SEED-TIME.

THE PRINCIPLES AND PRACTICE OF AGRICULTURE,

SYSTEMATICALLY EXPLAINED;

IN TWO VOLUMES:

Being a Treatise compiled for the Fourth Edition of The ENCYCLOPÆDIA BRITANNICA,

AND REVISED AND ENLARGED BY

ROBERT FORSYTH, Esq.

VOL. I.

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TO

THE RIGHT HONOURABLE

LORD SHEFFIELD,

PRESIDENT,

AND THE OTHER MEMBERS

OF

THE BOARD OF AGRICULTURE,

THIS WORK IS RESPECTFULLY DEDICATED,

THE PROPRIETOR.

PREFACE.

IT may here ſeem neceſſary to give ſome account of the origin and progreſs of the work now preſented to the public.

In the third edition of the Encyclopædia Britannica, which has been received by the world with ſuch approbation, as to obtain a degree of currency, which is without example in works of ſuch magnitude, the art of Agriculture was diſcuſſed under the various ſeparate heads, of Agriculture, Huſbandry, Draining, Moſs, and others, ſuggeſted by the alphabetical arrangement of a dictionary of Arts and Sciences. The property of that work having at length become concentrated in an individual, he reſolved to proceed to a fourth edition, containing ſuch alterations and improvements, as the courſe of time and the progreſs of the arts had rendered neceſſary.

In the execution of this taſk, it appeared an object of importance, to concentrate, as much as poſſible, the diſcuſſion of the various branches of Science or of Art, into a ſyſtematic form, under a few diſtinct heads; inſtead of leaving their different parts and members ſcattered, as formerly, throughout eighteen or twenty volumes.

Accordingly, at the commencement of the fourth edition of the Encyclopædia Britannica, the propoſed alteration was undertaken with regard to the ſubject of Agriculture, which, from the alphabetical arrangement, neceſſarily preſented itſelf for diſcuſſion at a very early period of the work. The various branches of that art were condenſed into a ſingle treatiſe; and, although

although various particulars were introduced or discuſſed at greater length than formerly, yet by lopping off the redundancies which unavoidably occurred in the former ſcattered mode of diſcuſſion, and by adhering ſtrictly to a ſyſtematic arrangement, the whole was conſiderably abbreviated.

After the treatiſe alluded to had been compiled and printed, it occurred to the proprietor, that conſiderable numbers of perſons, to whom the peruſal of it might be productive of much advantage, would be very unlikely to become purchaſers of a literary work of ſuch magnitude and expence as the Encyclopædia Britannica. As it is of the utmoſt importance, however, to the public, to give all poſſible currency to literary works upon an art which is of ſuch extenſive and eſſential utility to mankind, a reſolution was adopted to introduce to the world, as a ſeparate publication, the treatiſe upon Agriculture, which had been prepared for the fourth edition of the great work above mentioned. At the ſame time it was thought, that before carrying this reſolution into effect, it might be proper to reviſe the whole treatiſe, and to make ſuch additions or alterations as ſhould ſeem requiſite for its farther improvement. This taſk has accordingly been undertaken, and the reſult is preſented to the public. The alterations which have been made conſiderably exceed, both in number and extent, what was originally intended; ſo that a great part of the treatiſe has changed its character, although the former arrangement has, upon the whole, been adhered to: In particular, the hiſtory of the art has been much enlarged; advantage has been taken of recent publications, eſpecially of thoſe which the Board of Agriculture ſuggeſted or brought forward, to explain the principles

principles upon which the rotation of crops and the culture of graffes ought to be conducted; various other branches of the fubject have, in like manner, been enlarged or altered; and fome fubjects of agricultural curiofity in the practice of foreign nations have been introduced, which, it is hoped, will prove not unacceptable to the clafs of readers for whofe ufe this work is intended.

Throughout the treatife, practical utility is the object kept in view; and the notions of ingenious and fpeculative men, which have a tendency to miflead into rafh projects perfons engaged or engaging in agriculture, are carefully avoided. No more of theory is introduced than feemed abfolutely neceffary to exhibit a view of thofe general principles, which long experience in the art has dictated to men of found judgment and correct obfervation.

In the details given, concifenefs, as far as confiftent with perfpicuity, has been chiefly kept in view; but by adhering ftrictly to a fyftematic arrangement, a very great variety of fubjects will be found introduced and difcuffed.

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SYSTEM

OF

AGRICULTURE.

INTRODUCTION.

AGRICULTURE in general, or in the abſtract, may be defined to be, The art of making the earth to produce in large quantities, and in the greateſt perfection of which their nature is capable, thoſe vegetables which are neceſſary to the ſubſiſtence, or uſeful for the accommodation, of mankind. Agriculture differs from gardening in this reſpect, that the gardener is chiefly occupied in rearing ſmall quantities of the nicer and more delicate vegetables, which are rather valued as objects of luxury than as articles of food; whereas the agriculturiſt labours upon a larger ſcale, with a view to ſupply himſelf and his countrymen with the neceſſaries of life. Definition. Differs from gardening.

In civilized ſocieties, agriculture, or the cultivation of the ſoil, becomes a ſeparate buſineſs or employment; and agriculturiſts, or the perſons engaged in agriculture, receive the appellation of *farmers* or *huſbandmen*. Is a ſeparate art.

To enable the agriculturiſt or huſbandman to conduct his buſineſs with ſucceſs, it is neceſſary that he Includes the rearing of cattle.

Nature of the Art.

ſhould not confine his attention to the mere cultivation of the ſoil, or the rearing of vegetables. The vegetables which are capable of affording a comfortable ſubſiſtence to the human conſtitution are few in number; and it has been found by experience, that they cannot be profitably ſown and reproduced year after year upon the ſame ſpot of ground. Hence it becomes neceſſary at times to rear upon it graſſes or other plants which are unfit for affording nouriſhment to man. But although men cannot eat graſs, they may, nevertheleſs, contrive to obtain ſubſiſtence from it in an indirect manner. They may give it to cattle, whoſe ordinary and natural food it is; and having thus, as it were, converted the graſs into the fleſh of animals, they can devour theſe animals; and in this way, obtain a richer and more ſtimulating food than any vegetable production can poſſibly afford. It is therefore a part of the buſineſs of the huſbandman to rear and to feed thoſe animals which are uſed as food in the ſociety of which he is a member, that he may be enabled at all times to derive profit from the portion of territory that he cultivates. It is alſo neceſſary towards conducting his operations with ſucceſs, that he ſhould rear and feed other animals, not as a ſource of human ſubſiſtence, but for the ſake of the ſervices which they are capable of affording; for it has pleaſed the beneficent Contriver of this world, to place upon it beings of a ſubordinate nature, capable of aſſiſting mankind in their labours, without being degraded by the ſtate of ſervitude in which they are placed. To the cultivators of the ſoil, theſe animals, from their ſtrength and patience of labour, are particularly uſeful, and even abſolutely neceſſary in our cold and barren climates.

They muſt therefore be fed and lodged with the greateſt care.

Importance of the Art.

Hence, the employment of the huſbandman is of an extenſive nature, requiring much foreſight, and a conſiderable knowledge of the relations that ſubſiſt between the moſt important objects in nature—the ſoil, the ſeaſons, the animals, and the plants, ſo far as they are connected with the ſubſiſtence of mankind. It is by bringing to perfection this art that man becomes truly the lord of the univerſe. He ſubdues by his operations every part of the ſurface of the earth, and acquires over the animals which inhabit it, a ſolid right of dominion or of property, in conſequence of having reared, and afforded them ſubſiſtence by his ſkill and his labour. He uſes them indeed as food; but before he can do ſo, he muſt firſt beſtow upon them ſubſiſtence, attend to their multiplication, and to their health and welfare. As they poſſeſs no foreſight, the purpoſe to which they are deſtined is to them no evil.

It is only in proportion to the degree in which this important art of agriculture has flouriſhed, that nations have been, or ever can be, permanently proſperous. Every improvement that is made in it is a moral benefit conferred upon mankind; for, by increaſing the quantity of human food, or facilitating the production of it, one of two things muſt always happen: Either the number of our ſpecies will be increaſed, that is to ſay, a greater multitude of rational and intelligent beings will exiſt in the creation; or a greater number of thoſe who already exiſt, will find leiſure for the improvement of their intellectual characters, by ſtudying and carrying to perfection the ſciences and arts. Thus, the

History. ſtrength of nations is increaſed in proportion to the degree in which their ſoil is ſkilfully cultivated, and their independence is ſecured by finding upon the ſpot *which they inhabit all that is neceſſary for their ſubſiſtence.*

It is a fortunate circumſtance, that the art of the *huſbandman, which is the foundation of all others, and* at all times *indiſpenſable to human* exiſtence, is in every reſpect conducive to the welfare of thoſe engaged in it. The practice of it beſtows health upon the body; and

tages to thoſe who practiſe it.

by the variety of occupations which it affords, it alſo beſtows a conſiderable degree of reflection upon the minds of the loweſt perſons occupied in it; while, at the ſame time, it prevents their acquiring that ſpirit of artifice and of cunning, which in all countries is apt to degrade the character of thoſe engaged in the inferior branches of commercial employment. Nor does it fail, in all ranks and conditions of life, to produce a more candid and liberal character than any other employment. No Britiſh huſbandman has ever refuſed, or even heſitated to allow to be communicated to the public every branch of his art, and every improvement which he and his forefathers may have made in it; whereas, in all the branches of manufacture or of commerce, every tranſaction, as far as poſſible, is covered with a myſterious veil of ſecrecy, and every improvement is concealed by its inventor, and ſometimes undoubtedly periſhes with him.

History. No branch of hiſtory is more inſtructive, nor conſequently more important, than that which explains the progreſs of the human mind in the diſcovery and improvement of the uſeful arts. As the art of agriculture, in point of utility, ranks above all others, a detail of the

efforts

efforts by which ingenious men have brought it to its present degree of perfection, would undoubtedly prove extremely interesting. It has hitherto, however, been one of the misfortunes of mankind, that, in consequence of a false taste, they have bestowed more attention and applause upon great talents or ingenuity, when exerted in the arts of destruction, than when employed in devising the means of giving plenty and felicity to nations. The writings of historians and poets are filled with the actions of men, who, under the influence of an insatiable lust of dominion, have wasted cities and provinces, and have defaced the fairest monuments of human genius and industry; while the beneficent enterprizes and efforts of those men are neglected or forgotten, who invented the instruments of agriculture, who selected or imported into their country the plants most worthy of cultivation, or who drained morasses, gave fertility to barren wastes, and pointed out the best modes of preserving and augmenting the productive powers of the soil. History.

Mankind have suffered severely, in consequence of their absurd admiration of successful ambition, and the applause which they bestow upon it. By this applause they in every age tempt restless individuals to lay schemes for their destruction, and to glory in the debasement and misery which they bring upon large portions of the human race. It were well, therefore, if the friends of humanity could contrive to do away this false taste, by calling from obscurity, and bestowing [illegible]tion of renown, upon the true friends of mankind, whose labours have in ancient or modern times been directed towards promoting the best interests of mankind by the improvement of this most important

History. of all arts. The materials, however, for a hiſtory of agriculture are few, and it is inconſiſtent with our plan to give more than the moſt general outline of what is known concerning it in paſt ages.

The hiſtory of agriculture is equivalent to the hiſtory of civilization and of arts. Men who paſs their days in the unſettled ſtate of hunters and ſhepherds, muſt always be few in number. As their wants are not many, their means of ſupplying them, that is, their arts, will be proportionably unimportant. It is only when the increaſe of their numbers has compelled them to have recourſe to the cultivation of particular plants, and when the reſult of an improved agriculture has in its turn provided ſubſiſtence for multitudes of men in a ſtationary or ſettled ſtate, that human ingenuity is rouſed to the diſcovery of the ſecrets of nature, by ſearching after modes of gratifying new and more refined wants than were formerly known. Accordingly, we find in every country, and in every age of the hiſtory of mankind, that agriculture has been the baſis of civilization, and that they have gone hand in hand in improvement.

Eaſtern agriculture. The great civilized nations which in ancient times occupied the eaſt were chiefly three: towards the riſing ſun was the great empire of China; on the ſouth was India; and on the weſt was Perſia, which in its progreſs ſtill further weſtward, came to include the country of the Aſſyrians, and the territories which bound the eaſtern ſhores of the Mediterranean ſea, Leſſer Aſia, Syria, and Egypt. In all theſe countries letters and arts have exiſted from very remote periods, and along with them, as their foundation and ſupport, agriculture has flouriſhed; and, which is of more importance,

portance, the persons engaged in it have been held in very great estimation. On the contrary, the Tartars, who have in all ages occupied the northern regions of Asia, together with the great, elevated, and desert tract of country between Persia and China, have always existed in a pastoral, and consequently in a barbarous state, equally strangers to agriculture and to the arts which it produces. History.

The civilization of the Chinese empire appears to have existed from the remotest antiquity; and long experience has taught that people the great importance of agriculture, and the estimation in which it ought to be held. Accordingly, by a fundamental part of their policy, it is distinguished and encouraged by the government beyond all other arts or employments. To render it honourable, the emperor annually, at the beginning of the spring, which is the commencement of their year, goes to a field in person, in a common cart or waggon, painted green, and in presence of the princes of the blood royal, of the officers of state, and first mandarins of the empire, holds the plough for a time. The ceremony is extremely solemn, and the emperor offers up prayers for a plentiful crop to his people. On the same day, a similar ceremony is performed by the governor or chief mandarin in every province of that great empire.

With a similar view of rendering it honourable, and calling the attention of all orders of men to the importance and value of agriculture, it was a custom the ancient Persians, that once a-month their king sat down to table with a party of practical husbandmen, or persons engaged in the ordinary labours of agriculture. This people had a regular priesthood for in-

History. *ſtructing the people in their religious duties; and it is* not a little remarkable that agriculture was repreſented by them as the moſt acceptable ſervice which a devotee could perform in the ſight of their ſupreme deity, the ſun or element of fire. The *ſaint* among them was obliged to work out his ſalvation by the practice of all the labours of agriculture; and it was a maxim, that he who cultivates and ſows the ground with care and diligence, acquires a greater chance of paradiſe than he could have gained by the repetition of ten thouſand prayers.

Hindoſtan, at the time of its invaſion by Alexander of Macedon, appears to have been nearly in the ſame ſtate in which we at preſent find it. Agriculture was carefully attended to, and along with it the uſeful arts flouriſhed, riches abounded, and the people were numerous, humane, and happy, though unfortunately enfeebled by a degrading ſuperſtition, which by preventing the free exertion of their faculties, renders them an eaſy prey to every invader. Even in their ſuperſtition, however, their reſpect for agriculture appears. Hence aroſe the divine honours long paid by them to Bacchus, as the firſt teacher of the art of cultivating the vine.

From a ſimilarity of ſuperſtitions and of manners, it appears extremely probable that ſome cloſe connexion ſubſiſted at a remote period between the Hindoos and the ancient Egyptians. The banks of the Ganges and of the Nile are fertilized in the ſame manner, and upon both, the art of agriculture is of an extremely remote antiquity. The ancient Egyptians, like the Hindoos, raiſed vaſt quantities of corn; and ſo ſenſible were they of the importance of the art which enabled them to do ſo, that they

They worshipped as a god, its real or reputed inventor, under the appellation of Osiris. They regarded Isis, their second deity, as the discoverer of the use of wheat and barley, and as the first who, having gathered the seeds of these grains in the woods, sowed them on prepared land, and reaped a crop thus procured by art. History.

In these eastern nations the most valuable practices in agriculture were well known. The use of the plough was known. Hollow draining was so well understood, together with the purposes to which it may be applied, that the modern Persians are in some places said to find water in their fields, conveyed in channels, of which they know not the course, but which have been placed there in former times by a more industrious and intelligent people. Artificial canals for watering the soil, and even for conveying its produce to distant places, appear to have been long used in the east. Mills were used in India of a very simple and ingenious construction for grinding grain. No threshing machine, however, appears to have been invented; and to this day, over all Asia, the corn is trodden out from the ear by the feet of cattle.

The Phœnicians, who inhabited the eastern coast of the Mediterranean, and are so frequently mentioned in the sacred Scriptures by the appellation of Philistines, (i. e. Palestines, or inhabitants of Palestine,) appear to have made considerable progress in agriculture. Being a maritime people, they carried their civilization and arts to various islands, and to several countries along the shores of the Mediterranean. Carthage was one of their colonies; and we know that, as early as the days of Herodotus, the part of Africa adjoining to that city, and which formed its territory to the westward.

History. ward, was inhabited by an agricultural people. As the Greeks derived the first rudiments of their literature from the Phœnicians, there can be little doubt of their having obtained their knowledge of agriculture from the same quarter.

Agriculture of the Greeks. Notwithstanding their constant wars, the situation of the Greeks appears upon the whole to have been favourable to agriculture. They were divided into a great variety of petty states, in which the territory was chiefly held by small proprietors who cultivated their own lands. The great population of the country, wasted as it so frequently was by intestine wars, could only be supported by considerable skill, or at least by great industry in agriculture.

Hesiod was the first known to us among the Greeks who wrote on this interesting subject. According to the custom of the Oriental authors, he wrote in poetry, and embellished his poem with luxuriant description and sublime imagery. He calls his poem *Works and Days*, because agriculture requires the exact observation of times and seasons.

Xenophon, in his Oeconomics, has remarked, that agriculture is the nursing mother of the arts. For, says he, "where agriculture succeeds prosperously, there the arts thrive; but where the earth necessarily lies uncultivated, there the other arts are destroyed."

Other eminent Greek writers upon agriculture were, Democritus of Abdera, Socraticus, Archytas Tarentinus, Aristotle, and Theophrastus, from whom the art received considerable improvements.

Of the Romans. The state of agriculture among the ancient Romans merits a very particular degree of attention, on account of its influence upon the political destiny of that singular people. Histories of Rome and of the Romans are in the hands of all perſons, and their military achievements, as well as civil diſſenſions, have been tranſmitted to us with minute care and accuracy by various writers. It is underſtood by few, however, that the Romans were only conquerors becauſe they were cultivators of the ſoil, and that their love of war aroſe from their attachment to agriculture, and the independence and felicity which is enjoyed in that mode of life. History.

At the period when the foundation of Rome was laid, Italy appears to have been divided, as in later times, into a great multitude of petty ſtates, deſtitute of any common bond of union. From the ſimilarity of language, of inſtitutions, and of religion, as well as from vicinity of ſituation, it appears certain that Italy muſt have been peopled by colonies from Greece. Theſe colonies had arrived after the Greeks had made ſome progreſs in civilization; becauſe we learn from hiſtory, that when Rome was founded, all the neighbouring ſtates were acquainted with agriculture, and no people that is entirely barbarous can poſſeſs this art. At the date of the foundation of Rome Italy was only partially ſettled, like the United States of America, at the preſent day. Romulus appears to have acquired the property of a ſmall diſtrict of a few miles over, upon which he reſolved to eſtabliſh a colony. With this view he invited ſettlers, by gratuitous offers of ſmall portions of land; and, as the country was under no common government, he made his eſtate an aſylum for runaway ſlaves. That he was no barbarian is evident from his adopting regulations founded upon the wiſeſt maxims of colonial policy. He granted to every individual who choſe to ſettle on his territory as much land as, when well cultivated, was accounted ſufficient to ſupport

History. port a poor and frugal family (two jugera). His territory was soon stocked with small proprietors. The children of these persons, though bred up in frugal and laborious habits, were unable to find subsistence upon the small properties belonging to their parents. The country being destitute of commerce and manufactures, they had no other resource than that of emigrating in search of new lands. They had no money to purchase such lands; but, uniting into a body under the chief of their community, they attacked the weakest of the petty neighbouring states, and forced them to cede or make over to them some part of their territory. Thus the dominions of the petty chieftain of the Roman state were increased, while his young men were provided for by the shares which they received of the conquered lands, which were fairly and equally divided among them.

The new families which were settled in this way upon small properties, speedily cast out another swarm of hardy young men, trained up in frugality and the labours of agriculture, and therefore prepared to become most excellent soldiers. The same necessity which compelled their parents to invade their neighbours, obliged this new generation also to rest upon the success of their swords, their whole hopes of obtaining lands, on which to make use of the ploughshare. Thus war became necessarily the occupation of the Roman youth, that they might be enabled to pass their old age in the cultivation of the soil. The territory of Rome became a nursery of soldiers. Her armies were invincible, because the individuals of which they were composed, being young men of a robust constitution, and frugal and laborious habits, urged on by want, and engaged in a contest for what

what they accounted riches and independence, ſeldom encountered their equals in fortitude and courage, and never failed to perſevere in every ſtruggle, till they were either ſucceſsful or exterminated. It is true, that no nation ever ſuffered greater or more frequent defeats than the Romans in war; and in the management of their campaigns and battles, they often committed the moſt groſs military errors: but theſe were rendered of no importance to the general hiſtory of the people, in conſequence of their agricultural policy, which enabled them at all times to renew the war by means of new ſwarms of military adventurers, the ſons of their peaſantry. Hence, alſo, they never loſt a foot of territory that they once gained; becauſe the conquering army conſiſted of young men who had no intention of returning home, but who inſtantly ſettled upon the lands which they had ſubdued. A Roman army was thus a colony of huſbandmen, who made war with the ſame views, with which the original ſettlers in North America made war upon the ſavages or native inhabitants of the country, that is, that they might ſeize, and cultivate, and inhabit their lands. The Romans, indeed, were not ſuperior in arts to their immediate neighbours; and hence, their conteſt for dominion was long and arduous, and owed its ultimate ſucceſs merely to the inſtitutions of * Romulus the founder of the ſtate, the ſpirit of which, his

History.

* The learned reader will eaſily recollect authorities which illuſtrate and confirm what is here ſtated. Ac primus agros quos bello Romulus ceperat, diviſit viritim civibus. Cic. *de Republica*, lib. 2.

Quantum attinet ad antiquos noſtros ante bellum Punicum pendebant bina jugera, quod a Romulo primum diviſa dicebantur viritim. VARRO *de Re Ruſtica*, lib. 1. cap. 10.

Tandem

History. his ſucceſſors, whether kings or conſuls, appear (with the exception of Numa) to have well underſtood, and for ſome ages to have correctly and zealouſly carried into effect.

By degrees, indeed, the fundamental maxims, that is to ſay, the agricultural maxims of Roman policy, were diſregarded. Like other ſtates, they at laſt engaged in war not merely to provide for their ſupernumerary youth, but from a love of national power and aggrandizement. They gave pay to their ſoldiers, and kept them long in the ſervice. They no longer divided among theſe hired troops the lands, or a large portion of the lands conquered in war, but ſet them up to ſale, or left them to be held for a tribute, which was ſpent in corrupting the populace of the capital. Still, however, the whole hiſtory of Rome, from its earlieſt to its lateſt period, exhibits proofs that the labours of agriculture, even when unattended by riches, were held in higher eſtimation than they have ever been by any other European nation. The religion of the ſtate connected itſelf in a peculiar manner with this art, and impreſſed upon it a great degree of reſpectability. The people were taught to believe, that the † ſupreme divinity was the firſt who inſtructed

Tandem pro multis vix jugera bina dabantur
Vulneribus. Juvenal, *Sat.* 14. lib. 5.

Multis legionibus contigit bellum feliciter tranſigere, et ad glorioſam agriculturæ requiem primo tyrocinii gradu pervenire, cum ſignis et aquila et primis ordinibus et tribunis deducebantur. Hyginus.

† Ante Jovem nulli ſubigebant arva coloni. Virg. Georg. lib. i.
Diique Deæque omnes ſtudium quibus arva tueri,
Quique novas alitis nullo de ſemine fruges,
Quique ſatis largum cœlo demittitis imbrem. *Id.* lib. i.

Pan

ſtructed men in the art of agriculture; and a variety of inferior deities were repreſented as preſiding over the different fruits of the earth, and the operations of nature in bringing theſe fruits to maturity, to reward the toil of the huſbandman. In all the ſeaſons of the year, different feſtivals were appointed, upon which the magiſtrates went in proceſſion to the temples of the gods, and ſometimes to the fields, to offer up prayers for the ſafety of the crop, or of the cattle, and for ſucceſs in every agricultural undertaking. History.

The political inſtitutions of the ſtate were all calculated in a ſimilar manner to confer reſpectability upon the practice of this art. In the early ages of the republic, the individual ſoldiers of a victorious army were each put in poſſeſſion of his portion of the conquered territory, with all the ſolemnity and parade of a military proceſſion, thereby giving dignity to the labours of the huſbandman, by aſſociating them with the proud ideas of conqueſt and dominion. Hence, the perſons engaged in any branch of art or manufacture, or in any commercial employment, were regarded as an inferior claſs, and as holding a far lower rank in ſociety than the meaneſt huſbandman, or perſon engaged in the cultivation of the ſoil. One of the puniſhments which the public cenſors or inſpectors of morals, ſometimes inflicted upon a diſorderly citizen, conſiſted of ſtriking his name out of the liſt of the inhabitants of the country, and of enrolling him among the city tribes.

The

Pan curat oves oviumque magiſtros, VIRG. *Eclog.*
Et ruber, hortorum decus et tutela Priapus. OVID. *Faſt.* lib. 1.
Populus Alcida gratiſſima, vitis Iaccho. VIRG. *Eclog* 7.
Montium cuſtos nemorumque virgo. HORAT. *Ode* 16. lib. 1.

History.

The very high degree of respect in which agriculture was held among the ancient Romans, explains what has often appeared a strange circumstance in their history, that after they had made considerable conquests, they should still have employed as consuls, dictators, and commanders of mighty armies, men accustomed to support themselves by holding the plough upon their own farms. In this there is nothing wonderful. Among the Romans, the husbandmen were accounted the most respectable order of society. Their morals were the purest, and the young men of this class formed the military strength of the state. As in modern Europe, a nobleman or gentleman with little private property, is often employed to conduct fleets and armies, on account of the respectability of his birth, talents, and education; the Romans in like manner disregarded private wealth in the choice of their leaders, but at the same time selected them from the most respectable and warlike, that is, the agricultural class of their citizens. Examples of this sort of preferment, tended to preserve to a very late period a taste for agriculture and for frugal manners. Hence, the most illustrious senators of the empire, in the intervals of public concerns, applied themselves to this profession; and such was the simplicity of those ages, that they assumed no appearance of magnificence and splendour, or of majesty, but when they appeared in public. At their return from the toils of war, the taking of cities, and subduing of hostile nations, their greatest generals were impatient till they were again employed in the arts of cultivation.

Regulus, when in Africa, requested of the senate to be recalled, lest his farm might suffer, for want of proper cultivation, in his absence; and the senate wrote him for anſwer, that it ſhould be taken care of at the public expence, while he continued to lead their armies. History.

Cato the cenſor, after having governed extenſive provinces, and ſubdued many warlike nations, did not think it below his dignity to write a Treatiſe on Agriculture. This work (as we are told by Servius) he dedicated to his own ſon, it being the firſt Latin treatiſe written on this important ſubject; and it has been handed down to us in all its purity, in the manner that Cato wrote it.

Varro compoſed a treatiſe on the ſame ſubject, and on a more regular plan. This work is embelliſhed with all the Greek and Latin erudition of that learned author, who died 28 years before the commencement of the Chriſtian æra. Virgil, who lived about the ſame time, has, in his Georgics, adorned this ſubject with the language of the Muſes, and finely illuſtrated the precepts and rules of huſbandry laid down by Heſiod, Mago, and Varro.

Columella, who flouriſhed in the reign of the emperor Claudius, wrote 12 books on huſbandry, replete with important inſtruction.

From this period to that of the reign of Conſtantine Poganatus, huſbandry continued in a declining ſtate; but that wiſe emperor cauſed a large collection of the moſt uſeful precepts relating to agriculture to be extracted from the beſt writers, and publiſhed them under the title of *Geoponics*. It has been aſſerted, that he made this collection with his own hand; and the truth of the aſſertion is not improbable, as it is well known, that after he had conquered the Saracens and the Arabians, he not only practiſed and encouraged, but ſtudied

History. the arts of peace, fixing his principal attention on agriculture, as their beſt foundation.

After the death of Conſtantine, however, the increaſing attention of the people to commerce, and the ignorance and groſs ſuperſtition of the ages which ſucceeded, ſeem to have rendered agriculture an almoſt neglected ſcience. The irruptions of the northern nations ſoon aboliſhed any improved ſyſtem. Theſe innumerable and enterpriſing barbarians, who overran all Europe, were originally ſhepherds or hunters, like the preſent Tartars and the ſavages of America. They contented themſelves with poſſeſſing, without labour or trouble, thoſe vaſt countries rendered deſerts by their own ravages, cultivating only a very ſmall ſpot near their habitations; and in this trifling huſbandry only the meaneſt ſlaves were employed: ſo that the art itſelf, which formerly was thought worthy of the ſtudy of kings, was now looked upon as mean and ignoble; a prejudice which is ſcarcely effaced at preſent, or at leaſt but very lately.—During this period, therefore, we find no veſtiges of any thing tolerably written on the ſubject.

The earlieſt efforts that were made in Europe towards the reſtoration of agriculture, after the conqueſt by the northern and eaſtern ſwarms of barbarians, appear to have occurred in Italy, which, after all its miſfortunes, ſtill continued to take the lead of the weſtern world, in whatever regarded the civilization of mankind and the improvement of the uſeful arts. But as the barbarians had introduced a pernicious notion, which remained long faſhionable in Europe, that labour was diſgraceful, and more eſpecially that kind of labour which is employed in the cultivation of the ſoil, it was long before

before hiſtorians began to take notice of agricultural im- provements, or of any other events than thoſe petty wars which were at that period continually taking place among the free cities and feudal chieftains. One circumſtance, however, deſerves attention, as it ſufficiently marks the progreſs in agriculture that had been made by the Italians at a very early period; works of great expence and magnificence were formed in Lombardy during the middle ages, for the purpoſe of irrigation or with a view to water the ſoil. History.

As the irrigation of the Milaneſe is perhaps the greateſt exertion of the kind that the world exhibits, and certainly was the firſt that was undertaken in Europe, after the decline of the Roman empire, it undoubtedly merits every attention, and ought to be held up to the view of the people of Great Britain, as an object in many inſtances well deſerving imitation. The water is there conveyed to every diſtrict of the country, in extenſive and noble canals, from which the graſs lands belonging to private perſons are periodically watered. All rivers or running ſtreams are declared by law to belong to the ſovereign, who ſells the waters to ſpeculators for the beneficial purpoſe of irrigation. It is ſometimes meaſured out by the length of time a certain quantity of water is allowed to run upon the lands, and ſometimes a ſtream of water proceeding through a tube or hole of a certain diameter from a canal, is ſold or let at the higheſt price it will bring. The property of ſuch ſtreams of water derived from canals, is often held in perpetuity, and diſpoſed of by a ſeparate tenure from the land. The practice is found ſo profitable both to the public and to private individuals, that the whole country, as far as poſſible, is interſected with canals, formed for the

History. purpose of conveying water to the lands. Every considerable spring that is found, becomes the origin of a new canal. He who discovers a spring, conducts it where he pleases, paying a fixed compensation for cutting through the properties of others. "As an example of the beneficial influence of this law, (says Mr Arthur Young *) I was shewn between Milan and Pavia a spring, that was discovered two miles from the lands of the discoverer, the properties of many persons lying between him and the spring. He first bought the property of the person in whose lands it was situated, which was easily done, as it was too low to be there of any use; then he conducted it by a trench at pleasure the two miles, paying the fixed price for cutting through his neighbours lands, and having gained it upon his own, presently changed poor hungry arable gravel into a very fine watered meadow." In the neighbourhood of the cities of Milan and of Lodi, the exertions in irrigation are the greatest. Canals are not only numerous and uninterrupted, but are conducted with great skill and expence. Along the public roads there is almost everywhere one canal on the side of the road and sometimes two. Cross ones are thrown over these on arches, and pass in trunks of brick or stone under the road. A very considerable one, says the above author, "after passing for several miles by the side of the highway, sinks under it, and also under two other canals carried in stone troughs eight feet wide; and at the same place under a smaller that is conducted in wood. The variety

* *Travels*, vol. ii.

riety of directions in which the water is carried, the ease with which it flows in contrary directions, the obstacles which are overcome, are objects of admiration. The expence thus employed, in the 20 miles from Milan to Lodi, is immense. There is but little rice, and some arable, which does not seem under the best management, but the grass and clover rich and luxuriant; and there are some great herds of cows, to which all this country ought to be applied. I cannot but esteem the 20 miles, as affording one of the most curious and valuable prospects in the power of a farmer to view. We have some undertakings in England that are meritorious; but they sink to nothing in comparison with these great and truly noble works. It is one of the rides which I wish those to take who think that every thing is to be seen in England." History.

It is not easy, amidst the darkness of the middle ages, to discover the precise period at which these interesting and valuable works were begun. In the year 1037, however, mention is made of the canal Vecchiabbia. In 1067, watered meadows were common, called *pratoroco* by Landolfo. In 1077 there are notes of many streams used. In 1138, the monks of Chiarevalle bought of Giavanni Villano some commons, woods, and meadows, for 81 livres, under the contract, (a parchment yet remaining) "ut monasterium possit ex Vecchiabbia trahere lectum ubi ipsum monasterium voluerit; et si fuerit opus, liceat facere eidem monasterio fossata super terram ipsius Johannis ab ima parte vice et ab alia . . . . &c. Possit firmare et habere clusam in prato ipsius Johannis, &c." There is a similar contract of the following year, and various others until the beginning of the 13th century; from which, and others, it appears that the Vecchiabbia

History. was the entire property of the monaſtery, and confirmed in 1276 by the diploma of the emperor Frederick II. The merit of theſe monks appears to have been great, for they gained ſuch a reputation for their ſkill and induſtry, that they had many applications for aſſiſtance in directing works ſimilar to their own upon uncultivated lands; and the imperial chancellor Rinaldo, in the time of the emperor Frederick I. being appointed archbiſhop of Cologne, found the poſſeſſions of his ſee in ſuch a deplorable ſtate, that he applied for, and received the ſame aſſiſtance, as reported by Ceſarior Eiſterbacenſe. Their greateſt exertions were in irrigation, which was ſo well known, that they ſold their ſuperfluous water, tranſferring the uſe and property of ſome by the hour, day, and week. In two centuries they came to be poſſeſſed of 60,000 pertiche, moſtly watered. There is reaſon to believe that the practice in the 13th century did not materially differ from the preſent modes; becauſe in the papers of the archives of the abbey, of that period, mention is made of *chiuſe* or ſluices, *incaſtri* or water-gates that are moved perpendicularly, *bochilli* or openings in the banks to diſtribute the water, *ſoratoi* or *ſcaricatori*, diſcharges for carrying off ſuperfluous water, and other works to diſtribute the water and regulate the irrigation. In 1164, the emperor Frederick gave various rights in certain rivers to the people of Pavia, for the purpoſes of irrigation. In 1177, the people of Milan enlarged and continued the Navillio Grande, from Abbiate Graſſo to Milan, being 14 miles; it was brought from the Teſino near the Lago Maggiore to Abbiate Graſſo, 20 miles, by the people of Pavia, long before the date of any records now known to remain. In 1271, it was made navigable.

gable. It is 32 Italian miles long, and 25 braccia wide, or 49 English feet. History.

In 1220 was executed the ſecond great work or canal of this kind, which conveys the waters of the Adda from Caſſano to Marignano, where it waters much of the country around Lodi. In 1305, the canal of Treviglio was made, which takes the waters from the Brembo, and carries them for ſeveral miles, about 25 feet wide, and about three deep; it irrigates the territory of Treviglio and the Chiara d'Adda; and within four or five miles there are five canals, taken from the Adda and the Brembo, all of great antiquity. In 1460, the canal de Marteſano was begun under Duke Francis Sforza I.; it was 24 miles long, and 18 braccia (35 Engliſh feet) wide; ſince lengthened ſeven or eight miles more. It takes the waters of the Adda, a little before Trezzo, by means of a powerful wear (chiuſe) founded upon the living rock: it is then ſupported for five miles by a ſolid wall of ſtone 40 braccia (80 feet) above the bottom of the Adda, and parallel with it. At Gorgonſola, it paſſes over the torrent Molgora by a bridge of three ſtone arches. At Carſenſago it is croſſed by the river Lambro, which enters and quits the canal with all its floods. And in order to prevent the ſurplus of water which this circumſtance occaſions, from breaking the banks of the canal, or overflowing them, there are 19 *ſcaricatori* in the canal, above, below, and facing the junction, which are ſo calculated that they have not only powers ſufficient to take off the waters of that river, but alſo half of thoſe of the canal itſelf. Theſe ſcaricatori are canals which take the water when ſluice-gates are opened for that purpoſe, and convey it at various diſtances to the Lambro again, the fall in its

History. courfe being confiderable enough to free the canal from all fuperfluity of water. The chief of thefe canals are fo contrived as to be completely emptied once a-year, for cleaning and repairing whatever accidents may have happened to any of the works. Thefe facts fhow how well that important branch of agriculture, which confifts of irrigation, and which is only of recent introduction among ourfelves, was underftood in Italy, and how admirably it was practifed when the countries on this fide of the Alps were altogether barbarous.

On the general fubject of agriculture at large, however, few Italian writers appeared till towards the end of the 15th century. In 1478 Crefcenzio publifhed an excellent performance on the fubject at Florence. This roufed the flumbering attention of his countrymen, feveral of whom foon followed his example. Among thefe, Tatti, Steffano Auguftino Gallo, Sanfovino, Lauro, and Tarello, deferve particular notice.

At what time agriculture was introduced into Britain, is uncertain. When Julius Cæfar firft invaded this ifland, it was not wholly unknown. That conqueror was of opinion, that agriculture was firft introduced by fome of thofe colonies from Gaul which had fettled in the fouthern parts of Britain, about 100 years before the Roman invafion*.

It is not to be expected that we can now be acquainted with many of the practices of thefe ancient hufbandmen. It appears, however, that they were not unacquainted with the ufe of manures, particularly marl.

* Cæfar *de Bell. Gall.* lib. v. c. 12.

marl. This we have on the authority of Pliny †, who tells us, that it was peculiar to the people of Gaul and of Britain; that its effects continued 80 years; and that no man was ever known to marl his field twice, &c.—It is highly probable, too, that lime was at this time alſo uſed as a manure in Britain, it being certainly made uſe of in Gaul for this purpoſe at the time of Julius Cæſar's invaſion. History.

The eſtabliſhment of the Romans in Britain produced great improvements in agriculture, inſomuch that prodigious quantities of corn were annually exported from the iſland; but when the Roman power began to decline, this, like all the other arts, declined alſo, and was almoſt totally deſtroyed by the departure of that people. The unhappy Britons were now expoſed to frequent incurſions of the Scots and Picts, who deſtroyed the fruits of their labours, and interrupted them in the exerciſe of their art. After the arrival of the Saxons in the year 449, they were involved in ſuch long wars, and underwent ſo many calamities, that the huſbandmen gradually loſt much of their ſkill, and were at laſt driven from thoſe parts of their country which were moſt proper for cultivation.

After the Britons retired into Wales, though it appears from the laws made relative to this art, that agriculture was thought worthy of the attention of the legiſlature, yet their inſtruments appear to have been very unartful. 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 of twiſted willows, with

† Plin. *Nat. Hiſt.* lib. xvii. cap. 6.

