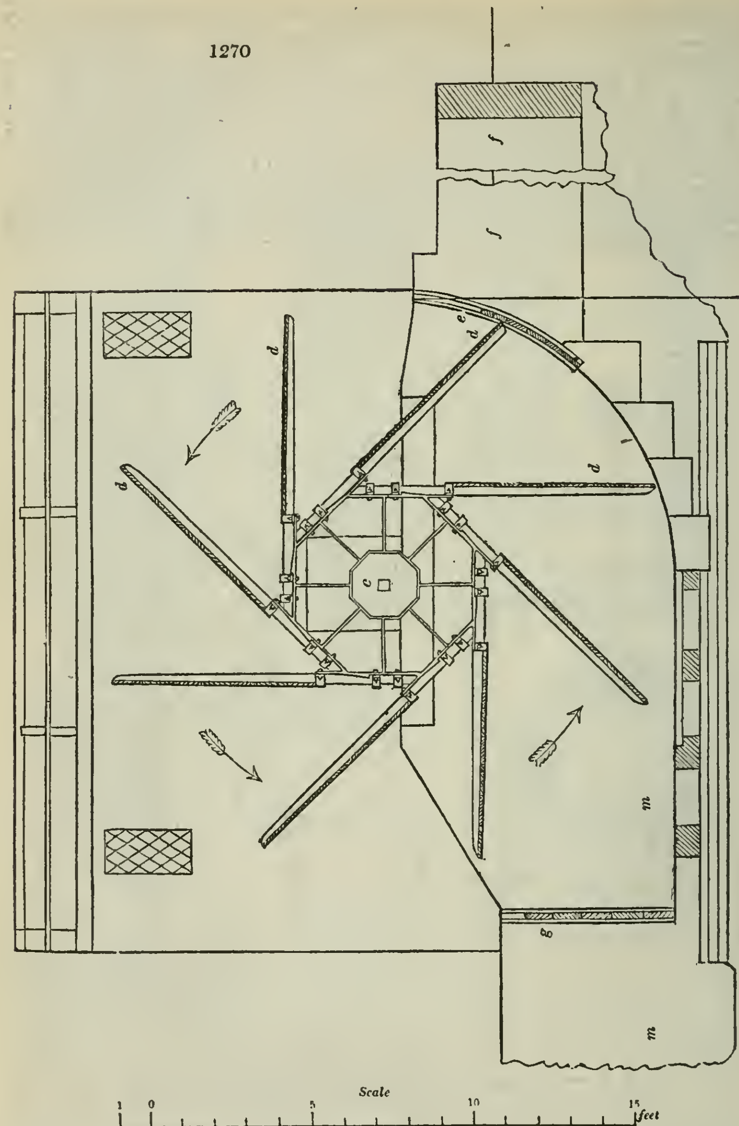


will run; in this case, at about 3 feet higher than the surface of the lands to be drained, and about 6 feet higher than the bottom of the drains. At the lower end of the trough there is a sluice, *g*, for regulating the quantity of water introduced into the lifting wheel; because, if this were too great, the power of the steam-engine might be insufficient to turn the wheel, or the machinery might be injured. The wheel, as it will be seen, consists of eight iron paddles, fixed to an octagon iron casing; each paddle acts by lifting up a portion of water from the bottom of the wheel-race, and raising it to the top of the sluice *e*. When the whole of the water, or nearly so, is lifted up, of course the boards composing the sluice *e* must be attended to, lest the water force its way back again upon the wheel.

Fig. 1268. is a ground plan of the boiler, engine, and water-wheel; in which *a* is the boiler; *b*, the engine; *c*, the water-wheel shaft; *d*, the paddles of the water-wheel; *e*, the upper sluice, over which the water is thrown; *f*, the pond or reservoir which receives the water; and *g*, the lower sluice, placed across the drain which conveys the water to the wheel-race.

Fig. 1269. is a section through the steam-engine and the water-wheel; in which *a* is the boiler; *b*, the engine; *c*, the shaft or axle of the water-wheel; *d*, the paddles; *o*, the tube for supplying water to the boiler; *p*, the steam pipe; *q*, the fly-wheel; *r*, the spur-wheels; and *s s*, the roof.