History. our money: a very trifling price, even in comparison with that of other commodities at the same time: for, by comparing other accounts, it appears, that four sheep were then equal in value to an acre of the best land, and one horse of the same value with three acres. The frequent and deplorable famines which afflicted England about this time, are further instances of the wretched state of agriculture. In 1043, a quarter of wheat sold for 60 Saxon pennies (15 of our shillings), at that time equal in value to seven or eight pounds of our money now.

The invasion of the Normans, in 1066, contributed very much to the improvement of agriculture; for, by that event, many thousands of husbandmen from Flanders, France, and Normandy, settled in Britain, obtained estates or farms, and cultivated them after the manner of their country. The implements of husbandry, used at this time, were of the same kind with those employed at present; but some of them were less perfect in their construction. The 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 the plough, as well as for breaking the clods. The Norman plough had two wheels; and in the light soil of Normandy was commonly drawn by one or two oxen; but, in England, a greater number was often necessary. In Wales, the person who conducted the oxen in the plough walked backwards. 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. In Wales, they did not use a sickle for reaping their corns, but

but an inftrument like the blade of a knife, with a wooden handle at each end.—Their chief manure, next to dung, feems ftill to have been marl. Summer fallowing of lands defigned for wheat, and ploughing them feveral times, appear to have been frequent practices of the Englifh farmers in this period. History.

We are, after all, very much in the dark with refpect to the ftate and progrefs of agriculture in Great Britain previous to the fourteenth century. That it was pretty generally practifed, efpecially in the eaftern, fouth, and midland parts of England, is certain; but of the mode, and the fuccefs, we are left almoft totally ignorant. In the latter end of the fifteenth century, however, it feems to have been cultivated as a fcience, and received very great improvement.

At this time Fitzherbert, judge of the common-pleas, fhone forth with diftinguifhed eminence in the practical parts of hufbandry. He appears to have been the firft Englifhman who ftudied the nature of foils and the laws of vegetation with philofophical attention. On thefe he formed a theory confirmed by experiments; and rendered the ftudy pleafing as well as profitable, by realizing the principles of the ancients, to the honour and advantage of his country. Accordingly, he publifhed two treatifes on this fubject: the firft, intituled *The Book of Hufbandry*, appeared in 1534; and the fecond, called *The Book of Surveying and Improvements*, in 1539. Thefe books, being written at a time when philofophy and fcience were but juft emerging from that gloom in which they had long been buried, were doubtlefs replete with many errors; but they contained the rudiments of true knowledge, and revived the ftudy and love of an art, the advantages of which

History. were obvious to men of the leaſt reflection. We therefore find that Fitzherbert's books on agriculture ſoon raiſed a ſpirit of emulation in his countrymen; and many treatiſes of the ſame kind ſucceſſively appeared, which time has however deprived us of, or at leaſt they are become ſo very ſcarce as only to be found in the libraries of the curious.

In England, during the civil wars, though the operations and improvements in huſbandry ſuffered ſome temporary checks, there flouriſhed ſeveral excellent writers on the ſubject, and the art itſelf received conſiderable encouragement. Sir Hugh Platt was one of the moſt ingenious huſbandmen of the age in which he lived; yet ſo great was his modeſty, that all his works, except his Paradiſe of Flora, ſeem to be poſthumous. He held a correſpondence with moſt of the lovers and patrons of agriculture and gardening in England; and ſuch was the juſtice and modeſty of his temper, that he always named the author of every diſcovery communicated to him. Perhaps no man in any age diſcovered, or at leaſt brought into uſe, ſo many new kinds of manure. This will be evident to thoſe who read his account of the compoſt and covered dunghills, and his judicious obſervations on the fertilizing qualities lodged in ſalt, ſtreet dirt, and the ſullage of ſtreets in great cities, clay, fullers earth, mooriſh earths, dunghills made in layers, fern, hair, calcination of all vegetables, malt duſt, willow tree earth, ſoapers aſhes, urine, marl, and broken potſherds.

Gabriel Plattes may be ſaid to have been an original genius in huſbandry. He began his obſervations at an earlier period, in the reign of Queen Elizabeth, and continued them down to the Commonwealth. But notwithſtanding

notwithstanding the great merit of this writer, and the essential service he had rendered his country by his writings, the public ungratefully suffered him to starve and perish in the streets of London; nor had he a shirt on his back when he died. History.

Among these we may mention the writings of Captain Walter Blyth, on account of the very complete manner in which he appears to have understood the subject of irrigation or watering lands. In his principal work, called the *English Improver improved*, published in 1652, he gives directions for the practice of this branch of the art which mark great intelligence and observation, and would do no discredit to the experience of our own age.

Samuel Hartlib, a celebrated writer on agriculture in the 17th century, was highly esteemed and beloved by Milton, and other great men of his time. In the preface to his work entitled his *Legacy*, he laments that no public director of husbandry was established in England by authority; and that we had not adopted the Flemish method of letting farms upon improvement. This remark of Hartlib's procured him a pension of 100l. a-year from Cromwell; and the writer afterwards, the better to fulfil the intention of his benefactor, procured Dr Beatti's excellent annotation on the Legacy, with other valuable papers from his numerous correspondents.

The time in which Hartlib flourished seems to have been an era when the English husbandry rose to great perfection, compared with that of former ages; for the preceding wars had impoverished the country gentlemen, and of course made them industrious. They found the cultivation of their own lands to be the most

profitable

Hiſtory.

profitable ſtation they could fill. But this wiſe turn was not of long continuance. At the Reſtoration, they generally became infected with that intoxication and love of pleaſure which ſucceeded. All their induſtry and knowledge were exchanged for idleneſs and diſſipation; and huſbandry deſcended almoſt entirely into the hands of common farmers.

Evelyn was the firſt writer who inſpired his countrymen with a deſire of reviving the ſtudy of agriculture; and he was followed by the celebrated Jethro Tull. The former, by his admirable treatiſes on earth and on planting, and the latter, by contending for the ſuperior advantages of the drill huſbandry, excited numbers to bring their theory to the teſt of fair experiment.

Many valuable and capital improvements have ſince that period been made in Engliſh huſbandry: and theſe great men have been ſucceeded by a variety of writers, who have performed the moſt eſſential ſervice to their countrymen, by enlightening their minds, and exciting them to emulation in this important art.

About the middle of the laſt century, Ireland began to make a conſiderable figure in the art of huſbandry. It muſt indeed be confeſſed, that the Iriſh had very ſtrong prejudices in favour of a wretched method of agriculture, till Blyth opened their eyes by his excellent writings. Since that time, a ſpirit of improvement has more or leſs been promoted, and in many inſtances carried on with great zeal, by the nobility, clergy, and gentry of that kingdom. In proof of this, it will be ſufficient to obſerve, that the Tranſactions of the Dublin Society for encouraging Huſbandry are now quoted by all foreigners in their memoirs relating to that ſubject. And the obſervations of that diſcerning and ju-

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dicious writer, Arthur Young, Efq. in his Tour through that kingdom, fhew, that in many refpects improvements there have of late years made a progrefs nearly as rapid as in England. History.

About the year 1600, France made fome confiderable efforts to revive the art of hufbandry, as appears from feveral large works, particularly *Les Moyens de devenir Riche*; and the *Cofmopolite*, by Bernard de Paliffy, a poor porter, who feems to have been placed by fortune in a ftation for which nature never intended him; *Le Theatre d'Agriculture*, by Deferres; and *L'Agriculture et Maifon Ruftique*, by Meffrs Etienne, Liebault, &c.

Nearly in the fame period, the fkilful practice of hufbandry became more prevalent among the Flemings, than the publifhing of books on the fubject. Their intention feemed to be that of carrying on a private lucrative employment, without inftructing their neighbours. Whoever therefore became defirous of copying their method of agriculture, was obliged to vifit that country, and make his own remarks on their practice.

The principal idea they had of hufbandry was, by keeping the lands clean and in fine tilth, to make a farm refemble a garden as nearly as poffible.

Such an excellent principle, at firft fetting out, led them of courfe to undertake the culture of fmall farms only, which they kept free from weeds, continually turning the ground, and manuring it plentifully and judicioufly. When they had by this method brought the foil to a proper degree of cleanlinefs, health, and fweetnefs, they chiefly cultivated the more delicate graffes, as the fureft means of obtaining a certain pro-

History. fit upon a ſmall eſtate, without the expence of keeping many draught horſes and ſervants. A few years experience was ſufficient to convince them, 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 on land badly cultivated. They alſo found, that the beſt vegetables for this purpoſe were lucerne, ſaintfoin, trefoil of moſt kinds, field-turnips, &c.

The grand political ſecret of their huſbandry, therefore conſiſted in letting farms on improvement. They are ſaid alſo to have diſcovered nine ſorts of manure; but what they all were, we are not particularly informed. We find, however, that marl was one of them; the uſe and virtues of which appear alſo to have been well known in this kingdom two hundred years ago, although it was afterwards much neglected. They were the firſt people among the moderns who ploughed in green crops for the ſake of fertilizing the ſoil; and who confined their ſheep at night in large ſheds built on purpoſe, the floors of which were covered with ſand or virgin earth, &c. which the ſhepherd carted away each morning to the compoſt dunghill.

After the peace of Aix-la-Chapelle, moſt of the nations of Europe, by a ſort of tacit conſent, applied themſelves to the ſtudy of agriculture, and continued to do ſo, more or leſs, amidſt the univerſal confuſion that ſucceeded.

The French found, by repeated experience, that they could never maintain a long war, or procure a tolerable peace, unleſs they could raiſe corn enough to ſupport themſelves in ſuch manner as not to be obliged to ſubmit to harſh terms on the one hand, or to periſh

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by famine on the other. This occafioned the king to give public encouragement to agriculture, and even to be prefent at the making of feveral experiments. The great, and the rich of various ranks and ftations, followed his example; and even the ladies were candidates for a fhare of fame in this public-fpirited and commendable undertaking.

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During the hurry and diftreffes of France in the war of 1756, confiderable attention was paid to agriculture. Prize queftions were annually propofed in their rural academies, particularly thofe of Lyons and Bourdeaux; and many judicious obfervations were made by the Society for improving agriculture in Britanny.

After the conclufion of that war in 1763, matters were carried on there with great vigour. The univerfity of Amiens made various propofals for the advancement of hufbandry; and the marquis de Tourbilly (a writer who proceeded chiefly on experience) had the principal direction of a georgical or agricultural fociety eftablifhed at Tours.

The fociety at Rouen, which made a confiderable figure at the fame period, alfo deferves notice. In confequence of encouragement from the government, there foon exifted about fifteen focieties in France, eftablifhed by royal approbation, for the promoting of agriculture; and thefe had twenty co-operating focieties belonging to them.

After all, however, the hiftory of the kingdom of France affords a ftriking example how little can be done towards the improvement of agriculture, by the mere efforts of government, or of fpeculative men, in publifhing books or offering premiums for treatifes upon the fubject. The agriculture of the country at large, notwithftanding all that was done in this way, ftill

History. continued in a very deplorable ſtate. In the years 1787, 1788, and 1789, when Mr Young made his agricultural tour upon the continent, it was ſuppoſed that nearly ſeven-eighths of the lands in France were held by *metayers*, that is, by the tenure which in Scotland anciently received the appellation of *ſteel-bow*, and which to this day is not unknown in the Highland diſtricts. By this tenure the landlord or proprietor ſtocked the farm with ſeed corn, cattle, and implements of huſbandry, while the tenant afforded nothing more than his labour. The produce was divided between the two parties in ſuch proportion as they could agree upon. "This tenure," ſays Mr Young, "pervades almoſt every part of Sologne, Berry, La Marche, Limoſin, Anjou, Bourgogne, Bourbonnois, Nivernois, Auvergne, &c. and is found in Bretagne, Maine, Provence, and all the ſouthern counties, &c. In Champagne there are many at *tier franc*, which is the third of the produce, but in genera it is half. The landlord commonly finds half the cattle and half the ſeed; and the metayer labour, implements, and taxes: but in ſome diſtricts the landlord bears a ſhare of theſe. In Berry ſome are at half, ſome one-third, ſome one-fourth produce. In Rouſſillon the landlord pays half the taxes; and in Guienne, from Auch to Fleuran, many landlords pay all. Near Aguillon on the Garonne, the metayers furniſh half the cattle. Near Falaiſe in Normandy I found metayers, where they ſhould leaſt of all be looked for, on the farms which gentlemen keep in their own hands; the conſequence there is that every gentleman's farm muſt be preciſely the worſt cultivated of all the neighbourhood. This diſgraceful circumſtance needs no comment. At Nangis, in the Iſle of France, I met with an agreement for

for the landlord to furnifh live-ftock, implements, harnefs, and taxes; the metayer found labour and his own capitation tax; the landlord repaired the houfes and gates, the metayer the windows; the landlord provided feed the firft year, the metayer the laft; in the intervening years they fupply half and half—Produce fold for money divided. Butter and cheefe ufed in the metayer's family, to any amount, compounded for at 5s. a cow. In the Bourbonnois the landlord finds all forts of live-ftock; yet the metayer fells, changes, and buys at his will, the fteward keeping an account of thefe mutations; for the landlord has half the product of fales, and pays half the purchafes. The tenant carts the landlord's half of the corn to the barn of the chateau, and comes again to take the ftraw. The confequences of this abfurd fyftem are ftriking; land, which in England would let at 10s. pays about 2s. 6d. for both land and live-ftock."

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"The tenants," adds this excellent and accurate obfer-"ver, are found in the loweft ftate of poverty, and fome of them in mifery. At Vatan in Berry I was affured that the metayers almoft every year borrowed their bread of the landlord before the harveft came round, yet hardly worth borrowing, for it was made of rye and barley mixed. I tafted enough of it to pity the poor people; but no common perfon there eats wheaten bread. With all this mifery among the farmers the landlord's fituation may be eftimated by the rents he receives. At Salbris in Sologne, for a fheep-walk that feeds 700 fheep, and 200 Englifh acres of other land, paid the landlord for his half about 33l. fterling: the whole rent for land and ftock too did not, therefore, amount to 1s. per head on the fheep! In Limofin the metayers are confider-

History. ed as little better than menial servants, removeable at pleasure, and obliged to conform in all things to the will of the landlords. It is commonly computed, that half the tenantry are deeply in debt to the proprietor, so that he is often obliged to turn them off, with the loss of these debts, in order to save his land from running waste." The hard plea of necessity, continues the same author, can alone be urged in favour of this mode of cultivating land; "the poverty of the farmers being so great, that the landlord must stock the farm, or it could not be stocked at all. This is a most cruel burden to a proprietor, who is thus obliged to run much of the hazard of farming, in the most dangerous of all methods, that of trusting his property absolutely in the hands of people who are generally ignorant, many careless, and some undoubtedly wicked. Among some gentlemen I personally knew, I was acquainted with one at Bagnere de Luchon, who was obliged to sell his estate, because he was unable to restock it; the sheep having all died of epidemical distempers, proceeding doubtless from the execrable methods of the metayers, cramming them into stables, as hot as stoves or reeking dunghills; and then, in the common custom of the kingdom, shutting every hole and crack that could let in air. In this most miserable of all modes of letting land, after running the hazard of such losses, fatal in many instances, the defrauded landlord receives a contemptible rent—the farmer is in the lowest state of poverty—the land is miserably cultivated, and the nation suffers as severely as the parties themselves."

The great evil which prevented the tenantry of France from attaining to that respectable and easy situation which they have reached in Great Britain, and which

which the publication of books, and the efforts of agricultural ſocieties could not remove, was the improper principles upon which their revenue laws have at all times been conducted. Heavy taxes were impoſed upon the farmers, from which the nobles and the clergy were exempt. Theſe taxes were impoſed arbitrarily upon individuals, according to the eſtimate formed of their wealth by the intendant of the province and his delegates; the reſult of which was, that although the ſovereign received only a moderate revenue into his exchequer, the cultivators of the ſoil were oppreſſed, in conſequence of the partiality with which the taxes were impoſed, according to the favour or diſlike of the inferior officers of the revenue. Hence the farmers, even when not really poor, pretended to be ſo, to eſcape the arbitrary riſe of a tax which was profeſſedly impoſed in proportion to their power of bearing it: They choſe therefore to have poor cattle, poor implements of huſbandry, and poor dunghills, even when they could have done otherwiſe. The reſult of the whole was, that the huſbandry of by far the greater part of France never roſe above a very low ſtate. They have in general no better mode of ameliorating the ſoil than merely by the uſe of a fallow year after every two white crops, the conſequence of which is, that notwithſtanding their fine climate, and their fertile ſoil, the produce of the Britiſh iſlands on a given extent of arable territory, is incomparably ſuperior to that of France; a circumſtance which perhaps affords ſome explanation of the political equality which has long exiſted between the two countries, notwithſtanding the magnitude of France and the natural advantages of its territory. As it is an important fact in the hiſtory of agriculture, that, of two rival

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History. nations, ſituated in the cloſe vicinity of each other, the one ſhould have poſſeſſed this art in a very high degree of perfection, while in the other it ſhould have remained in ſuch a ſtate of inferiority as could not fail to produce much weakneſs in every national effort; we ſhall here ſtate the compariſon made by Mr Young between the reſult of French and Engliſh agriculture, in the production even of wheat, which is the French favourite crop.

"In order, (ſays this author), the better to underſtand how the great difference of product between the French and Engliſh crops, may affect the agriculture of the two kingdoms, it will be proper to obſerve that the farmer in England will reap as much from his courſe of crops, in which wheat and rye occur but ſeldom, as the Frenchman can from his in which they return often.

An English Course.	Buſhels per acre.	A French Course.	Buſhels per acre.
1. Turnips,		1. Fallow,	
2. Barley,		2. Wheat,	18
3. Clover,		3. Barley or oats,	
4. Wheat,	25	4. Fallow,	
5. Turnips,		5. Wheat,	18
6. Barley,		6. Barley or oats,	
7. Clover,		7. Fallow,	
8. Wheat,	25	8. Wheat,	18
9. Tares or beans,		9. Barley or oats,	
10. Wheat,	25	10. Fallow,	
11. Turnips,		11. Wheat,	18
	75		72

"The

History.

"The Englishman in eleven years gets three bushels more of wheat than the Frenchman. He gets three crops of barley, tares, or beans, which produce nearly twice as many bushels per acre as what the three French crops of spring corn produce. And he farther gets at the same time three crops of turnips and two of clover, the turnips worth 40s. the acre, and the clover 60s. that is, 12l. for both. What an enormous superiority! more wheat; almost double of the spring corn; and above 20s. per acre per annum in turnips and clover. But farther; the Englishman's land, by means of the manure arising from the consumption of the turnips and clover is in a constant state of improvement, while the Frenchman's farm is stationary. Throw the whole into a cash account, and it will stand thus:"

English System.				French System.			
Wheat 75 bushels at 5s.	L.18	15	0	Wheat 72 bushels at 5s.	L.18	0	0
Spring corn 3 crops at 32s. 96 bushels at 2s. 6d.	12	0	0	Spring corn 3 crops at 20 bushels, 60 bushels at 2s. 6d.	7	10	0
Clover two crops	6	0	0				
	36	15	0		25	10	0
Per acre per annum,	3	6	10	Per acre per annum,	2	6	4

"In allowing the French system to produce 20 bushels of spring corn, while I assign 32 only to the English, I am confident that I favour the former considerably; for I believe the English produce is the double of that of France; but stating it as above, here are the proportions of 36 on an improving farm, to 25 on a stationary one; that is to say, a country contain-

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History. ing 82,000,000 acres produces as much as another whofe area contains 119,000,000, which are in the fame ratio as 36 and 25."

The effect of the French revolution upon the fituation of the perfons immediately engaged in agriculture, was not a little fingular. While the higheft orders of fociety were driven into exile, or exifted in terror, and while the inhabitants of the cities fuftained the greateft hardfhips from the annihilation of all commerce, this terrible tempeft paft in a manner comparatively light and harmlefs over the heads of the obfcure and fcattered cultivators of the foil. In many quarters of the country their condition was even greatly and rapidly ameliorated. By the confifcation of the church lands, and of the eftates of the emigrant nobles, the government for the time came to hold the property of a great part of the country. This government had too much bufinefs upon hand, to be able to levy correctly the rents of the property that had fallen into its poffeflion; and for fome time it had no occafion to do fo, in confequence of the fupport which it derived from the iffue of an immenfe paper currency. As this paper was a legal tender of payment in all tranfactions, and for all debts, thofe farmers who held their lands for payment of a money rent, took care to pay their landlords with paper, which they foon obtained at a cheap rate, while they themfelves contrived to difpofe of the produce of their farms for cafh. Hence, a landlord, after the affignats had funk in value, was often under the neceffity of difpofing of a part of his moveables to purchafe from his own farmers a part of the grain which grew upon his own lands. In this way, by one means or other, a great proportion of the farmers in France found means during fome

fome years to avoid paying any rent whatever, and thus great numbers of them rofe to fudden opulence, amidft the general calamities of their country. Many perfons alfo perceiving the fecurity of a country life, invefted whatever money they had been able to fave from the wrecks of other employments in agriculture, and became farmers or fmall proprietors. We have hitherto had too little connection with that country to be able to afcertain with accuracy, the effect of fuch a change of circumftances upon the practice of agriculture. It is underftood, however, upon the whole, from infpecting the face of the country, that the agriculture of France is not conducted upon more enlightened principles than formerly: the general appearance of the foil ftill exhibits only white crops or fallow; the cattle are few; little manure therefore is prepared. Hence, the crop produced is always greatly inferior to what the land by more fkilful arrangements might be made to bear. History.

Of the hiftory of the agriculture of the reft of the continent of Europe we have little information, though fome valuable practices made ufe of in particular fituations will be afterwards noticed under their proper heads. In Germany, after the ruinous war of 30 years was brought to a termination by the treaty of Munfter or Weftphalia in 1648, agriculture was gradually diffufed and improved in that vaft country. In the Proteftant ftates, at leaft, the art appears to be much better underftood than in France. For many years it has been publicly taught in various univerfities, and during the laft half of the late century great attention was paid to its improvement by many princes of the Empire. In Ruffia, vigorous exertions have repeatedly been made by the government to introduce, as far as poffible into that climate, History. climate, the moſt approved ſyſtems of huſbandry, which have been eſtabliſhed in other parts of Europe. The late empreſs ſent ſeveral gentlemen into Britain and other countries to ſtudy agriculture, and gave it all the encouragement in her own dominions which the nature of her government, and the enſlaved and barbarous ſtate of the lower claſſes of her people, would permit. Even Italy, during the ſame period, was not inactive. The Neapolitans condeſcended to recur to the firſt rudiments of revived huſbandry, and began to ſtudy anew the agricultural ſyſtem of Creſcenzio, firſt publiſhed in 1478. In Bergamo the ſame plan was purſued, and a new edition was given of the Recordo d'Agriculturæ de Tarello, firſt publiſhed in 1577. The patriotic ſociety of Milan exhibited ſpecimens of ability, and enlightened information upon this important ſubject, which entitle it to a reſpectable place among the literary aſſociations of Europe. The duchy of Tuſcany, eſpecially under the late Archduke Leopold, afterwards emperor of Germany, imbibed the ſame ſpirit of improvement. A private gentleman there, upwards of 40 years ago, left his whole fortune to endow an academy of Agriculture. The firſt eccleſiaſtic in the duchy was preſident of this ſociety, and many of the chief nobility were members. But the events of the late war, by which Italy from the Alps to the gulf of Tarentum ſuffered ſo much, muſt undoubtedly for a time have injured the progreſs of agriculture, as well as of every other valuable art.

In the year 1759, a few ingenious and public-ſpirited men at Berne in Switzerland eſtabliſhed a ſociety for the advancement of agriculture and rural economics. In that ſociety were many men of great weight in the republic, and moſt of them perſons of a true caſt for

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making improvements in husbandry, being enabled to join the practice with the theory. History.

Nor must we here omit to mention, that the justly celebrated Linnæus and his disciples have made great efforts in the north of Europe, particularly in discovering new kinds of profitable and well-tasted food for cattle. About the same time, Sweden bestowed successful labours on a soil which had before been looked upon as cold, barren, and incapable of melioration. Of this the Stockholm Memoirs will be a lasting monument.

Denmark, and many of the courts of Germany, followed the same example. Woollen manufactures were encouraged; and his Danish majesty sent three persons into Arabia Felix to make remarks and bring over such plants and trees as would be useful in husbandry, building, and rural affairs.

Neither must we forget the very assiduous attention of of the learned in Leipsic and Hanover to this important object. During the rage and devastation of a long war, they cultivated the arts of peace; witness the *Journal d'Agriculture* printed at Leipsic, and the *Recueils d'Hanover* printed in that city.

Even Spain, constitutionally and habitually inactive on such occasions, in spite of all her natural indolence, and the prejudices of bigotry, invited Linnæus, with the offer of a large pension, to superintend a college founded for the purpose of making new inquiries into the history of nature and the art of agriculture.

But, without any improper partiality to our own country, we are fully justified in asserting, that Britain alone exceeds all modern nations in husbandry;

and

History. and from the ſpirit which for the laſt twenty years has animated many of our nobility and gentry, to become the liberal patrons of improvement, there is reaſon to hope that this moſt uſeful of arts will, in a few years, be carried to a greater pitch of perfection than it has ever yet attained in any age or country.— The Royal Society, the Bath Society, and the Society of Arts, &c. in particular, have been ſignally uſeful in this reſpect; and the other aſſociations, which are now eſtabliſhed in many parts of the kingdom, cooperate with them in forwarding their laudable deſigns.

It is not, however, to the exertion of public ſocieties, excellent and honourable as they are, that all our modern improvements in agriculture owe their origin. To the natural genius of the people, and the mildneſs and wiſdom of the government, have been added the theory and practice of all nations in ancient and modern times. This accumulated maſs of knowledge has been arranged, divided, and ſubdivided; and after paſſing the teſt of practical experiments, the eſſential and moſt valuable parts of it have been preſerved, improved, and amply diffuſed in a variety of valuable publications upon this great art of rendering mankind happy, wealthy, and powerful, particularly in the works of Stillingfleet, Lord Kaimes, Dr Hunter, Dr Anderſon, Mr Marſhall, Mr Kent, The Reverend Mr Dickſon, and various others, but more eſpecially in the compilations and treatiſes publiſhed by Arthur Young, Eſq. already mentioned.

Board of Agriculture. We alſo remark with much ſatisfaction, that the Britiſh government has of late years thought fit to render the improvement of agriculture an object of public attention and encouragement, by the inſtitution of a *board of agriculture.*—About the year 1790, Sir John Sinclair, Bart. invited the clergy of the church of Scotland to tranſmit to him deſcriptions of the ſtate of their different pariſhes, with a view to the publication of what is called a *Statiſtical Account of Scotland.* The whole members of this body having readily complied with his requeſt, a work in 20 volumes octavo was compiled from the materials afforded by them, containing an account of the agriculture, manufactures, and population of the country. The ſame gentleman, about that period, was alſo active in obtaining the inſtitution of a private ſociety, called *The Britiſh Wool Society,* which was very ſucceſsful in calling the attention of the public to the improvement of that important article of national growth and manufacture. By theſe patriotic exertions, having acquired a conſiderable ſhare of popularity, he was encouraged on the 15th May 1793, to make a motion in the houſe of commons, of which he was a member, for an addreſs to the crown, recommending the inſtitution of a board of agriculture. The chancellor of the exchequer, Mr Pitt, on perceiving that the propoſal was acceptable to the majority of the houſe, gave it a decided ſupport, and on the 17th May, to which the debate had been adjourned, the motion was carried for an addreſs to his majeſty to inſtitute ſuch a board, at an expence not exceeding 3000l.—In conſequence of this application, a charter paſſed the great ſeal, incorporating the members of adminiſtration for the time, with the archbiſhops of Canterbury and York, and all their ſucceſſors in office, together with certain other noblemen and gentlemen, into a board or ſociety, by the name of the *Board* or *Society for the encouragement of Agriculture and internal improvement,* under the patronage History.

History. tronage of the crown; with power to the members to elect office-bearers and successors to themselves: and in the mean time Sir John Sinclair was appointed to be the first president, to continue in office till the 25th March following; Sir John Caul, Bart. was appointed to be the first treasurer, and Arthur Young, Esq. was appointed secretary.

Commencement of its sittings. The regular sittings of the board did not commence till 23d January 1794, since which time it has continued to exert a very considerable degree of activity in establishing an extensive foreign correspondence, and in procuring and publishing every kind of useful domestic agricultural intelligence, some specimens of which we shall afterwards have occasion to notice. This board, soon after its institution, also employed persons of known reputation to prepare agricultural surveys of every county in the island of Great Britain.—Many of these surveys have been published, and form treatises upon this important art, which, for extent of intelligence and ability of execution, have not been exceeded in any age or country. The board has also obtained parliamentary rewards to some individuals for important discoveries, and has offered premiums for essays or treatises upon subjects connected with the purpose of its institution, which have produced a great variety of valuable and ingenious disquisitions.

More particularly, in consequence of the late extraordinary dearth and scarcity of provisions, the legislature thought fit to have recourse to the assistance of the board for the purpose of endeavouring to alleviate the evil. In December 1800, a committee of the house of lords, with a view to extend the cultivation of grain, required the board to make out a report upon the best

History.

means of converting grafs lands into tillage without exhaufting the foil, and of returning the fame to grafs after a certain period in an improved ftate, or at leaft without injury. The Board having taken the fubject into confideration, refolved that the beft mode of inducing landlords to permit grafs lands to be ploughed, would be to convince them that they may do it in many cafes, not only without injury, but alfo to their advantage. In confequence of this refolution, an advertifement was publifhed by the Board, offering very liberal premiums for the moft fatisfactory effay upon the fubject. This advertifement produced a great number of difquifitions or effays, the greater part of which were written by candidates for the premiums, but fome of them were the productions of public-fpirited gentlemen who made no fuch claim. From the whole number feveral effays have been felected and publifhed by the Board, and form a very valuable volume, upon an interefting part of the moft important of all fubjects in the art of agriculture, the rotation or fucceffion of different crops upon the fame foil.

This affords an example of the utility of an inftitution acting, like the Board of Agriculture, under the fanction of the legiflature. It enjoys the means of directing the attention of men of talents in all parts of the country, to any fubject upon which practical information may be wanted; and it poffeffes the means of communicating to the public at large, in the moft advantageous manner, whatever information may be obtained from the communications made to it. But although the diffufion of the knowledge of the principles of any art affords at all times the beft means of its improvement, this undoubtedly is only a part of the duty

History. of ſuch a public body as the Board of Agriculture. Public eſtabliſhments and efforts are in many caſes neceſſary towards carrying the art to its ultimate perfection. Means ought to be adopted in all the great ſeminaries of learning for rendering the knowledge of its principles a part of a liberal education. Obſtacles to its progreſs, ariſing from tythes, rights of commonty, &c. ought to be removed; and it may even be found advantageous to give public aſſiſtance towards the erection of works which may prove too expenſive to be undertaken by individuals for the purpoſes of irrigation, in the ſame manner as has been done in other countries, as already mentioned. In theſe and all ſimilar caſes, it becomes the duty and the moſt valuable privilege of a board eſtabliſhed by public authority to give counſel to the legiſlature, to ſuggeſt improvements, and to urge the expenditure of money upon public works, in caſes where the advice of individuals might be diſregarded, or liſtened to under the ſuſpicion of its being prompted by views of private intereſt.

THEORY

OF

AGRICULTURE.

General Remarks.

IN an art that is so necessary to mankind, and that has been so universally practised, it might perhaps be expected, that the principles upon which its operations depend, would have been by this time completely and accurately investigated, and consequently that a correct theory of agriculture could easily be exhibited. This, however, is by no means the case; and it is not a little singular, that, in this most useful of all arts, the theory should still be more defective than in almost any science with which we are acquainted. It is fortunate, however, for the human race, that in most cases, or at least in all important arts, they succeed better in practice than in speculation. During many ages, various artists were accustomed to extract the most ordinary, but most useful metals, from the state of ore or earth in which nature produces them, and to reduce them back from their metallic form and lustre, to a state of ore or earth again. These artists were unacquainted with the principles upon which the success of their operations depended; and it is only within these few years that some ingenious chemists have successfully investigated the nature of these processes, and have ex-

The theory of agriculture is defective.

D 2 plained

General Remarks.

plained what they have called the oxygenation and dis-oxygenation of metals. The same thing has happened in agriculture. Men have often cultivated the ground well, while they have speculated ill concerning the mode of doing so.

Difficulty of forming it.

Various reasons render it still more difficult to form a complete theory of agriculture, than of chemistry, mechanics, or other arts. In agriculture, an experiment cannot be made in an instant, or even in an hour, or in a day or two. A whole season must pass away before a single experiment can be performed, and after all, as in other arts, the inquirer after truth may be misled by some unobserved circumstances. Some fact, quite foreign to the experiment itself, arising out of the peculiar state of the soil, or of the train of seasons, may produce plentiful crops for a year or two, though, in ordinary circumstances, no such effect would follow; and the ingenious contriver of the experiment, who thought he had made an important discovery, may afterwards derive from it only disappointment and mortification. But human life is too short to admit of a very great variety of agricultural experiments to be performed by the same individual. After a few seasons, he must leave his place to be occupied by a new inquirer, possessed of a different character and of different views. Unfortunately, till of late years, it was not usual for husbandmen to publish, and thus to immortalize and diffuse over whole nations, the result of their private experience and reflections. Scattered over the face of great countries, and having little intercourse with foreigners, or even with each other, they knew little of what was done by men engaged in the same profession, though at no great distance.—In this way, the benefit

of

of local discoveries was not communicated to the world at large, nor was an opportunity afforded of eradicating local prejudices and erroneous practices. As the state of this valuable profession is now rapidly altering in these respects, there is little doubt that we are fast approaching towards a period at which it will be possible to exhibit a clear and correct theory of agriculture, or to arrange under a few simple heads the rules or principles upon which the practice of the art depends.— What we are now to offer, is not to be considered as perfect, nor even as possessing any nearer approximation towards a perfect theory of the husbandman's art; but merely, such a general statement of its principles as results from the degree of information hitherto collected upon the subject.

Division of the Subject.

What it ought to contai.

A theory, or general view of the principles of agriculture seems necessarily to resolve itself into the two following investigations: 1st, To inquire, among the great variety of vegetables that exist in nature, what particular plants ought to be regarded as most worthy of cultivation: and, 2dly, To consider the best mode of cultivating with success the plants thus selected.

The value of vegetables is absolute and relative.

With regard to the first of these divisions of the subject, or the vegetables that ought to be chosen as most valuable and worthy of cultivation, it may be observed, that the value of a plant is of two kinds, *absolute*, or *relative*: The *absolute* value of a plant depends upon its fitness to afford subsistence to the human species, whereas its *relative* value consists of the tendency which the cultivation of it will have to enrich a particular husbandman, or class of husbandmen, either because their lands are well adapted for its growth, or because there

Vegetables used by Man. is a ready market for it in the vicinity, where it bears a high price.

They are useful directly and indirectly. Concerning the abſolute value of plants, or their tendency to afford ſubſiſtence to mankind, it is to be obſerved, that ſome plants are *directly* uſeful or valuable, becauſe they are immediately conſumed as food by man, ſuch as wheat, oats, or potatoes; whereas mankind derive ſubſiſtence from another claſs of plants, only in an *indirect* manner, by giving them to cattle, and afterwards eating the fleſh of theſe cattle, as happens with regard to graſs and ſtraw of all kinds.

SECT. I.

OF VEGETABLES TO BE CULTIVATED AS FOOD FOR MAN.

Men feed on fruits and roots. SOME vegetables afford ſubſiſtence to the human ſpecies by means of the fruit that grows upon them, which hangs, and is brought to maturity in the air, at the ſummit of their ſtems. Other vegetables derive their value from producing roots, which come to maturity in the boſom of the ſoil, and are dug from thence to be conſumed by mankind.

Fruit trees not truſted to for food, Of fruit-bearing vegetables, thoſe called *trees*, which riſe aloft with a ſtrong trunk, are the moſt permanent and remarkable. It is ſaid that a ſpot of ground, occupied by ſome kinds of trees, ſuch as cheſnuts or dates, is capable of producing a very great portion of food, uſeful for the ſupport of the human ſpecies. One advantage attending the cultivation of ſuch vegetables, would be that, after the trees are planted, and ſecured by fences for a few years againſt animals, they would for ever

ever after, or at leaſt for many years, continue to grow and flouriſh without care or labour. It does not appear, however, that in any nation of ancient or modern times, foreſts of fruit-bearing trees have been reared with a view to afford ſubſiſtence to the community. For this two reaſons may be aſſigned. In the firſt place, a conſiderable number of years muſt elapſe, before ſuch plants could arrive at maturity, and fulfil the purpoſe of their deſtination. Of whatever uſe, therefore, they might be to future ages, it is evident that they could afford little benefit to the generation which planted them. But in a queſtion about ſubſiſtence, mankind are uſually under the neceſſity of conſidering their own immediate wants, and hence they have been led to the cultivation of ſuch plants, as afford the moſt ſpeedy reward for the efforts of their induſtry. Another reaſon for preferring the culture of ſmall annual plants, to the greater and more permanent productions of nature, would ariſe, in the early ages of the world, from the turbulent ſtate of ſociety and the frequency of wars. A community that ſhould depend for its ſubſiſtence upon the fruit of foreſt trees, might be ruined for half a century by the inroad of an enemy. An example of this was exhibited in the war between Great Britain and her North American colonies. When the parent ſtate hired the ſavages on the weſtern frontier, to join her party and to make inroads upon the coloniſts, the latter retaliated upon the ſavages in the following manner. Several of the colonies united in ſending an expedition againſt the Indians. The bodies of militia employed upon this expedition, were ſurpriſed to find ſmall corn fields around a conſiderable number of the Indian hamlets. They were not ſatisfied however with deſtroying the huts of the natives, and theſe incipi-

Vegetables uſed by Man.

becauſe they ripen ſlowly, and are deſtroyed in war.

Vegetables used by Man.

ent efforts of savage industry; but they anxiously sought out and destroyed every fruit-bearing tree that they found in their progress of almost a thousand miles, thereby rendering the wilderness utterly uninhabitable to a people destitute of agriculture, and who could not always depend for subsistence upon their success in hunting. From this example we see that the frequent wars arising from the barbarous character of ancient nations, would compel them to seek subsistence, not from the fruit of forest trees, but from grain, which speedily arrives at maturity, and which when destroyed can soon be renewed. Thus war becomes a less wasteful scourge to the human race, and communities are enabled speedily to recover from the devastation which it produces. Had the nations of Europe depended for subsistence upon any fruits which could not be speedily restored when destroyed, it is evident, that, in the late sanguinary conflict, the greater number of them must have been irretrievably ruined.

Men rather trust to grain.

Hence it appears that the cultivation of plants of annual growth, as a source of subsistence, is favourable to the permanence of civilization in the world; and that before nations can venture to rely for their subsistence upon the fruit of plants of slower growth, their character must have arrived at a degree of moral amelioration far superior to what it has ever been known to possess.

Of annual plants cultivated for fruit, wheat has always been accounted the most valuable. This has probably arisen from the extreme facility with which the flour of it undergoes a process of fermentation, which renders it capable of becoming a more light and agreeable kind of bread than the flour of any other grain. This

This quality is believed to arise from a quantity of a substance contained in wheat that is of the same nature with the gluten, or glue, that is prepared from animal bodies. In other respects, however, it does not appear that wheat is more valuable than some other kinds of grain: by means of long boiling, a given weight of barley, or even of oats, will render a quantity of water as thick or full of mucilage as can be done by the same weight of wheat.

Vegetables used by Man.

After wheat, oats have in our country been considered as of very great importance. It is a hardy and beautiful plant; grows with little cultivation, and is particularly well suited for lands newly brought in from a state of nature, upon which it was always used as the first crop, till the introduction of the turnip husbandry. The meal of it is usually very coarsely grinded, and mixed with a considerable quantity of the inner covering of the grain. Hence it has always a considerable degree of roughness, and is harsh and unsuited to very delicate constitutions; but this very harshness, from its stimulant effect, producing a feeling of warmth in the stomach, renders it more grateful to persons much exposed to the open air, and accustomed to hard labour, who account it a hearty kind of food. Essentially, and in its intrinsic qualities, this grain differs little from some others.

Oats a valuable grain.

Barley is chiefly valued in consequence of the facility with which it produces a great quantity of saccharine matter by the process of vegetation or malting, which fits it for the preparation of vinous or spirituous liquors. Pease are also sometimes used when grinded into meal as an article of human food; but, on account of their viscid and indigestible quality, they can never become

Barley valuable from its easy conversion to a saccharine substance.

Vegetables used by Man.

become valuable in that point of view, unlefs to perfons engaged in the open air, in the moft active and fevere kinds of labour.

Different kinds of grain are not effentially different.

In other refpects, however, it does not appear that there is much difference in point of quality or wholefomenefs between the various kinds of grain cultivated in different countries. They are all capable of affording nourifhment to the human conftitution, and of preferving it in health and vigour: When grinded into meal, they require little farther preparation, and are eafily made into bread, or otherwife prepared for immediate confumption, by being mixed according to the fancy or tafte of different nations, with a fmall quantity of water, or any other liquid.

Roots ufed as human food.

Of the roots which are ufed to afford fubfiftence to man, the potato has hitherto been the principal. The reft, confifting chiefly of carrots, turnips, and parfnips, are never ufed as a fole nutriment, being rather adopted for the purpofe of giving variety and relifh to other food, and chiefly to butchers meat. The potato, however, is in fome meafure an exception to this general rule. It contains a large quantity of ftarch, which does not feem inferior to the ftarch prepared from wheat, fo far at leaft as that ingredient is to be regarded as contributing to the nourifhing qualities of the grain. Its tafte refembles, more nearly than any other root, the tafte of bread; and accordingly it is daily beginning to be more extenfively ufed, and to form a larger portion of the food of the poor. The celebrated Dr Adam Smith long fince remarked its tendency to produce a ftrong and handfome race of people, as demonftrated by its effect upon the common people of

Ireland;

Ireland, who have for a confiderable length of time in a great meafure fubfifted upon it. Vegetables ufed by Man.

It is to be obferved concerning all the roots now mentioned, that a crop of them always contains a much larger quantity of human food than a crop of any kind of grain, upon the fame extent of ground. A Scots acre of good land, which will not produce more than 1280 pounds weight of oatmeal, will eafily produce 16,000 pounds weight of potatoes, and will fometimes in favourable feafons produce 25,000 or 30,000 pounds weight of that valuable root. Suppofing one pound of oatmeal to contain as much nourifhment as two pounds and a half of potatoes, ftill it is evident, that, where an extent of territory employed in the production of oats can only fupport one million of people, the fame territory employed in the cultivation of potatoes will fupport five millions of perfons. They produce more food on the fame extent of foil than grain.

Potatoes, however, and all the other roots, have hitherto poffeffed thefe radical defects: The carriage of them is extremely expenfive, in confequence of their weight, arifing from the vaft quantity of moifture they contain. Hence they can only be cultivated in abundance in the vicinity of great towns, or where they are meant to be confumed upon the farm as the food of cattle. Their defect as food. The tranfportation of them expenfive.

Roots are alfo incapable of long prefervation. In the winter they are deftroyed by froft, and in fummer by heat, which caufes them to vegetate or to corrupt; both of which changes render them unfit to be ufed as food. Are unfit for long prefervation.

Thefe roots are alfo much more bulky than grain in proportion to the quantity of nourifhment contained in them. Hence they are rendered lefs fit to be confumed Too bulky for the ftomach.

Vegetables used by Man.

med by perſons engaged in ſedentary profeſſions. Such perſons accordingly ſeldom fail to find them hurtful to the ſtomach, by their bulkineſs, and their tendency to injure the powers of digeſtion, by producing flatulencies and other unpleaſant conſequences.

Wherein they differ from grain.

On the whole, the difference between theſe ſucculent roots and the grain of corn plants ſeems to amount to this, that, although they are both formed of ſimilar ſubſtances, the potato being analogous to wheat, and the carrot and parſnip to rye, or rather to barley, after it has been converted into malt, yet, as the roots are formed in the boſom of the ſoil, and are of a looſe and watery texture, their formation requires from nature a ſlighter effort than the bringing to perfection the ſmall grains which are produced in the air at the top of corn plants. She therefore compenſates, by an abundant crop, the diminiſhed quality of her work.

How they may be rendered equal in value to grain.

Hence it has appeared an important problem in economics, to deviſe a plan by which the ſucculent roots of vegetables may be deprived of their ſuperfluous moiſture, that thus human art may perform for them what nature has not accompliſhed; and that they may be rendered completely equal in value to grain in point of quality, while in quantity they are ſo ſuperior. With this view different proceſſes have been adopted.

Potato-ſtarch.

Potatoes have been grated down in their raw ſtate, and repeatedly waſhed with water; the reſult of which operation is, that the ſtarch contained in them is obtained with great labour, but the reſt of the root is loſt; and this operation cannot be applied to other kinds of roots with ſucceſs.

Grenet's mode of granulating potatoes.

Another mode of accompliſhing the object was deviſed a few years ago by M. Grenet, and publiſhed in the Journal of the Lycæum of Arts of Paris. It is performed in this manner: The potatoes must first be boiled by the heat of the steam of boiling water, without touching the water itself. They are then stript of their skin, and allowed to cool, and made use of in the following way:—A white-iron tube of two inches diameter, and eight inches in length, open at the one end and close at the other, is everywhere perforated with small holes, and a round piece of wood is prepared, which easily goes into the tube, but which at the same time fills it. Things being thus in readiness, a quantity of the potatoes, boiled as already mentioned, is put into the tube till it is full. They are then forcibly rammed down with the round piece of wood or piston; the consequence of which operation is, that they are forced through the little holes in the sides of the tube, and come out in the shape of worms. They are received upon linen cloths, covered with unsized paper, and dried in the heat of the sun, or in a warm room. The small pieces must be stirred from time to time; and it is said, that in less than 12 hours, the preparation dries so as to be capable of being preserved.

Vegetables used by Man.

The defect of this process evidently is, that it is a petty operation, which can only proceed slowly, and upon a diminutive scale. It is therefore unlikely to be adopted in the great operations of an extensive agriculture, as a mode of preparing or preserving human food.

At the beginning of the year 1802, another process for accomplishing this important object was contrived by Robert Forsyth, Esq. advocate. Of this process, we are authorized to give the following account:

Mr Forsyth's process for converting roots into flour.

The

Vegetables used by Man.

The whole difficulty of discovering a process, with the view to render succulent roots as easily preserved and transported, and therefore in every respect as valuable as grain, arises from our not having the command of such a degree of steady and vigorous, but moderate heat, as will deprive them of their moisture, while at the same time they are prevented from being burnt or scorched in the way that coffee-beans are treated before being grinded. This requisite degree of heat may be obtained in a very cheap and easy manner, by making use of the steam of boiling water, which never can burn any vegetable substance. Upon this principle, Mr Forsyth's process is founded, and is conducted in the following manner:

1st, Let a quantity of potatoes, or carrots, or parsnips, &c. be washed, and then cut or chopped into very small pieces.

2dly, Lay them upon a metallic plate, and dry them with the heat of steam transmitted through the metal. They are then in a state analogous to grain, and seem capable of being preserved for any length of time.

3dly, Reduce them into flour or meal, by grinding in any mill, or with any instrument capable of grinding grain.

The meal or flour thus prepared has no tendency to attract moisture from the atmosphere, and may be preserved during any length of time, if closely pressed or packed. Without this precaution, Mr Forsyth has preserved it for twelve months, when it had been coarsely grinded in a coffee-mill.

The drying process is not tedious. As potatoes contain a great quantity of starch or gummy matter, the pieces of them, while drying, are apt to adhere to each other; they must therefore be frequently turned or stirred during that part of the operation. When dry, they are almost as hard as barley, and taste somewhat like the skin of a roasted potato.

Vegetables used by Man.

Carrots and parsnips contain less gummy matter. They require less attention while drying, and do not become so hard. They may be grinded with ease. Their flour is very sweet to the taste. Its smell is fragrant, and though the taste of the roots cannot be said to be altered, it is rendered rich and agreeable by the concentration produced by the process. This is more particularly the case with regard to the parsnips. Their meal, when coarsely grinded, and exposed to the air for a month or two, loses its grateful smell, but the taste continues unchanged. The taste is communicated very rapidly to lukewarm water, by pouring it upon the meal, so that it may probably prove of [illegible] value when subjected to the vinous fermentation; and it seems not improbable, that if sugar is ever to be produced in abundance from plants of European growth, it must be by preparing them according to this process.

Mr Forsyth performed his experiments with a steam apparatus, which, with some alterations, may prove not unsuitable, when erected upon a great scale.

Mr Forsyth's steam apparatus.

A, Plate XIII. fig. 5. a shallow vessel of tinned plate, commonly called *white iron*, one foot square, and two inches in depth, for containing substances to be dried.

B, a small round vessel, in which water is kept boiling by a lamp, C, with three wicks.

D, a tube, by which the steam passes into E, which contains

contains the drying veſſel A, and is cloſely ſoldered all round to the bottom of it.

F, a tube, by which the water formed by the condenſed ſteam, flows from the ſteam veſſel, E, back into the boiler B, entering at the bottom of the boiler.

G, a crooked tube, by which the ſuperfluous ſteam eſcapes into the open air. It is crooked, that it may retard the paſſage of the ſteam when the veſſel is at work, which forces it to depoſite more of its heat on the bottom of the drying veſſel A.

H, a tube by which the boiler B is filled with hot water.

I, a tube paſſing up through the centre of the boiler, and ſerving as a chimney to the lamp C. It does not communicate with the water in the boiler.

K ſhews the figure of the cover of the drying veſſel A. The cover has a groove or gutter LL, paſſing round its lower edge. The vapour which riſes from the roots when drying, condenſes on touching the cover, and flows down to the gutter, from which it eſcapes in the ſtate of water, by a hole left for that purpoſe at each corner. The cover is only uſed for the neatneſs requiſite in making experiments.

The whole is ſupported by four moveable feet, attached to the corners of the drying veſſel A, but not appearing in the figure. Every part of it is made of white iron or tinned plate.

Inſtead of the lamp C, a ſmall iron pan filled with pieces of burning charcoal, was ſometimes uſed to keep the water boiling, and a ſtill more convenient plan was at times adopted during the winter ſeaſon. It conſiſted of reſting the bottom of the boiler B, upon the front of the grate of the chamber, while a fire was burning, the reſt of the inſtrument being at the ſame time ſupported by a rope attached to the back of a chair, to a nail or peg in the wall for hanging a picture, or to any other convenient ſupport. When uſed in this laſt manner, however, the inſtrument has this defect, that the water in the tube H boils over at times into the fire, which might be avoided, by placing the tube on the oppoſite ſide of the boiler.

Vegetables food for Cattle.

Upon the above contrivance it may be remarked, that a kiln formed of a large metallic plate, heated by the ſteam of boiling water, may prove valuable in many proceſſes. In particular, it will probably be found uſeful for drying malt, with a view to prevent the ale formed of it from having a brown colour. It may alſo, perhaps, be uſed with ſucceſs for drying wheat that is intended to be ſown, to prevent the future crop from ſuffering by mildew, as will be afterwards mentioned; and it affords a ready and cheap mode of drying not only roots, but all vegetable productions, without burning them, or altering their taſte or other eſſential properties.

SECT. II.

OF THE MOST PROPER KINDS OF VEGETABLES TO BE RAISED ROR THE PURPOSES OF FEEDING CATTLE.

Though this muſt be an article of the utmoſt conſequence to every farmer, we do not find that it has been much conſidered. Dr Anderſon ſeems to have been the firſt writer on agriculture who has properly attended to this ſubject; and what he has wrote upon

 it,

Vegetable food for Cattle.

it, is rather a catalogue of desiderata, than any thing else: and indeed the desiderata on this subject are so many and so great, that we must acknowledge ourselves very unable to fill them up.——To attain to a competent knowledge in this respect, the following things must be taken into consideration. (1.) The wholesomeness of the food for cattle, with regard to health and strength, or fatness. (2.) The quantity that any extent of ground is capable of yielding. (3.) The quantity necessary to feed the different kinds of cattle. (4.) The labour of cultivation; and, (5.) The soil they require to bring them to perfection, and the effect they have upon it.

Qualities of the food requisite for cattle.

With regard to the wholesomeness, it is plain, that as the natural food of wild cattle is the green succulent plants they meet with all the year round, food of this kind, could it be had, must be preferable to hay; and accordingly we find that cattle will always prefer succulent vegetables where they can get them. To find plants of this kind, and having proper qualities in other respects, we must search among those which continue green all the year round, or come to their greatest perfection in the winter time.—Of these, cabbages bid fair for holding the first place; both as being very succulent, and a very large quantity of them growing upon a small space of ground. In Mr Young's Six Months Tour, we have an account of the produce of cabbages in many different places, and on a variety of soils. The produce by Mr Crow at Keplin, on a clay soil, was, on an average of six years, 35 tons per acre; by Mr Smelt at the Leases, on a sandy gravel, 18 tons per acre; by Mr Scroop at Danby, on an average of six years, 37 tons per acre: and the general average of

Cabbages, their properties.

of all the accounts given by Mr Young, is 36 tons per acre.

Vegetables food for Cattle.

Cabbages, however, have the great inconveniency of fometimes imparting a difagreeable flavour to the milk of cows fed with them, and even to the flefh of other cattle. This, it is faid, may be prevented by carefully picking off the decayed and withered leaves: and very probably this is the cafe; for no vegetable inclines more to putrefaction than this; and therefore particular care ought to be taken to pull off all the leaves that have any fymptoms of decay. Dr Prieftley found that air was rendered noxious by a cabbage leaf remaining in it for one night, though the leaf did not fhew any fymptom of putrefaction.—For milch cows, probably, the cabbages might be rendered more proper food by boiling them.

Air rendered noxious by them.

The culture of the turnip-rooted cabbage has lately been much practifed, and greatly recommended, particularly for the purpofe of a late fpring feed; and feems indeed to be a moft important article in the farming economy, as will be fhown in its proper place.

Turnip-rooted cabbage.

Turnips likewife produce very bulky crops, though far inferior to thofe of cabbages. According to Mr Young's calculations, the fineft foil does not produce above five tons of turnips per acre. In this refpect, however, great varieties occur, as will be afterwards mentioned; and turnips poffefs the advantage of flourifhing upon a poorer foil than cabbages.

Turnips.

Carrots are found to be an excellent food for cattle of all kinds, and are greatly relifhed by them. In a rich fand, according to Mr Young's account, the produce of this root was 200 bufhels per acre. In a finer

Carrots.

Vegetables food for Cattle.

ſoil, it was 640 buſhels per acre. A lean hog was fatted by carrots in ten days time: he ate 196 lb.; and his fat was very fine, white, firm, and did not boil away in the dreſſing. They were preferred to turnips by the cattle; which, having taſted the carrots, ſoon became ſo fond of them, as with difficulty to be made to eat the turnips at all. It is probable, indeed, that carrots will make a more wholeſome food for cattle than either cabbages or turnips, as they are ſtrongly antiſeptic; inſomuch as to be uſed in poultices for correcting the ſanies of ulcers. It is probably owing to this, that the milk of cows fed on carrots is never found to have any bad taſte. Six horſes kept on them through the winter, without oats, performed their work as uſual, and looked equally well. This may be looked upon as a proof of their ſalubrity as a food; and it certainly can be no detriment to a farmer to be ſo much verſant in medical matters, as to know the impropriety of giving putreſcent food to his cattle. It is well known what a prodigious difference there is in the health of the human ſpecies when fed on putrid meats, in compariſon of what they enjoy when ſupplied with food of a contrary nature; and why may there not be a difference in the health of beaſts, as well as of men, when in ſimilar circumſtances?—It is alſo very probable, that as carrots are more ſolid than cabbages or turnips, they will go much farther in feeding cattle than either of them. The above-mentioned example of the hog ſeems ſome kind of confirmation of this: he being fed, for ten days together, with 21lb. leſs weight of carrots, than what an ox devoured of cabbages and hay in one day. There is a great diſproportion, it muſt be owned, between the bulk of an ox and that of a hog; but we can ſcarce think

think that an ox will eat as much at a time as ten hogs. At Parlington in Yorkſhire, 20 work horſes, four bullocks, and ſix milch cows, were fed on the carrots that grew on three acres, from the end of September till the beginning of May; and the animals never taſted any other food but a little hay. The milk was excellent, and 30 hogs were fattened upon what was left by the cattle. Vegetables food for Cattle.

Potatoes likewiſe appear to be a very palatable food for all kinds of cattle; and not only oxen, hogs, &c. are eaſily fed by means of them, but even poultry. According to a correſpondent of the Bath Society *, " roaſting pork is never ſo moiſt and delicate as when fed with potatoes, and killed from the barn doors without any confinement. For bacon and hams, two buſhels of pea-meal ſhould be well incorporated with four buſhels of boiled potatoes, which quantity will fat a hog of twelve ſtone (fourteen pounds to the ſtone). Cows are particularly fond of them: half a buſhel at night, and the ſame proportion in the morning, with a ſmall quantity of hay, is ſufficient to keep three cows in full milk; they will yield as much and as ſweet butter as the beſt graſs. In fattening cattle, I allow them all they will eat: a beaſt of about 35 ſtone will require a buſhel per day, but will fatten one-third ſooner than on turnips. The potatoes ſhould be clean waſhed, and not given until they are dry. They do not require boiling for any purpoſe but fattening hogs for bacon, or poultry; the latter eat them greedily. I prefer the champion potato to any ſort I ever cultivated. They do not anſwer ſo well for horſes Potatoes.

* *Letters* and *Papers* on *Agriculture*, &c. vol. iii. art. 16.

Vegetables food for Cattle.

and colts as I expected (at leaft they have not with me), though fome other gentlemen have approved of them as fubftitutes for oats."

The above-mentioned vegetables have all of them the property of pulverizing or foftening the foil; and this is certainly a very valuable qualification: but carrots and cabbages will not thrive except in foils that are already well cultivated; while potatoes and turnips may be ufed as the firft crops of a foil with great advantage. In this refpect, they are greatly fuperior to the others, on account of the encouragement which they give to the cultivation of wafte lands.

Buck-wheat.

Buck-wheat (*Polygonum fagopyrum*) has been lately recommended as an ufeful article in the prefent as well as other refpects. It has been chiefly applied to the feeding of hogs, and efteemed equal in value to barley; it is much more eafily ground than barley, as a malt-mill will grind it completely. Horfes are very fond of the grain; poultry of all forts are fpeedily fattened by it; and the bloffom of the plant affords food for bees at a very opportune feafon of the year, when the meadows and trees are moftly ftripped of their flowers. Probably the grain may hereafter be even found a material article in diftillation, fhould a fufficient quantity be raifed with that view. From the fuccefs of fome experiments detailed in the Bath Society Papers, and for which a premium was beftowed, it has been inferred, that this article ought in numerous cafes to fuperfede the practice of fummer-fallowing.

Whins an excellent food for horfes.

Whins have lately been recommended as very proper food for cattle, efpecially horfes; and are recommended by Dr Anderfon in a particular manner. They have this advantage, that they require no culture, and grow

grow on the very worſt ſoil; but they are troubleſome to cut, and require to be bruiſed in a mill conſtructed for this purpoſe; neither is the ground at all meliorated by letting whins grow upon it for any length of time. Notwithſtanding theſe diſadvantages, however, as whins continue green all the year round, and when bruiſed will afford an excellent ſucculent food, which ſeems poſſeſſed of ſtrongly invigorating qualities, they may be looked upon as the cheapeſt winter food that can poſſibly be given to cattle.—According to the calculations of Mr Eddiſon of Gateford, a ſingle acre, well cropped with whins, will winter ſix horſes. At three or four years growth, the whole crop ſhould be taken, cut cloſe to the ground, and carried to the mill, in which the whins are to be bruiſed, and then given to the horſes. Four acres ought to be planted, that one may be uſed each year, at the proper age to be cut; and he reckons the labour of one man ſufficient for providing food to this number of horſes He ſays they all prefer the whins to hay, or even to corn.

Vegetables food for Cattle.

The herb called *burnet* has likewiſe been recommended as proper food for cattle, on account of its being an evergreen; and further recommended, by growing almoſt as faſt in winter as in ſummer. Of this herb, however, we have very various accounts. In a letter addreſſed by Sir James Caldwell, F. R. S. to the Dublin Society, the culture of this plant is ſtrongly recommended, on the authority of one Bartholomew Rocque, farmer at Walham-Green, a village about three miles ſouth-weſt of London.

Burnet.

What gave occaſion to the recommendation of this plant, was, that about the year 1760, Mr Wych, chairman of the committee of Agriculture of the London

Recommended by Sir James Caldwell.

Vegetables food for Cattle.

Society for the encouragement of arts, manufactures, and commerce, came to Rocque (who was become very eminent by the premiums he had received from the society), and told him, he had been thinking, that as there are many animals which subsist wholly upon the fruits of the earth, there must certainly be some plant or herb fit for them that naturally vegetates in winter; otherwise we must believe the Creator, infinitely wise and good, to have made creatures without providing for their subsistence; and that if there had been no such plants or herbs, many species of animals would have perished before we took them out of the hands of nature, and provided for them dry meat at a season, when, indigenous plants having been indiscriminately excluded, under the name of weeds, from cultivated fields and places set apart for natural grass, green or fresh meat was no longer to be found.

Rocque allowed the force of this reasoning; but said, the knowledge of a grass, or artificial pasture, that would vegetate in winter, and produce green fodder for cattle, was lost; at least, that he knew of no such plant.—Mr Wych, however, knowing how very great the advantage would be of discovering a green fodder for winter and early in the spring, wrote to Bern, and also to some considerable places in Sweden, stating the same argument, and asking the same question. His answers to these letters were the same that had been given by Rocque. They owned there must be such plant, but declared they did not know it.

Mr Wych then applied again to Rocque; and desired him to search for the plant so much desired, and so certainly existing. Rocque set about this search with great assiduity; and finding that a pimpernel, called

called *burnet*, was of very ſpeedy growth, and grew nearly as faſt in winter as in ſummer, he took a handful of it and carried it into his ſtable, where there were five horſes; every one of which ate of it with the greateſt eagerneſs, ſnatching it even without firſt ſmelling it. Upon the ſucceſs of this experiment he went to London, and bought all the burnet ſeed he could get, amounting to no more than eight pounds, it having been only uſed in ſalads; and he paid for it at the rate of 4s. a-pound. Six of the eight pounds of ſeed he ſowed upon half an acre of ground, in March, in the year 1761, with a quarter of a peck of ſpring wheat, both by hand. The ſeed being very bad, it came up but thin. However, he ſowed the other two pounds in the beginning of June, upon about ſix roods of ground: this he mowed in the beginning of Auguſt; and at Michaelmas he planted off the plants on about 20 rood of ground, giving each plant a foot every way, and taking care not to bury the heart. Theſe plants bore two crops of ſeed the year following; the firſt about the middle of June, the ſecond about the middle of September; but the June crop was the beſt. The year after, it grew very rank and produced two crops of ſeed; both very good. As it ought not to be cut after September, he let it ſtand till the next year; when it ſheltered itſelf, and grew very well during all the winter, except when there was a hard froſt; and even during the froſt it continued green, though it was not perceived to grow. In the March following it covered the ground very well, and was fit to receive cattle.

Vegetables food for Cattle.

If the winter is not remarkably ſevere, the burnet, though cut in September, will be 18 inches long in March;

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March; and it may be fed from the beginning of February till May: if the cattle are taken off in May, there will be a good crop of feed in the beginning of July. Five weeks after the cattle are taken off, it may be removed, if that is preferred to its ſtanding for ſeed. It grows at the rate of an inch a-day, and is made into hay like other graſs. It may be mown three times in one ſummer, and ſhould be cut juſt before it begins to flower. Six rood of ground has produced 1150 pounds at the firſt cutting of the third year after it was ſowed; and, in autumn 1763, Rocque ſold no leſs than 300 buſhels of the ſeed.

According to Rocque, the ſoil in which burnet flouriſhes beſt, is a dry gravel; the longeſt drought never hurts it: and Sir James Caldwell aſſerts, that he ſaw a very vigorous and exuberant plant of this kind, growing from between two bricks in a wall in Rocque's ground, without any communication with the ſoil; for he had cut away all the fibres of the root that had ſtretched downward, and penetrated the earth, long before.

Burnet was found equally fit for feeding cows, ſheep, and horſes; but the ſheep muſt not be ſuffered to crop it too cloſe. Though no ſeed was left among the hay, yet it proved nouriſhing food; and Rocque kept a horſe upon nothing elſe, who, at the time of writing the account, was in good heart, and looked well. He affirmed alſo, that it cured horſes of the diſtemper called the *greaſe*, and that by its means he cured one which was thought incurable; but ſays, it is only the firſt crop which has this effect.

Burnet reckoned an improper food by Mr Miller and Mr Anderſon.

This is the ſubſtance of Sir James Caldwell's letter to the Dublin Society, at leaſt as to what regards the culture of burnet; and it might reaſonably be expected, ed, that a plant, whofe ufe was recommended to the public with fo much parade, would foon have come into univerfal efteem. We were furprifed, therefore, on looking into Mr Miller's Dictionary, to find the following words, under the article *Poterium*:—"This plant has of late been recommended by *perfons of little fkill*, to be fown as a winter pabulum for cattle: but whoever will give themfelves the trouble to examine the grounds where it naturally grows will find the plants left uneaten by the cattle, when the grafs about them has been cropped to the roots; befides, in wet winters, and in ftrong land, the plants are of fhort duration, and therefore very unfit for that purpofe; nor is the produce fufficient to tempt any perfon of fkill to engage in its culture; therefore I wifh thofe perfons to make trial of it in fmall quantities, before they embark largely in thefe new fchemes."—Dr Anderfon, too, in his Effays on Agriculture, mentions the produce of burnet being fo fmall, as not to be worth cultivating. Vegetables food for Cattle.

Upon the authority of Mr Rocque, likewife, the white beet is recommended as a moft excellent food for cows; that it vegetates during the whole winter, confequently is very forward in the fpring; and that the moft profitable way of feeding cows is to mow this herb, and give it to them green all the fummer. It grew in Rocque's garden, during a very great drought, no lefs than four feet high, from the 30th of May to the 3d of July; which is no more than one month and four days. In fummer it grows more than an inch a-day; and is beft fown in March: a bufhel is enough for an acre, and will not coft more than ten fhillings. It thrives beft in a rich, deep, light foil: the ftalks White beet recommended.

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Vegetables food for Cattle. are very thick and ſucculent; the cows ſhould therefore eat them green.

Root of Scarcity. Another ſpecies of beet (*Beta cicla*), the Mangel Wurzel, or *Root of Scarcity*, as it has been called, has been lately extolled as food both for man and cattle; but, after all, ſeems only to deſerve attention in the latter view. It is a biennial plant; the root is large and fleſhy, ſometimes a foot in diameter. It riſes above the ground ſeveral inches, is thickeſt at the top, tapering gradually downward. The roots are of various colours, white, yellow, and red; but theſe laſt are always of a much paler colour than beetrave. It is good fodder for cows, and does not communicate any taſte to the milk. It produces great abundance of leaves in ſummer, which may be cut three or four times without injuring the plant. The leaves are more palatable to cattle than moſt other garden plants, and are found to be very wholeſome. The farmers in thoſe parts of Germany where it is chiefly cultivated, we are told, prefer this ſpecies of beet, for feeding cattle, to cabbages, principally becauſe they are not ſo liable to be hurt by worms or inſects; but they think they are not ſo nouriſhing as turnips, potatoes, or carrots, and that cattle are not nearly ſo ſoon fattened by this root as by carrots, parſnips, or cabbages. It has even been aſſerted, that this root affords leſs nouriſhment than any of thoſe that have been commonly employed for feeding cattle. This does not correſpond with the pompous accounts with which the public has been entertained. Upon the whole, however, it is a plant which ſeems to deſerve the attention of our farmers; as on ſome ſoils, and in particular circumſtances, it may prove a very uſeful article for the above purpoſes.

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In Dr Anderfon's Effays, we find it recommended to make trial of fome kinds of graffes, which probably would not only anfwer for frefh fodder during the winter, but might alfo be cut for hay in fummer. This is particularly the cafe with that fpecies called *Sheep's fefcue grafs*. "I had, fays he, a fmall patch of this grafs in winter 1773; which, having been cut in the month of Auguft or September preceding, was faved from that period, and had advanced before winter to the length of five or fix inches; forming the clofeft pile that could be imagined. And although we had about fix weeks of very intenfe froft, with fnow, and about other fix weeks, immediately fucceeding that, of exceeding keen froft every night, with frequent thaws in the day time, without any fnow, during which time almoft every green thing was deftroyed; yet this little patch continued all along to retain as fine a verdure as any meadow in the month of May; hardly a point of a leaf having been withered by the uncommon feverity of the weather. And as this grafs begins to vegetate very early in the fpring, I leave the reader to judge what might be the value of a field of grafs of this kind in thefe circumftances." Vegetables food for Cattle. Sheep's fefcue grafs.

Of another kind of grafs, called *purple fefcue*, Dr Anderfon gives the following character: "It retained its verdure much better than rye-grafs during the winter feafon; but it had more of its points killed by the weather than the former. It likewife rifes in the fpring, at leaft as early as rye-grafs." Purple fefcue.

This ingenious farmer, and well-known author, has alfo made experiments on the culture of thefe and feveral other kinds of graffes.

In every branch of fcience actual experiment is the

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only means by which any real or permanent improvement can be made. It is in consequence of a conviction of this truth, and of the active industry which has resulted from that conviction, that physical science has made such rapid improvements in modern times. *Every experiment in the art of agriculture, when made with rational views, and reported with candour, is entitled to an uncommon degree of attention.* It is not only, as in other branches of science, the only mode in which knowledge or improvement can be successfully pursued, but the person who engages in it usually possesses more merit than the contriver of other physical experiments, on account of the patient observation which he is under the necessity of exerting, in consequence of the length of time which must elapse before his trials can be rendered complete. The importance of the subject also entitles it to particular regard. We have every reason to believe that valuable plants will still be discovered, the use of which will give additional fertility to the earth, and additional resources for the support of the animals by which it is inhabited. It is certain at least that the person who introduced into any country the use of the turnip or potato plant, performed a more valuable service to its inhabitants, than if he had realized for them the imaginary art of the transmutation of all the metals into gold. We account it unnecessary, therefore, to make any apology for inserting here Dr Anderson's experiments upon several kinds of our native grasses, as, in another part of our work, we shall have occasion to state other experiments upon the same subject, which have been made by intelligent cultivators.

1. *Purple fescue grass.* "Although this grass is very often found in old pastures, yet, as it has but few flower-

ſtalks, and as it is greedily eaten by all domeſtic animals, theſe are ſeldom ſuffered to appear; ſo that it uſually remains there unperceived. But it ſeems to be better able to endure the peculiar acrimony of the dung of dogs than almoſt any other plant; and is, therefore, often to be met with in *dog-hills*, as I call the *little hills by road ſides where dogs uſually piſs and dung*: and as it is allowed to grow there undiſturbed, the farmer may have an opportunity of examining the plant, and becoming acquainted with its appearance.

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"The leaves are long and ſmall, and appear to be roundiſh, ſomething like a wire; but, upon examination, they are found not to be tubulated like a reed or ruſh; the ſides of the leaf being only folded together from the middle rib, exactly like the ſtrong bent-graſs on the ſea ſhore. The flower-ſtalk is ſmall, and branches out in the head, a little reſembling the wild oat; only the grains are much ſmaller, and the ear does not ſpread full open, but lies bending a little to one ſide. The ſtalks are often ſpotted with reddiſh freckles, and the tops of the roots are uſually tinged with the ſame colour; from whence it has probably obtained its diſtinctive name of *feſtuca rubra*, or *red (purple) feſcue*.

"It is often to be met with in old garden walks; and, as its leaves advance very quickly after cutting, it may uſually be diſcovered above the other graſſes, about a week or a fortnight after the walks are cut. Nor do they ſeem to advance only at one ſeaſon, and then ſtop and decay, like the rye-graſs; but continue to advance during the whole of the ſummer, even where they are not cut; ſo that they ſometimes at-

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tain a very great length. Laſt ſeaſon (1774), I meaſured a leaf of this graſs, that ſprung up in a neglected corner, which was four feet and four inches in length, although not thicker than a ſmall wire. It is unneceſſary to add, that theſe leaves naturally trail upon the ground, unleſs where they meet with ſome accidental ſupport; and, that if any quantity of it is ſuffered to grow for a whole ſeaſon, without being eaten down or cut, the roots of the leaves are almoſt rotted, by the overſhadowing of the tops of the other leaves, before the end of the ſeaſon.

Appearance in its cultivated ſtate.

"This is the appearance and condition of the plant in its native ſituation: as it is ſeldom that it is diſcovered but in pretty old paſtures, and, as in that ſtate it carries only a very few ſeed-ſtalks, it was with ſome difficulty that I could collect a ſmall handful of the ſeed, which I carefully ſowed in a ſmall patch of garden mould, to try if it could be eaſily cultivated. It came up as quickly as any other kind of graſs, but was at firſt as ſmall as hairs; the leaves, however, advanced apace; and were, before autumn, when the grain with which they had been ſowed was cut down, about 16 or 18 inches in length; but having been ſown very thin, it was neceſſary to pick out ſome other kinds of graſs that came up amongſt it, leſt it might have been choked by them. Early the next ſpring it advanced with prodigious vigour, and the tufts that were formed from every ſeed became exceeding large; ſo that it quickly filled the whole ground. But now the leaves were almoſt as broad as thoſe of common rye-graſs, and the two ſides only inclined a little towards one another from the mid-rib, without any appearance of roundneſs. In due time a great many ſeed-ſtalks ſprung out, which attained very nearly to the height of four feet, and produced feeds in abundance; which may be as easily saved as those of common rye-grass. Vegetables food for Cattle.

"*The prodigious difference between this plant in its native and cultivated state amazed me; but it was with a good deal of satisfaction that I found there would be no difficulty in procuring seeds from it, which I had much doubted of at first.* It would seem, that nature hath endowed this plant with a strong generative power, during its youth, which it gradually loses as it advances in age (for the difference perceived in this case could not be attributed to the richness of the soil); and that, on the contrary, when it was old, the leaves advanced with an additional vigour, in proportion to the declining strength of the flower-stalks: for the leaves of the young plants seldom exceed two feet, whereas numbers of the old leaves were near four feet in length.

" From these peculiarities in the growth of this plant, it would seem to promise to be of great use to the farmer; as he could reap from a field of it, for the first two or three years, as great a weight of hay as he could obtain from any of the culmiferous grasses (those bearing a long jointed stalk); and, if he meant afterwards to pasture it, he would suffer no inconveniences from the flower-stalks; and the succulent leaves that continue to vegetate during the whole summer, would at all times furnish his cattle with abundance of wholesome food. It has also been remarked, that this grass rises as early in the spring as rye-grass; and continues green for the greatest part of winter, which the other does not. It is moreover an abiding plant, as it seems never to wear out of the ground where it has once

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been eftablifhed. *On all which* accounts, it appears to me highly to merit the attention of the farmer; and well deferves to have its feveral qualities, and the culture that beft agrees with it, afcertained by accurate experiments.

Sheep's fefcue defcribed.

2. " *Sheep's fefcue grafs*, or *feftuca ovina*, is much praifed by the Swedifh naturalifts for its fingular value as a pafture-grafs for fheep; this animal being reprefented as fonder of it than of any other grafs, and fattening upon it more quickly than on any other kind of food whatever. And indeed, the general appearance of the plant, and its peculiar manner of growth, feem very much to favour the accounts that have been given us of it.

" This plant is of the fame family with the former, and agrees with it in feveral refpects; although they may be eafily diftinguifhed from one another. Its leaves, like the former, in its natural ftate, are always rounded, but much fmaller; being little bigger than large horfe hairs, or fwine-briftles, and feldom exceed fix or feven inches in length. But thefe fpring out of the root in tufts, fo clofe upon one another, that they refemble, in this refpect, a clofe hair brufh more than any thing elfe I know: fo that it would feem naturally adapted to form that thick fhort pile of grafs in which fheep are known chiefly to delight. Its flower-ftalks are numerous, and fometimes attain the height of two feet; but are more ufually about 12 or 15 inches high.

Its appearance when cultivated.

" Upon gathering the feeds of this plant, and fowing them as the former, it was found that they fprung up as quickly as any other kind of grafs; but the leaves are at firft no bigger than a human hair. From each fide side springs up one or two of these hair-like filaments, that, in a short time, sends out new offsets, so as quickly to form a sort of tuft, which grows larger and larger, till it at length attains a very large size, or till all the intervals are closed up, and then it forms the closest pile of grass that it is possible to imagine. In April and May it pushed forth an innumerable quantity of flower-stalks, that afforded an immense quantity of hay; it being so close throughout, that the scythe could scarcely penetrate it. This was allowed to stand till the seeds ripened; but the bottoms of the stalks were quite blanched, and almost rotted for want of air before that time. Vegetables food for Cattle.

" This was the appearance that it made the first year after it was sowed: but I have reason to think, that, after a few years, it likewise produces fewer seed-stalks, and a greater quantity of leaves, than at first. But, however that may be, it is certain, that if these are eaten down in the spring, it does not, like rye-grass, persist in a continued tendency to run to seed; but is at once determined to push forth a quantity of leaves without almost any stalks at all: and, as all domestic animals, but more especially sheep, are extremely fond of this grass, if they have liberty to pasture where it grows, they bite it so close as never to suffer almost a single seed-stalk to escape them; so that the botanist will often search in vain for it, when he is treading upon it with his feet. The best way to discover it in any pasture, is to search for it in winter, when the tufts of it may be easily distinguished from every other kind of grass, by their extraordinary closeness, and the deep green colour of the leaves.

" It seems to grow in almost any soil; although it is imagined What soil most proper.

[illegible] imagined that it would flouriſh beſt in a light ſandy ſoil, as it can evidently live with leſs moiſture than almoſt any other kind of graſs; being often ſeen to remain in the ſods that have been employed in coping for ſtone dykes, after all the other graſſes that grew in them have diſappeared. It is likewiſe found in poor barren ſoils, where hardly any other plant can be made to grow at all; and on the ſurface of dry worn-out peat moſs, where no moiſture remains ſufficient to ſupport any other plant whatever: but in neither of theſe ſituations does it thrive; as it is there only a weak and unſightly plant, very unlike what it is when it has the good fortune to be eſtabliſhed upon a good ſoil; although it is ſeldomer met with in this laſt ſtate than in the former.