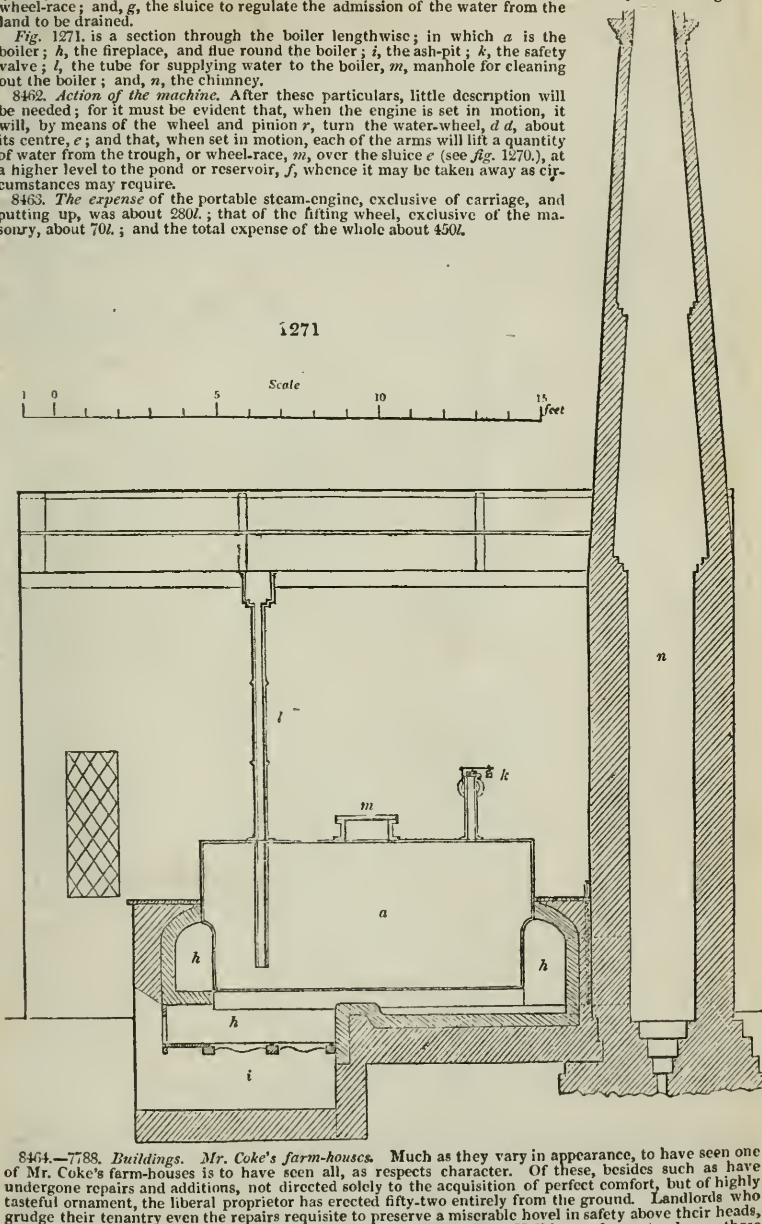
Fig. 1270. is a longitudinal section through the water-wheel, the trough, and the two sluices; in which *c* is the axle of the water-wheel; *d*, the paddles; *e*, the upper sluice, over which the water is thrown; *f*, the pond or reservoir to receive the water before it is carried off to the nearest river; *m* the trough or wheel-race; and, *g*, the sluice to regulate the admission of the water from the land to be drained.

Fig. 1271. is a section through the boiler lengthwise; in which *a* is the boiler; *h*, the fireplace, and flue round the boiler; *i*, the ash-pit; *k*, the safety valve; *l*, the tube for supplying water to the boiler, *m*, manhole for cleaning out the boiler; and, *n*, the chimney.

8462. *Action of the machine.* After these particulars, little description will be needed; for it must be evident that, when the engine is set in motion, it will, by means of the wheel and pinion *r*, turn the water-wheel, *d d*, about its centre, *e*; and that, when set in motion, each of the arms will lift a quantity of water from the trough, or wheel-race, *m*, over the sluice *e* (see *fig.* 1270.), at a higher level to the pond or reservoir, *f*, whence it may be taken away as circumstances may require.