"I will not here repeat what has been already ſaid about the particular property that this plant poſſeſſes of continuing all winter; nor point out the benefits that the farmer may reap from this valuable quality.—He need not, however, expect to find any verdure in winter on ſuch plants as grow upon the looſe moſſy ſoil above mentioned; for, as the froſt in winter always hoves up the ſurface of this ſoil, the roots of the plants are ſo lacerated thereby, as to make it, for ſome time in the ſpring, to all appearance dead. Nor will he often perceive much verdure in winter upon thoſe plants that grow upon poor hungry ſoils, which cannot afford abundant nouriſhment to keep them in a proper ſtate of vegetation at all times: but ſuch plants as grow on earthen dykes, which uſually begin to vegetate with vigour when the autumnal rains come on, for the moſt part retain their verdure at that ſeaſon almoſt as well as if they were in good garden-mould.

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"I have been very particular in regard to this plant; because, in as far as my obfervations have yet gone, it promifes, on many accounts, to make a moft valuable acquifition to the farmer, and therefore juftly demands a very particular fhare of his attention." Vegetables food for Cattle.

3. The *holcus lanatus*, or creeping foft-grafs of Hudfon, commonly called *York* or *Yorkfhire white*.—This is confidered by our author as one of the moft valuable kinds of meadow-graffes; its pile being exceedingly clofe, foft, and fucculent. It delights much in moifture, and is feldom found on dry ground, unlefs the foil is exceeding rich. It is often found on thofe patches near fprings, over which the water frequently flows; and may be known by the uncommon foftnefs and fucculence of the blade, the lively light green colour of the leaves, and the matted intexture of its roots. But, notwithftanding the foftnefs of its firft leaves, when the feed-ftalks advance, they are rough to the touch, fo that the plant then affumes a very different appearance from what we would have expected. The ear is branched out into a great number of fine ramifications, fomewhat like the oat, but much fmaller.—This kind of grafs, however, would not be eafily cultivated; on account of a kind of foft membrane that makes the feeds adhere to the ftalk, and to one another, after they are feparated from it, as if they were intermixed with cobweb, fo that it is difficult to get them feparated from the ftalk, or to fpread readily in fowing. It fpreads, however, fo faft by its running roots, that a fmall quantity fowed very thin, would be fufficient to ftock a large field in a fhort time. Holcus lanatus.

These are the kinds of *graffes*, properly fo called, which have not as yet been fo generally cultivated as

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they ought to be; but which Dr Anderſon, at the time of writing his treatiſe, thought moſt likely to be of value. It is probable his recommendation has contributed not a little to procure attention to ſeveral of them; as it will afterwards appear, when we come to conſider the culture of graſſes, that they are now commonly ſown by the beſt agriculturiſts. Beſides theſe he recommends the following of the pea tribe.

Milk-vetch.

1. *Milk-vetch*, *liquorice-vetch*, or *milk-wort*. This plant, in ſome reſpects, very much reſembles the common white clover: from the top of the root a great number of ſhoots come out in the ſpring, ſpreading along the ſurface of the ground every way around it; from which ariſe a great many cluſters of bright yellow flowers, exactly reſembling thoſe of the common broom. Theſe are ſucceeded by hard round pods, filled with ſmall kidney-ſhaped ſeeds. From a ſuppoſed reſemblance of a cluſter of theſe pods to the fingers of an open hand, the plant has been ſometimes called *ladies-fingers*. By others it is called *crow-toes*, from a fancied reſemblance of the pods to the toes of a bird. Others, from the appearance of the bloſſom, and the part where the plant is found, have called it *feal*, improperly *fell-broom*. It is found plentifully almoſt everywhere in old graſs fields; but as every ſpecies of domeſtic animals eat it, almoſt in preference to any other plant, it is ſeldom allowed to come to the flower in paſture grounds, unleſs where they have been accidentally ſaved from the cattle for ſome time; ſo that it is only about the borders of corn fields, or the ſides of incloſures to which cattle have not acceſs, that we have an opportunity of obſerving it. As it has been imagined that the cows which feed on the paſtures where this

plant

plant abounds, yield a quantity of rich milk, the plant has, from that circumſtance, obtained its moſt proper Engliſh name of *milk-vetch*. Vegetables food for Cattle.

One of the greateſt recommendations of this plant is, that it grows in poor barren ground, where almoſt no other plant can live. It has been obſerved in ground ſo poor, that even heath, or ling (*erica communis*), would ſcarcely grow; and upon bare obdurate clays, where no other plant could be made to vegetate, inſomuch that the ſurface remained entirely uncovered, unleſs where a plant of this kind chanced to be eſtabliſhed; yet, even in theſe unfavourable circumſtances, it flouriſhed with an uncommon degree of luxuriance, and yielded as tender and ſucculent, though not ſuch abundant ſhoots, as if reared in the richeſt manured fields. In dry barren ſands, alſo, where almoſt no other plant could be made to live, it has been found to ſend out ſuch a number of healthy ſhoots all round, as to cover the earth with the cloſeſt and moſt beautiful carpet that can be deſired. Its good qualities.

The ſtalks of the milk-vetch are weak and ſlender, ſo that they ſpread upon the ſurface of the ground, unleſs they are ſupported by ſome other vegetable. In ordinary ſoils they do not grow to a great length, nor produce many flowers; but in richer fields the ſtalks grow to a much greater length, branch out a good deal, but carry few or no flowers or ſeeds. From theſe qualities our author did not attempt at firſt to cultivate it with any other view than that of paſture; and, with this intention, ſowed it with his ordinary hay ſeeds, expecting no material benefit from it till he deſiſted from cutting his field. In this, however, he was agreeably diſappointed; the milk-vetch growing the

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first season as tall as his great clover, and forming exceeding fine hay; being scarce distinguishable from lucerne, but by the slenderness of the stalk, and proportional smallness of the leaf.

Another recommendation of this plant is, that it is perennial. It is several years after it is sowed before it attains to its full perfection; but, when once established, it probably remains for a great number of years in full vigour, and produces annually a great quantity of fodder. In autumn 1773, Dr Anderson cut the stalk from an old plant that grew on a very indifferent soil; and, after having thoroughly dried it, he found that it weighed 14 ounces and a half.

The stalks of this plant die down entirely in winter, and do not come up in the spring till the same time that clover begins to advance; nor does it advance very fast, even in summer, when once cut down or eaten over: so that it seems much inferior to the above-mentioned grasses; but might be of use to cover the worst parts of a farm, on which no other vegetable could thrive.

Yellow vetchling.

2. The *common yellow vetchling* (*Lathyrus pratensis*), or *everlasting tare*, grows with great luxuriance in stiff clay soils, and continues to yield annually a great weight of fodder, of the very best quality, for any length of time. This is equally fit for pasture or hay; and grows with equal vigour in the end of summer as in the beginning of it; so would admit being pastured upon in the spring, till the middle, or even the end of May, without endangering the loss of the crop of hay. This is an advantage which no other plant except clover possesses; but clover is equally unfit for early pasture or for hay. Sainfoin is the only plant whose qualities approach

proach to it in this respect, and the yellow vetchling will grow in such soils as are utterly unfit for producing sainfoin.—It is also a perennial plant, and increases so fast by its running roots, that a small quantity of the seed would produce a sufficient number of plants to fill a whole field in a very short time. If a small patch of good ground is sowed with the seeds of this plant in rows, about a foot distance from one another, and the intervals kept clear of weeds for that season, the roots will spread so much as to fill up the whole patch next year; when the stalks may be cut for green fodder or hay. And if that patch were dug over in the spring following, and the roots taken out, it would furnish a great quantity of plants, which might be planted at two or three feet distance from one another, where they would probably overspread the whole field in a short time. Vegetables food for Cattle.

3. The *common blue tare* seems more likely than the former to produce a more flourishing kind of hay, as it abounds much more in seeds; but as the stalks come up more thinly from the root, and branch more above, it does not appear to be so well adapted for a pasture grass as the other. The leaves of this plant are much smaller, and more divided, than those of the other; the stalks are likewise smaller, and grow to a much greater length. Though it produces a great quantity of seeds, yet the small birds are so fond of them, that, unless the field were carefully guarded, few of them would be allowed to ripen. Blue tare.

4. The *vicia sepium; purple, everlasting*, or *bush-vetch*. Our author gives the preference to this plant beyond all others of the same tribe for pasture. The roots of it spread on every side a little below the surface of the ground, Bush-vetch.

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ground, from which, in the fpring, many ftems arife quite clofe by one another; and as thefe have a broad tufted top covered with many leaves, it forms as clofe a pile as could be defired. It grows very quickly after being cut or cropt, but does not arrive at any great height; fo that it feems more propet for pafturage than making hay; although, upon a good foil, it will grow fufficiently high for that purpofe; but the ftalks grow fo clofe upon one another, that there is great danger of having it rotted at the root, if the feafon fhould prove damp. It feems to thrive beft in a clay foil.

Everlafting pea.

Befides thefe, there are a variety of others of the fame clafs, which he thinks might be ufeful to the farmer. The common garden everlafting pea, cultivated as a flowering plant, he conjectures, would yield a prodigious weight of hay upon an acre; as it grows to the height of ten or twelve feet, having very ftrong ftalks, that could fupport themfelves without rotting till they attained a great height.

Achillea millefolium.

One other plant, before unnoticed, is recommended by our author to the attention of the farmer; it is the *common yarrow (Achillea millefolium)*, or *hundred-leaved grafs*. Concerning this plant, he remarks, that in almoft every fine old pafture, a great proportion of the growing vegetables with which the field is covered confifts of it; but the animals which feed there are fo fond of the yarrow, as never to allow one feed-ftalk of it to come to perfection. Hence thefe feed-ftalks are never found but in neglected corners, or by the fides of roads; and are fo difagreeable to cattle, that they are never tafted; and thus it has been erroneoufly thought that the whole plant was refufed by them.—The leaves of this plant have a great tendency to grow very thick upon

upon one another, and are therefore particularly adapted for pafturage. It arrives at its greateft perfection in rich fields that are naturally fit for producing a large and fucculent crop of grafs. It grows alfo upon clays; and is among the firft plants that ftrike root in any barren clay that has been lately dug from any confiderable depth; fo that this plant, and thiftles, are ufually the firft that appear on the banks of deep ditches formed in a clayey foil. All animals delight to eat it; but, from the dry aromatic tafte it poffeffes, it would feem peculiarly favourable to the conftitution of fheep. It feems altogether unfit for hay. Vegetables food for Cattle.

Befides thefe plants, which are natives of our own country, there are others which, though natives of a foreign climate, are found to thrive very well in Britain; and have been raifed with fuch fuccefs by individuals, as highly to merit the attention of every farmer. Among them the firft place is claimed by lucerne. Lucerne.

This is the plant called *medica* by the ancients, becaufe it came originally from Media, and on the culture of which they beftowed fuch great care and pains. It has a perennial root, and annual ftalks, which, in a good foil, rife to three feet, or fometimes more, in height; its leaves grow at a joint like thofe of clover; the flowers, which appear in June, are purple; and its pods are of a fcrew-like fhape, containing feeds which ripen in September. All forts of domeftic cattle are fond of this plant, efpecially when allowed to eat it green, and black cattle may be fed very well with the hay made from it; but an excefs of this food is faid to be very dangerous.

Lucerne has the property of growing very quickly after

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after it is cut down, *insomuch that Mr Rocque has mowed it five times in a season, and Dr Anderson affirms he has cut it no less than six times. It is, however*, not very easily cultivated; in consequence of which it sometimes does not succeed.

Timothy grass.

Another grass was brought from Virginia, where it is a native, and sown by Rocque in 1763. This grass is called *timothy*, from its being brought from New-York to Carolina by one Timothy Hanson. It grows best in a wet soil; but will thrive in almost any. If it is sown in August, it will be fit for cutting in the latter end of May or beginning of June. Horses are very fond of it, and will leave lucerne to eat it. It is also preferred by black cattle and sheep; for a square piece of land having been divided into four equal parts, and one part sowed with lucerne, another with sainfoin, a third with clover, and the fourth with timothy, some horses, black cattle, and sheep, were turned into it, when the plants were all in a condition for pasturage; and the timothy was eaten quite bare, before the clover, lucerne, or sainfoin, were touched.

One valuable property of this grass is, that its roots are so strong and interwoven with one another, that they render the wettest and softest land, on which a horse could not find footing, firm enough to bear the heaviest cart. With the view of improving boggy lands, therefore, so as to prevent their being poached with the feet of cattle, Dr Anderson recommends the cultivation of this kind of grass, from which he has little expectation in other respects.

Grazing compared with the plough.

On this subject, of the kind of plants most proper to be raised for feeding cattle, one general question ought not to pass unnoticed concerning the propriety of feeding them upon roots and plants cultivated by the aid of the plough, or upon leaving them to derive their ſubſiſtence from lands allowed to remain continually in paſturage. The advantages of the latter practice are ſet forth by Thomas Davis, Eſq. of Longleet, in the following words *. "Experience ſufficiently evinces the extreme difficulty of perſuading tenants that they get more (generally ſpeaking) by feeding their lands, than by ploughing them; yet it requires very few arguments to convince a landlord, that, in cold wet land eſpecially, the leſs ploughed land you have, the leſs you put it in the tenant's power to ruin your eſtate. That a tenant of 60l. per annum on a dairy farm will get money, while a corn farm of the ſame ſize will ſtarve its occupier (though perhaps the former gives 15s. per acre for his land, and the latter only 10s.), is ſelf-evident. The plough is a friend of everybody's, though its advantages are very far from being particularly and locally felt; corn being an article that will bear keeping till the whim or caprice, or ſuppoſed advantage of its poſſeſſor, call it forth. But the produce of the cow is far otherwiſe. Cheeſe muſt neceſſarily be ſold at a certain period: it is a ponderous article; and one-twelfth, or at leaſt one-fifteenth of its value, is often paid for carrying it to a fair 50 miles off; and the butter and ſkimmed milk find their way no great diſtance from home, as is evident by the price of butter varying frequently one-third in 20 or 30 miles. Every inhabitant of Bath muſt be ſenſible, that butter and cheeſe have riſen one-third or more in price

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* *Bath Papers*, vol. iii.

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price within 20 years. Is not this owing to the great encouragement given to the plough and to grazing, at a time when, on account of the increafed demand for milk, cream, butter, and cheefe, every exertion on behalf of the dairy fhould have been encouraged?" &c.

In fome remarks on this letter by Mr Billingfley, the fame fuperiority of dairy farms to the arable kind is afferted in the moft pofitive terms. "Perhaps (fays he) there cannot be a ftronger proof of the inferiority of the plough, with refpect to profit, than the fuperior punctuality of the dairy farmer in the payment of his rent. This obfervation, I believe, moft ftewards who *fuperintend manors devoted partly to corn and partly to dairy farms, will verify; at leaft I have never met with one who controverts it. But perhaps the advocate* for the plough will defire me not to confound the abufe of a thing with its intrinfic excellence; and fay, that the generality of corn farmers are moft egregious flovens; that lands devoted to the plough are not confined to fuch a mediocrity of profits as 20s. per acre; that the produce of artificial graffes (without which a well managed arable farm cannot exift), far exceeds that of natural grafs both in refpect of quantity and nutrition: that the ftraw yard is a moft convenient receptacle for the cow when freed from the pail. Thefe, and many other reafons, may be adduced to fhew the propriety of walking in the middle path, and of judicioufly blending *arable* with *pafture*, in the proportion perhaps of *three* of the latter to *one* of the former."

On thefe letters we fhall only remark, that for the good of mankind we hope the notions contained in them will never be acted upon, even for the fhorteft period, on account of their tendency to raife the price of bread. They certainly never can be followed during a long period, as we are satisfied that they are founded on error, and have arisen chiefly from not attending to the usual situation of persons holding small corn and dairy farms. The dairy farmer usually possesses a sufficient capital, which enables him to carry on his business, which is of a very simple nature, to complete advantage; whereas, this is seldom the case with the holders of small corn farms: but where the latter possess sufficient capital to enable them to derive from the land every advantage which it is capable of bestowing, there can be no doubt of the superiority of the plough. In such cases, however, it is necessary that the arable farmer possess a large stock of cattle, to *enable him to consume advantageously the produce of the lands*, and to preserve them in an improving condition by large quantities of manure. In the Bath Papers, vol. v. p. 43. we have a method proposed by Mr Wimpey of improving small arable farms in such a manner as to make them yield as much milk, butter, and cheese, as those which are kept continually in pasture. He agrees with the maxim already mentioned, that small arable farms do not afford to the occupier so good a maintenance as dairy farms of the same value; and that the possessor of a dairy farm will do well and save money, while the former, with much toil and trouble, is starving himself and family. Notwithstanding this, he maintains, that there is an essential difference between ground that is naturally arable, and such as is by nature adapted for pasture. Land which is naturally arable, according to him, can by no means be converted into pasture of any duration. "Such as, from a wild state of nature, overrun with furze, fern, bushes and brambles, has been rendered

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dered fertile by means of the plough, muſt be kept in that improved ſtate by its frequent uſe; otherwiſe it would ſoon revert to that wild barren ſtate which was its original condition. A farm, therefore, which conſiſts wholly, or almoſt ſo, of land that is properly arable, muſt ever continue arable; for it is not practicable to render it in any degree fertile but by means of the plough, or to keep it long in that ſtate even when it is made ſo." He is of opinion, however, that by raiſing crops proper for feeding cattle, the poſſeſſor of an arable farm may raiſe as great a number of horned cattle as one who has a paſture farm; the only queſtion is, Whether he can be reimburſed of his expences by the produce? "To aſcertain this fact (ſays he), we muſt inquire what may be the average expences of keeping a milch cow on a dairy farm for any given time. It is ſaid, upon very good authority, that the expence is generally from 3l. to 3l. 10s. per annum. Two acres and a half of paſture fit for this uſe is ſufficient to keep a cow the whole year through, and ſuch land is valued at from 25s. to 30s. per acre. At 25s. the keeping of each cow would amount to 3l. 2s. 6d. per annum. A dairy farm, therefore, conſiſting of 48 acres, at 25s. per annum, would amount to 60l. rent; and the number of cows that might be kept on ſuch a farm would be about 20. In the next place, with regard to the expence of keeping a cow upon food raiſed in arable land as a ſuccedaneum for graſs, we are aſſured by unqueſtionable authority, that a buſhel of potatoes, given half at night and half in the morning, with a ſmall allowance of hay, is ſufficient to keep three cows a day; by which allowance their milk will be as rich and as good as in the ſum-

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mer months when the cows are in paſture. An acre of land, properly cultivated with potatoes, will yield 337 buſhels; and the total expence of cultivation, rent and tithe included, will not exceed 6l. 13s. If three cows eat ſeven buſhels per week, then they would eat 364 buſhels in a year; and 20 cows would conſume 2433 buſhels:" So that, according to this calculation, ſeven acres and a quarter would nearly maintain as many cows as on the paſture farm could be maintained by 48 acres. If then the cultivation of one acre of ground coſts 6l. 13s. the cultivation of ſeven acres and a quarter will coſt about 48l. We have ſeen, however, that the rent of a dairy farm capable of maintaining 20 milch cows, is not leſs than 60l. ſo that the calculation is thus entirely in favour of the arable farm; ſeven or eight acres of the arable farm being ſuperior by 12l. in value, when cultivated with potatoes, to 48 acres of meadow or paſture ground. "It muſt indeed be obſerved (adds our author), that in this ſtatement no allowance is made for the ſmall quantity of hay given to the cows with the potatoes. It muſt be noted alſo, that the account of cultivation is charged with 40s. an acre for manure, and ſome expence for ploughing, which of right is chargeable to the crop of wheat that is to follow. Now, if we deduct 40s. an acre from the expence of cultivating the potatoes, it reduces the ſum to 4l. 13s.; and the whole expence upon ſeven acres and a quarter is thus leſs than 34l. and conſequently the keeping of 20 cows is little more than half to the occupier of the arable farm what it is to the occupier of the grazing farm. If this concluſion be fairly drawn, and the calculation free from errors, it is matter of the greateſt import-

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ance, eſpecially to the little arable farmer. It plainly raiſes him from a ſtate of acknowledged inferiority to one greatly ſuperior."

Objection anſwered from an experiment of Mr Vagg.

Our author next proceeds to obviate an objection, "that the whole of his reaſoning muſt be indeciſive, as relating only to potatoes." In oppoſition to this, he adduces an experiment made on a pretty large ſcale by Mr Vagg; from which it appears, that cabbages, when raiſed upon arable ground, are nearly as much ſuperior to a natural crop as potatoes are. Twelve acres were employed in this experiment, and thoſe of an indifferent quality. The rent was 30s. per acre, and the whole expence of culture and carting off the crop amounted only to 1l. 14s. ſo that all the coſt of the twelve acres was 38l. 9s. From the produce were fed 45 oxen and upwards of 60 ſheep; and he was aſſured that they improved as faſt upon it as they do in the beſt paſture months, May, June, and July. "Now (ſays Mr Wimpey), if inſtead of 60 ſheep we reckon 15 oxen, or that four ſheep are equal to about one ox, in which we cannot err much; then 60 oxen were kept well for three months, or, which is the ſame thing, 15 for a whole year, for 38l. 9s.; and conſequently 20 oxen would coſt 51l. 5s. 4d. which is not quite 3l. more than the keeping of 20 cows would coſt in potatoes. Turnips, turnip-rooted cabbage, carrots, parſnips, and ſome other articles, by many experiments often repeated, have been found quite adequate to the ſame valuable purpoſes; at leaſt ſo far as to be more lucrative than meadow or paſture. Clover and rye-graſs are omitted, as having been long in general practice; but are uſually very ſhort of the advantages which may be derived from the culti-

Number of cattle fed from 12 acres of cabbages.

vation of the other articles recommended." Sainfoin is greatly recommended; but our author acknowledges that it makes but a miferable appearance the firft year, though afterwards he is of opinion that one acre of fainfoin is equal to two of middling pafture ground; for which reafon he accufes the farmer of intolerable indolence who does not cultivate fo ufeful a plant. On this fubject, however, we muft remember, that the culture of fainfoin is clogged with the lofs of one if not two crops; which may fometimes be inconvenient, though afterwards it remains in perfection for a great number of years. The moft advantageous method of raifing it he fuppofes to be after potatoes. In this way it will thrive even upon very poor ground; as the culture and manure neceffary for the potatoes both pulverize the foil and enrich it to a fufficient degree.

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The opinions here ftated are fupported and maintained by the beft informed authors, in fuch a manner as to leave no doubt of their truth. The Reverend Edmund Cartwright recommends, upon arable farms, the following courfes of crops with a view to this fubject *. "On ftrong lands, fays this writer, the following courfes I have known fuccefsfully practifed: 1ft, beans; 2d, wheat; 3d, cabbages; 4th, barley; 5th, clover: this courfe prefents three ameliorating crops to two exhaufting ones. 1ft, Potatoes; 2d, wheat; 3d, turnips (carried off); 4th, barley, and fometimes oats: this was a very common courfe about twenty years ago in a bleak part of Derbyfhire, where I formerly refided. 1ft, Wheat; 2d, tares,

 and

* *Communications to the Board of Agriculture*, vol. iii.

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and afterwards turnips; 3d, barley; 4th, clover, or 5th, wheat; 6th, tares; 7th, oats; 8th, turnips. Thefe were the general courfes, with few deviations, obferved by a Leicefterfhire farmer.

"It admits not of a queftion," adds he, "that an acre of clover, tares, rape, turnips, or cabbages, will furnifh at leaft twice the food that the fame acre would have done had it remained in pafture: by any one of thefe courfes, therefore, it follows, that the land would maintain at leaft as much ftock as when in grafs, befides producing every other year a valuable crop of corn. No calculation is made upon the value of the ftraw, which, whether confumed as litter or as food, will add confiderably to the ftock of manure.

"That the condition of the land would be improved there can fcarcely remain a doubt upon the mind of any man who will confider the fubject attentively. The plough, by pulverizing the foil and breaking its tenacity, not only gives admiffion to the fertilizing influence of the atmofphere, but, by intimately mixing the manure, prevents that tenacity from taking place in future, fo long at leaft as the manure remains totally unexhaufted. But as the foil will have a frefh and ample fupply, every other year, the ftock of manure, with its concomitant fertility, will rather accumulate than be diminifhed; in confequence of which, whenever it is again converted into pafture, it will be in fuperior condition to what it was when firft broken up."

Feeding of cattle not brought to perfection.

We fhall afterwards have an opportunity of attending to this fubject when we come to confider the fubject of feeding cattle. In the mean time, it may be remarked, that this branch of the art of the hufbandman, has by no means hitherto been carried to its

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highest perfection in this country; and that in proportion as it is improved, and cattle are more carefully fed, the value of the plough will appear more conspicuous.

Profit from different Vegetables.

SECT. III.

OF THE COMPARATIVE PROFIT TO BE DERIVED FROM THE CULTIVATION OF DIFFERENT VEGETABLES.

Circumstance that render vegetables profitable or not.

LIKE every other artist or tradesman, a husbandman will always be under the necessity of regarding himself as the servant of the community, and must endeavour to rear the vegetables that are in greatest demand, and that will enable him to derive the greatest profit from the portion of territory which he occupies. The product of some soils and situations is so fixed by nature, that it is in vain for human art or industry to alter her destination. In our own and in many other countries, there are extensive tracts of lofty and rugged mountains, from which the art of agriculture seems to be for ever banished. Such situations belong exclusively to the shepherd and his flock, to the utter exclusion of the plough. Even on some arable lands it may be found fruitless to attempt to rear many of the more valuable vegetable productions. In many bleak and unsheltered fields of the higher country of Scotland, in which turnips and oats are cultivated with tolerable success, it would be in vain to expect regular crops of wheat; and though potatoes are found to prosper in a sandy, or even a mossy soil, it would be in vain to expect

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rofit from different vegetables. them to produce an equally valuable crop upon a ſtiff clay, in which the roots cannot ſwell or expand to a proper ſize. In forming a plan of agriculture, therefore, the huſbandman muſt not overlook the peculiar nature of the ſoil that has fallen to his lot, or its phyſical relation to the nature of certain vegetables, as he can only hope for ſucceſs by adapting the one of theſe to the other.

The huſbandman muſt alſo have a ſpecial regard to the ſtate of the market to which his commodities are to be brought. It is in vain for him to cultivate large quantities of roots, ſuch as potatoes or carrots, at a diſtance from great towns, which alone can afford a market for them, unleſs he intend to conſume them upon his own farm by feeding cattle. In a part of the country, however, in which great breweries are eſtabliſhed, if his ſoil is fit for the purpoſe, he may ſafely venture to rear large quantities of barley; as he cannot in ſuch a ſituation be at any time deſtitute of a market. Hence we can perceive, that it is the ſtate of the market which muſt at all times regulate the enterpriſes of the agriculturiſt, and the kind of crops which he is to bring forward. Thus alſo we ſee the mode in which agriculture may be moſt ſucceſsfully encouraged by a nation. Let an abundant market be provided for the produce of the ſoil, and that produce will infallibly be augmented. In this way, it is evident that the conſumption of grain, by means of diſtilleries or breweries, is highly favourable to the production of it in great quantities. They are even favourable to the exiſtence of plenty, or of abundance of bread for the uſe of the people. In good ſeaſons, by affording a ready market, they give acti-

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vity to the husbandman, and in bad seasons their operations can be arrested by law, and the superfluous quantity of grain which was meant to be consumed by them, can be converted into human food. Thus they operate in some measure like a great public granary, in which provisions should be kept against an accidental scarcity.

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It may sometimes happen, that by the character of the age in which he lives, and the state of the market which it produces, a husbandman may find himself most profitably employed, when rearing a kind of food which is by no means the most advantageous to the population of his country. This takes place, when he is employed in preparing butchers meat instead of bread; that is, when he finds it more profitable to rear upon his lands vegetables which can only be consumed by cattle, and thus contribute only in an indirect manner to the sustenance of the human species, than to cultivate those vegetable productions which are suited to the human stomach, and which therefore directly and immediately afford subsistence to man. According to Archdeacon Hislop's comparative statement, lately published, the weight of food from an acre of arable land, on the average of three years, a fallow year being included, is nine and a half times greater than from an acre of feeding stock.

Pasturage and agriculture compared.

The Reverend Dr Walker of Collington, professor of natural history in the university of Edinburgh, in a memorial addressed to the Board of Agriculture, states the subject thus *: He observes, that a Scots acre of good land,

* *Communic.* vol. iii.

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land, of 40 ſhillings rent, which is capable of producing 1280 pounds of oat-meal in a ſeaſon, will only produce 120 pounds weight of mutton. He then adds, "The difference which ariſes to the public from theſe two different methods of occupying land, is indeed moſt ſurpriſing. A labourer, a manufacturer, or a mechanic, often conſumes at the rate of a pound of meat each day. The 120 pounds of meat, therefore, afforded by the above acre, cannot ſupport ſuch a conſumer above one-third of the year. He requires no leſs than three ſuch acres to ſupply his wants for the ſingle article of meat. On the other hand, the ſingle acre affording 1280 pounds of oat-meal is capable of ſupporting three laborious men in health and vigour, and with leſs additional ſuſtenance than the former conſumer requires.

"The labourer, therefore, who lives chiefly on meat, demands for his ſupport about nine times the quantity of land that is neceſſary for the ſuſtenance of a labourer who lives chiefly on grain."

Let it even be ſuppoſed, however, that one pound of mutton contains in itſelf as much ſubſtantial nouriſhment for the human conſtitution, as two pounds weight of oat meal; ſtill it will follow, that land cultivated for the production of oats, will ſupport a population five times greater in number, than can be ſupported by the ſame land when uſed for the paſture of ſheep; and, where one million of people are found to exiſt upon a territory occupied in the one way, between five and ſix millions of people might exiſt upon the ſame land, if it were cultivated for raiſing grain, and if the inhabitants would conſent to uſe it as their food. Were any contrivance adopted,

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of the nature of thofe already mentioned, for convert- ing the fucculent roots of potatoes, carrots, &c. into dry meal or flour; the fame proportional difference of population would continue to exift, between nations in which that kind of flour fhould be confumed as human food, and in which it fhould be ufed for feeding cattle: For a man always commits an enormous wafte of food, who, inftead of eating grain himfelf, gives it to an inferior animal, in the expectation of afterwards receiving an equivalent, by devouring the flefh of that animal.

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Accordingly, it feems impoffible for any nation to reach a very extenfive degree of population, unlefs the people at large confent to fubfift, in a very confiderable degree, upon vegetable food. In China, where the practice of polygamy renders the families of rich men very numerous, and where the equal diftribution of the property among the children of the fame family prevents the accumulation of great wealth by individuals, almoft all perfons have found it convenient or neceffary to relinquifh the ordinary ufe of butchers meat, and to have recourfe to vegetable food. It is only in confequence of this circumftance, that the enormous population of that empire is fupported. The quantity of butchers meat confumed in a country will, therefore, always in fpite of every agricultural improvement, fet bounds to its population. A nation of hunters and fhepherds, who live upon wild animals, or upon flocks and herds, muft always be few in number. By agriculture, the numbers of thefe animals may indeed be increafed; but the men who can find fubfiftence by confuming them, will always be five or fix times fewer in number, than might live upon the

Population greateft where men live on vegetable food.

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fame territory, were the cattle expelled, and the lands occupied in rearing food to be immediately ufed by man.

It is to be obferved, however, that, independent of the public tafte and manners, this laft idea of the expulfion of cattle, or the total relinquifhment of animal food, is in our foil and climate, at leaft in the prefent ftate of the fcience of agriculture, merely a fpeculative notion, incapable of being reduced into practice, confiftently with the rules of good hufbandry. Our foil requires to be conftantly renewed by the addition of manure, which can only be procured of the beft quality and in abundance, at a diftance from great cities, by means of cattle. We have already taken notice of the great fuperiority of Britifh over French hufbandry. That fuperiority arifes entirely from the cattle kept upon our farms, which enable their owners, by manure and by ameliorating green crops, to raife larger quantities of corn than can be done in any other way, while, at the fame time, a great fupply of butchers meat is over and above provided. When cattle, therefore, are reared only in moderate numbers, for the purpofe of confuming the green crops upon a farm, to afford the means of improving the fertility of the foil, they ought not to be regarded as diminifhing the quantity of human food; but, on the contrary, as greatly increafing it, by enabling the agriculturift to bring to market larger quantities of grain than could otherwife be done; while, at the fame time, a fupply of the moft nourifhing of all food is over and above provided for the ufe of man. Thus Providence feems to have contrived to render it the intereft of the human race to preferve, and to give fubfiftence to great numbers of the inferior animals, by enabling

enabling these animals to pay liberally for the protection which they receive.

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Circumstances that lead husbandmen to prefer pasturage to the rearing of grain.

With these general considerations, however, the practical agriculturist, or husbandman, may have nothing to do. To succeed in his profession, he must accommodate himself to the public taste, or to the state of the market around him; and must consider what commodity, whether grain or butchers meat, will there bring the best reward for his labour. He may even find the state of the market affected by other circumstances, than the mere taste of the public for butchers meat, in preference to vegetable food; although that must always be of great importance among a luxurious people. Conquering nations, who extend their political dominion over distant regions, never fail to draw to their native country a very great portion of the wealth of the vanquished states. The victorious nation never fails, in such cases, to contain a great number of wealthy individuals, whose revenue is not derived from the cultivation of their native soil, or from any branch of manufacture or of commercial industry carried on by them upon it; but which consists of money drawn from the remote provinces of the empire, in consequence of estates possessed, or fortunes acquired there, in the service of government. The result of such circumstances naturally is, that these wealthy individuals not only live at home in a luxurious manner, and increase to an immense extent the consumption of butchers meat by themselves and their numerous retinue; but for the sake of ostentation, and as the only means of employing their wealth, they maintain great numbers of carriages and of riding horses. To support such establishments, they themselves

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selves not only convert large tracts of territory from arable into pasture lands; but even the whole husbandmen of the country are induced to do the same, to derive a profit from supplying them with butchers meat, and with food for their pleasure horses. In the mean time, the grain that may be wanted for the consumption of the people, whether rich or poor, being a commodity which is easily preserved and transported, must be brought from foreign nations, by a portion of the superfluous wealth of the state; and thus a rich and prosperous people may come to depend upon foreigners for a morsel of bread; and, when these foreign nations happen to experience an unfortunate season, this wealthy people may suffer all the horrors of famine upon a fertile soil, and in the midst of overflowing treasures.

Such was the state of Italy under the ancient Romans. Every part of it was adorned with the parks and villas and gardens of the nobles, who derived their revenues from the remote parts of the empire. This seat of dominion exhibited a picture of boundless splendour and magnificence. But the soil was entirely occupied in the service of ostentation or of luxury; and Italy, one of the most fertile corn countries in Europe, depended for grain upon Egypt, and the western provinces of Africa that border upon the Mediterranean. Such also, though perhaps in an inferior degree, seems to be the present state of Great Britain. It has acquired vast and fertile and populous provinces, within the torrid zone in the east, from which individuals are annually transporting home immense treasures obtained in the public service. In the west, also, within the same torrid zone, by a great expence of treasure and of human

man lives, the cultivation of certain valuable commodities has been eſtabliſhed; and from eſtates ſituated there, individuals reſiding at home now derive great revenues. The principles which regulate human affairs are unalterable; and in every age the ſame cauſes are attended with the ſame conſequences. What occurred in ancient Italy, took place among us as ſoon as the poſſeſſion of diſtant territories had leiſure to diſplay its natural effects. Britain formerly not only produced abundance of grain, for the ſupport of its own inhabitants, but it poſſeſſed a conſiderable ſurplus for exportation. After the acquiſition of foreign poſſeſſions, this ſurplus produce gradually ceaſed to exiſt; and it appears from documents, which the legiſlature has acknowledged to afford authentic and complete evidence of the truth of the fact, that, for twenty years paſt, notwithſtanding all our agricultural improvements, and the waſte lands that have been brought under the plough, the produce of grain is annually becoming more and more unequal to the conſumption; and this decreaſe appears in ſome meaſure to keep pace with the increaſing value of our diſtant poſſeſſions. In the mean time, we are annually coming under the neceſſity of purchaſing larger and larger ſupplies of grain, from the foreign ſtates of Europe or of North America; and thus theſe nations, without undergoing the imputation of uſurpation, and without encountering the hazard of an unfriendly climate, have been enabled through the medium of our luxury to obtain a ſhare of the riches of Hindoſtan, and of the profits of our Weſt India cultivation. In the mean time their agriculture is encouraged, while we are made to depend upon them for the neceſſaries of life. After all, it appears unreaſonable, and would perhaps be improper, to

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to regret a ſtate of affairs, which is the reſult of national aggrandizement, and of the ſuperiority and ſucceſsful enterpriſes of our countrymen. Still, however, it is obviouſly to be wiſhed, that, ſo far as agriculture is concerned, we could be reſtored to the ſtate of independence which our anceſtors enjoyed, when they were able, from their own ſoil, to ſupply themſelves with the neceſſaries of life: ſuch a ſtate is ſometimes neceſſary to the independent exiſtence of a community, and is at all times conducive to its welfare. It can only however be produced by means of agriculture. Therefore,

Ye generous Britons, venerate the *plough*,
And o'er your hills and long withdrawing vales,
Let autumn ſpread her treaſures to the ſun;
So with ſuperior boon may your rich ſoil,
Exuberant, nature's better bleſſings pour
O'er every land, the naked nations clothe,
And be th' exhauſtleſs granary of a world!

THOMSON.

SECT. IV.

GENERAL PRINCIPLES OF CULTIVATION.

IT is not our intention here to enter into a minute diſquiſition, concerning the nature of vegetables, & the different ſubſtances with which they may be connected, in their growth or in their decay. Such inveſtigations, in a proper arrangement of the ſciences, ought to be left to chemiſtry; but even that ſcience, ſo far as vegetable ſubſtances are concerned, is ſtill in ſuch a ſtate of imperfection, that a detail of the experiments and opinions of philoſophical chemiſts, concerning vegetables, would as yet afford but a very trifling portion of uſeful information to the huſbandman. We ſhall therefore content ourſelves with here ſtating ſuch general remarks, as appear neceſſarily connected with the important art of which we are now treating.

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A vegetable is not to be regarded merely as a piece of matter, or as a mixture of certain material ſubſtances. It is an organized being, poſſeſſed of life, which is derived from another ſimilar organized being that exiſted previous to itſelf; and this former organized and living being derived its conſtitution from a parent ſtem, which grew out of a ſtill older plant, up to an antiquity of which we have no knowledge. A vegetable, in this manner, not only has a birth, but it alſo has a growth, which is ſupported by food that it takes in and conveys by peculiar organs to the particular parts for which it is deſtined. When it has arrived at maturity, or reached the perfection of its form and conſtitution, a vegetable, like an animal, begins to decay, and finally dies, and, by a proceſs of putrefaction, is converted into a kind of earth.

Nature of the growth of vegetables.

To the life of vegetables, in the ſame manner as to the life of animals, the preſence of atmoſpheric air is neceſſary. They alſo require a certain moderate degree of heat; without which their growth cannot proceed, although a great degree of it is utterly fatal even to their texture. That they require moiſture, is equally obvious; as appears from the ordinary effect of rain, or of the continued want of it, upon fields and plants.