8463. *The expense* of the portable steam-engine, exclusive of carriage, and putting up, was about 280*l.*; that of the lifting wheel, exclusive of the masonry, about 70*l.*; and the total expense of the whole about 450*l.*

1271



8464.—7788. *Buildings. Mr. Coke's farm-houses.* Much as they vary in appearance, to have seen one of Mr. Coke's farm-houses is to have seen all, as respects character. Of these, besides such as have undergone repairs and additions, not directed solely to the acquisition of perfect comfort, but of highly tasteful ornament, the liberal proprietor has erected fifty-two entirely from the ground. Landlords who grudge their tenantry even the repairs requisite to preserve a miserable hovel in safety above their heads, will find everything to censure in this part of the arrangements at Holkham; for, not only are these cottages tasteful beyond anything usually erected of the kind, but it is utterly impossible to imagine anything more commodious and replete with convenience. They are, in fact, suitable for the residence of gentlemen of moderate independent fortune. This may be considered superfluous, and certainly less might be made to suffice; but Mr. Coke's farms are all large, and his tenantry must be men of a certain capital. Independently of these considerations, Mr. Coke's is evidently the right system. He does not fail to reflect, when he builds for a tenant, that, in all probability, he has like notions of comfort (though more humble) with himself, and that without certain and ample conveniences he cannot employ the produce of his farm advantageously to either tenant or landlord. In this spirit Mr. Coke has provided amply for the comfort of his tenantry, not only cultivating and improving their taste while he gratifies his own; but, which is infinitely more important, convincing them at the same time that all the requisites to their comfort and advantage are duly cared for. Though built in a style the most simple, these houses present a whole in accordance with the truest taste, and all has been accomplished by the most simple means. A sea shingle, of which grey is the predominant hue, embedded in plaster, and occasionally divided into compartments, gives a beautiful appearance to the walls; and where coping can be useful or ornamental, it is happily introduced in blocks of what appears beautiful stone, but is, in fact, a naked brick earth, produced on the estate. In this way the neighbourhood has been studded with a number of most tasteful structures, calculated to produce even a moral influence on the conduct of the occupants. Taste, neatness, cleanliness, are thus daily upheld before them, as a pattern set by their landlord; and they are continually silently, but expressively, reminded, that he who has done this for them expects, and has a claim for, a corresponding return. Such is the value of good example, no matter how directed to us; even a well-arranged house, with a cleanly and tasteful exterior, may teach its occupant excellent morality. (*Brit. Farm. Mag.*, vol. viii. p. 12.)

8465. *Mr. Coke's cottages.* "The village of Holkham is occupied, I believe, solely by Mr. Coke's servants and workmen, or by the superannuated members of both classes. The cottages are rendered highly picturesque and neat by the application of shingle, as in the case of the farm-houses; and to each is allotted a garden, sufficient for the occupation of leisure hours, and no more; it being Mr. Coke's opinion, that his labourers would not find their condition ameliorated, nor their capacity to do justice to their employer or themselves extended, were they converted into small farmers or market gardeners." (*Brit. Farm. Mag.*, vol. viii. p. 12.)

8466. *Lady Anne Coke's school* forms a pleasing structure in the village of Holkham, in which the children of the village receive, in the words of the Rev. Henry Berry, "an education suitable to their Christian vocation, and for the rank of life to which God has been pleased to call them." "I am happy," continues the rev. gentleman, "to be able to record the unquestionable utility of this establishment. There is a certain moderate degree of education, which has always been found adequate to raise an industrious and talented man to that consequence in his business, of whatever nature, which such characters are entitled to attain." (p. 14.)