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They require likewiſe to be inſerted in the earth, or in ſome way connected with a collection of its particles; for although ſome plants, particularly the bulbous-rooted kinds, vegetate in pure water and air alone, it appears that they acquire little addition of ſolid ſubſtance, and that neither they, nor any of the other larger plants, reach perfection, or produce ſeed, unleſs planted in the earth, or ſupplied with a portion of it.

As all ſoils are by no means equally adapted for ſupporting vegetables, or bringing them to maturity, it is neceſſary for the huſbandman to attend to their nature, and the modes in which they may be altered or ameliorated for his uſe. Independent of theſe hard concretions, which obtain the name of ſtones or rocks, it is to be obſerved, that the looſer and more diviſible earth which covers moſt part of the ſurface of the globe, and receives the appellation of *the ſoil*, may, upon the whole, and with ſufficient accuracy for practical purpoſes, be divided into four kinds, which are in general mixed with each other, but which receive their name, in ordinary language, from the kind that predominates, or is moſt abundant. Theſe are ſand, clay, chalk, and garden mould. Of theſe, ſand and clay are in ſome meaſure the oppoſites of each other, while chalk forms a kind of medium between them. Sand allows water to filter rapidly through it, and ſpeedily becomes dry, while clay is extremely tenacious of moiſture; but a mixture of chalk renders ſand conſiderably more tenacious of water, while it renders clay more looſe and eaſily penetrated. None of theſe ſoils, when pure, are valuable for the purpoſes of agriculture.—Sand does not ſufficiently retain water for the uſe of vegetables; nor does clay ſuffer their roots to expand with freedom in queſt of nouriſhment. Chalk, or, as it is uſually called, a calcareous ſoil, is not of itſelf adapted for raiſing uſeful plants; for, although it may not have the mechanical defects of ſand and clay, yet, it is found by experience to be of little value to them, either in conſequence of its tendency to deſtroy their texture by its corroſive quality, that is, by having too much chemical affinity with the materials of which they conſiſt, or from its not containing within itſelf the proper materials neceſſary to them as food.

The fourth kind of ſoil we have denominated garden mould; becauſe it is in its higheſt perfection when it approaches neareſt to the rich black earth which receives that appellation. This is the moſt proper of all kinds of ſoil for rearing the whole of thoſe vegetables which are accounted valuable in our climate. In proper circumſtances, that is, with a moderate degree of heat and of moiſture, it never fails to ſend forth and to bring to perfection an abundant crop. In proportion to the degree in which any ſoil conſiſts of this black mould, its value increaſes. If, therefore, a huſbandman could cover the portion of territory allotted to him with a tolerable depth of this kind of ſoil, nothing more would be neceſſary to the ſucceſs of his enterpriſes, as he could rear whatever vegetables he thought fit, in perfection, and in great profuſion. It is to be obſerved, however, that this kind of mould or ſoil cannot be relied upon as permanent. If crops of grain ſhould be taken from it year after year, it would ſoon loſe its fertile qualities, and become unfit for the purpoſes of a proſperous agriculture. Here then is the remarkable difference between this kind of ſoil and the three others

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that were formerly mentioned, ſand, clay, and chalk.— Whatever properties theſe poſſeſs are unperiſhing, and can only be altered or modified by the operation of a fierce heat. Unfortunately, however, in their pure ſtate, as already mentioned, they are of little value to the huſbandman; and it is only in proportion to the degree in which they are mixed with the dark coloured or garden mould, that they become adapted to his purpoſes: but as the qualities of this mould are of a tranſitory nature, it is of the utmoſt importance, and ought indeed to form the great baſis of every theory of agriculture, to explain how they may be preſerved in exiſtence, or reſtored when loſt.

To underſtand this ſubject correctly, it is neceſſary to conſider the nature and origin of this fertile mould. It is evidently not one of thoſe original ſubſtances which form a part of the great maſs of the ſolid globe of the earth, but appears to be the reſult of the operations and of the deſtruction of living and organized beings

Proceſs by which nature fertilizes the earth.

that have exiſted upon it. "Were a naked rock, (ſays Mr Headrick, in an eſſay * which we ſhall afterwards have occaſion to mention), ſuddenly thrown up from the ſea or from the bowels of the earth, the firſt plants which nature would place upon it, would be the various ſpecies of *lichens*, and ſuch as can ſubſiſt wholly upon what they imbibe from the air, without needing a ſoil in which to puſh their roots. Theſe plants ſerve the double purpoſe of clothing the rock, and thus preventing the fine particles that are diſſolved by air and moiſture from being waſhed away, and, from their growth

* *Communications of the Board of Agriculture*, vol. ii.

growth and diſſolution, of accumulating vegetable ſoil for the ſuſtenance of more ſucculent plants. The rock is thus gradually made to acquire ſuch a depth of ſoil, that it becomes able to ſuſtain not only graſſes and ſhrubs, but may become a receptacle for the oak itſelf." The progreſs here ſtated is correct; but ſome circumſtances muſt be added to it, to render it practically uſeful to the huſbandman. It is to be obſerved, then, that animal ſubſtances, after they have ceaſed to form a part of a living body, have a tendency to proceed rapidly into a ſtate of putrefactive fermentation, by which the greateſt part of their maſs is rendered volatile. When animal ſubſtances are mingled with vegetables, they ſpeedily communicate their own fermentation or putrefaction to the vegetables, which by means of it are decompoſed, fall to pieces, and are transformed into that kind of black earth, which we have called garden mould, and which forms the moſt fertile of all ſoils for the production of vegetables. It is by this proceſs then, that is, by the fermentation of vegetable by means of animal ſubſtances, that the ſurface of this globe has been fertilized, or a black and rich mould produced upon it, as we daily ſee taking place in a variety of ſituations. No ſooner do the ſmall lichens or moſſes cover the face of the naked rock, or gravel, or clay, than a variety of ſpecies of ſmall animals appear, and feed upon them. As the plants and animals die in ſucceſſion, their ſubſtances mingle and give riſe to the putrefaction already mentioned, which is productive of a ſmall portion of ſoil. A new race of plants of greater ſtrength and bulk riſes upon the ruins of the firſt, and ſupports larger animals, all deſtined in their turn to periſh and to increaſe the

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inciples Cultivation. quantity of fertile ſoil. Mòre valuable graſſes ſoon ſupplant the original ſmall and coarſe vegetables, and the ſpot aſſumes the appearance of a rich verdure. New ſpecies of animals alſo begin to inhabit it: ſnails and worms abound; and by their remains contribute to the diſſolution of the roots of plants which everywhere penetrate the new ſoil, and to the decompoſition of the ſtems which periodically fall down. When the ſoil has acquired ſufficient depth, it is ſheltered by ſhrubs; and, laſtly, by foreſt trees, under the ſhade of which the larger animals exiſt. The trees ſhed their leaves every ſeaſon, and every ſeaſon conſequently gives an additional layer or *ſtratum* of fertile mould to the ſoil: and thus, while the foreſt endures, the fertility of the territory on which it ſtands continues to be augmented by its ſpoils, and by the bodies of the animals which repair to it for ſhelter.

This proceſs, by which nature gives fertility to the earth, or creates the rich mould on which vegetables flouriſh, ought to be imitated by the huſbandman; and, in fact, it has been imitated, in conſequence of a knowledge that is derived from experience and from practice, rather than from the general ſpeculations of ſcience. The imitation of nature upon this point conſtitutes the art of producing manures, which will be afterwards conſidered. The principle upon which it proceeds, reſts upon this foundation, which is known to be true in fact, that the fermentation of animal and vegetable ſubſtances produces that kind of dark rich mould which forms the moſt fertile ſoil.

In what way, or by what peculiar operation, this kind of mould or ſoil becomes ſo highly conducive and ſubſervient to the growth of plants, is a point of more difficult

difficult refearch, and is fortunately of lefs importance to be known to the practical agriculturift. It may be obferved, however, that this mould poffeffes, in an eminent degree, all the requifites neceffary to the fuccefs of vegetation. It retains moifture, which is fo neceffary to that procefs, without, at the fame time, keeping hold of it with that retentivenefs which, in clay, has the effect of injuring the roots of the plants. As this mould confifts of the remains both of animal and vegetable life, it neceffarily contains an immenfe variety of ingredients which have different degrees of chemical affinity to each other. By the operation of thefe affinities in bringing the different fubftances into new combinations, a great quantity of heat muft be continually produced or evolved, as occurs in fo many chemical proceffes. By this heat the roots of the plants will be nourifhed, efpecially when affifted by the heat which they themfelves throw out or produce when germinating. Thus, by the kind of foil now mentioned, or by the aid of manure, the defects of a cold and ungenial climate may, in fome meafure, be rectified, and the feeds and roots of vegetables may be fupplied with due and feafonable warmth. It is alfo probable, that what is called the exhaufted ftate of a foil, in confequence of much ploughing, and many crops having been taken from it, may partly arife from this circumftance, that all the chemical affinities having at laft operated, every particle of the foil remains at reft, and no more heat is produced by the activity of its parts.

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Conjecture about exhaufted foils.

That plants growing in fertile mould like that now mentioned, derive nourifhment or food from it, cannot be doubted, fince we fee, that when taken out of it, or placed in another but lefs favourable foil, they fpeediiciples ultiva- ion.

ly go into decay. What the particular ſubſtances are, however, *which they take from it, has not been diſco*vered. But it appears from the minuteneſs of the extreme fibres of the roots of plants, that the food which they abſorb muſt be ſoluble in water, or in a liquid ſtate when taken in by them. Accordingly, their food is actually found to aſcend through their organs in a liquid form. Of this liquor or ſap there are two kinds, the aſcending and the deſcending. The aſcending ſap is that which riſes in the ſpring; and by cutting a ſhort way through the bark into the wood of many trees, large quantities of it may be drawn off, without injury to their health or growth. This ſap aſcends to the leaves, and there undergoes ſome change by the action of the air; for the leaves of vegetables appear to perform to them an office ſimilar to that which is accompliſhed in animals by the organ called the *lungs*. From the leaves the ſap, thus changed, deſcends to every part of the plant, and contributes to its growth by becoming a part of its ſubſtance. It would ſeem, however, that the liquors which circulate in plants, not only undergo a change at the leaves, but alſo at their firſt entrance by the veſſels of the roots; for if ſeveral different kinds of trees are ingrafted upon the ſame common ſtock, each of them is able to derive the ſap peculiar to itſelf from the ſap of the common ſtock. Thus alſo the chemiſts have informed us, that vinegar, called by them the *acetous acid*, is found variouſly combined in the aſcending ſap of various trees; but it has never yet been diſcovered, that vinegar exiſts in any perceptible quantity in vegetable mould. That ſubſtance, therefore, muſt be formed by the root, by bringing together the ingredients of that acid which it finds and ſelects in the earth.

When

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When any plant, whether great or ſmall, is put into a cloſe veſſel, and ſtrongly heated, allowing only the ſmoke to eſcape, the reſidue in all caſes is of the ſame nature, and is called *charcoal*, or by the chemiſts *carbon*. Of this carbonaceous matter a conſiderable quantity is always found in rich garden mould, derived no doubt from the remains of vegetable ſubſtances of which that mould was originally formed. This carbonaceous matter, however, or charcoal, being inſoluble in water, cannot in its ordinary ſtate enter into the veſſels of growing vegetables; but, as it is rendered ſoluble by a variety of combinations, it is no doubt found out in ſuch a ſtate by the fibres of growing roots, and conveyed upwards in the juice. But as all vegetable mould, and the charcoal or carbonaceous matter which it contains, is the reſult of the ruins of vegetation, and as the lichens or vegetables of the coarſeſt and ſimpleſt kinds, which originally grow upon the naked ſtone, have no other nouriſhment than water and atmoſpheric air, it is probable, that out of theſe materials they are capable of forming the charcoal, which conſtitutes the baſis of their form, and of the conſtitution of every other vegetable. It is true, that the chemiſts ſtill regard carbon or charcoal as a ſimple and uncompounded ſubſtance; and they have not found it in water, nor in atmoſpheric air, unleſs in the moſt minute degree, reſulting probably from the combuſtion of fires and the breathing of animals in inhabited countries. But although chemiſts have not hitherto been able to find charcoal in the three ſimple ſubſtances, oxygen, hydrogen, and azote, of which atmoſpheric air and water are compoſed, it ſeems evident, that the mighty Chemiſt who contrived this world and the con-

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ſtitution of vegetables, finds no difficulty in forming it of thoſe materials by means of their organization. Hence we rather think, that water and air muſt conſtitute the original food of the ſimpleſt and coarſeſt kind of plants; but if this idea be true, it is to be regarded as a fact that is more curious in ſpeculation than uſeful in practice: for it is certain, that the more valuable and larger vegetables, which it is the buſineſs of the huſbandman to cultivate, cannot be reared to perfection without the aid of vegetable mould. Though they may poſſeſs, therefore, the power of deriving a portion of their ſolid ſubſtance, or of the carbonaceous matter which they contain, from common air and water, they cannot obtain the whole by this means, and require the aid of the remains of former vegetation. It is thus that one ſyſtem is ſeen to pervade every part of nature, as through all her works one claſs of animated beings only enjoys life in conſequence of the deſtruction of another. Thus the carnivorous animals conſume thoſe that live upon vegetables; and thus, in like manner, one ſpecies of vegetables only ſubſiſts upon the ruins, and is fed by the ſubſtance, of a former generation of plants.

Vegetables the food of each other.

Beſides animal ſubſtances, there are ſome minerals that have a tendency to accompliſh the decompoſition of vegetables, and thereby to reduce them into a ſtate of mould, poſſeſſing in a great degree the qualities of the garden mould that is produced by the fermentation of the remains of animals and vegetables, the formation of which has now been deſcribed. Of the minerals that have this tendency, lime is the chief, and indeed the one commonly in uſe, either pure or when combined with clay under the form of marl. To the

effect

effect of lime, therefore, we shall call the attention of the reader.

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Where the ground has been suffered to remain uncultivated for many ages, producing all that time succulent plants which are easily putrefied, and trees, the leaves of which likewise contribute to enrich the ground by their falling off and mixing with it, the soil will in a manner be totally made up of pure vegetable earth, and be the richest, when cultivated, that can be imagined. This was the case with the lands of America. They had remained uncultivated perhaps since the creation, and were endowed with an extraordinary degree of fertility; nevertheless we are assured, by persons who have examined the lands in America, that such grounds as have been long cultivated, are often so much exhausted, as to be much worse than the generality of cultivated grounds in this country. Here, then, we have an example of one species of poor soil; namely, one that has been formerly very rich, but has been deprived, by repeated cropping, of the greatest part of the vegetable food it contained. The farmer who is in possession of such ground, would no doubt willingly restore it to its former state; the present question is, What must be done in order to obtain this end? We shall suppose the farmer tries lime. This substance, being of a septic nature, or having a tendency to reduce vegetable substances into a state of putrefaction, will act upon such parts of the soil as are not putrefied, or but imperfectly so; in consequence of which, the farmer will reap a better crop than formerly. The septic nature of the lime is not entirely altered by any length of time. In ploughing the ground, the lime is more and more perfectly mix-

One species of poor soil destroyed by lime.

Principles of Cultivation. ed with it, and gradually exerts its power on every putrefcible matter it touches. As long as any matter of this kind remains, the farmer will reap good crops; but when the putrefcible matter is all exhaufted, the ground then becomes perfectly barren; and the cauftic qualities of the lime are moft unjuftly blamed for *burning* the ground, and reducing it to a *caput mortuum*; while it is plain the lime has only done its office, and made the foil yield all that it was capable of yielding.

A Species of poor foil meliorated by lime. When ground has been long uncultivated, producing all the time plants, not fucculent, but fuch as are very difficultly diffolved, and in a manner incapable of putrefaction; there the foil will be exceffively barren, and yield very fcanty crops, though cultivated with the greateft care. Of this kind are thofe lands covered with heath, which are found to be the moft barren of any, and the moft difficultly brought to yield good crops. In this cafe lime will be as ferviceable as it was detrimental in the other; for by its feptic qualities, it will continually reduce more and more of the foil to a putrid ftate; and thus there will be a conftant fucceffion of better and better crops, by the repeated ufe of lime when the quantity firft laid on has exerted all its force. By a continued ufe of this manure, the ground will be gradually brought nearer and nearer to the nature of garden mould; and, no doubt, by proper care, might be made as good as any: but it will be as great a miftake to imagine, that, by the ufe of lime, this kind of foil may be rendered perpetually fertile, as to think that the other was naturally fo; for though lime enriches this foil, it does fo, not by adding vegetable food to it, but by preparing what it already contains; and when all is properly prepared, it muſt as certainly be exhauſted as in the other caſe.

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Here, then, we have examples of two kinds of *poor* ſoils; one of which is totally deſtroyed, the other greatly improved, by lime, and which therefore require very different manures; lime being more proper for the laſt than dung; while dung, being more proper to reſtore an exhauſted ſoil than lime, ought only to be uſed for the firſt.

Poor ſoils, how reſtored.

By attending to the diſtinction between the reaſons for the poverty of the two ſoils juſt now mentioned, we will always be able to judge with certainty in what caſes lime is to be uſed, and when dung is more abſolutely neceſſary. The mere poverty of a ſoil is not a criterion whereby we can judge; we muſt conſider what hath made it poor. If it is naturally ſo, bearing heath and other coarſe plants, we may almoſt infallibly conclude, that it will become better by being manured with lime. If it is *artificially* poor, or exhauſted by continual cropping, we may conclude that lime will entirely deſtroy it. We apprehend, that it is this *natural* kind of poverty only which Dr Anderſon ſays, in his Eſſays on Agriculture, may be remedied by lime; for we can ſcarce think that experience would direct any perſon to put lime upon land already exhauſted. His words are,

> "Calcareous matters act as powerfully upon land that is naturally poor, as upon land that is more richly impregnated with thoſe ſubſtances that tend to produce a luxuriant vegetation."

Mr Anderſon's opinion concerning lime.

"Writers on agriculture have long been in the cuſtom of dividing manures into two claſſes, viz. *Enriching* manures, or thoſe that tended directly to render the ſoil more prolific, however ſterile it may be; among the foremoſt

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foremoſt of which was dung: *Exciting* manures, or thoſe that were ſuppoſed to have a tendency to render the ſoil more prolific, merely by acting upon thoſe enriching manures that had been formerly in the ſoil, and giving them a new ſtimulus, ſo as to enable them to operate anew upon that ſoil which they had formerly fertilized. In which claſs of ſtimulating manures, *lime* was always allowed to hold the foremoſt place.

"In conſequence of this theory, it would follow, that lime could only be of uſe as a manure when applied to rich ſoils—and when applied to poor ſoils, would produce hardly any, or even perhaps hurtful effects.

"I will frankly acknowledge, that I myſelf was ſo far impoſed upon by the beauty of this theory, as to be hurried along with the general current of mankind, in the firm perſuaſion of the truth of this obſervation, and for many years did not ſufficiently advert to thoſe facts that were daily occurring to contradict this theory.—I am now, however, firmly convinced, from repeated obſervations, that lime, and other calcareous manures, produce a much greater *proportional* improvement upon poor ſoils than ſuch as are richer;—and that lime alone, upon a poor ſoil, will, in many caſes, produce a much greater and more laſting degree of fertility than dung."

Thus far Dr Anderſon's experience is exactly conformable to the theory we have laid down, and what ought to happen according to our principles. He mentions, however, ſome facts which ſeem very ſtrongly to militate againſt it; and indeed he himſelf ſeems to proceed upon a theory altogether different.

"Calcareous

Calcareous matter alone (ſays he) is not capable of rearing plants to perfection;—mould is neceſſary to be mixed with it in certain proportions, before it can form a proper ſoil. It remains, however, to be determined, what is the due proportion of theſe ingredients for forming a proper ſoil.

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Query concerning the nature of a proper ſoil.

"We know that neither chalk, nor marl, nor lime, can be made to nouriſh plants alone; and ſoils are ſometimes found that abound with the two firſt of theſe to a faulty degree. But the proportion of calcareous matter in theſe is ſo much larger than could ever be produced by art, where the ſoil was naturally deſtitute of theſe ſubſtances, that there ſeems to be no danger of erring on that ſide. Probably it would be much eaſier to correct the defects of thoſe ſoils in which calcareous matters ſuperabound, by driving earth upon them as a manure, than is generally imagined; as a very ſmall proportion of it ſometimes affords a very perfect ſoil. I ſhall illuſtrate my meaning by a few examples.

"Near Sandſide, in the county of Caithneſs, there is a pretty extenſive plain on the ſea coaſt, endowed with a moſt ſingular degree of fertility. In all ſeaſons it produces a moſt luxuriant herbage, although it never got any manure ſince the creation; and has been from time immemorial ſubjected to the following courſe of crops.

Examples of ſoil perpetually fertile.

"1. Bear, after once ploughing from graſs, uſually a good crop.

"2. Bear, after once ploughing, a better crop than the firſt.

"3. Bear, after once ploughing, a crop equal to the firſt.

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"4. 5. and 6. Natural graſs, as cloſe and rich as could be imagined, might be cut, if the poſſeſſor ſo inclined, and would yield an extraordinary crop of hay each year.

"After this the ſame courſe of cropping is renewed. The ſoil that admits of this ſingular mode of farming, appears to be a pure incoherent ſand, deſtitute of the ſmalleſt particle of vegetable mould; but, upon examination, it is found to conſiſt almoſt entirely of broken ſhells: the fine mould here bears ſuch a ſmall proportion to the calcareous matter, as to be ſcarce perceptible, and yet it forms the moſt fertile ſoil that ever I yet met with.

"I have ſeen many other links (downs) upon the ſea ſhore, which produced the moſt luxuriant herbage, and the cloſeſt and ſweeteſt pile of graſs, where they conſiſted of ſhelly ſand; which, without doubt, derive their extraordinary fertility from that cauſe.

"A very remarkable plain is found in the iſland of Jir-eye, one of the Hebrides. It has been long employed as a common: ſo that it has never been diſturbed by the plough, and affords annually the moſt luxuriant crop of herbage, conſiſting of white clover and other valuable paſture graſs, that can be met with anywhere. The ſoil conſiſts of a very pure ſhelly ſand.

"From theſe examples, I think it is evident, that a very ſmall proportion of vegetable mould is ſufficient to render calcareous matter a very rich ſoil. Perhaps, however, a larger proportion may be neceſſary when it is mixed with clay than with ſand; as poor chalky ſoils ſeem to be of the nature of that compoſition."

To theſe examples brought by Dr Anderſon, we may add ſome of the ſame kind mentioned by Lord Kaimes,

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Kaimes. His lordſhip having endeavoured to eſtabliſh the theory of water being the only food of plants, though he himſelf frequently deviates from that theory, yet thinks it poſſible, upon ſuch a principle, to make a ſoil perpetually fertile.

"To recruit (ſays he), with vegetable food, a ſoil impoveriſhed by cropping, has hitherto been held the only object of agriculture. But here opens a grander object, worthy to employ our keeneſt induſtry, that of making a ſoil perpetually fertile. Such ſoils actually exiſt; and why ſhould it be thought, that imitation here is above the reach of art? Many are the inſtances of nature being imitated with ſucceſs. Let us not deſpair while any hope remains; for invention never was exerciſed upon a ſubject of greater utility. The attempt may ſuggeſt proper experiments: it may open new views: and if we fail in equalling nature, may we not, however, hope to approach it? A ſoil perpetually fertile muſt be endowed with a power to retain moiſture ſufficient for its plants, and at the ſame time muſt be of a nature that does not harden by moiſture. Calcareous earth promiſes to anſwer both ends; it prevents a ſoil from being hardened by water; and it may probably alſo invigorate its retentive quality. A field that got a ſufficient doſe of clay marl, carried above 30 ſucceſſive rich crops, without either dung or fallow. Doth not a ſoil ſo meliorated draw near to one perpetually fertile? Near the eaſt ſide of Fife, the coaſt for a mile inward is covered with ſea ſand, a foot deep or ſo; which is extremely fertile, by a mixture of ſea ſhells reduced to powder by attrition. The powdered ſhells, being the ſame with ſhell marl, make the ſand retentive of moiſture; and yet no quantity of moiſture will

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will unite the sand into a solid body. A soil so mixed seems to be not far distant from one perpetually fertile. These, it is true, are but faint essays; but what will not perseverance accomplish in a good cause?"

Inconsistency in Lord Kaimes's theory.

Having thus, in a manner, positively determined with Dr Anderson, that no dose of calcareous matter can possibly be too great, we cannot help owning ourselves surprised on finding his lordship expressing himself as follows: "An overdose of shell marl, laid perhaps an inch, and an inch and a half, or two inches thick, produces, for a time, large crops: but at last it renders the soil a *caput mortuum*, capable of bearing neither corn nor grass; of which there are too many instances in Scotland. The same probably would follow from an overdose of clay marl, stone marl, or pounded limestone." To account for this, he is obliged to make a supposition directly contrary to his former one; namely, that calcareous matter renders the soil *incapable* of retaining water. This phenomenon, however, we think is solved upon the principles above laid down, in a satisfactory manner, and without the least inconsistency.

Perpetual fertility of soils chimerical.

As to rendering soils perpetually fertile, we cannot help thinking the attempt altogether chimerical and vain. There is not one example in nature of a soil perpetually fertile, where it has no supply but from the air and the rain which falls upon it. The above recited examples can by no means be admitted as proofs of perpetual fertility. We know, that the grass on the banks of a river is much more luxuriant than what grows at a distance: the reason is, that the water is attracted by the earth, and communicates its fertilizing qualities to it; but was the river to be dried up, the

grass

grass would soon become like the rest. Why should not the ocean have the same power of fertilizing plains near its shores, that rivers have of fertilizing small spots near their banks? We see, however, that it hath not: for the sea shores are generally sandy and barren. The reason of this is, that the waters of the ocean contain a quantity of loose acid; and this acid is poisonous to plants: but, abstracting this acid part, we hesitate not to affirm, that sea water is more fertilizing than river water. It is impossible to know how far the waters of the ocean penetrate under ground through a sandy soil. Where they meet with nothing to absorb their acid, there the ground is quite barren; but in passing through an immense quantity of broken shells, the calcareous matter will undoubtedly absorb all the superfluous acid; and thus the soil will be continually benefited by its vicinity to the ocean. All the above fields, therefore, are evidently supplied with nourishment from the ocean: for if the salt water has sufficient efficacy to render fields which are in its neighbourhood barren, why should it not, like other water, render them fertile when the cause of barrenness is removed from it?

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After all, the field in Caithness, mentioned by Dr Anderson, seems to have been perpetually fertile only in grass; for though the second year it carried a better crop of bear than it did the first, yet the third year the crop was worse than the second, and only equal to the first. Had it been ploughed a fourth time, the crop would probably have been worse than the first. Ground is not near so much exhausted by grass as corn, even though the crop be cut and carried off; and still less if it only feeds cattle, and is manured by their dung; which appears to have been the case with this field.

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Lord Kames, indeed, mentions fields in Scotland, that, past memory, have carried successive crops of wheat, pease, barley, oats, without a fallow, and without manure; and particularizes one on the river Carron, of nine or ten acres, which had carried 103 crops of oats without intermission and without manure: but as we are not acquainted with any such fields, nor know any thing about their particular situation, we can form no judgment concerning them.

Soils improved by mixture.

Defective soils are sometimes improved by being mixed with each other. Thus clay, or a soil chiefly formed of that ingredient, is apt, as formerly noticed, to be hardened by the heat of the sun, so that the vegetables can scarce penetrate it in such a manner as to receive proper nourishment. Sand, on the contrary, if it is not situated so as to receive a great deal of moisture, is very apt to be parched up in summer, and the crop destroyed; nor has it sufficient adhesion to support plants that have few roots and grow high. From these opposite qualities, it is evident that these two soils would be a proper manure for one another: the clay would give a sufficient degree of firmness to the sand, and the sand would break the too great tenacity of the clay. According to Dr Home's experiments, however, sand is the worst manure for clay that can be used. He recommends marl most. To reduce clay ground as near as possible to the form of pure vegetable mould, it must first be pulverized. This is most effectually performed by ploughing and harrowing; but care must be taken not to plough it whilst too wet, otherwise it will concrete into hard clods which can scarcely be broken. After it is pulverized, however, some means must be taken to keep it from concreting again into the same hard masses as before.

According

According to Lord Kaimes, though clay, after pulverization, will concrete into as hard a mafs as before, if mixed with water; yet if mixed with dunghill juice, it will not concrete any more. Lime alfo breaks its tenacity, and is very ufeful as a manure for this kind of foil. Principles of Cultivation.

The conclufion, however, which we wifh the practical farmer to draw from our theory is, That there is a certain limit to the fertility of the earth, both as to duration and to degree, at any particular time: that the nearer any foil approaches to the nature of pure garden mould, the nearer it is to the moft perfect degree of fertility; but that there are no hopes of keeping it perpetually in fuch a ftate, or in any degree of approximation to it, but by conftant and regular manuring with dung. Lime, chalk, marl, &c. may be proper to bring it near to this ftate, but are abfolutely unfit to keep it continually fo. They may indeed for feveral years produce large crops; but the more they increafe the fertility for fome years, the fooner will they bring on an abfolute barrennefs; while regular manuring with plenty of dung will always enfure the keeping up the foil in good condition, without any occafion for fallow. What we have faid concerning the ufe of lime, &c. applies likewife to the practice of frequent ploughing, though in a lefs degree. This tends to meliorate ground that is naturally poor, by giving an opportunity to the vegetable parts to putrefy; but when that is done, it tends to exhauft, though not fo much as lime. A judicious farmer will conftantly ftrive to keep his lands always in good condition, rather than to make them fuddenly much better; left a few years fhould convince him that he was in reality doing almoft irre- Fertility of the earth limited.

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parable miſchief, while he fancied himſelf making improvements. As for the ridiculous notions of ſtimulating the ground by ſaline manures, for the purpoſe of exciting it to perpetual fertility, we hope they will never enter the brain of any rational practitioner of agriculture.

In addition to what is here ſtated, however, concerning the diſtinction of ſoils in general, it may be neceſſary to take notice of the manner in which, with a practical view, they have uſually been diſcriminated by agricultural writers. This is the more neceſſary, on account of the frequent recurrence of various denominations of ſoil in treatiſes upon this important ſubject, the uſe of which, from the want of a ſcientific nomenclature, it will not be entirely in our power to avoid. Mr Young remarks, that in ſome parts of England where huſbandry is ſucceſsfully practiſed, any looſe clay is called marl, in others marl is called chalk, in others clay is called loam. To avoid increaſing this confuſion, we ſhall here follow the practical deſcription of ſoils given by the celebrated chemiſt Richard Kirwan, Eſq. previouſly obſerving, that by calcareous earth, is meant chalk and all ſtones that burn to lime, effervеſcing in their natural ſtate with all acids. Argil is pure clay, which forms alum with the vitriolic acid, but ſcarcely effervеſces with any of the acids. Siliceous earth is flint or pure ſand, ſuch as that whereof glaſs is made; it effervеſces with no acid. We may add that ferruginous earth, or iron, is the cauſe of the red or brown colour that appears in many ſoils.

" The ſoils moſt frequently met with, ſays Mr Kirwan, and which deſerve a diſtinct conſideration, are clay, chalk, ſand, and gravel, clayey loam, chalky loam, ſandy loam, gravelly loam, ferruginous loam,

 boggy

boggy soil, and heathy soil, or mountain as it is often called.

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" Clay is of various colours; for we meet with white, gray, brownish red, brownish black, yellowish, or bluish clays; it feels smooth, and somewhat unctuous; if moist, it adheres to the fingers, and if sufficiently so, it becomes tough and ductile; if dry, it adheres more or less to the tongue; if thrown into water it gradually diffuses itself through it, and slowly separates from it. It does not usually effervesce with acids, unless a strong heat be applied, or that it contains a few calcareous particles or magnesia. If heated, it hardens and burns to a brick.

" It consists of argil and fine sand, usually of the siliceous kind, in various proportions, and more or less ferruginous. The argil forms generally from 20 to 75 per cwt. of the whole mass, the sand and calx of iron the remainder. These are perfectly separable by boiling in strong vitriolic acid.

" Chalk, if not very impure, is of a white colour, moderate consistence, and dusty surface; stains the fingers; adheres slightly to the tongue; does not harden when heated, but on the contrary, in a strong heat, burns to lime, and loses about $\frac{4}{10}$ of its weight. It effervesces with acids, and dissolves almost entirely therein. I shall also add, that this solution is not disturbed by caustic volatile alkali, as this circumstance distinguishes it from magnesia. It promotes putrefaction.

" Sand.—By this is meant small loose grains of great hardness, not cohering with water nor softened by it. It is generally of the siliceous kind, and therefore insoluble in acids.

" Gravel differs from sand chiefly in size; however,

 stones

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ſtones of a calcareous nature, when ſmall and rounded, are often comprehended under that denomination.

"Loam denotes any ſoil moderately coheſive, that is, leſs ſo than clay, and more ſo than looſe chalk; by the author of the Body of Agriculture it is ſaid to be a clay mixed with ſand. Dr Hill defines it an earth compoſed of diſſimilar particles, hard, ſtiff, denſe, harſh and rough to the touch, not eaſily ductile while moiſt, readily diffuſible in water, and compoſed of ſand and a tough viſcid clay. The definition I have given, ſeems moſt ſuited to the different ſpecies I ſhall now enumerate.

"Clayey loam denotes a compound ſoil, moderately coheſive, in which the argillaceous ingredient predominates; its coherence is then greater than that of pure clay; the other ingredient is a coarſe ſand, with or without a ſmall mixture of the calcareous ingredient. It is this which farmers generally call *ſtrong*, *ſtiff*, *cold*, and *heavy* loam, in proportion as the clay abounds in it.

"Chalky loam. This term indicates a loam formed of clay, coarſe ſand, and chalk; in which, however, the calcareous ingredient, or chalk, much predominates. It is leſs coheſive than clay loams.

"Sandy loam, denotes a loam in which ſand predominates. It is leſs coherent than either of the above mentioned. Sand, partly coarſe, and partly fine, forms from 80 to 90 per cwt. of this compound.

"Gravelly loam differs from the laſt, only in containing a larger mixture of coarſe ſand or pebbles. This and the two laſt are generally called by farmers *light* or *hungry* ſoils; particularly when they have but little depth.

"Ferruginous loam, or till. This is generally of a dark brown or reddiſh colour, and much harder than any

any of the preceding. It consists of clay and calces of iron, more or less intimately mixed. It may be distinguished not only by its colour, but also by its superior weight. It sometimes effervesces with acids and sometimes not; when it does, much of the irony part may be separated, by pouring it when well dried into spirit of salt, from which the iron may be separated by alkalies or chalk. Principles of Cultivation.

"Akin to this are certain *vitriolic soils*, which, when steeped in water, impart to it the power of reddening syrup of violets. These are generally of a blue colour, but redden when heated.

"Boggy soil, or bogs, consist chiefly of ligneous roots of decayed vegetables mixed with earth, mostly argillaceous, and sand, and a coaly substance derived from decayed vegetables. Of bogs there are two sorts: the black, which contains a large proportion of clay and of roots more perfectly decayed, with mineral oil; in the red, the roots seem less perfectly decayed, and to form the principal part.

"Heathy soil, is that which is naturally productive of heath."

Though not properly a kind of soil, yet, as used for the purpose of improving other soils, we may here take notice of the description given by the same writer of what is called *marl*. "Marl is of three sorts, calcareous, argillaceous, and siliceous or sandy. All are mixtures of mild calx (i. e. chalk) with clay, in such a manner as to fall to pieces by exposure to the atmosphere, more or less readily.

"Calcareous marl is that which is most commonly understood by the term *marl without addition*. It is generally of a yellowish white, or yellowish gray colour;

 rarely

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rarely brown or lead coloured. It is feldom found on the furface of land, but commonly a few feet under it, and on the fides of hills or rivers that flow through calcareous countries, or under turf in bogs, frequently of a lofe texture, fometimes moderately coherent, rarely of a ftony hardnefs, and hence called *ftone-marl*; fometimes of a compact, fometimes of a lamellar texture, often fo thin as to be called *paper-marl*. It often abounds with fhells, and then is called *fhell-marl*, which is looked upon as the beft fort. When in powder, it feels dry between the fingers; but in water, it quickly falls to pieces or powder, and does not form a vifcid mafs. It chips and moulders by expofure to the air and moifture, fooner or later, according to its hardnefs and the proportion of its ingredients. If heated, it will not form a brick, but rather lime. It effervefces with all acids. It confifts of from 33 to 80 per cwt. of mild calx, and from 66 to 20 per cwt. of clay.

"To find its compofition, pour a few ounces of weak, but pure, fpirit of nitre or common falt, into a Florence flafk; place them in a fcale, and let them be balanced; then reduce a few ounces of dry marl into powder, and let this powder be carefully and gradually thrown into the flafk, until, after repeated agitation, no effervefcence is any longer perceived; let the remainder of the powder marl be then weighed, by which the quantity projected will be known: let the balance be then reftored; the difference of weight between the quantity projected and that requifite to reftore the balance, will difcover the weight of air loft during the effervefcence; if the lofs amounts to 13 per cwt. of the quantity of marl projected, or from 13 to 32 per cwt. the marl effayed is calcareous marl. This

This experiment is decisive, when we are assured by the external characters above mentioned, that the substance employed is marl of any kind; otherwise, some sorts of the sparry iron-ore may be mistaken for marl. The experiments to discover the argillaceous ingredient, being too difficult for farmers, I omit. The residue left after solution being well washed will, when duly heated, generally harden into a brick.

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"Argillaceous marl contains from 68 to 80 per cwt. of clay, and consequently from 32 to 20 per cwt. of aerated calx. Its colour is gray, or brown, or reddish brown, or yellowish or bluish gray; it feels more unctuous than the former, and adheres to the tongue; its hardness is generally much greater; in water it falls to pieces more slowly, and often into square pieces; it also more slowly moulders by exposure to the air and moisture, if of a loose consistence; it hardens when heated, and form an imperfect brick; it effervesces with spirit of nitre or common salt, but frequently refuses to do so with vinegar; when dried and projected into spirit of nitre, in a Florence flask, with the attentions above mentioned, it is found to lose from 8 to 10 per cwt. of its weight. The undissolved part well washed, will, when duly heated, harden into a brick.

"Siliceous or sandy marls are those whose clayey part contains an excess of sand; for, if treated with acids, in the manner above mentioned, the residuum or clayey part will be found to contain above 75 per cwt. of sand; consequently chalk and sand are the predominant ingredients.

"The colour of this marl is brownish gray or lead colour; generally friable and flaky, but sometimes forms very

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very hard lumps; it does not readily fall to pieces in water; it chips and moulders by expofure to the air and moifture, but flowly; it effervefces with acids, but the refiduum after folution will not form a brick.

"Lime-ftone gravel. This is a marl mixed with large lumps of lime-ftone; the marl may be either calcareous or argillaceous, but moft commonly the former; the fandy part is alfo commonly calcareous."

We fhall difcufs particularly the fpecial modes of ameliorating, by proper mixtures and additions, thefe feveral kinds of foil, when we come afterwards to treat of the practical preparation and ufe of manures in hufbandry.