8467.—7862. *Description of a machine for making subterraneous drains in bogs*, the invention of William Kersall Wrigg, C. E., Dublin. This invention may probably be considered impracticable; but we have given it a place on account of its ingenuity, and because it may lead to something better. In *fig.* 1272., A A′ are wheels, upon which the frame B B B is mounted; the wheels being made of such a breadth upon the sole as to prevent the weight they carry from sinking them in the bog. On the axle of the fore wheels, and revolving with them, is fixed a wheel, C, the teeth of which work in those of the bevel-wheel D, mounted on the shaft B; and upon the same shaft are affixed the bevel-wheels F and O, and a crank B; the shaft B revolving in a socket, *a*, fixed to the axle-tree *b*, and a socket, *a′*, fixed to the frame B. I K are bevel-wheels, working in those marked F O; L is a knife five or six feet long, according to the depth the drain is made under the surface of the bog, and whose cutting edge, c, is made of highly tempered steel, and whose back is an inch thick. M N are spindles, say of one inch diameter, revolving with their respective wheels, I K, to which they are attached; and at the bottom of these spindles, as at O and P, are affixed knives, made in the form of oyster-knives, and so placed that the vertical section of their contour shall be a circle, and that each knife be upon a different horizontal plane; so that, in revolving, they shall not move in the same track. This will be understood by referring to the figure: the knife *e*, for instance, is in a different plane to the knife *f*. Other knives may be placed upon the spindles at right angles to the first set, taking care that each blade shall move in a different track from any of the others. The saw L is pointed at the bottom to make its entrance into the bog easy; and the spindles M N are held in the required position, by the sockets in which they work, as shown in drawing. Let us now suppose the carriage is drawn forward in the direction from A to A′. As the wheel A′ turns, the machinery connected with it causes the crank B and the wheels F O to revolve; the crank giving an alternate motion up and down to the saw, which, being pressed against the fibres of the moss, by being obliged to follow the wheel A′ at a fixed distance, will cut those fibres, and in its progress divide the bog, so as to leave a passage for the spindles M N: but, at the same time the bog is being cut, or sawn through, the spindles M N will be revolving at a rapid rate; and as the several knives fixed at their extremities revolve with them, each one presenting its sharp edge to the fibres of the moss, upon a different plane to any other, it is evident that portion of the bog in which the knives revolve, will be divided into a number of minute parts, in proportion to the number of knives used, and the rapidity with which they revolve. We will trace the effect constantly dividing the mossy fibres of the bog will produce. First, for that of the spindle M. It will be seen by the drawing, the knives affixed to this spindle are not so close as those at P; and for this reason; the fibres of the bog would be cut into minute particles easier by two operations than by one; the action of the knives P being much more effective upon the moss previously separated from the large body to which it was attached, than they would before it was so detached; hence the knives at *o* are only designed to cut the fibres so as to separate that portion of the bog where the drain is about to be made, from the large body connected with it.

8468. *The knives* at P are intended to be an inch apart, and as there are four sets, and each knife moves in a different track, the tracks will be but a quarter of an inch asunder, and consequently the matter opposing them will be divided into portions of this length by the action of these knives alone; but the divisions produced by the revolving of the knives at O, make the particles still smaller, particularly so, as the spindles M and N move in opposite directions. This would be the effect if the knives acted upon a body of mere dry twigs; but upon the matter upon which it is intended to operate, the effect would be somewhat different; for the vegetable matter composing bogs is generally found, at a depth of five or six feet, to be in a state of decay, and so easily divided, that, upon being agitated in water, a great portion of it separates into very minute particles, the rest being fine moss, or rotten twigs. It is easy to convert such a substance into a puddle, or semifluid, by mixing it well in water; and as every portion of bog contains a sufficient quantity for this purpose, and the revolution of the knives will divide and mix the bog and water so intimately, as to make a semifluid, having a tendency, like water, to run to a lower level (but of course by no means so great), the moss, or bog, which has been divided into such minute parts, will be easily carried off to a lower level, if we can get a stream of water to pass over it. It is intended to do so.

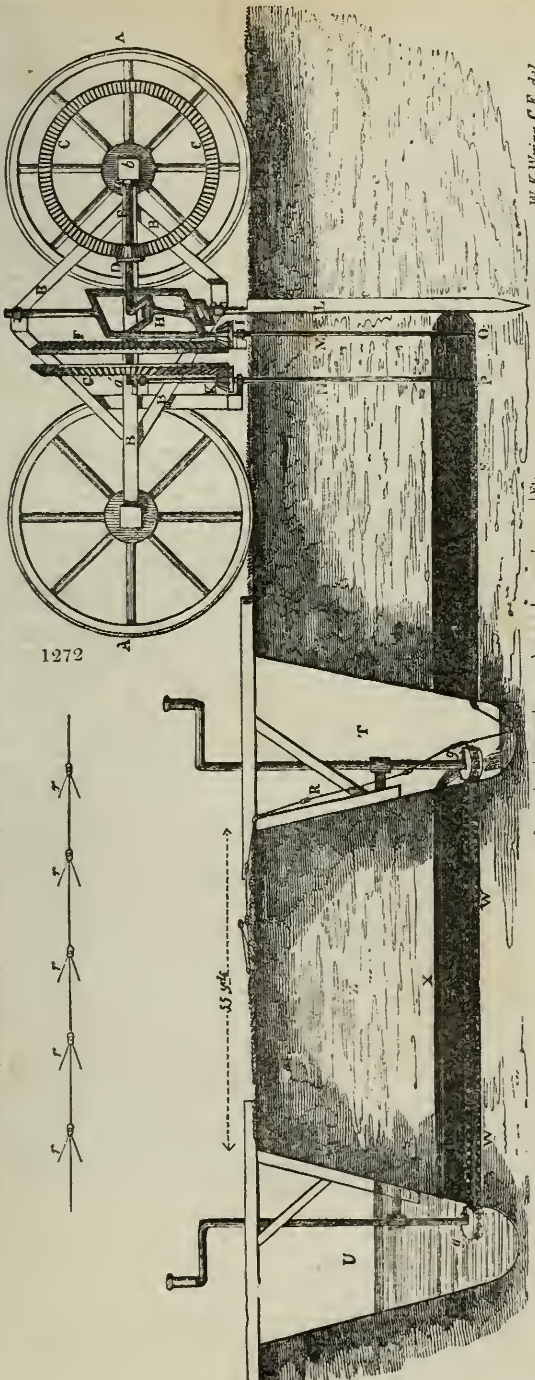
8469. *A chain*, R, made of wire, and in links, in order that it may accommodate itself to the turn out of the main drain T, into the minor drain Q, is attached to the lower part of the spindle N, as at S, by means of a ring playing upon the spindle, N, at perfect ease. Let us suppose the machine has now cut out the minor drain, from one main drain to another, as from U to T; we shall then have the chain extending through the minor drain V, an end being in each of the main drains U and T. The chain is then detached from the machine, and a fresh chain attached to it, making it ready to proceed with another cross minor drain.

8470. If the *puddle* made in the minor drain V is of a very semifluid nature, it is probable drawing the chain alternately backwards and forwards (which might be done by a labourer at each end) would bring a sufficient quantity of it out into the main drains, to cause an unoccupied space immediately under the undisturbed portion of the bog at X; thus making a passage for the water previously dammed up in the drain U, to pass over the puddle in the subterraneous drain V, and fall into the main drain T. As soon as this is effected, the drain may be left to the action of the water, which will very shortly carry away all the puddle out of it into the main drain T, from whence it may easily be cleared, without any expense.

8471. But should a *simple wire chain* not bring out the puddle quick enough, then a similar chain, but having fangs attached to it, as shown at *r r r*, *fig.* 1272., may be used, instead of the one before mentioned. The fangs are to be so arranged, that when they meet resistance moving in one direction, they open a certain distance from the chain, but upon meeting resistance moving in the opposite direction, they lie close to it. It will be unnecessary to describe how this may be accomplished, it will be so easily seen. Its operation in clearing out the puddle will be thus: — Having got it through the drain (and it will offer little more resistance than a plain wire chain, as the fangs will lie close), it is to be moved by men at each end, alternately backwards and forwards: each time it moves backwards, the fangs, from meeting resistance, opening, and bringing before them some portion of the puddle; thus, by a number of such movements, dragging out sufficient puddle to cause an unoccupied space, through which the water will rush.

8472. Or, *if the bog is very compact*, and the puddle very stiff, such as is likely to be the case in what is known by the name of "black bog," then the following method may be taken, which will give two men sufficient power to drag out the puddle from the subterraneous drain: — Suppose the wire chain R (without fangs) to be already dragged through the minor drain. Fastening one end of the chain W to the end of the chain R, it is drawn through and passed round the rag-wheels *g g*, which rag-wheels are connected with the winches, as shown in the drawing. Now it is evident, if the winches are turned, one portion of the chain will be moving in one direction, while the other portion is moving in the opposite one; and as the chain passes out of the minor drain it brings with it, between the links, and otherwise attached to it, portions of puddle, which fall off in the drain T, or are washed off in passing through the water in the drain U; the pins, or spikes, on the rag-wheel, as they pass through the several links, forcing off that portion of the stuff held between them. Besides this, that portion of the chain, passing out of the water in the drain U into the minor drain V, will carry with it a small portion of water, thus assisting the fluidity of the puddle, and consequently decreasing the resistance to the chain passing through. The quantity of stuff brought out of the minor drain by the revolution of the chain, will, after a few turns, cause the puddle in it to sink, and so leave a passage, as by the other methods, immediately under the undisturbed portion of the bog at X, for the water to discharge itself; in doing which it will continue to carry along with it portions of the minutely divided matter until the minor drain is cleared out.