SECT. V.

OF THE DIFFERENT KINDS OF VEGETABLES PROPER TO BE RAISED WITH A VIEW TO THE MELIORATION OF SOIL.

Soil improved by pulverization.

THE cultivation of certain plants, when properly conducted, has a confiderable tendency to increafe the fertility of the foil. In fuch a cafe the farmer enjoys the fatisfaction of meliorating his lands, and of reaping crops at the fame time.

One very confiderable ftep towards the melioration of ground is its pulverization. This is ufually accomplifhed by repeated ploughings, and more particularly by the ufe of fummer fallow; which latter practice confifts of allowing the foil to remain without a crop for a whole feafon, and during that time of repeatedly turning it over with the plough,

plough. In the French husbandry, as already mentioned, to this day, the summer fallow is almost the only resource that is employed to render the soil capable of bearing successive crops of grain; and the same practice anciently prevailed in our own country, and even continues to prevail to a great extent.

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Uses of summer fallow.

It is undoubtedly true, that under a rotation, consisting of summer fallow and crops of grain alternately, the land has not been found to improve; but, it is also true, that upon certain soils, when the cropping was not severe, the land continued, with little other aid than that of summer fallow, to produce grain during a great length of time, without any sensible deterioration. The benefits which the use of fallow confers upon the soil, or the advantages which the husbandman derives from it, appear to be chiefly these: it pulverizes, cleans, and manures, the soil. In the first place, as already mentioned, it pulverizes the soil, and breaks that tenacity of parts which, in its rude state, it naturally acquires, and thereby enables the roots of delicate plants to pervade it freely in all directions in quest of their natural nourishment. From the nature of the thing, however, it is obvious, that repeated ploughings (especially when performed in autumn, with a view to expose the soil to the pulverizing effects of the winter's frost), must be chiefly valuable upon lands of a stiff and adhesive texture, and that upon light and sandy soils it will be less necessary. Accordingly it has been found by experience, that such soils have been very perceptibly injured by too frequent ploughings. It is no doubt true, that all plants require a certain openness to be preserved in the earth around their roots, that they may be enabled to push out with advantage; but it is

 also

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also necessary that the soil should possess such a degree of firmness as may enable it to retain, for a sufficient length of time, the moisture requisite for the support of vegetation; and, at the same time, afford a steady support to the stems of the plants which grow upon it.

The second use of summer fallow consists of its tendency to clear the ground from those other plants which we wish to destroy for the purpose of making room for the vegetables that we would wish to rear, as most valuable for the support of men or cattle. The destruction of noxious plants is accomplished by summer fallowing in two ways: 1st, By its effect upon the roots of such plants; and, 2dly, by its effects upon the seed. Nature has provided very carefully and effectually for the preservation of most of her vegetable productions, by rendering them capable of propagating themselves in two ways—either by the seed, or, if that is not suffered to arrive at maturity, by putting forth new stems from the roots. By means of summer fallow both these modes of reproduction are, in some measure, counteracted. The roots of the plants we wish to destroy being turned up, and exposed to the action of the sun and air, are rendered unfit for vegetation. The seeds of plants are in general so well protected by the kind of covering in which they are enveloped, as to remain long indestructible by exposure to the air; but, being suffered to vegetate, and at the same time ploughed down before they are allowed to ripen or bring forth new seed, they also are destroyed by the frequent stirring of the land for which a summer fallow affords an opportunity.

A third and last advantage derived from summer fallow

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low, consists of its effect in ameliorating or enriching the soil. That the use of summer fallow must confer something nutritive, or some kind of manure upon the land, seems demonstrable. During the old system of husbandry, many soils received little other amelioration that what they derived from a summer fallow; yet for ages they continued to produce a certain quantity of grain, which was carried off from the lands, and consumed at a distance, without any care being taken to give to the soil a compensation for what it had thus lost. While this practice prevailed, it was found that no number of ploughings, even where the land was tolerably clean, could produce the effect of a summer fallow, or enable the land to bear a tolerable crop without the kind of amelioration which that practice conferred.

That a summer fallow tends actually to enrich, or, in the strict sense of the word, to add manure to the soil, seems obvious. By exposing to the air the roots of the various plants, whether of natural or artificial growth, with which the soil abounds, it converts these roots into a source of new fertility. By the action of the air and of light they suffer a chemical decomposition, which is analogous to fermentation, and which ends in the production of a portion of fertile soil or garden mould. It is probably in consequence of this change which the roots of plants undergo, or their rotting, that land turned up by the plough soon acquires a darker colour than it formerly possessed.

It does not appear, however, that the manure obtained in this way from the decayed roots of vegetables, will entirely account for the fertilizing effects of a summer fallow, or that a sufficient compensation is thus made to the soil for what is lost by a previous crop. It

Fertilizing Plants. is probable, therefore, *that the earth itself when turned up, attracts or absorbs from the light, and from the air some fertilizing principles. We are still too little* acquainted with the laws which govern the circulation of the different elements of nature, to be able to explain precisely and clearly the kind of change which is thus operated. It is certain that all putrid effluvia are rapidly absorbed, or putrid substances deprived of their smell, by fresh earth or mould; and it is probable that as cultivated countries are the most healthful, the soil when newly stirred or turned up, has a tendency speedily to withdraw from the atmosphere all bad air, or the great quantities of volatile or carbonaceous matter thrown into it by the respiration of animals or artificial combustion.

The practice of summer fallow, however, for the purpose of ameliorating the soil, is attended with immense disadvantages. That a third or a fourth of the whole arable territory of a state should annually remain not merely unproductive, but a source of expence from the frequent ploughings it requires, is undoubtedly a very serious evil;—to landlords, as occasioning a proportional inferiority of rent; to farmers, as lessening the profit of their occupation; and to the nation, as implying a slender population, in consequence of the scantiness of the produce of its territory. Hence it has always appeared an important object in agriculture, to diminish as far as possible the quantity of fallows, without injuring the productive energies of the soil. Here modern husbandry enjoys one of its greatest triumphs over ancient practices, by introducing certain crops, which perform to the land and to the husbandman the three services already ascribed to fallows, of pulverizing, clean-

ing,

ing, and manuring the soil, while at the same time a great additional quantity of food is produced for man or cattle. Fertilizing Plants.

By planting in the field those vegetables whose roots swell to a considerable bulk, the ground must constantly be acted upon by the swelling of their roots in all directions: and thus the growing of the crop itself may be equal, or superior, in efficacy to several ploughings, at the same time that the farmer enjoys the benefit of it. The plant most remarkable for the swelling of its roots is the potato, though it undoubtedly exhausts the productive powers of the soil in a very great degree. Potatoes are not, however, equally proper for all soils. In clay they do not thrive, nor are palatable; but in gravelly or sandy soils, they grow to a large size, and are of an excellent quality. Turnips likewise contribute to loosen the soil by the swelling of their roots, though not so much as potatoes. They have this advantage, however, that they will thrive in almost any soil. In clay ground, pease and beans thrive exceedingly well, and therefore are proper in this kind of soil as a preparatory for other kinds of grain. These push their roots deep into the ground, and cover it with their leaves more than other crops; so that the sun has not so much access as when it is covered with other kinds of grain. Wherever any of these kinds of vegetables are raised, it is observable, that more or less blackness is communicated to the soil: an evident sign of its melioration; this being the colour of the true vegetable mould, or rich *loamy soil*, as it is often called.

Besides the above-mentioned plants, carrots, parsnips, cabbages, and all those vegetables which sink their roots deep into the ground, answer the same purpose of loosening

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loosening and pulverizing the earth: but as they will not thrive but on ground already well cultivated, they cannot be raised to any advantage upon a poor soil.

Most of the same vegetables, by means of the drill husbandry, that is, by being planted in rows which admit the earth to be freely stirred by the plough about their roots while the plants are growing, afford an opportunity of clearing the soil of weeds to no less advantage than can be obtained by the costly operation of a summer fallow. Nay it is even found, that while one farmer, by means of these green crops, frequently ploughed in the intervals, or between the rows, reduces his lands to the state of a garden, both in point of pulverization and cleanness, his neighbour, trusting to the old summer fallow, in spite of all his labour and expence, finds annual weeds gaining ground upon him apace, and has no other resource than that of laying down his fields to grass for some years.

When the plants already mentioned are used upon a farm instead of fallow, and when they are employed for feeding cattle, they afford an opportunity of ameliorating the soil in a far higher degree than could ever be accomplished by means of summer fallow. If the dung thus produced is properly managed, it not only prevents the deterioration of the most ordinary soil, but gradually carries it forward in a state of progressive improvement, and it is only by the extension of the system of raising green crops or crops of roots instead of fallow, and by feeding cattle upon the farm with the produce, that we can expect to see the distinction between what is called in-field and out-field land completely abolished, and the whole arable waste lands of the kingdom profitably brought under the plough.

It

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It has been cuſtomary in many places, particularly in England, to ſow turnips, peaſe, buck-wheat, &c. and then to plough them down for manuring the land. This being ſimilar to that operation of nature by which ſhe renders uncultivated ſoils ſo exceedingly fertile, cannot fail of being attended with ſingular advantages; and might be looked upon as preferable even to driving dung on the land to fatten it, were it not attended with the entire loſs of a crop for that year.

Attempts have indeed been made to avoid the loſs of a crop in ſuch caſes. Theſe attempts well deſerve the attention and approbation of agriculturiſts, and we regret that their general practicability has not yet been ſufficiently eſtabliſhed in our climate. A correſpondent of Mr Young* tried ſucceſsfully to raiſe a crop of turnips after ploughing down a crop of buck-wheat which had been raiſed during the ſame ſeaſon. "This year I have the pleaſure to inform you, (ſays this gentleman, Colonel Vavaſour), that I have made trial of turnips after buck-wheat ploughed in on the ſecond week of July. The buck-wheat was ſown the ſecond week of May, upon four acres of very light land that had been marled the former ſummer. The turnips are a very good crop; I think the beſt in our neighbourhood.

"The making turnips ſucceed buck-wheat ploughed in I moſt earneſtly recommend to farmers on light land who have a difficulty in procuring manure; and upon ſtrong heavy lands that have been long under the plough, and ſubjected to the old huſbandry, viz. two crops and a fallow.

* *Annals of Agriculture*, vol. xxxii.

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"I do not know any crop like buck-wheat ploughed *in as a preparative for winter corn: I have a field o strong land under this husbandry of wheat sown the* end of September after buck-wheat ploughed in. At present its appearance promises to be a good crop; and it seems to me reasonable, that a heavy crop of vegetable matter ploughed into land that has been long under tillage in the old way of husbandry above mentioned, must greatly refresh the soil. A heavy crop of buck-wheat is certain to be procured on strong clay land well pulverized in the month of June, provided the summer proves tolerably dry after the seed is sown.

"And now, after recommending turnips on buck-wheat ploughed in, I do not know a better way to lay down light land to permanent grass, than to let buck-wheat in the month of June, with grass seeds, follow turnips. I mean the roota baga, which will remain good for sheep all the month of May, or longer, if other provision should be scarce.

"I laid down a field three years ago to permanent grass with buck-wheat sown the end of June and harvested the end of September. This mode has many advantages which must occur to every practical farmer. The grass seeds came up well."

[...]me crops [...]em to en- [...]h the

In addition to this, it may be proper to remark, that an idea has been entertained with regard to the succession of vegetables to each other, which ought not to be overlooked, as at some future period it may lead to important consequences. It has been supposed, that the roots of plants, or at least of some plants, possess a power of throwing out, as excrementitious, a part of the substances which they have taken in, but which are no longer necessary for their subsistence or growth.

It

It is undoubted, at leaſt, that while by ſome plants the ſoil ſeems to be rendered altogether unfit for the production of certain others, it is rendered by different plants extremely well adapted to their growth. Thus wheat ſucceeds uncommonly well after drilled beans; and theſe two vegetables have even been repeated for a great number of years in rotation, without any deficiency or failure of crop. Of I- ing We-

SECT. VI.

OF DESTROYING WEEDS.

WHAT we have already ſaid regarding the cultivation of the ſoil, reſpects only the fitting it for producing all kinds of vegetables indiſcriminately. Experience, however, ſhows, that the ground is naturally much more diſpoſed to produce and nouriſh ſome kinds of vegetables than others; and thoſe which the earth ſeems moſt to delight in, are commonly ſuch as are of very little uſe to man; but if neglected, will increaſe to ſuch a degree, as entirely to deſtroy the plants intended to be raiſed, or at leaſt hinder them from coming to perfection, by depriving them of nouriſhment. The clearing the ground of weeds, therefore, is an article no leſs neceſſary in agriculture, than the diſpoſing it to produce vegetables of any kind in plenty.

Weeds may be divided, according to the time of their duration, into *annual*, or ſuch as ſpring from a ſeed, and die the ſame year; and *perennial*, that is, Weeds divided into annual and perennial.

 ſuch

Destroying Weeds. such as are propagated by the feeds, and last for a number of years. The first kind are the least noxious, *and most easily destroyed. For this purpose it will be sufficient to let them spring up till near the time of ripening their feed, and then plough them down before it comes to maturity.* This was formerly done by means of a summer fallow, as already mentioned, but may be performed more advantageously by green crops carefully horse-hoed. It is also of service to destroy such weeds as grow in borders or neglected corners, and frequently scatter their feeds to a great distance; such as the thistle, dandelion, rag-weed, &c. for these are sufficient to propagate their species through a deal of ground; as their feeds are carried about with the wind to very considerable distances. A farmer ought also to take care, that the small feeds of weeds, separated from corn in winnowing, be not sown again upon the ground; for this certainly happens when they are thrown upon a dunghill; because, being the natural offspring of the earth, they are not easily destroyed. The best method of preventing any mischief from this cause, would be to burn them.

Perennial weeds, how destroyed. Perennial weeds cannot be effectually destroyed, but by removing the roots from the ground, which is often a matter of some difficulty. Many of these roots strike so deep in the ground, that they can scarcely be got out. The only method that can be depended upon in this case, is frequent ploughing, to render the ground as tender as possible; and harrowing with a particular kind of harrow, which shall hereafter be described, in order to collect these pernicious roots. When collected, they ought to be dried and burnt, as the only effectual

fectual method of ensuring their doing no further mischief. Of Destroying Weeds

There is a particular species of weed, peculiar only to grass lands, of a soft spongy nature, called *fog*, which *it is found very difficult to exterminate.*

What is vulgarly called fog uniformly consists of one or more species of what are properly denominated the moss plants. Nature of fog. The nature of these plants, and consequently of fog, will be fully explained when we come to treat of the subject of mosses, and their improvement. In the mean time it may be remarked, that the moss plants are extremely hardy in their nature, and grow up readily upon poor soils in all such cold and bleak situations as are unfit for the permanent production of more delicate plants. When lands, therefore, have been laid down to grass in a poor and exhausted state, the grasses die out in a few years, and their place is occupied by various species of the hardy moss plants under the denomination of fog, which is unfit for the sustenance of cattle. The proper mode of exterminating this weed upon arable lands consists of using the plough for the purpose of putting them under one or more crops of turnips. If the turnips are eaten upon the field by cattle or sheep, the soil will necessarily be enriched by their dung, but if these roots are conveyed to cattle intended to be stall-fed, the cattle's dung ought to be entirely laid upon the field. In either case the soil thus enriched may again be laid down to grass.

In the case of high or upland pastures that are not arable, the best mode of permanently destroying fog or the moss plants, and of encouraging the growth of the more delicate grasses, consists of improving the climate by belts of planting, and at the same time of spreading upon the surface of the soil quick-lime, which is a deadly foe to all the moss plants, and consequently to fog.

Mr Young* mentions a mode *of temporarily destroying fog, which deserves notice on account of the facility of the practice, and the advantages with which it is attended.*

" Many years past, (says this author), the late Reverend Mr Lord of Welnetham, in Suffolk, practised a husbandry which I have often heard farmers condemn; it was that of keeping for winter use the whole crop of grass. I have seen him thus preserve what would in July have produced two tons of hay per acre. I did not then approve the practice, and urged theoretically, that the plants perfecting their seeds, and standing long after, must become mere straw, and of no value; he replied that it should be what I pleased to call it *straw*, if I would have it so; but that he found this straw mixed, as it will be, with a young growth, better than hay. I once ordered a field to be kept in like manner; but my bailliff, disliking much the experiment, in my absence turned cattle in, and fed it the latter end of August or beginning of September. It now appears to be no uncommon practice in South Wales. The account we have of it is very curious: On uplands, so dry and sound that no animal can, in the wettest weather, make an impression on the surface, and naturally running to white-clover and good grass, it is the practice to set apart many acres. Early in May the fields are shut up for the summer season with no ther

* *Annals of Agriculture*, vol. xxiii.

other attention than to cut docks and thiftles, and thus left till December, when all the ftock is turned in, and all forts are kept in excellent condition without any hay, ftraw, or other food; and the butter thus gained as good as in any part of the year. The *froft* fweetens *the grafs, and fnow does not injure it; but while it is buried, dry food is given. Early in fpring there is* under this fhelter a great growth of young grafs; and both together eaten with avidity. Mofs is thus cured, and difappears without the aid of the plough or manure. It betters every year; and the beft acre of hay will not keep more ftock, or in fuch good condition, as an acre of fog. The fields are found to be much improved by the quantity of feeds that fall. It appears that the practice is found in the weft riding of Yorkfhire; but they do not train up till the beginning of July."

Of Deftroying Weeds.

Broom, furze, &c. how deftroyed.

Befides thefe kinds of weeds, which are of an herbaceous nature, there are others which are woody, and grow to a very confiderable fize; fuch as broom, furze or whins, and thorns. *Broom* is an evergreen fhrub, that thrives beft in a fandy foil; and there it grows fo vigoroufly, as fcarcely to admit any grafs under it. It propagates by feed which grows in pods; and thefe, when fully ripe, break with violence, fcattering the feeds all around. Thus, a field which is overgrown with broom, befides the old plants, always contains an infinite number of young ones: fo that though the old plants die when cut over, a frefh crop conftantly fprings up. It may, however, be deftroyed by frequent ploughing and harrowing, in the fame manner as other perennial weeds are; for it does not for fome time carry any feed, and the frequent ploughing encourages the vegetation of all thofe feeds that are already in the

 ground,

Of Destroying Weeds. ground, which cannot fail of being destroyed by frequent repetitions of the operation. Another method of destroying broom, is by pasturing the field where it grows with sheep. A few of the old bushes may be left as a shelter, and these will be in a good measure prevented from spreading by the cropping of the sheep. These animals are very fond of broom, and greedily devour every young shoot; so that if any remain after the first year, there will not be a vestige the second. If this method of extirpating broom is equally effectual with that of frequent ploughing, it is certainly much more profitable, as there is no food more nourishing to sheep than young broom. Broom, however, is said to have a singular effect upon sheep: it makes them drunk so effectually, that when heated with a little driving, they tumble over, and lie without motion.

The *whin* is a fine evergreen shrub, carrying a sweet-smelling flower all the year round. It propagates both by seed and by its roots, which spread sometimes to the distance of 10 or 12 feet; and hence, when once established, it is with difficulty extirpated. The best method is to set fire to the whins in frosty weather; for frost has the effect to wither whins, and make them burn readily. The stumps must then be cut over with a hatchet: and when the ground is well softened by rain, it may be ploughed up, and the roots taken out by a harrow adapted to that purpose. If the field is soon laid down to grass, the whins will again spring up in great abundance from the seeds, and small parts of the roots left in the ground. In this case, pasturing with sheep is an effectual remedy; as they are no less fond of young whins than of young broom; and if there are a sufficient number, they will not leave a single

plant

plant above ground. But if grafs is not immediately wanted, the moft effectual method of clearing a field of whins, is by reiterated ploughings.

Difeafes of Plants.

The *thorn*, or *bramble*, fpreads its roots very wide, and at the fame time finks them deep in the earth. Though cut in the winter, it rifes, and comes to fuch perfection as to carry fruit in fummer. It can only be extirpated by ploughing up the ground, and collecting the roots.

One effectual plan, which, as will afterwards appear, is practicable in many more fituations than it has hitherto been applied to, for deftroying thefe and all other woody fhrubs and plants, together with a great number of weeds that are of no value upon pafture grounds, confifts of flooding the land, by directing over it a ftream of water. By means of fuch a device, all whins and other fhrubs are completely rotted and deftroyed.

Shrubs are deftroyed by flooding the land.

SECT. VII.

OF THE DISEASES OF PLANTS.

As fome of the moft valuable kinds of vegetables are liable to fuffer much by difeafes peculiar to themfelves, it is of much importance to the hufbandman to be aware of this circumftance, and to adopt every known mode of protecting his crop againft them. At the fame time, as the principles of vegetable life are by no means well underftood, the caufes and the cure of the moft ferious difeafes affecting plants ftill remain

The difeafes of vegetables are ill underftood.

main under a great degree of obſcurity, and the moſt experienced and intelligent huſbandmen expreſs great uncertainty reſpecting the meaſures to be adopted for preventing their appearance. Hence it ſeems moſt proper, to introduce the conſideration of them in this place before we proceed to the practical part of the ſubject; and as wheat is accounted the moſt valuable kind of grain, we ſhall begin with the diſeaſes to which it is expoſed.

Wheat chiefly ſuffers from two diſeaſes, the blight and the mildew. Of the blight in wheat we ſhall give an account upon the authority of an eſſay by Robert Somerville, Eſq. ſurgeon, 1ſt Battalion, 8th Fencible Regiment, inſerted in the communications to the Board of Agriculture *, giving a ſtatement of the nature and appearance of the blight which occaſioned the failure of the crop in 1795. When the crop had juſt ſhaken the flowers, and the grains were beginning to form, moſt of them ſeemingly in a healthy manner, it was obſerved that many of the blades and ſtalks were rather of a dirty green colour, and in two weeks thereafter there appeared upon them great numbers of ſmall red inſects. As the ſeaſon advanced, theſe inſects not only increaſed in ſize, but became more numerous, and in almoſt every field the grain began to manifeſt unequivocal ſymptoms of diſeaſe, which were ſo formidable, that, in many inſtances, a total loſs was dreaded, and, in not a few caſes, one half of the crop was actually deſtroyed. The minute ſymptoms of the blight were theſe:

1ſt,

* Vol. ii.

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1st, In the very early stages of the disease, and before the ear was affected, the blades and stalks were marked with black and rusty spots. These spots seemed to be occasioned by a glutinous substance deposited upon them, easily soluble in water, and which could be readily washed off by rubbing the stalks with a wet cloth. Some spots, however, were white, and these seemed to be owing to wounds or punctures made by vermin; the leaf having, to a certain extent, in consequence of these, withered and become white. As the season advanced, the black and rusty-coloured spots became larger and more numerous: and when the grain began to ripen, not only the blades but the straw were almost entirely discoloured with black spots.

2d, After the crop had begun to shoot, and was in the ear, many of the heads were entirely empty. Where the stalk was green, and to appearance tolerably healthy, but the ear at the same time withered and without grain, the misfortune seemed to have arisen from an injury done to the neck of the ear, at the place of its junction with the stalk. There the outer rind was destroyed all round, which must have cut off the circulation between the ear and the stalk, as happens in trees that have had their bark destroyed all round.

3d, Many of the ears were entirely empty in the upper part, while the lower half was well filled. In these cases, the injury seemed owing to the rind being destroyed about the middle of the ear, at that place which separated the full from the empty part, and was similar to the injury done in the preceding case where the whole ear was destroyed.

4th,

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4th, In very many cafes the ears had a plump well-filled pickle and an empty hufk alternately. In thefe the injury femed owing to a wound inflicted at the bottom of the empty grains, where they are joined to the ftalk, and which had taken place while they were in flower, preventing them from making any farther progrefs.

5th, Many ears, though not entirely empty, contained only fmall fhrivelled grains, or what are called *hungry pickles*. Thefe feemed to have efcaped any accident till they had made fome progrefs in filling, after which they became ftationary and ripened prematurely. On examination they were found to be injured at the place where they were joined to the ftalk, in the fame manner as was already mentioned, in the cafe of thofe that had empty heads or ears. Like thefe alfo the whole ear was in fome cafes ill-filled. In others only half of it was in that ftate, and in a very great number the ears confifted of a well and ill-filled grain alternately. Without a fingle exception, the whole of the ill-filled or hungry grains, were wounded at the place of their infertion into the ear.

6th, A number of ears, though well-filled, were, upon opening the hufks, found almoft entirely covered with black and rufty fpots, nearly refembling thofe already defcribed, and like them alfo they were eafily rubbed or wafhed off. The downy part of many of thefe grains, when examined carefully with a good glafs, appeared to contain feveral fmall white tranfparent globules, refembling the eggs of infects.

7th, In many fields, efpecially fuch as had been fallowed and well manured for the wheat crop, a great number of plants were entirely withered from top to bottom.

bottom. The decay, in moft of thefe cafes, took place when the wheat was beginning to fhoot. No injury was vifible in thefe cafes upon the blade or ftalk, but on examining the roots, a worm was found at every one of them. Difeafes of Plants.

Laftly, As the crop began to whiten, the dark or rufty fpots on the ftraw and ears became more numerous, and appeared more confpicuous. In place of putting on a white or yellow appearance, the whole crop looked as if it had been fprinkled with foot.

The whole of thefe fymptoms appeared to arife from the attack of an infect, and from the injuries and depredation which it committed upon the plants. This infect, when firft diftinguifhable by the eye, was of a red colour, and fo foft as to be killed by the flighteft preffure. As it increafed in fize the colour gradually changed to a dusky black, at which it became ftationary. [illegible] which it loft its foft texture, and in proportion as its colour darkened it became hard, and as it were covered with a cruft or fhell upon the back. It is faid to be not uncommon, and to be met with at all times, even in the beft fields of wheat, though its numbers are infinitely increafed in late wet feafons. From its eggs appearing to lodge upon the well-filled ears of the grain, it might be confidered as in danger of being propagated to the fucceeding crop. On this account our author hazards fome conjectures upon the beft means of preventing future danger from it. One of thefe confifts of the ufe of lime mixed up with all manure, with a view to prevent infects from being generated in it. It is alfo fuggefted that the manure, by means of which flugs and worms are chiefly fuppofed to be produced, ought not to be ploughed into the ground

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ground in autumn, but applied as a top dressing in the spring; because it is understood that manure, exposed to the sun and air, has much less tendency to foster insects, than when it is covered up in the earth.

Mildew is red or black, called *smut*.

Another disease, which is much more destructive to wheat, and much more frequently met with, is the mildew. It is of two kinds, the black and the red. In both cases it consists of a quantity of seemingly coarse powerder attached to the grain in the ear, or loosely surrounding it; in consequence of which it is evidently prevented from filling or arriving at perfection. The black kind of mildew is by far the most frequent and the most pernicious. It is most generally known in England by the name of *smut*, and in Scotland, by that of the *black*, both of which are sufficiently expressive. Concerning the cause of this disease various opinions have been entertained. Dr Home, in his Principles of Agriculture and Vegetation, ascribes it to an over luxuriancy of growth. He is of opinion, that too great an abundance of juices in a vegetable will produce diseases similar to those occasioned by repletion in animal bodies, viz. stagnations, corruptions, varices, cariosites, &c. along with the too great luxuriancy we have just now mentioned, which he expresses by "too great an abundance of water shoots." Hence he is induced to class the smut among diseases arising from this cause, it being a corruption happening most in rainy seasons and to weak grain. Like other contagious diseases, he tells us, the smut may be communicated from the infected to healthful grain. As a preventive he recommends steeping the seed in a strong pickle of sea salt. Besides the effect which this has upon the grain itself, it it is useful for separating the good from the bad; the best seed falling to the bottom, and the faulty swimming on the top of the liquor.

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Opinions concerning the cause of mildew.

Independent of this notion of an over luxuriancy of growth, it may be observed, that two opinions have chiefly been supported by persons who have speculated and written on this subject. One opinion is, that the mildew consists of a great multitude of parasitical plants adhering to the grains of wheat, living upon it, and thereby consuming its substance. Another opinion is, that it consists of great numbers of insects and of eggs of insects, whose form is too small to be distinguishable by the naked eye. The first of these opinions has been adopted by the celebrated Italian writer Fontana, and the other by certain writers of our own country.

Fontana's opinion.

Fontana endeavours to refute the hypothesis, that the dust of the mildew consists of animal eggs, by the following experiment. He closely confined the grains of the mildew between two glass plates, in such a manner as necessarily to break the supposed eggs. He then, with an accurate microscope, observed them while crushed in succession. No liquid or glutinous juice proceeded from them, though great force was used in crushing them; but they appeared wholly to consist of tough resisting substances, altogether unlike real animal eggs: their being fastened to the stalk or leaves of the grain, appeared also to militate against such a supposition. From a variety of microscopic observations, he is of opinion, that the powder of the black mildew or smut consists of a great multitude of small plants attached to the grain by a slender fibre. These parasitical plants, though extremely small, he thinks

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sufficiently regular. With regard to the red mildew he admits, that it appears to be composed of an immense multitude of minute eggs. After a variety of experiments and observations, however, he thought he discovered, that these apparent eggs are in truth the heads or fruit of very fine threads fixed on the ear of corn; that these threads or stems are exceedingly fine and transparent, which gives the appearance of eggs to their outward extremities. These stems or tails are represented by him, as infinitely finer than those of the black mildew; and their heads, which resemble eggs, may be separated from them by the slightest shock. From all his observations he concludes, that both the black and the red mildew consist of real plants, though, perhaps, of an imperfect kind; and that they enfeeble and waste the crop by absorbing the nutritive juices of the plant. He observes, that, if a heavy rain speedily fall on an extensive mildew, washing the leaves and stalks affected, it presently disappears with hardly any damage to the corn; because the small plants having hardly taken root are easily dispersed before any mischief is done. He thinks, that the damage occasioned by this disease may sometimes be moderated or diminished by cutting down the grain before it is fully ripe. In this case, he says, that the crop will be less than it ought to be; but still it will be considerably greater than if the customary time of harvest is waited for, when the disease will have leisure to produce greater mischief.

In our own country, and particularly by Mr Somerville, in the essay already quoted, the smut in wheat has been regarded as consisting of a great variety of insects. He also founds his opinion upon microscopic

 observations,

observations, and apprehends that from them he has clearly ascertained the existence of the insects; and he thinks that the disease is communicated to other grain by contact, in consequence of the passage of the insects. Hence he endeavours to explain the utility of steeping the seed in pickles before it is sown, with a view to the destruction of such insects.

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Pickles to prevent smut or mildew.

It is to be remarked, that in all countries a great variety of these pickles has been contrived, with a view to prevent the existence of smut in wheat, some of which we shall now mention. One of the most common is the salt pickle, consisting of a solution of common salt in water, of such strength as that an egg will swim in it. To the wheat, after it has been washed in this pickle, and the light grains removed, some new slaked lime is added, and carefully mixed with it with a wooden shovel, till it attain a sufficient degree of dryness, in which state it is committed to the earth. A pickle consisting of very stale urine has also been recommended to be used for washing wheat that is meant to be used as seed. It is attended with this disadvantage, however, that if the urine is very stale, and if any length of time is suffered to elapse, in consequence of rain or other accidents, before the grain is sown, its vegetative power is said to be greatly injured by the corrosive quality of the volatile alkali with which such urine abounds. This is more particularly the case when quicklime is added to the urine; as the alkali is then brought into a caustic state.

Another pickle has been proposed to the Board of Agriculture by the Italian physician, J. B. Scandella. It is prepared and used in the following manner: —Take of nitre, three pounds; alum, one pound; vi-ſix ounces; verdegris, three ounces; wood-aſhes, well ſifted, ſix pounds: Boil the whole in a copper with five pails of water for an hour, then remove them from the fire, and pour them into a large veſſel; then add ſixteen pails of water, in which half a buſhel of quicklime has been previouſly diſſolved: mix the whole intimately, and allow them to ſtand till they are quite cold. In this ſteep, two buſhels and a half of wheat are to be plunged, and left for about ſix hours, ſtirring it up frequently with a wooden ſhovel, and ſkimming off what riſes to the ſurface; the wheat is then to be withdrawn, and ſpread out till it is dry enough for ſowing. The proceſs is thus to be continued until the whole quantity of ſeed intended to be ſown is pickled. The above ſteep is generally ſufficient for preparing about twenty-four buſhels of wheat.

Another pickle has been recommended,* conſiſting of a decoction in water of Barbadoes aloes, tobacco, and hellebore powder. A committee of the Royal Society of Agriculture at Paris, in 1786, recommended the following pickle for the ſame purpoſe, contrived by M. Tillet†:—Pour upon 50 pounds of wood-aſhes, 900 pints of water; ſtir it well for three days, and then draw off. Waſh the black wheat in ſo many clear waters as not at laſt to dirty it. Heat the lye, ſo as juſt to bear the hand in it; ſlake in the hot lye one pound of lime to every ſeven or eight pints of it. Into the preparation dip the ſeed in baſkets many times. For want of wood-aſhes uſe potaſh, ſeven or eight pounds for 100 pints of water.

In

* *Communications to the Board of Agriculture*, vol. ii.

† *Annals of Agriculture*, vol. ix.

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In addition to these it may be remarked, that a solution of arsenic in water is made use of in some counties of England, as a pickle in which they wash or steep the grain previous to its being sown for the purpose of protecting the future crop against smut.

Arsenic used to prevent the mildew.

The most complete set of experiments, however, which we have met with upon the subject, was made by Arthur Young, Esq. at present secretary to the Board of Agriculture. December 7. 1787, he sowed 14 beds with the same seed wheat as black with the smut as any he ever saw.

Arthur Young, Esq. his experiments to prevent mildew.

N° 1. Sown dry, nothing done to it.
2. Washed well in clean water.
3. Washed in lime-water.
4. Washed in a lye of wood-ashes.
5. Washed in an arsenic and salt mixture.
6. Steeped in lime-water four hours.
7. Ditto in the lye four hours.
8. Ditto in the arsenic 12 hours.
9. Ditto in lime-water 12 hours.
10. Ditto in the lye 12 hours.
11. Ditto in the arsenic 12 hours.
12. Ditto in the lime-water 24 hours.
13. Ditto in the lye 24 hours.
14. Ditto in the arsenic 24 hours.

RESULT.

N° 1. Had	377 smutty ears.
2. Ditto	325
3. Ditto	43
4. Ditto	31
5. Ditto	28

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N°	6. Ditto	12
	7. Ditto	3
	8. Ditto	1
	9. Ditto	6
	10. Ditto	0
	11. Ditto	4
	12. Ditto	0
	13. Ditto	0
	14. Ditto	5

A propofal has alfo been made, to deftroy by means of heat the infects which are fuppofed to propagate the difeafe called *fmut* from the feed wheat to the future crop. The following directions for that purpofe are extracted from the Agricultural Survey of the County of Clackmannan, by J. F. Erfkine, of Marr, Efq. "Let the wheat be laid upon the kiln about three or four inches thick: the kiln to be heated middling ftrong with blind coal; the wheat to continue on the kiln for 24 hours, but turned frequently. After taking it off the kiln, it muft be allowed 24 hours to cool; during which time it muft be frequently turned; then put it through the fanners once or twice. After the wheat has lain a few hours on the kiln, and the fire begins to have effect, a great number of very fmall worms, formerly undifcovered by the eye, appear on the top of the grain, and are foon deftroyed by the heat. Thefe come from blacked wheat, or other corns, that could not be fufpected to be indifferent; or may lie in or on good wheat; which worms continuing, (when not thus killed) might confume the corn after it is thrown into the earth, thereby checking the growth entirely, or preventing it from having the ftrength it otherwife would have to bring forth

Erfkine of Marr's remedy.

forth a ſtrong productive ſtalk. This practice is ſaid to have been brought from Ireland, and is recommended as preferable to pickling. It might perhaps be performed with greater ſucceſs by the uſe of a kiln heated by the ſteam of boiling water, in the way already mentioned, as ſuch a kiln would inſtantly afford a fixed and known degree of heat, which could in no caſe be exceeded." Diſeaſes of Plants.

The ſubject is thus treated by a correſpondent of Mr Young ‡. "The cauſe of ſmut-balls is ſimply this: every grain of wheat, that the *duſt* of theſe ſmut-balls ſhall touch and *adhere to*, is thereby cauſed to produce ſmut-balls, the next ſeaſon, as certain as the ſmalleſt quantity of matter put into the arm of any perſon who hath not had the ſmall-pox, cauſeth ſuch to have that diſorder. This duſt is of a very virulent nature; and wheat being extremely ſuſceptible, is liable to take the infection various ways.

"I am fully convinced, and believe that moſt of my readers will ſoon be ſo, that wheat is not liable to this diſorder, but by contagion, as is the caſe in the ſmall-pox; and to thoſe who may query from whence ſmut-balls at firſt proceeded, I think I may ſafely promiſe an anſwer to their queſtion, on their informing me of the origin of that contagious diſorder. For it evidently appears, that where men have, at their firſt entering into the farming life, had wheat for ſeed *free from ſmut-balls, and their barns*, &c. *all free from infectious matter*, and not being in the practice of unneceſſarily changing their ſeed, (as too many are) they have continued clear, whilſt perhaps ſeveral of their neighbours have been often peſtered

‡ *Annals of Agriculture*, vol. xxi.

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pestered with it, although they have frequently changed their seed, (a part of it every year) at a great expence, giving an advanced price in the purchase, and having it brought from a considerable distance.

"When I first supposed that the cause of *smut-balls* was owing to their dust adhering to the grains of wheat, I took four gallons of wheat which abounded with them, and rubbed all well together with my hands, by which most of the balls were broken, and the grains of wheat tinged with the dust; in this state it was sown. And believing that something of a *cleansing nature* was all that is necessary to remove the cause; I took two bushels of the same parcel of wheat, which, after being well winnowed, was taken to a brook and washed in the following manner: viz. A gallon at a time was put into a wire sieve, which had eight bars to an inch; at first it was gently immerged a few times in the water, by which every smut-ball amongst it was easily discovered and taken away; this being done, the sieve was whirled round briskly in the water for about a minute; then all being washed in the sieve, and thrown into a tub with some water, was stirred round with a broom, and lastly, put into the sieve again, a gallon at a time, and washed in the brook, expecting that the remaining particles would sink through the bottom of the sieve, and be carried away with the stream.

"This was sown in the same field with the former, where no different kind of manure could have the least tendency to produce smut-balls, amongst either this or that. But at harvest the difference in the crops astonished every one who saw them: the first produced as many smut-balls as grains of wheat, but the latter was almost perfectly free from them.

"The

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" The next year, I took some grains of wheat which had been *rubbed out* of ears that contained both wheat and smut-balls, and sowed half of them in that smutted stated; the remainder was well washed in water, and then sown near the unwashed grains in a separate drill: at harvest the produce of the two was opposite; the first yielded exactly twenty-four ears of smut-balls to one ear of wheat, the other about twenty-four of wheat to one ear of smut-balls.

" The same season, two bushels of the under part of the heap, and the sweepings, were washed and sown like those already mentioned; the produce was very similar, both being nearly free from smut-balls."