8473. Let us now assume that *the puddle has been washed out* of the minor drain. It will be seen by the distribution of the knives fixed upon the spindles M N, the transverse section of the bog divided and puddled by those knives is a perfect circle, and consequently the transverse section of the drain is also a circle, a form best adapted to resist the tendency of the cir-



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cumambient bog to collapse; but although the bog immediately surrounding the drain has not been changed in its consistency by any operation of the machine, yet, containing so much water as it does, it necessarily partakes in some degree of the nature of fluids; hence we find the bottom of drains made in wet spongy "red bogs," have as strong a tendency to rise at the bottom, as the sides have to approach each other. Partaking, then, as the great mass of the bog surrounding the minor drain does, of a fluid nature, it will have a tendency to fill up the space made by extracting the puddle, but, in doing so, it will slowly approach. Now, as the pressure upon the bottom, sides, and top, in fact, upon every part of the circle surrounding the vacant space, is equal, or nearly so, the surrounding matter will approach the centre of the vacant space with equal velocity; and as it approaches, the circle being narrowed, the mossy fibres composing the bog immediately adjoining it will be pressed nearer to each other; and thus, being forced to part with a considerable quantity of the water which kept them apart, will gradually acquire a greater compactness and resistance, as the circle narrows, until, in the end, the fibrous matter will be pressed so close as to resist the pressure of the surrounding bog forcing it into a smaller space. We shall thus have formed a tubular drain, though something less in its dimensions than the diameter of the circle made by the knives O P. I never yet saw sufficient water coming from a minor drain to fill a two-inch bore, and I have seen a great deal of bog draining, and paid much attention to it. Even when any considerable quantity is discharged, it is to be supposed not from the drainage of the bog immediately about it, but from its having crossed the course of some spring. I may remark here (though the remark is unconnected with the effects produced by this draining-machine), that, when this is suspected, means should be taken to discharge the waters of the spring as quickly as possible, if it is a bog spring; but, if a spring supplied from the upland, the water should be impounded for irrigation. In general, both these objects may be obtained with little trouble or expense.

8474. *Minor drains* should not only be sufficiently large to pass off the water from the bog immediately surrounding them, but also to prevent them from being easily choked. I think they ought not to be less than six inches in diameter, and by way of securing them this size, the diameter of the circle made by knives might be ten inches, thus allowing them four inches for collapsing. The bog immediately surrounding the drain would have to be pressed into three fifths of its original bulk, before it enclosed the drain so as to reduce it to six inches in diameter; but, before it was pressed into so much less space than it originally occupied, it would have acquired a compactness enabling it to resist the pressure behind it, and the drains would, in general, be more than six inches in diameter. According to the consistency of the bog, the diameter of the circle made by the knives might be regulated.

8475. *Mode of using the machine.* Having described the operation of the machine, it will be necessary to point out the methods of overcoming any obstructions that may present themselves upon putting it in motion. We will, in the first instance, consider horses to be used for this purpose; in which case it will be necessary that the main drains, such as T and U, be made some time before the minor drains are commenced; in order that the bog Z, lying between them, may be sufficiently consolidated to admit of horses, with proper pattens, working upon it. This will take place upon the edges of bogs in a short time after the main drains are opened; but in the interior the consolidation will take place slowly, for, from its very spongy quality, it will not part with its water so quickly as the denser bog on the edges. It is the general practice to make the main drains parallel to each other, and at a distance of about ten statute perches asunder; and yet, although so near, so strongly retentive is bog of water, that, in very soft spongy bogs, it would require at least two or three years to drain them sufficiently, by this means, to admit of horses working upon them. Upon the edges they would be sufficiently firm in a few months. The bog may always be rendered sufficiently dry by taking a large quantity in hand at once, so that, before the last of the main draining is finished, the banks between the first drains cut will be well consolidated; or, if a small quantity only is taken in hand, by waiting till it does consolidate.