The same writer adds, that from experiment he is satisfied, that the most smutty wheat may at once be cleaned in such a manner, that it will produce grain of a perfectly sound quality. This however, he says, cannot be completely accomplished by washing with cold water, on account of the defective nature of its cleansing powers. He recommends therefore a wash to be made of boiling water and new burned lime, to be used at a moderate warmth. He describes the process thus: " I recommend those who buy wheat for seed, or are about to sow such as they are suspicious of, to wash it in the manner I have already described; but if washing in a brook is not convenient, wash it as well as circumstances will admit, having an eye to the end intended to be obtained, viz. to dispossess the wheat from all infectious matter. Afterwards put it into a tub or cistern, and pour so much thin wash, such as plaisterers make use of to white-wash walls, &c. made of boiling water and new *burnt lime*, as will cover the wheat wholly for the space of six, eight, or twelve hours; then pour it

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forth on a sloping floor, and in a few hours it will be dry enough to sow.

"But observe the necessary care of not making use *of this wash in so hot a state as to injure vegetation*; about the medium between boiling and milk or blood warm will be a proper degree, as the wheat will reduce its heat instantly."

After all, however, both from the reason of the thing, and from the concurring opinion of the most experienced and intelligent farmers, we think ourselves authorized to say, that the husbandman will act imprudently if he place entire and complete confidence in any one of the remedies above mentioned, to the exclusion of the others. His safest and best plan for procuring crops of wheat free from smut is probably this: In the first place, he ought to procure seed from a situation in which the grain has risen absolutely free from this disease. He ought next to exert the greatest care in cleaning out, in the most anxious manner, his whole barns and their floors, and every place within doors into which his grain may come, and in which diseased grain has formerly been kept: with this view it may probably be necessary to whitewash the walls with a mixture of quicklime and water, which will prove an effectual remedy. After having adopted these precautions, it may still be necessary, with a view to secure a sound and full crop, to plunge the seed into a strong pickle of salt and water, with a view to float the lighter grains, which ought to be skimmed off and laid aside for poultry, to which they may be given after being washed in fresh water; or at least it may be proper to use the precaution of washing the seed in a running stream, or in warm

warm lime water. No future change of feed will be neceſſary. Of the farmers who have adopted this judicious mode of proceeding, there is no inſtance recorded of any one whoſe crop has ſuffered by ſmut; on the contrary, they have uſually derived a conſiderable profit from becoming the furniſhers of grain for ſeed to all their neighbours.

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The want of nouriſhment in plants may be eaſily known by their decay; in which caſe, the only remedy is, to ſupply them with food, according to the methods we have already directed, or to remove from their neighbourhood ſuch other plants as may draw off the nouriſhment from thoſe we wiſh to cultivate.—In the Memoirs of the Academy of Sciences for 1728, Mr Du Hamel mentions a diſeaſe, which he calls *le mort*, that attacks ſaffron in the ſpring. It is owing to another plant, a ſpecies of trefoil, fixing ſome violet-coloured threads, which are its roots, to the roots of the ſaffron, and ſucking out its juice. This diſeaſe is prevented by digging a trench, which ſaves all the unaffected.

Diſeaſes peculiar to ſaffron.

The bad qualities, and unequal diſtribution of the juices of plants, are the occaſion of ſo few of the diſeaſes to which vegetables in this country are ſubject, that we forbear to mention them at preſent. Moſt of the diſeaſes of our plants are owing to external accidents, particularly to the depredations of inſects.—The inſects by which the greateſt devaſtations are committed in this country are, ſnails, caterpillars, grubs, and flies. The ſnails and caterpillars feed on the leaves and young ſhoots; by which means they often totally deſtroy the vegetable. Where the plants are of eaſy acceſs, theſe vermin may be deſtroyed by ſprinkling the vegetable with lime-water; for quicklime is a mortal

Vegetables deſtroyed by inſects.

Inſects deſtroyed by lime-water.

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tal poison to creatures of this kind, and throws them into the greatest agonies the moment they are touched with it. On trees, however, where this method cannot so well be followed, fumigation is the most proper; and, for this purpose, nothing is better than the smoke of vegetables not perfectly dry. In some cases the eggs of these destroying creatures may be observed, and ought without doubt immediately to be taken away. On the fruit trees, as apples, pears, medlars, on some forest trees, the oak and dwarf maple especially, and the white and black thorn in hedges, a kind of little tufts are to be observed, resembling at first sight withered leaves twisted by a cobweb about the uppermost twigs or branches. These contain a vast number of little black eggs, that, in the spring, produce swarms of caterpillars which devour every thing. To prevent this, all the twigs on which these cobwebs appear should be taken off and burnt as soon as possible. This ought to be done before the end of March, that none of the eggs be allowed sufficient time for hatching.

Grubs.

Grubs are a kind of worms which destroy the corn by feeding upon its roots; they are transformed every fourth year into the beetles called *cock-chaffers may-bugs*, &c. they are very destructive when in their vermicular state, and cannot then be destroyed because they go deep into the ground. When become beetles, they conceal themselves under the leaves of trees, where they seem asleep till near sunset, when they take their flight. It is only now that they can be destroyed, and that by a very laborious method; namely, by spreading pack-sheets below the trees in the day-time when the beetles are in their torpid state, then

shaking

ſhaking them off and burning them. Some time ago they made ſuch devaſtations in the county of Norfolk, that ſeveral farmers were entirely ruined by them; one gathered 80 buſhels of theſe inſects from the trees which grew on his farm. It is ſaid, that in 1574 there fell ſuch a multitude of theſe inſects into the river Severn, that they ſtopped and clogged the wheels of the water-mills. Diſeaſes of Plants.

Turnips, when young, are apt to be totally deſtroyed by a multitude of little black flies, from thence called the *turnip-fly*. As a preventive of theſe, ſome adviſe the ſeed to be mixed with brimſtone; but this is improper, as brimſtone is found to be poiſonous to vegetables. The beſt method ſeems to be the fumigation of the fields with ſmoke of half-dried vegetables. For this purpoſe weeds will anſwer as well as any. This fumigation muſt no doubt be often repeated, in order to drive away the innumerable multitudes of theſe inſects which are capable of deſtroying a large field of turnips. Turnip-fly. Prevented by fumigation, &c.

Some have ſuppoſed that the fly is either engendered in new dung, or enticed by it; and have therefore adviſed the manure to be laid on in the autumn preceding, by which it loſes all its noxious qualities, while its nutritive ones are retained, notwithſtanding theſe might be ſuppoſed liable in ſome degree to be exhaled by the ſun. This method is ſaid to have been aſcertained by experiments; and it is added, that another material advantage accruing from autumn manuring for turnips is, that all the ſeeds contained in the dung, and which of courſe are carried on the land with it, vegetate almoſt immediately, are moſtly killed by the ſeverity

verity of the winter, and the few that remain ſeldom avoid deſtruction from the ploughſhare.

Various remedies againſt the turnip-fly.

The following method of ſowing has alſo been recommended as a preventive of the fly:—"About midſummer, take the firſt opportunity when it rains, or there is an apparent certainty of rain approaching, to ſow your turnip ſeed; if about the full moon, the better. In this caſe, neither harrow, bruſh, nor roll, after ſowing. The natural heat of the ground at that ſeaſon, and the conſequent fermentation occaſioned by copious rain, will give an aſtoniſhingly quick vegetation to the ſeed, which in a few days will be up and out of all danger from the fly. At all events, ſow not till it rains; it is better to wait a month, or even longer, for rain, than to ſow (merely for the ſake of ſowing about the uſual time) when the ground is parched with heat. By the ſcorching of the ſun, the oil and vegetative quality of the ſeed are exhauſted; and the few weak plants that come up will be deſtroyed by the fly before they can attain ſtrength to put forth their rough leaves. The fly infeſts the ground abundantly in dry hot weather, but does no injury in rain. The falling rain will ſufficiently waſh the turnip ſeed into the ground without harrowing it in: which, inſtead of merely covering, too often buries this ſmall ſeed at ſo great a depth, as never afterwards to get above ground."

The following remedies are alſo recommended as having often proved ſucceſsful:—A ſmall quantity of ſoot ſown over the land at their firſt appearance. Branches of elder, with the leaves bruiſed, drawn in a gate over them. Muſk mixed with the ſeed before it is ſown. And ſulphur burnt under it, after moiſtening it with water in which tobacco has been ſteeped.

But

But ſhowers on the plants, as ſoon as they appear above ground, are eſteemed the beſt preſervatives. They enfeeble and kill the fly, and haſten the plants into the rough leaf, in which ſtate they are out of danger. Diſeaſes of Plants.

The ſweet ſmell of the turnip has been thought to attract the fly; upon which ſuppoſition, the remedy appeared to conſiſt in overpowering that ſmell by one which is ſtrong, fetid, and diſagreeable. Hence it has been recommended, that upon an acre of turnips ſown in the uſual way, a peck or more of dry ſoot be thrown after the ground is finiſhed, and in as regular a way as the ſeed is ſown.

It has alſo been recommended to ſow about two pounds of radiſh ſeed on every Engliſh acre ſown with turnips. The radiſhes riſe before the turnips, and entertain the fly till the turnips are out of danger. The radiſh and turnip ſeed ought to be ſown at the ſame time, and may be mixed by the ſeedman or perſon employed to ſow.

Some time ago an inſect, called the *corn-butterfly*, committed ſuch ravages while in its vermicular ſtate, in France, that upwards of 200 pariſhes were ruined by it; and the miniſtry offered a reward to the diſcoverer of an effectual remedy againſt this deſtroying worm. The cure which was at laſt diſcovered was, to heat the corn in an oven ſo much as not to deſtroy its vegetative power, but ſufficiently to deſtroy the ſmall worms which made their neſt in the ſubſtance of the grain, and at laſt ate out the ſubſtance ſo completely, that nothing could be got from the huſk even by boiling it in water. It is certain, that though inſects can bear a great deal of cold, they are eaſily de- Corn-butterfly.

ſtroyed

Diseases of Plants. ſtroyed by a ſlight degree of heat; nor is the vegetative power of corn eaſily deſtroyed, even when kept for a long time in a pretty ſtrong heat. This method muſt therefore be very effectual for deſtroying all kinds of inſects with which grain is apt to be infected: but care muſt be taken not to apply too great a heat; and the adjuſting of the preciſe degree neceſſary to deſtroy the inſect, without hurting the corn, will be attended with ſome difficulty. The precautions recommended when treating of the mildew in wheat, may be adopted with ſucceſs.

The curled diſeaſe in potatoes.

The curled diſeaſe in potatoes has long been a ſubject of inveſtigation and experiment among farmers: and the knowledge of its cauſe and cure ſeems yet to remain a deſideratum. The *Agricultural Society* at Mancheſter, a few years ago, offered a premium *for* diſcovering by actual experiment the cauſe of the diſeaſe in queſtion; and a great variety of letters were, in conſequence, addreſſed to them upon the ſubject.—As theſe contain many intereſting obſervations both on the diſeaſe itſelf and the beſt methods hitherto adopted for preventing it, the following abſtract of them may not improperly be introduced in this place.

Various methods of prevention.

I. According to the writer of the firſt letter, this diſeaſe is cauſed by an inſect produced by froſt or bad keeping before ſetting; and the neweſt kinds, ſuch as have been raiſed within theſe nine or ten years, are moſt apt to curl, becauſe they will not ſtand to be kept in winter and ſpring before ſetting, as the old kinds will. In autumn 1776, he got up a bed of potatoes to lay by in winter, leaving plenty in the ground as regular as poſſible; and, before the ſeverity of winter came on, covered part of the bed with ſtraw and peaſe-haulm, and left the other part of the bed uncovered.

That part of the bed which was covered was quite free from curled ones; but the uncovered part produced a great many curled, owing, as the writer ſays, to froſt and ſeverity of the weather.

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II. This writer had about a quarter of an acre of potatoes, well manured with cow and horſe dung, and took the greateſt care in picking the fine ſmooth-ſkinned potatoes for ſets; yet nine out of ten parts were curled. He attributes the cauſe of this diſeaſe to a white grub or inſect, which he found near the root, about half an inch long, with eight or ten legs, its head brown and hard; as, upon examining a number of the curled roots, he found them all bitten, chiefly from the ſurface to the root, which of courſe ſtopped the progreſs of the ſap, and threw the leaf into a curl. The uncurled roots were not bitten. He tried a few experiments as follow: Firſt, he put ſoot to the inſects in the rows for two days; and after that, he put lime to them for the ſame time, but they ſtill kept lively: next he put a little ſalt, which deſtroyed them in a few hours. From which he infers, that if coarſe ſalt were put into the ground at the time the land is preparing for potatoes, it would effectually cure this diſtemper.

III. In this letter, the cauſe of the diſeaſe is attributed to the method of earthing the ſtems while in cultivation; and the branch, ſtriking root into the new earthed-up ſoil, it is ſaid, produces potatoes of ſuch a nature as the year following to cauſe the diſeaſe complained of.

To prevent the diſeaſe, it is recommended to take the ſets from thoſe potatoes that have not bred any from the branch covered; or, otherwiſe, to dig the part the ſets are to be raiſed from.

IV.

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IV. According to this writer, the disorder proceeds from potatoes growing in old-tilled or worn-out ground; for though these potatoes may look tolerably well, yet their sets will mostly, if not all, produce curled potatoes.

Hence he is convinced, that no sets ought to be used from old-tilled or couch-grass land; and that, in order to have good sets, they should be procured from land that was purposely fallowed for them; from fresh ley land, where they are not curled; or from ley land that was burnt last spring.

To avoid the uncertainty of getting good sets, he recommends crabs to be gathered from potatoes growing this year on fresh land free from curl, and the next spring to sow them on fresh ley land; and continue to plant their sets on fresh ley land yearly, which he is convinced will prevent the curl.

V. In 1772, this writer planted some potatoes by accident full nine inches deep: when taken up, many of the plants were rotted, and a few curled. He kept the whole produce for seed, and planted two acres with it in 1773, not quite six inches deep. The crop was amazingly great; and he did not observe any curled plants among them. In 1774, many of these were planted in different soils; yet they were so infected with the curled disease, that not one in twenty escaped. In 1775, the complaint of this disease became general. In 1776, it occurred to him that the good crop of 1773 was owing to the accidental deep setting of 1772; and that the reason why the same seed became curled in 1774, was their being set so near the surface in 1773; and attributes the disease to the practice of ebb-setting. In 1777, he took some potatoes from a crop that was curled the year before, and after cutting the

I sets,

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sets, left them in a dry room for a month. Half were planted in ground dug fourteen days before; the other half, having been steeped in a brine made of whitster's ashes for two hours, were also planted in the same land at the same time. The steeped ones came up ten days before the others, and hardly any missed or were curled. The unsteeped ones generally failed, and those few that came up were mostly curled.

He therefore advised as a remedy, 1. That the potatoes intended for next year's sets be planted nine inches deep. 2. That they remain in the ground as long as the season will permit. 3. That these sets be well defended from frost till the beginning of March. 4. That the sets be cut a fortnight before planting. 5. That they be steeped, as above, two hours in brine or lye. 6. That the dung be put *over* the sets. And, 7. That fresh sets be got every year from sandy soils near the coast, or on the shore.

P. S. At planting, the hard dry sets should be cast aside, for they will probably be curled. Curled potatoes always proceed from sets which do not rot or putrefy in the ground.

VI. This writer had five drills of the old red potatoes, and four of the winter whites, growing at the same time in the same field. The drills were prepared exactly alike. Among the red not one was curled; the winter whites were nearly all curled. He says he has found by experience, that the red never curl.

VII. Two of the writer's neighbours had their sets out of one heap of potatoes. They both set with the plough, the one early, and the other late, in the season. Most of those early set proved curled, and most of those set late smooth; the latter on clay land.

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A few roods of land were also planted with small potatoes, which had lain spread on a chamber floor all the winter and spring till the middle of May. They were soft and withered; they proved smooth and a good crop. Middle-sized potatoes, withered and soft, which had been kept in a large dry cellar, and the sprouts of which had been broken off three times, produced also a smooth good crop.

Hence he was led to think a superfluity of sap, occasioned by the seed being unripe, might cause the disease.

He concludes, the only sure way to prevent the curl is, to let potatoes intended for seed stand till they are fully ripe, and to keep them dry all winter.

VIII. This writer set a quantity of the red potatoes, without having a curled one amongst them. His method is, when the sets are cut, to pick out such as are reddest in the inside. On digging them up at Michaelmas, he mixes none of the curled seed among the others. The curled are easily distinguished, by their stalks withering two months before the rest of the crop.

The cause of the curled disease he attributes to potatoes being of late years produced from seed instead of roots, as formerly. Such will not stand good more than two or three years, use what method you please. Last spring, he set the old red and white russets, and had not a curled potato amongst them.

On the limestone land about Denbigh, in North Wales, they have no curled potatoes. If this be owing to the nature of that land, perhaps lime might prevent the disease.

IX. According to this writer, all sorts of grain wear out and turn wild if sown too long on the same

land;

land; the same will hold good in all sorts of pulse, peafe, beans, and (as he conceives) potatoes. It generally happens, that those who have most curled potatoes plant very small sets. Diseases of Plants.

Eleven years ago he bought a parcel of fresh sets, of the golden-dun kind, and has used them without change to the present year, without any being curled. This he principally attributes to his having always planted good large sets.

About four years since, he thought of changing his sets, as his potatoes were too smooth, too round, and much diminished in size. But the curl at that time beginning to be very alarming, he continued his sets till part of his crop missing last year, he was obliged to buy new sets this spring, which, being small, were curled like other people's.

He allows, that the curl has frequently happened to persons who have used large potatoes for sets; for, as all roots are not equally affected, some curled ones may be mixed with the rest.

To prevent the evil, cut your sets from clear and middle-sized potatoes, gathered from places as clear of the curl as possible; preserve them as usual till spring. If any are harder, or grash more in cutting than usual, cast them aside. He would also recommend the raising a fresh sort from the crab produced on the sorts least affected, which in Lancashire are the long-duns.

X. Set potatoes with the sprits broke off, and they will (says the writer of this letter) be curled ones; if set with the sprits on, they will not be curled. Again, take a potato which is sprit, and cut a set off with two sights: break one sprit off, and let the other stay on,

 and

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and set it; the former will be curled, and the latter will not.

When you have holed your potatoes, take them out before they are sprit, and lay them dry until you have set or sown them, and you will have no curled potatoes.

XI. This writer was at the expence of procuring sets at fifty miles distance, and where this disease was not known. The first year's trial was succesful; the year following he procured sets from the same place, but one-fifth of his crop was infected. By way of experiment, he planted sets from roots which had been infected the year before, and some of these produced healthy plants, free from all infection.

As every effect must have a cause, he supposed it might be some insect, which, living on the leaves, gave them that curled and sickly appearance, as is the case in the leaves of many shrubs and trees. But whether the insect is lodged in the old sets, and to be destroyed at the time of planting, or, proceeding from some external cause, can only be destroyed afterwards, he is not yet certain, although he has made the following experiments.

On a piece of ground that had not been dug for 20 years, he planted four rows of sets, which he knew to be perfectly clear; the drills were two feet distant, the sets one foot distant in each drill. He then planted on the same ground four rows with sets from curled potatoes, at equal distances; in each row were about 20 sets.

Lot 1st, The curled sets.

N° 1. Without manure,	N° 3. In soot,
2. In salt,	4. In quicklime.

Lot

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Lot 2d, The clear sets.

N° 1. Without manure,	N° 3. In soot,
2. In salt,	4. In quicklime.

Those planted in salt and soot in both lots were destroyed. In Lot 1st, N° 1. and 4. all curled. Lot 2d, N° 1. and 4. quite clear.

This experiment was made on a supposition that the insect lodged in the set, and must be destroyed on planting. But of that he is not fully satisfied. He repeated salt, soot, and quicklime, on the branches of several curled potatoes. Salt destroyed all he touched with it. Lime and soot had, he thought, a partial effect on the plants. After some time, they appeared almost as healthy as the rest. Thus, although he had done little towards the cure, he flatters himself he has pointed out the cause, the insects on the curled plants being not only very numerous, but visible to the naked eye.

XII. This writer ascribes the cause of the disease to the frost, and bad keeping in winter and spring before setting. They are liable to be damaged by frost after they are set; but this may be prevented by covering. If it be asked, why frost did not injure them formerly? he answers, it is only the NEW kinds which are apt to curl. To this may be added, that less care is now taken of the seed than formerly. To prevent the latter, let them remain in the ground covered with haulm or litter till the time they are wanted for setting: and, in case no frost touches them afterwards, they will be free from the disease.

XIII. This writer says, the red potato was as generally planted as the winter white and the Lincolnshire

 kidney

Diseases of Plants. kidney are now. The first, being a later potato, did not sprout so early as the others. The white sprout very early, and therefore should first be moved out of the place where they have been preserved in the winter. Instead of that, they are often let remain till their roots and sprouts are matted together. On separating them, these sprouts are generally rubbed off, and they are laid by till the ground is ready; during which interval they sprout a second time: but these second sprouts, being weak and languid, will shrink, sicken, and die; and the fruit at the roots will be small, hard, ill-shaped, and of a brown colour.

Now, if putting off the sprouts once or more, before the sets are put in the ground, be the cause (as he verily believes it is) of the curled disease, an easy remedy is at hand. When the potatoes intended for sets are dug up, lay them in a west aspect as dry as possible: in such a situation they will not sprout so soon. The best time for removing most sorts, is the first fine day after the 24th of February. Cut them into sets as soon as possible, and let them remain covered with dry sand till the ground is prepared, which should be a winter fallow. Lay the sets in without breaking off any of the sprouts, for the second will not be so vigorous. This accounts for one sprout out of three from the same set being curled. The two stems not curled rose from two later eyes, and were first sprouts. The sprout curled was a second, the first having been rubbed off.

XIV. This writer says, that last spring one of his neighbours cut and set, in the usual way of drilling, some loads of the largest potatoes he could procure; and more than half of them proved curled. Being a few

few ſets ſhort of the quantity wanted, he planted ſome very ſmall potatoes which he had laid by for the pigs. Theſe being fully ripe and ſolid, there was not a curled plant among them. He apprehends, the others being curled was owing to their not being fully ripe.

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XV. Of late years, this writer ſays, great improvements have been made in ſetting potatoes and cutting the ſets. The ground is dreſſed cleaner and dunged ſtronger. Many people, in drilling, wrap up the ſets entirely in the duug; by which means, though their potatoes are larger, the diſeaſe ſeems to be increaſed. They alſo cut their ſets out of the richeſt and largeſt potatoes, which is perhaps another cauſe of this evil. In cold countries, where they ſet their own ſeed, which has grown on poor land, with leſs dung, they have no curled plants. On the contrary, when they bought rich and large potatoes for ſeed, they have been curled in great quantities. He believes, the richneſs and largeneſs of the ſeed to be the cauſe of the evil; for he does not remember to have ſeen a curled ſtem which did not ſpring from a ſet of a large potato.

XVI. This writer apprehends the curled diſeaſe in potatoes to proceed from a defect in the *planta ſeminalis*, or ſeed plant; and from comparing curled ones with others, there appeared to be a want of, or inability in, the powers of expanding or unfolding the parts of the former; which, from this defect, forms ſhrivelled, ſtarved, curled ſtems. On examining ſome of the ſets at the time of getting the crop, he found them hard and undecayed; ſo hard, indeed, that ſome of them would not be ſoft with long boiling. This led him to think, that ſome manures might have the

Diseases of Plants. same effect on them as tanners ooze has on leather, and so harden them, that the embryo plant could not come forth with ease; but a closer examination taught him otherwise, and that they grow equally in all manures.

He thinks the most consistent and rational opinion is, that the disease is occasioned by the potatoes being taken from the ground before the stamen, or miniature plant, is properly matured and ripened,

One of his neighbours, last year, set two rows of potatoes, which proving all curled, he did not take them up; and this year there is not a curled one among them. Such potatoes, therefore, as are designed for seed, should be preserved as long in the ground as possible.

XVII. This writer advises such sets to be planted as grow in moss land; and, he says, there will not be a single curled one the first year. This is affirmed by the inhabitants of two townships, where they grow amazing quantities. A medical gentleman sowed last year two bushels of sets from one of the above places, and had not one curled; but on sowing them again this year, he had a few.

Notwithstanding there seems to be a diversity of opinions in the above writers, occasioned by the different appearances of their crops, and the seemingly contrary effects of the means used to prevent or cure the disease, we conceive that the following general propositions may be fairly drawn from the whole. 1. That some kinds of potatoes are (*cæteris paribus*) much more liable to be affected by the disease than the rest; and that what are called in England the old-red, the golden-dun, and the long-dun, are the most free from it.—2. That the disease is is occasioned by one or more of the following causes, either singly or combined: 1st. By insects: 2d, By frost, either before or after the sets are planted: 3d, From planting sets out of large unripe potatoes: 4th, From planting too near the surface, and in old worn out-ground: 5th, From the first shoots of the sets being broken off before planting; by which means there is an incapacity in the *planta seminalis* to send forth others sufficiently vigorous to expand so fully as they ought.—3. That the most successful methods of preventing the disease, are cutting the sets from smooth middle-sized potatoes, that were fully ripe, and had been kept dry after they were taken out of the ground; and without rubbing off their first shoots, planting them pretty deep in fresh earth with a mixture of quicklime, or on limestone or moss land. Diseases of Plants.

A correspondent of the Bath Society is convinced, that, whatever may be its cause, the fault itself is inherent in the seed; and has communicated the following method of avoiding it: "I made a hot-bed in the following manner (which method I have used ever since): I laid horse dung, &c. (as is generally used in making hot-beds), about 18 inches thick; over which I spread a layer of fine rich mould about four or five inches thick: upon the top of this mould I laid, in different divisions, a certain number of potatoes of various sorts, some of my own growth, and others bought from different parts, and covered these lightly over with more mould; they soon came up. I then observed which was freest from the blight or curl; for if there were not more than one defective in *forty* or *fifty*, I concluded I might set of that sort with safety. This method I have now practised near twelve years, and never lost my crop, or any part thereof worth mentioning; whilst my neighbours, who followed

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followed the old method, were frequently disappointed in their crops; and to the best of my knowledge, all those of my neighbours who have of late been persuaded to take the trouble of using the same means as myself, have never failed of success to their utmost wishes in one instance; nor do I ever think it will fail, if duly attended to. The fault being some hidden cause in the seed unknown at present, and I believe incurable by any means, at least which have yet come to my knowledge; my reason for planting my hot-beds so soon is, that if the frost hinder the first experiment, or they all prove bad, I may have time to make a second or third, if necessary, with different sorts of seed, before the proper season arrives for planting in the fields and grounds appointed for the great and general crops."

In addition to the information upon this subject, which has been obtained by means of these societies, various other speculations about the cause and cure of this disease have of late been introduced to the notice of the public *. In particular it has been strongly urged, that the disease is almost always occasioned by insects. It is said, that on looking at the roots of such potatoes as grow up curled, it will usually be found, that the bearing plant is devoured and excavated by snails, centipedes, or beetles. Sometimes also, though more rarely, the curl is supposed to arise from the leaves themselves being infected with minute animalcula. Hence, in rich soils in the neighbourhood of cities, and well manured gardens, the potatoes are most subject to the curl, because such insects as devour the seed abound most in these

* *Farmer's Magazine.*

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these soils. The insects are thought to prefer one potato to another. They will hardly touch a yam. A potato from a late part of the country, which has been hardly ripened, the vermin do not seem to like; but a potato that has been somewhat sweetened or mellowed by the frost, is supposed to be greedily devoured by them.

An ingenious notion concerning the cause of the disease has been suggested from attending to the history of the plant in this country. The potato plant was introduced into the island of Great Britain from a climate much warmer than ours, as early as the reign of Queen Elizabeth; but it is a singular circumstance, that the curled disease did make its appearance till within less than 40 years ago. Indeed *, the disease is said to have first occurred in the year 1764, in the very district of Lancashire where potatoes had been first cultivated. It is also said, that the Surinam potato, and some other kinds which have been more recently introduced into our climate, have never yet exhibited any symptom of the curl. It is farther said, that till within these 40 years the potato plant never brought its seeds to maturity in this country, though the roots were in full perfection; that the Surinam potato and others lately introduced do not as yet produce perfect seeds at the top of their stem; and that potatoes, which have been cultivated for a length of time in bleak and mountainous situations, are still in the same state, and do not bring their seeds to maturity. Hence it is endeavoured to be inferred, that there exists a connexion in the nature of the plant between

* *Transact. Soc. for Encouragement of Arts*, vol. viii.

Diseases of Plants. tween this disease and the state of maturity to which the seed is brought. It is supposed, that the plant is unfit at once to afford mature and perfect seed at the summit of its stem, and also roots capable of propagating it in perfection. From these premises it is suggested, that, to prevent the curl, it will be necessary to procure seed potatoes from mountainous situations into which the disease has not yet come, because the plant has never produced perfect fruit at the summit of its stem; or an attempt may be made to procure more perfect seed from the ordinary kind of potatoes, by destroying the flowers, which may have the effect to prevent the plant from being exhausted by bringing to maturity both fruit at its summit and roots at its bottom. Lastly, it has been supposed, upon these principles, that the disease may be prevented by rearing potatoes from the seed produced at the summit of the stem; the mode of practising which will afterwards be explained.

In the mean time, it may be observed, that the subject has been farther discussed, in a less speculative manner, by an anonymous correspondent of the Board of Agriculture *. This gentleman does not consider the curl as a specific disease, but as an accidental debility of those plants in which it occurs; that we are not, therefore, to seek for a cure or preventive in a change of seed alone, as many have all along done, but in complete attention to all that experience shows to be necessary to an accurate culture, and to their perfect growth. In this way alone, he thinks, there is reason to expect that this very useful article of human food may be cultivated

* *Communications of the Board of Agriculture*, vol. ii.

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cultivated with the same success as before its dreadful enemy the curl made such havoc in our crops, as of late years it certainly has done. He describes the disease as occurring, in Mid-Lothian, most frequently from the following causes: 1st, From planting potatoes on soils altogether unfit for them. Being unable to penetrate a stiff soil, potatoes require a light, pervious, or open mould. For a long period after potatoes first appeared in the country, this circumstance was carefully attended to. They were planted entirely with the spade, in the lightest spots upon every farm. Hence, the plants rose vigorous, and no curl was seen; but on farmers wishing to extend the culture of potatoes, they were tempted to plant them on every soil, without regard to its nature, or tendency to produce this crop. 2dly, Imperfect culture is described as a frequent cause of curling. A crop of potatoes is commonly strong, abundant, and free from curl, in proportion to the previous culture given to the soil, and the care taken to keep it clean after they are planted. Hence, it frequently happens, that while a farmer who cultivates this root in a negligent manner, and upon a great scale, by means of the plough, finds his crop deficient in consequence of this disease; his cottars and servants, to whose use he allots small portions of potato ground, which they cultivate with the spade, obtain crops free from curl, and often double in quantity to his, in proportion to the extent of ground which they occupy. 3dly, Small roots, or too small a portion cut off along with the eye, that is to serve for seed, appears to be a cause of curl. In the case of grain, it seldom happens, unless in very fine seasons, that small seed produces a large crop; and it is thought that something similar may occur in the

case

Diseases of Plants. case of potatoes. As the young plant must always derive its earliest nourishment from the root, out of which it springs, before it is capable of seeking its food in the surrounding soil, those plants, whose early growth is best supported and fostered, must be expected to reach the greatest perfection. To subject these ideas to the test of experiment, 64 sets were planted; 16 of which were full grown potatoes, 16 from small roots, in which no curl appeared when in the field, 16 from roots raised from the seeds two years before, and 16 from roots of plants strongly curled. They were all planted in the same manner, in a light soil, in parallel furrows, with a moderate quantity of dung, and covered to the depth of three inches. Of those taken from large potatoes, none were curled, and the plants were strong and healthy. Some good plants appeared in each of the other rows, but nearly a half of the whole was curled. The proportion of curled plants was rather greatest in those raised from the seed. 4thly, Sets taken from roots that have sprouted early, and from which the germs have been rubbed, are said never to fail to produce curl. 5thly, Too much, as well as too little dung, appears to have an influence in producing curl; the first probably by corrupting the germ of the young plant, the latter by not being sufficient to produce vigorous plants. Hence, attention ought to be paid to the regular spreading of dung, which ought not to be thrown about in a careless and slovenly manner, which allows some plants to have none, while others are covered with it to the depth of several inches. 6thly, Too deep, as well as too shallow planting, gives rise to the curl. To ascertain the proper depth, 12 were planted at 18 inches deep; the same number at the depth of

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16 inches, and of 14, 12, 10, 8, 7, 6, 5, 4, 3, and 2 inches; and 12 were so lightly covered, that they were not, perhaps at the depth of one inch. The sets were all from large roots, of the same crop, cut as nearly as possible of the same size. They were all planted at the same time, in the first week of April, in a light dry soil, and they all got the same quantity of dung. The plants at the depth of 1 and 2 inches appeared first; but they were weak, and some of them curled. Those at 3, 4, and 5 inches, were all strong, and free from curl. At 6 and 7 inches, they were also healthy, and free from curl; but they were three weeks later in getting above the ground than those that were thinly covered, and the plants were neither so strong, nor the roots so large. Those planted at the depth of 8 inches rose still later, and were all weak.—Nine out of the 12 were curled. Of those planted at 10 inches deep, only four appeared; and they were so weak, that they soon withered and died. Of those deeper planted, none ever appeared. On digging them up at the end of two months, those at 16 and 18 inches deep were found unchanged; while some of those at the depth of 12 and 14 inches, had put forth some feeble germs not exceeding the length of an inch. Those planted at 3 and 4 inches were evidently the strongest during the whole season, and their roots largest. Hence to procure an early, abundant, and healthy crop, 3 inches appears to be the best depth for planting potatoes. 7thly, Whatever injures the new sets or the germs afterwards may produce curl: such as the trampling of horses feet at the time of planting; their being partially covered with stones or hard clods of earth; deep harrowing, when the young shoots are advancing; and grubs,

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grubs, snails, or insects attacking the germs at first, or the stems afterwards. Hence, 8thly, The curl was produced to an uncommon degree upon a field of stiff land, by passing a roller over it, about a fortnight after planting. 9thly, The state of the weather when the crop is young may produce the curl. Rain alone will not do so, if it be not allowed to lodge; but a long continuance of dry weather, especially with cold winds, when the shoots first appear, is apt to produce this disease, and also hoar-frosts in this early state of the crop. Hence, it is thought, that the three first weeks of April answer best for planting potatoes in the south of Scotland and north of England, as they do not, in that case, appear till the middle or end of May. From all these remarks it is conculded, that, though with the best management, the curl can never be completely banished from our fields, yet with due attention to the leading points above mentioned, it may be prevented from being attended with any serious mischief.

As no information upon this interesting subject ought to be overlooked, we think it necessary to state, that the following plan for preventing the curl in potatoes has very recently been laid before the public, by an anonymous correspondent of the publishers of the Farmer's Magazine, who asserts, that he has adopted with complete success. It consists of using for seed what are called *potato beans*. These beans are a dark brown excrescence, larger than a horse bean, which grows near the ground, on the haulm or shaw, generally, it is supposed, where it has been broken or wounded. They are shaped like potatoes, and have a number of eyes, from one of which grow two small leaves. It is said, that eight or ten years ago, several

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of these potato beans were planted merely to try if they would grow, and that they produced a great number of common sized potatoes, but of a bad quality. These potatoes, however, being cut and planted next year, produced potatoes of an excellent quality, and in great plenty. Since that time, a number of beans have always been planted sufficient to produce enough of potatoes for next year's seed. They are planted at the same distance, and treated in every respect in the same manner with common sets; and their produce is equally plentiful. No other change of seed has ever been necessary.

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SECT. VIII.

OF THE OBSTACLES TO AGRICULTURAL IMPROVEMENT.

Moral and political obstacles to agricultural improvements.

BEFORE proceeding to the practical part of the subject, it may be proper to take notice of some of the moral and political circumstances which resist the progress of the art of agriculture, and which ought not to be overlooked by persons engaged, or who have an intention to engage in it.

Ignorance.

One of the first and most obvious obstacles to the improvement of this or of any other art consists of the ignorance of its practitioners, or of its being carried on by persons of an illiterate and unintelligent character, who are unable to take a comprehensive view of the principles of their profession, or who have not sufficient curiosity to inquire after the best modes of practice, or understanding to discern the value of any new prac-

Obstacles to Agriculture. tices that are explained to them. It ought never to be forgotten, that the art of the husbandman is an intricate and extensive one, and that one of the chief circumstances which has hitherto prevented its improvement has arisen, as already mentioned, from the secluded situation of persons engaged in it. They are scattered over the face of the country, instead of being collected together like other artists in towns, so as to be enabled to derive aid from each other's experience. Fortunately this difficulty is passing away, in consequence of the diffusion of agricultural knowledge, by means of the great number of publications upon that subject which are gradually introducing themselves into the remotest corners of the country. Persons receiving a liberal education, particularly at the university of Edinburgh, have now also an easier opportunity than formerly of acquiring a knowledge of the principles of this art, in consequence of the establishment of a professorship of agriculture, which has been endowed by a private gentleman, Sir William Pulteney. Even with all these advantages, however, aided as they are by the exertions of the Board of Agriculture, it can never be expected that this art can reach its ultimate degree of perfection, unless a considerable number of the persons engaged in it are men of intelligent characters and good education, who will call in the improvements which are making in other sciences as well as in this art, in distant countries, to the assistance of their personal experience.

In speculation, at least, nobody will deny the utility of general knowledge towards success in this profession; as it is evident, that nothing excellent can be accomplished by a very ignorant person in agriculture

more

more than in any other art. It has unfortunately happened, however, in some quarters of the country, that the introduction of agricultural improvements has, for some time been delayed, in consequence of the unsuccessful efforts in this department of business of some men otherwise accounted intelligent, who had rashly engaged in husbandry. Men of fortune, when they engage in this or in any other undertaking, are apt to disregard expence when a favourite object is in view, and are unwilling to leave any thing to nature or to time. Hence they introduce costly implements of husbandry, and laborious modes of cultivation, upon a rude, and perhaps upon a poor soil, in a cold and unsheltered situation. Having lavished away much money to little purpose, they become disgusted, and abandon the pursuit of agriculture as unprofitable; and thus their example comes to be regarded by the ignorant as a warning to avoid every kind of novelty; which necessarily puts an end to improvement, because all improvements are new.

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Such occurrences, however, only establish the truth of the maxim, that a little learning is a dangerous thing; a partial knowledge of agriculture leads to hasty schemes, sanguine hopes, and rash undertakings; whereas a correct acquaintance with the nature of a soil, the climate in which it is situated, the market which its neighbourhood affords, and the expence of rearing and bringing thither certain crops, leads to moderate and rational views, and to slow but sure success. This remark naturally introduces the consideration of a point of much importance both to individual husbandmen and to the general improvement of the art; which is, that every person engaging in the profession of a husband-

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man, ought to be well instructed in the best mode of keeping regular accounts of his affairs, and ought never to neglect, any more than a man engaged in commerce, to keep a correct arithmetical record of all his transactions, and of his profits and losses. The want of attention to this point has hitherto been one of the greatest causes of the slow progress of the art of agriculture, and also of the want of success of many individuals in the practice of it. This subject is so well discussed in the Annals of Agriculture *, that, although it is a long quotation, we account ourselves justifiable in inserting it in this place.

Importance of regular accounts.

"There is not a single step," says this judicious writer, "in the life of a farmer that does not prove the advantage of his keeping regular accounts; and yet there is not one in a thousand that keeps any. This is one, among the many instances, in which the unenlightened situation of the practisers of the art is the evident reason for the backwardness in which the art itself is found by any man who searches for the principles deduced from practice, which ought to give it the regularity of a cultivated science.