8476. *The probable expense of working the machine* by horses will be first calculated, and afterwards a method shown by which the minor drains may be made without waiting for the main drains to draw off any considerable quantity of water from the bog; thus expediting its reclamation, without adding to the expense.

8477. *The weight of the carriage and its machinery* is about one ton, and, as the wheels are intended to be nine inches upon the sole, they will sink little under so small a weight. Two horses would move the carriage with ease, and from two to four more (according to the depth and size of the drains, for they must vary with the nature of the bog) would overcome the resistance of the saw and spindles M N, with their knives. If we say five horses on an average, we shall be perfectly safe. I believe a less number would do. To this must be added two men for driving. The draining-machine is to proceed in a straight line, passing over the main drains, from one division of bog to another, until a minor drain is made from one extreme of the bog under reclamation to the other extreme.

8478. *In cutting main drains* it is usual to make them open, but I should propose, that occasionally bog bridges be left, say at a distance of every eleven yards; that is, leaving an open drain for eight yards, and having a bog bridge three yards broad. Many advantages attend this plan, not appertaining to the usual method. In the first instance, the labour and expense is something less; they afford an easy passage for men or cattle to walk over; thus preventing, in a great measure, the injury done in leaping across, and so destroying the sides of the drain, and choking it with the bog stuff thrown into it by these means. Bog bridges, if placed at short distances, prevent the collapse of the drains, and would on this account, enable us to cut them at once sufficiently deep, without waiting, as is necessary now, for two or three years. Viewed in connection with this draining-machine, they would afford a ready passage for the horses, and so save labour and expense, and facilitate the operation.

8479. *The method of passing the horses and machine over the main drains.* As soon as the horses arrive at the edge of a main drain, the chains by which they are drawing the carriage may be lengthened, so as to allow them to turn out of the direction they were proceeding in, and pass over a bog bridge, which will always be within two yards of the line of a minor drain; supposing them to be a statute perch distant from each other, as is usual. There will be little inconvenience, or loss of time, in this. As soon as they are on the other side they may again be hooked to the carriage, giving them chain sufficient to reach over the drain; a pass for the carriage-wheels having been previously formed. The pass is to be made thus: — Suppose the main drain to be four feet six inches wide at the top. Two three-inch planks are to be provided, each one foot broad and eight feet long, and having ribs of iron fastened on each edge of each of the planks, to prevent the wheels of the carriage from slipping off in passing over the drain. The length of these planks will give a bearing of one foot nine inches on each side of the drain, which will be quite enough, as there can only be a pressure of five hundred-weight on a plank at one time. Their extremes are to be worked off to a chisel edge, in order to facilitate the carriage mounting upon them. The planks being placed over the drain before the machine comes up, there will be no delay, except taking the horses to the other side of the drain, and unhooking them from the carriage and hooking them to again. As soon as the machine has passed over the drain, two men are each to take up a plank (they will not be a hundred weight each) and proceed to the next main drain and make a pass. They may easily have this done by the time the carriage comes up, there being little more trouble than throwing down the planks, of course due care being taken to place them in the line of direction in which the carriage is to move. In passing over drains already made, that have no bog bridges, it will be necessary to connect with the carriage pass more planks, so as to allow the horses to walk over without difficulty: this may easily be done.

8480. *The number of men* required to clean out a sufficiency of the puddle from the minor drains, so as to give vent to the water through them, is the next consideration. Except in very compact "black bog," it will not be required to use the winches with the chain and rag-wheel; and as bog of this description bears but a small proportion to the spongy or "red bog," this method will seldom need be resorted to. However, to make sure, the calculation of the expense is made upon the assumption that it will always be necessary. The platforms used for working the chain and rag-wheel, together with their machinery, do not weigh two cwt. each; so that two men would be able to carry one at a time, from drain to drain, as they were required. Let it be observed, it will not be necessary to move both platforms when a fresh drain is to be cleared by them. Thus, if the drain the machine is forming is to be cleared after the one in which the chain is working, the platform over the drain T would not have to be removed; it would merely have to be turned round: but the platform over U would have to be carried double the distance of U T. Calculating the men would be twice the time in carrying it this distance that the draining-machine is in moving from drain to drain, and that two men, having got the chain through the drain, would be about the same time in working out the necessary quantity of puddle from a minor drain as the draining-machine is in puddling one; and that it would take them twice this time to insert the chain, and draw it out again; we have two men occupied five times as long in cleaning a drain as is taken to puddle one; consequently it would, upon this calculation, take ten men to clean out the drains as fast as they were puddled. We will allow twelve men for this portion of the business. It must not be forgotten, we are assuming *all* the drains will have to be thus cleared, although it is by no means probable. We shall be under the mark, if it is only calculated the horses would move the draining-machine at the rate of one mile per hour: however, we will make our calculation on this assumption. If the horses work eight hours a day, they will make eight miles of draining. We shall have the day's expenses then as under, calculating them from the highest rate of labour in Ireland, a country to which this machine is particularly applicable.

	L.	s.	d.
5 horses, at 2s. per day - - - - -	0	10	0
2 men, making passes, at 1s. - - -	0	2	0
2 men, driving, at 1s. - - - - -	0	2	0
12 men, cleaning out drains, at 1s. - -	0	12	0
Wear and tear of machine, and pattens of horses, say	0	2	0
Cost of making eight miles of minor drains -	1	8	0

Now there would require 160 perches of minor drains per acre, supposing them to be made a perch asunder, the cost of which would only be 1s. 9d. The present expense is about 14s. per statute acre for the same work.

8481. *The main drains cost now, on an average,* about 9s. per statute acre, making the whole expense 23s. By the use of this machine the expense of main drains and minor drains would be 10s. 9d.; thus at once doubling the profits of bog reclamation, so far as draining is concerned.

8482. *Objections answered.* It may be said, horses could not work upon a very wet bog till a long time after the main drains had been made; perhaps years. To meet this objection, among many other obvious means, a windlass, mounted on a moveable platform, might be used; the windlass to be placed over the main drain, next the front of the draining-machine; and the platform upon which it is mounted to be made so that it shall have a bearing against the side of the drain, sufficient to enable it to resist the reaction from the draught of the machine. Its form will be similar to the platform used for clearing out the puddle; but, perhaps, it will be necessary to offer a greater face of planking to the side of the drain. Its weight need not exceed from three to four cwt., so that it may be easily removed, as occasion requires. By attaching a rope from the windlass to the carriage, it of course can be dragged on; and the expense by this method will probably be about the same as when horses are used. If it is objected, that drains made at one operation, in such wet bogs as we now are speaking of, will soon close; it may be answered, that though the collapse will undoubtedly be great, yet, being something like equal on all parts, the circular form of the drain will most certainly prevent a perfect closure of the aperture. This, though true of arched drains, is not so of the shoulder drains now in use: for, while the former increase their resistance to the pressure surrounding them, the nearer the approach to the centre of the unoccupied space, the latter, whose sides are straight lines, decrease in their power of resistance, under the same circumstances: hence it is found totally impossible to make shoulder drains to stand, except in tolerably firm bog; and, to secure this, they are generally made in three operations. I by no means admit it; but we will suppose every drain was to close after a short time: before doing so, they most certainly would have discharged a great portion of the water from the bog, and have consolidated it considerably, so that there would be no grounds to fear the closure of a second set of minor drains made after the first set had drawn off the great body of water from the bog. Should even this be necessary, the expense of the minor drain would only amount to 3s. 6d. per statute acre. It will readily be admitted, that, where there is the slightest fear of a circular drain closing, a straight-sided drain could not possibly stand.

8483. *The profits of reclaiming bogs.* By the use of such a machine as is here described, the profits of bog reclamation would be much increased; but, as in conjunction with other machines the inventor of this has contrived one for carrying earth on bogs cheaper than by movable railroads now in use, and performing other operations in bog improvements (which he will take another opportunity to describe), there can be little doubt that bogs may be converted into land not inferior to some of the best upland, and that, too, so as to yield a profit of from 10 to 40 per cent, according to the particular circumstances under which the bog lies; thus not only yielding a handsome income to the reclaimers, but also as providing a large field for the employment of the labouring population.

THE END.

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