"A few rough memoranda or figures, to yield a gross account of the general receipt or payment, are usually the greatest exertions that common farmers, who pretend to keep accounts, make in this line.

"The advantages of clear accounts are obvious in every other pursuit in life: and to conduct those of a merchant, by the Italian method of double entry, has been an essential branch of education for the classes intended

* Vol. xxviii.

tended for commerce. Men engaged in large ſpeculations who are not regular in their accounts, are always ſuppoſed, by the prudent part of the world, to be in a dangerous ſituation; nor is there a greater reproach to a merchant, ſhort of actual bankruptcy.

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" But agriculture is deſtined to be, in all its detail, an exception to every thing elſe. Men engage in it without previous education, or even ſtudy or inquiry; and they conduct large concerns in it without thoſe accounts known to be neceſſary in every other purſuit. With the loweſt and moſt uneducated farmers this is pardonable; but what excuſe have gentlemen for ſuch a conduct?

It ſhould be remembered, that experimental agriculture, or even theſe ideas, more or leſs detailed, which we meet in converſation, muſt depend for their juſtneſs very much on the accuracy of accounts. For a ſuppoſition deduced from general obſervation on a farm, and groſsly conceived, muſt fall exceedingly ſhort for correctneſs of the regular detail of exact accounts.

" The general fact is however admitted, and accordingly it is common to hear gentlemen ſpeak of their accounts. But, unfortunately, they are uſually kept in ſuch a manner as to prove rather the means of fortifying prejudices than removing errors. All thoſe queſtions of nicety where the contraſts are not exceedingly ſtrong, relative to the comparative profit of different ſoils, of different courſes, of different applications of the ſame ſoil, of different modes of culture, &c. depend entirely on accounts. Keep your accounts in the mode of one man, graſs is more profitable than tillage; keep them in a different method, and the contrary ſhall be the reſult. The variety in the mode of

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keeping these accounts is very great, and even among gentlemen of considerable attention, carefulness, and accuracy.

" This comes from the great and undoubted difficulties which rise in a thousand forms, whenever an attempt is made at positive accuracy. They are not imaginary, but real difficulties, and such as will demand a very considerable attention to obviate. I have reflected on the subject for many years; and they are few in which I have been satisfied with my approach towards accuracy. For while there are distinctions that must everywhere be kept up, there are many minutiæ that must be sacrificed, in order to render the account tolerably easy to keep without an attention that a man in an active line of life cannot give. To keep to this medium is the great difficulty.

" The nature of the farm must in some instances regulate the mode of the accounts. Suppose a man has the evil of an open field, or with scraps and bits of land scattered among his neighbours; in such a case it is impossible for him to keep an account for every field: and yet this is one of the most indispensible points that in general must be adhered to; for he who does not know what every field has paid him, is deficient in the very foundation of experience. In this light all little fields on a large farm are nuisances; they derange accounts entirely if the greatest attention is not paid, and they are as inconvenient in cultivation, and attended with as much loss in headlands and borders, as they are ruinous to any exactness of account.

" But as many persons keep accounts without attending to this point, I would observe, that when all the wheat, all the barley, all the oats, &c. are respectively

tively thrown together, ſome very eſſential objects of experience depend on gueſſes which ought to be aſcertained correctly. Has fallow, or clover, or beans, paid beſt, as preparations for wheat? How is that queſtion to be anſwered if all are huddled together in one barn or ſtack, and meet in the ſame account? *The farmer can gueſs nearly.* He may: but go to a chemiſt, a phyſician, or a mathematician, and aſk them if their ſciences were puſhed to their preſent perfection by accepting ſuch gueſſes inſtead of experiment? Beſides, they are in their nature quite uncertain; and when a compariſon is formed by two gueſſes, a very little error in each will amount to ſo much in both as to overturn all authority. Another point is, a man's gueſs being influenced by a favourite theory: a rigid friend to fallows, when he draws, by gueſs, a compariſon between them and beans, will be apt, in the nature of things, to be partial: he ſhould not put himſelf in the ſituation. He who would abhor the idea of falſifying a fact that is before him, might gueſs, at leaſt, without ſufficient accuracy. Obſtacles to Agriculture.

"If the fields are not very ſmall, the inconvenience of keeping crops ſeparate is little. Stacking corn is by far better underſtood and executed in the iſle of Wight than in any other part of the kingdom: a great ſtack is rarely to be ſeen there; a farmer that has 500 acres of corn, has none but ſmall ones. With ſuch, accounts are kept ſeparate with great facility; at leaſt, if there there are difficulties in it, there are others we ſhall meet with abundantly greater.

"To ſow one field with ſeveral crops at the ſame time, part wheat, part clover, &c. is very bad and inconvenient management, and ought to be avoided, were

 accounts

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accounts out of the question. If it cannot be shunned they must necessarily be more complex.

"The first object in keeping accounts is to ascertain the expences in order to divide them properly—Rent, tythe, and parish taxes.

"These articles demand three accounts to be kept separate; but they are all to be arranged on the same principle. The amount of the two last, when known, which is at the end of the year, must, like the rent, be divided over every field for which an account is kept: this is very easy when the measure of the fields is known. I need not observe, that the farmer in dividing the rent should do it as exactly and as fairly as possible, and that the two other articles should be proportioned to the rent.

"But here occurs one difficulty, which is, I confess puzzling. It is the difference between the gross and the neat measure of the fields of an inclosed farm. The hedges, ditches, and borders, take up in many farms a considerable portion of the field; from an eighth to a twelfth; and in some even more. Now if they are reckoned, and accounted for as part of the field; then the acreable produce is affected, and even the profit of the husbandry, by a circumstance not essentially connected with it; and if two fields are compared in their husbandry, that may be most advantageous which has least border, and for that reason; which would derange a comparison entirely. I know but one way of getting rid of this difficulty, which is, to measure the neat contents where the plough goes in an arable field, and where the scythe goes in a grass one; and then deducting the total of those measures from the gross contents of the farm, throw the difference into one account by itself

itself under the title of fences and borders; to which account must be charged the proportion of rent, tythe, and parish taxes. If wood is cut or grubbed from these borders, or grass is mown from them, the value of the wood or hay to be credited; the expence of the fences to be charged; and the balance of the whole, for it may everywhere be expected to prove a losing account considered as the expence of fences and acreably, divided over the whole farm, like rent, tythe, or parish taxes. The only person who ever had an attention to this accuracy was Mr Baker, experimenter to the Dublin Society. He published a map of his farm, with the gross and neat contents of every field. For want of observing this precaution, many experiments have been made, and many conclusions drawn which are mere errors.

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" *Sundry expences* may be the title of an account which must have place on every farm. Whatever payments concern the farm in general, and not any field or object in particular, and are not included in the preceding articles, must be entered under this title. Instances are, a bailiff's salary, payments to rat or mole-catchers, mending roads upon the farm, expences at market, &c. &c.

" *Wear and tear* includes all payments to blacksmith, carpenter, wheelwright, harnessmaker, &c. But in the division of this article there must be a variation from the preceding: they are divided over the whole farm; but these must be proportioned differently; the arable lands will absorb the greatest part of these expences; mowing grass very little; and feeding grass still less. But to avoid any arbitrary estimation when a rule can be established; the proper mode of dividing this

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this expence per acre will be by making the expence of the teams a rule for it; to find how much per cent. or in the pound of the team-account, this expence of wear and tear amounts to, and charge it accordingly.

"The team-account is that which is in general more miſtaken than any other on a farm. Nothing is more common than every day to ſee accounts in which ploughing is charged at 4s. an acre, or at 5s. or at 10s. or whatever may be the hiring price of the country; but few words are neceſſary to ſhew that this is entirely fallacious; it is probably much under the real expence. Every practical farmer muſt know that the way to have cheap tillage is to keep the teams well employed: when a man's own work is done, his team ſtands ſtill, if he does not employ it for his neighbours; to do which, he will work for them below the value, and yet find ſome advantage in it. In conſequence of ſuch a conduct being common, to ſay that ſuch is the price of tillage can never be accurate. It has by no means that beſt accuracy of *price*, becauſe you cannot buy your commodity when you want it; and he who depended on the market for all the work of his farm would ſoon find the ſtate of his fields calling for a very different ſyſtem.

"The means of aſcertaining the real expence of all team-work is very obvious; but depends totally and abſolutely on accurate accounts. So much in ſummer for their green food; ſo much hay and oats eaten; ſo much for ſhoeing and farrier; ſo much for the actual decline of value; and ſo much in labour for attendance, give the real expence of the team. In order to divide this total expence among the work executed, a day-book is neceſſary, which a man may keep himſelf, or truſt to his bailiff,

bailiff, as he pleafes. It muft contain the work of the teams and men every day in the year, fpecifying the field or bufinefs they are employed in. At the end of the year the amount of the expence is proportionally divided among the work, and the cleareft truth and correctnefs are neceffarily the refult. Obftacles to Agriculture.

"I ought to obferve, that this accuracy is very defireable for afcertaining various circumftances. The comparative profit of grafs and arable land depends much on it. Some perfons, from too lightly eftimating the expence of teams, think arable the moft profitable; and others, whofe calculation of thofe charges runs perhaps too high, give too much into the counter opinion. I can eafily conceive that many ftrenuous advocates for fallows might lofe a little of their warmth, if they knew what the expence of ploughing an acre of land really was on their farms. Such inftances might be multiplied; they are indeed obvious to every man capable of uniting the theory with the practice of a bufinefs.

"The article of manure is much more complex; and, upon the whole, the moft difficult account there is for a farmer to keep. It muft be arranged under the title *farm-yard;* and it connects with fo many objects, that no little care is neceffary to keep it, and with the greateft attention fome doubts will ftill remain.

"Suppofe the fyftem to be that of carting a ftratum of marl over the yard before foddering begins; that expence is to be afcertained at once without any difficulty; but how is the ftraw to be charged? cattle may be put out to ftraw in this country at 9d. a-week, and fome at 6d. At thefe prices a ton will pay about 5s.; but while the cattle may be thus fupported, the farmer

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may buy straw with a view to the dung at 15s. and 18s. and even 20s. a ton. This account is difficult to settle. The price per week is arbitrary though [illegible]; we take them at those rates, because they have none or not enough of their own; and it is not ascertained as the value which cattle will really pay for the ſtraw, which may be more or may be leſs. The whole is uncertain.

"*But with the ſtraw of one's own crop there is a double* difficulty, becauſe *there* muſt be two valuations inſtead of one. We muſt reckon ſo much an acre or load for it, and ſo much a week for the cattle that eat it; but both are ſuppoſitions. Among counter objections one muſt chooſe the leaſt. The beſt method perhaps is to charge the *farm-yard* account with the price of the ſtraw, at which it could be ſold, deducting the expence of carrying it out; and to credit the ſame account with the price per week of keeping the cattle; which price is charged to the debtor ſide of the cattle account, as part of the expences of keeping them. Whatever labour is beſtowed on the dung, in ſhovelling and cleaning yards, throwing up the urine, turning over, &c. is charged of courſe to it. When the whole is carted on the land, the total expence is divided by the number of loads, and the price per load aſcertained. It is charged the year following (as the time conſumed will make that delay neceſſary) to the account of the fields on which it is ſpread; and though the whole advantage is by no means exhauſted by the crop, yet the whole expence muſt be charged to the crop that receives it, or the accounts would be kept open ſo long as to create confuſion.

"The time of balancing the books every year ſhould be that of entering the farm. This is moſt uſual at Michaelmas, but the crop of the year is not then diſpoſed of.

of. To avoid valuations which ought never to be relied on when certainty can possibly be gained, the old year's accounts are to be kept open long after the new year's ones are begun; that is, till the corn is all threshed and sold, till the fatting beasts are gone, and till all these circumstances are decided which relate to the preceding year. This is essential to exact accounts, and can by no means be dispensed with. In this case, valuations may be totally rejected; but there are others in which no management can exclude them: these are, in *live stock* not bought and sold within the year, and *implements*.

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"A man may stock his farm with cows at 10l. a piece; but if he supposes them some years after to be worth the same sum, he will grossly deceive himself. He must value them every year, and also the young stock which he rears with a view to keep up the number or for sale; and the rule by which he should make the valuation ought to be the price they would sell for at the moment. The same management must direct him with succession beasts, bought or bred for fattening, and also with a flock of sheep. On which last head I must observe, that the want of keeping such accounts as I am describing, is alone the reason for a difference of opinion relating to the profit of sheep. Can any thing be a clearer proof of the barbarity of accounts as they are kept at present by stock-masters, than the surprising question once in agitation among them, whether they gain or lose by their flocks, a question that has arisen from Mr Macro's paper on that subject published in this work. Such uncertainty could not obtain if farmers kept regular accounts. The description of the profits of a flock not being properly a calculation, but an account,

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account, it ought to be transcribed from a man's private books. Unfortunately they are kept in such a manner that difficulties multiply at every step in the endeavour to understand them.

" Implements must all be valued every year; and the balance, being the expence, carried to the wear and tear account which it makes part of.

" One of the most complex and difficult accounts, if not the most so of all, is that of grass lands fed; it involves itself with cattle of all kinds, with hay, with the team, &c. and in such a manner as to make an accurate separation very difficult. How is the value of the feed to be calculated? If 2s. a week for a cow or bullock, or 3d. for a sheep is charged, it is merely arbitrary. Mr Macro has shewed us, by his grazing account, that such estimates are to the last degree fallacious. They imply profits, but allow nothing for losses. On the other hand, if the actual profit or loss on the live stock be made the product; in that case, the grass land must be made a mere cattle account. There are obvious objections to this; but it is, upon the whole, much less objectionable than a valuation per week, which must, in the nature of it, lead to nothing but error. On this principle the account must be kept in the following manner.

" One account opened for *mowing ground*, in which the rent, tythe, taxes, and all expences in one total for every field mown, are carried to this account; and the credit of it to consist of the value at the market price, (carriage deducted) of the hay mown as delivered to the team, fatting beasts, cows, sheep, &c. which several accounts are debited with their respective consumptions.

" But the fields which are mown have also an after-

2 grass,

grafs, which is fed; this muft of neceffity be valued at fo much an acre, and charged to the account of the *feeding ground.* There is no choice in this cafe, for any other mode would create confufion.

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" That account of *feeding ground* comes next. All the total debits of the fields fed muft be carried to it. The credit fide to confift of the food of the teams charged at the price per week, fuppofe 2s. and of that of any cattle taken in to joift. Thefe articles afcertain themfelves, but thofe which refult from profit on ftock kept are not fo eafily difcovered.

" There is further a *fheep* account, a *dairy* one, and another for *fatting beafts.* In thefe are to be charged all the expences peculiar to thofe articles,—fhepherds wages, hurdles, market expences, &c. to the fheep; dairy fed, fuel, ftraw yard, &c. to the cows; and the purchafe money of lean ftock to fatting beafts.

" Here, therefore, at the end of the year, lies open before the accountant, five or fix or more unfettled accounts, not one of which can be clofed but by reference to each other. Hence arifes the great complexity of the farmer's accounts; but amidft this apparent confufion, order muft be made to arife, or all our labour is vain.

" Further, the fatting beafts are put to turnips: the cows have turnips, the fheep have turnips; how is this to be accounted for? This creates a new difficulty, but we muft examine the beft mode of clearing it.

" If the cattle-account is charged with the prime coft of the turnips, that is, with the expence of cultivating them, it will by no means be fair, for the expence is ufually greater than the value; and a man may in a turnip country buy them cheaper than he can culti-

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vate them: he submits to a known loss, because he knows he will be more than repaid in the barley that follows them; but to transfer this loss to the cattle, would be unfair. The plain way of proceeding, therefore, is to value the turnips at what they would sell for, and to debit the cattle-accounts with their respective consumptions. But there are two prices of turnips: one for carrying the crop on to another man's land; the other, for eating them in the field. The latter ought to be the rate chosen on this occasion, charging the cattle with the labour and expences of carriage.

"That there is a complexity in this mode of arranging the accounts of live-stock is beyond doubt; but after the steadiest and most reflected attention that I have been able to give it, I can see no mode of simplifying it. Submit to the rules here laid down, and you have the satisfaction of all the accuracy that is attainable; but in any other method it will remain unknown, whether the profit or the loss belongs to the land or to the stock that feeds upon it.

"I am clear this method will be rejected by those who only read this paper in a common transitory manner, without studiously examining all the points on which the arrangement depends; but to such as will reflect on what they read, and give the due attention, I have little doubt but this method will appear the only clear and satisfactory one.

"When so much profit is actually made, to divide it by a weekly account to the fields that fed the stock, is making an easy calculation with full data before you; but to charge the stock with so much per week for feeding certain fields when you do not know but the account of ſtock may be loſs, not profit, is calculating without any better data than mere ſuppoſition. Obſtacles to Agriculture.

"Such are, I apprehend, the principal difficulties in keeping the accounts of a farm. I do not offer the mode as one that obviates all objections. I do not conceive it poſſible to obviate all; but I think that fewer ſources of inaccuracy will be found in it than in any other."

A ſecond obſtacle to agricultural improvement, conſiſts of the poverty of the huſbandman, or of his want of capital, to enable him fully and completely to labour the ſoil, and provide materials for its amelioration. Complaints have often been made with little reaſon, of the obſtinacy of farmers, and of the tenacious manner in which they adhere to old practices, though demonſtrated to be improper: But a poor man cannot afford to make experiments, or to hazard the loſs of a crop for the chance of obtaining a more valuable one by ſome untried practice. In conſequence of want of capital, large portions of territory remain in ſome parts of the country in a ſtate of nature, and conſequently unproductive, both to the occupier and to the proprietor. Both landlords and tenants, therefore, ought to know, that a man who engages in agriculture without a ſufficient capital takes up a bad trade, in which ſomething may be loſt by both parties by the deterioration both of the ſoil and of the ſtock upon it, but from which neither the public nor themſelves can derive profit. Poverty of huſbandmen.

It is difficult to point out the preciſe extent of capital which a man ought to poſſeſs, to entitle him to engage in agriculture. This muſt neceſſarily vary according to the circumſtances and ſituation of particular diſtricts; and we can only propoſe here to ſtate the general prin-

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ciples which ought to be under the view of a man of sense, while considering this important question. We need say nothing of the necessity which is incumbent not only upon the husbandman, but upon all persons engaging in commerce, manufactures, or any other employment, to make provision for the first outlay of stock and expence of labour necessary to be encountered before the profits of the business enable it to support itself. We pass over this original expence, because it has nothing peculiar to agriculture, and because its amount must depend upon the extent of the farm occupied, and the manner in which it is to be cultivated. To these last points only, therefore, we shall request attention.

A man about to engage in agriculture ought to possess sufficient capital to enable him to occupy a farm of such size, as will put it in his power to do justice to himself, while, at the same time, he does full justice to the soil of which he obtains possession: that is to say, he ought, in the first place, to have sufficient funds wherewith to stock and labour a farm of such magnitude, as will sufficiently occupy his whole time. If his farm be so small as to leave him unemployed for weeks or for months during the year, he can only be said to be a farmer at a time, or occasionally. At other periods he is either a man without a trade, that is, an idle man, whose existence is so far useless to himself and to the community; or he must engage in other employments, which will withdraw his attention from his principal business, and so far diminish the interest he takes in its success, as to render it far less likely to prosper in his hands than it otherwise would have been.

A person proposing to engage in agriculture ought not to evade the objection against too small a farm, by

proposing

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proposing to labour himself like one of his servants. A man of good education, which a farmer ought to be, misemploys his faculties when he engages in the constant drudgery of manual labour; nor will he be qualified to fulfil properly the duties of his situation, if he occupy himself in this manner. Farming is a liberal art, and consists in appointing and in superintending labour; in keeping a record of its result, and in devising means for laying it out hereafter to better advantage. Were the farmer to hold his own plough, and perform other menial services, he could not have time to make observations, to think, to read, to go to markets, to meet with his neighbours, to ride through the parish, and county, and neighbouring counties. Farming is the most difficult of all the arts; and, as already mentioned, nothing has retarded its advances so much as one farmer not knowing what another is doing at a distance from him. It is by no means here insinuated, that a farmer ought to be ignorant of labour or averse to it. On the contrary, he ought to be able to hold the plough, to reap, to build and stack, and to perform every other agricultural operation. He ought not only to be qualified to perform these operations, but he ought actually to engage in them with alacrity upon every press of business, not only for the sake of having the work done, but to render the labour in which they are employed respectable and important in the opinion of his servants, and to induce them to proceed in it with cheerfulness and vigour, which his example will have no small tendency to accomplish. The general rule, however, with regard to a farmer's situation is this, that he ought to be regarded as the superintending head of a manufactory requiring more vigilant attention than other manufac-

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tories; because the business from its nature cannot be conducted in a mechanical train, but requires a change of operations and management according to the variation of seasons and circumstances. If a man have not sufficient capital to enable him to occupy a farm which will place him in such a state of continued superintendence, it is evident that he does injustice to himself, and throws away his time by engaging in such a profession.

At the same time it is to be observed, that a man acts very improperly, who attempts to occupy a larger farm than his capital will enable him to manage with propriety and success. The perfection of agriculture consists, in ordinary cases, of labouring the soil by the most perfect and frequent tillage, and of enriching it by large quantities of manure. With regard to the former of these, it evidently cannot be accomplished, without obtaining, at whatever price they may cost, the best horses, the most skilful farm servants, and the best ploughs or other instruments of husbandry. An extraordinary outlay of money is also sometimes necessary. It frequently happens that a soil is in a state unfit to produce valuable crops, which might nevertheless, by an expence which it would amply repay, be speedily rendered extremely fertile; as in the case of lands that require to be drained, or of lands so situated as to admit of a stream of water being periodically poured over their surface. It is evident, that a man commits a crime against society who attempts to farm such lands, without possessing sufficient capital to enable him to do them justice by introducing these improvements.

With regard to the importance of repairing the exhausted

hausted powers of the soil by abundance of manure, and of the necessity of a farmer possessing sufficient capital to enable him to do so, too much cannot possibly be said. Nature is extremely grateful for every care bestowed upon the soil in this respect: not only does she repay with manifold interest on ordinary occasions every expence of manure, however profusely laid out, but she even places the agriculturist who acts liberally in this way, in some measure beyond the reach of fortune. In calamitous seasons, when nations suffer in consequence of sterility, the farmer whose lands are in excellent condition, by being richly manured, seldom fails to reap two-thirds of his usual crop, for which he receives perhaps three times the ordinary price; while other husbandmen, possessing less skilful industry or less capital, have to regret the total unproductiveness of their fields.

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The expence of providing manure may be different in different situations. In the neighbourhood of great cities it may amount to nothing more than the sum that is paid for it; but at a distance from these it becomes necessary for the farmer to be at the expence of purchasing, perhaps at a very high rate, a large stock of cattle, and to rear suitable crops of turnips, &c. for their food, that he may be enabled to enrich his lands by their dung. It may indeed be justly said, that in proportion to the quantity of cattle thus kept on a certain extent of soil for the purpose of renovating its fertility, and enabling it to produce heavy crops of grain, may the perfection to which the agriculture of any country has attained be fairly estimated.

In short, it is only by men possessing a considerable capital, that agriculture can be improved or carried on

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in ſuch a manner, as to bring any portion of ſoil to its utmoſt degree of fertility. What Arthur Young, Eſq.* has ſaid of ſmall farms and ſmall farmers applies, in truth, to farmers deſtitute of ſufficient capital. "Let me demand of the advocates for ſmall farms," ſays this writer, "where the little farmer is to be found who will cover his whole farm with marl, at the rate of 100 or 150 tons per acre; who will drain all his lands at the expence of two or three pounds an acre; who will pay a heavy price for the manure of towns, and convey it 30 miles by land carriage; who will float his meadows at the expence of 5l. per acre; who, to improve the breed of his ſheep, will give 1000 guineas for the uſe of a ſingle *ram* for a ſingle ſeaſon; who will give 25 guineas per cow for being covered by a fine bull; who will ſend acroſs the kingdom to diſtant provinces for new implements, and for men to uſe them; who employ and pay men for reſiding in provinces, where practices are found which they want to introduce on their farms? At the very mention of ſuch exertions, common in England, what mind can be ſo perverſely framed as to imagine, for a ſingle moment, that ſuch things are to be effected by little farmers? Deduct from agriculture all the practices that have made it flouriſhing in this iſland, and you have preciſely the management of ſmall farms."

We may farther mention, that a farmer ought to poſſeſs ſufficient capital, or ſufficient credit, to enable him to retain in his poſſeſſion his crop during ſix or eight months after it is reaped. It is neceſſary, both for his own

* *Travels into France*, vol. i.

own intereſt, and for the intereſt of the public, that he ſhould have it in his power to do ſo. He himſelf cannot poſſibly expect to receive the beſt prices, nor conſequently to obtain the juſt profit which ought to reſult from his profeſſion, if he is under the neceſſity of inſtantly bringing to ſale the produce of his farm, without being able to wait for the beſt ſtate of the market. In a country in which commercial ſpeculations are prevalent, it is extremely neceſſary, that farmers ſhould be able to keep back their grain for a time from the market, for the ſake of protecting the public againſt the combinations of monopolizing ſpeculators. Farmers themſelves are always too numerous a body to be able to injure the public by improper combinations to raiſe the price of grain; but if they were in general needy men, under the neceſſity of bringing their produce to market at the concluſion of the harveſt, there would exiſt no means of preventing combinations of monied men from obtaining at all times a complete command over the price of proviſions; and producing an artificial ſcarcity by buying up the grain.

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A third obſtacle to agricultural improvement ſometimes ariſes from the poſſeſſor of the ſoil not having a ſufficient intereſt in it. In barbarous nations, lands are often poſſeſſed by communities as an undivided property, without any individual member having an excluſive right to a particular ſpot. In ſuch caſes, the worſt kind of agriculture muſt always prevail; for the ſame reaſon that public affairs are always worſe managed than the affairs of private perſons, who find their induſtry ſtimulated not merely by a ſenſe of duty, but by the influence of avarice, and of all the other ſelfiſh paſſions. Conſiderable portions of territory in Eng-

Want of intereſt in the ſoil.

 land

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in all probability with bad temper on the part both of the landlord and tenant; the one endeavouring to enforce, and the other to evade, the ftipulations of the contract. The temptation is indeed, fo great, to exhauft a foil during the laft years of a leafe, that it becomes neceffary to the intereft of the public and of the landlord, that the mode of cropping fhould be regulated during thefe laft years. Beyond this point, however, a man of fpirit engaging in agriculture, ought not to fuffer himfelf to be fettered, but ought to fecure for himfelf an opportunity of making ufe of whatever additional improvements his art may receive, either from the enterprifes of others, or from his own increafing fkill and experience.

Under the fame head of a want of proper intereft in the foil, may be enumerated the payment of tithes, of which in England every farmer fo grievoufly complains. Whatever money the hufbandman may there lay out in improvements, is not expended for himfelf; as the proprietor of the tithes is entitled to draw a fhare of the whole additional increafe, and thus becomes a partner in the profits of the enterprife, without running any rifk of lofs by its failure. The odium of this tax, is faid to induce great numbers of hufbandmen to continue their lands in pafturage, to the no fmall detriment of the public, from the comparative unproductivenefs of human food, which attends that mode of occupying the foil. Fortunately in Scotland this evil has been removed, by the wifdom of our forefathers, as every landlord poffeffes the privilege of obtaining his tithes to be fixed at a fettled rate of payment for ever; and, in many cafes, of having his lands altogether

ther diſburdened, upon payment of a very moderate price.

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Want of reſpectability of the profeſſion.

The progreſs of the art of agriculture in Europe was long retarded by the want of reſpectability which attended it, when engaged in as a profeſſion or trade from which profit was to be derived. In the feudal times, the military profeſſion was the only employment in which a layman of liberal education could reſpectably engage. Agriculture, the only art which is abſolutely neceſſary to the exiſtence of man, was regarded with contempt, and left in the hands of the meaneſt of the people. Even the moſt ordinary mechanics were conſidered as ſuperior to perſons whoſe employment it was; becauſe the mechanic, reſiding in a town, and uſually under the protection of the prince, was ſafe from the dominion and the inſults of the petty chieftains that ruled in every part of the open country. The ſtate of affairs is now greatly altered in this reſpect: More enligtened views, and a better ſtate of ſociety, have reſtored to the profeſſion of agriculture the reſpectability which naturally belongs to it. It muſt be acknowledged, however, that the recent improvements which have taken place in the art, have contributed not a little to this change in the ſentiments of mankind concerning the perſons occupied in it. It is now found, that a man may become rich by agriculture, and that there are few better ways in which a prudent and induſtrious man can lay out a moderate capital. In a commercial age, the path that leads to wealth is always reſpected and accounted honourable, and accordingly it is now not unuſual for the ſons of Britiſh noblemen, and gentlemen of extenſive fortunes, to become apprentices to farmers.

The

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Defective legislation.

The last obstacle to agricultural improvements, of which we shall take notice, arises in some countries from the want of judicious legislation, or proper arrangements made by the public in its favour. The produce of the art of the husbandman, and the manures for which his lands have occasion, are all bulky commodities, which cannot be transported without labour and expence. Unless care is taken, therefore, to prepare and maintain good roads throughout the country, the profits of agriculture must always be subjected to such deductions as will greatly retard its prosperity. In the same manner, if the state, from any narrow policy, shall prevent the husbandman from bringing his goods to the best market, by exportation or otherwise, it is impossible that his art can flourish. In former times, nations were afraid to permit the exportation of grain, even in seasons of plenty, lest they should be left without food, not considering that the surest mode of producing abundance of any commodity consists in offering, at all times, a good price for it. This error is now rectified in most nations; and at all events, in the present state of affairs, the British husbandman has no reason to complain, as the grain reared in this country is, even in the best seasons, understood to be inadequate to afford subsistence to its inhabitants.

PRACTICE

PRACTICE

OF

AGRICULTURE.

THE practice of agriculture naturally divides itself into three parts: 1st, The cultivation of vegetable food for men and animals; 2dly, The cultivation of vegetables, ſuch as flax and hemp, which are more properly articles of commerce; and 3dly, The rearing and management of animals. To theſe we ſhall add, as connected with all the branches of agriculture, a ſhort deſcription of the moſt uſual modes of fencing and encloſing lands for cattle and other objects of huſbandry. Diviſion of the ſubject.

PART

PART I.

OF THE CULTIVATION OF VEGETABLE FOOD.

Cultivation of vegetables divided into four branches.

WE ſhall conſider this branch of the ſubject under four diviſions. In the firſt we ſhall preſent to the reader a ſtatement of the moſt uſeful inſtruments of agriculture. 2dly, We ſhall ſtate the mode of preparing land for cropping, by removing the phyſical obſtructions to agriculture, and reducing the ſoil into a proper ſtate. 3dly, We ſhall explain the culture of particular plants, and the practices of huſbandry connected with it; and, laſtly, We ſhall ſtate the principles and operations of the horſehoeing or drill huſbandry.

SECT. I.

INSTRUMENTS OF HUSBANDRY.

THE inſtruments employed in agriculture are various; as the plough, the harrow, the roller, &c, which are again diverſified by various conſtructions adapted to particular uſes.

1. *Of Ploughs.*

The plough

The plough is a machine for turning up the ſoil by the action of cattle, contrived to ſave the time, labour, and expence, which, without this inftrument, muft have been employed in digging the ground, and fitting it for receiving all forts of feeds. Inftruments of Hufbandry.

Amidft all the varieties which can occur in the manner of ploughing the ground, arifing from difference of foil, local habits, and other caufes, there is ftill a famenefs in the tafk which gives a certain uniformity to the chief parts of the inftrument, and fhould therefore furnifh principles for its conftruction. There is not, perhaps, any invention of man that more highly merits our utmoft endeavours to bring it to perfection; but it has been too much neglected by thofe perfons who ftudy mechanics, and has been confidered as a rude tool, unworthy of their attention. Any thing appears to them fufficient for the clumfy tafk of turning up the ground; and they cannot imagine that there can be any nicety in a bufinefs which is fuccefsfully performed by the ignorant peafant. Others acknowledge the value of the machine, and the difficulty of the fubject; but they think that difficulty infuperable, becaufe the operation is fo complicated, and the refiftances to be overcome fo uncertain, or fo little underftood, that we cannot difcover any unequivocal principle, and muft look for improvement only from experience or chance. an inftrument of the greateft value,

But thefe opinions are ill founded. The difficulty is indeed great, and it is neither from the ignorant farmer nor the rude artift that we can expect improvement. It requires the ferious confideration of the moft accomplifhed mechanician; but from him we *may* expect improvement. We have many data: we know pretty diftinctly what preparation will fit the ground for being the proper receptacle for the feed, and for fupporting and nourifhing the plants; and though it is, perhaps, impoffible and may be improved.

Instruments of Husbandry.

impoſſible to bring it into this ſtate by the operation of any inſtrument of the plough kind, we know that ſome ploughs prodigiouſly excel others in reducing the ſtiff ground to that uniform crumbling ſtate in which it can be left by the ſpade. The imperfections of their performance, or what yet remains to be done to bring the ground to this ſtate, is diſtinctly underſtood. It ſeems, then, a determinate problem (to uſe the language of mathematicians), becauſe the operation depends on the invariable laws of mechanical nature.

The taſk it performs.

It will therefore be very proper under this article, to aſcertain, if poſſible, what a plough in general ought to be, by deſcribing diſtinctly its taſk. This will ſurely point out a general form, the chief features of which muſt be found under every variety that can ariſe from particular circumſtances.

The plough performs its taſk, not by digging, but by being pulled along. We do not aim at immediately reducing the ground to that friable and uniform ſtate into which we can bring it by the ſpade; but we wiſh to bring it into ſuch a ſtate that the ordinary operations of the ſeaſon will complete the taſk.

For this purpoſe, a ſlice or ſod muſt be cut off from the firm land. This muſt be ſhoved to one ſide, that the plough and the ploughman may proceed in their labour; and the ſod muſt be turned over, ſo that the graſs and ſtubble may be buried and rot, and that freſh ſoil may be brought to the ſurface; and all muſt be left in ſuch a looſe and open condition, that it may quickly crumble down by the influence of the weather, without baking into lumps, or retaining water. The firſt office is performed by the coulter, which makes a perpendicular cut in the ground. The point of the ſock follows this,

this, and its edge gets under the fod, and lifts it up. While lifting it up, it alfo heels it over, away from the firm land. The mouldboard comes laft, and pufhes it afide, and gradually turns it over as far as is required.

Inftruments of Hufbandry.

The general form of the body of a plough is that of a wedge, or very blunt chiffel, AFEDBC, (fig. 1.), having the lower corner D of its edge confiderably more advanced than the upper corner B; the edge BD and the whole back AFDB is the fame perpendicular plane; the bottom FDB approaches to a triangular form, acute at D, and fquare at F; the furface BCED is of a complicated fhape, generally hollow, becaufe the angle ABC is always greater than FDE: this confequence will be eafily feen by the mathematician. The back is ufually called the LAND SIDE by the ploughman, and the bafe FDE is called the SOLE, and FE the HEEL, and BCED the MOULDBOARD. Laftly, The angle AFE is generally fquare, or a right angle, fo that the fole has level both as to length and breadth.

Plate XI. General form of the plough.

By comparing this form with attention, the reader will perceive that if this wedge is pulled or pufhed along in the direction FD, keeping the edge BD always in the perpendicular cut which has been previoufly made by the coulter, the point D will both raife the earth and fhove it to one fide and twift it over; and, when the point has advanced from F to D, the fod, which formerly refted on the triangle DFE, will be forced up along the furface BCED, the line DF rifing into the pofition D*f*, and the line EF into the pofition E*f*.—Had the bottom of this furrow been covered with a bit of cloth, this cloth would be lying on the mouldboard, in the pofition D*f*E: the flice, thus deranged from its former

Advantages of this form.

 fituation,

Inſtruments of Huſbandry. ſituation, will have a ſhape ſomething like that repreſented in fig. 2.

In as much as the wedge raiſes the earth, the earth preſſes down the wedge; and as the wedge puſhes the earth to the right hand, the earth preſſes the wedge to the left; and in this manner the plough is ſtrongly preſſed, both to the bottom of the furrow by its ſole, and alſo to the firm land by its back or land ſide. In ſhort, it is ſtrongly ſqueezed into the angle formed along the line FD (fig. 1.) by the perpendicular plane *a b* DF and the horizontal plane FDE; and in this manner the furrow becomes a firm groove, directing the motion of the plough, and giving it a reſiſting ſupport, by which it can perform all parts of its taſk. We beg our readers to keep this circumſtance conſtantly in mind. It evidently ſuggeſts a fundamental maxim in the conſtruction, namely, to make the land ſide of the plough an exact plane, and to make the ſole, if not plane, at leaſt ſtraight from point to heel. Any projection would tear up the ſupporting planes, deſtroy the directing groove, and expend force in doing miſchief.

A fundamental maxim in the conſtruction of a plough.

This wedge is ſeldom made of one piece. To give it the neceſſary width for removing the earth would require a huge block of timber. It is therefore uſually framed of ſeveral pieces, which we ſhall only mention in order to have the language of the art. Fig. 3. repreſents the land ſide of a plough, ſuch as thoſe made by James Small at Roſebank, near Foord, Mid Lothian. The baſe of it, CM, is a piece of hard wood, pointed before at C to receive a hollow ſhoeing of iron CO, called the SOCK, and tapering a little towards the hinder end, M, called the HEEL. This piece is called the HEAD of the plough. Into its fore part, just behind the ſock,

The ſeveral parts of the plough.

fock, is mortifed a floping poft, AL, called the SHEATH, the front of which is worked fharp, forming the edge of the wedge. Nearer the heel there is mortifed another piece, RQ, floping far back, called the STILT, ferving for a handle to the ploughman. The upper end of the fheath is mortifed into the long BEAM RH, which projects forward, almoft horizontally, and is mortifed behind into the ftilt. To the fore end of the beam are the cattle attached. The whole of this fide of the wedge is fafhioned into one plain furface, and the intervals between the pieces are filled up with boards, and commonly covered with iron plates. The COULTER, WFE, is firmly fixed by its fhank, W, into the beam, rakes forward at an angle of 45° with the horizon, and has its point E about fix inches before the point of the fock. It is brought into the fame vertical plane with the land fide of the plough, by giving it a knee outward immediately below the beam, and then kneeing it again downward. It is further fupported on this fide by an iron ftay FH, which turns on a pin at F, paffes through an eye-bolt I on the fide of the beam, and has a nut fcrewed on it immediately above. When fcrewed to its proper flope, it is firmly wedged behind and before the fhank. Fig. 4. reprefents the fame plough viewed from above. ST is the right hand or fmall ftilt fixed to the infide of the mouldboard LV.

Instruments of Hufbandry.

Fig. 5. reprefents the bottom of the wedge. CM is the head, covered at the point by the fock. Juft behind the fock there is mortifed into the fide of the head a fmaller piece DE, called the wreft, making an angle of 16° with the land fide of the head, and its outfide edge is in the fame ftraight line with the fide of the fock. From the point to the heel of the head is about

Instruments of Hufbandry.

33 inches, and the extreme breadth of the heel is about nine. The fide of the wedge, called the furrow fide, is formed by the mouldboard, which is either made of a block or plank of wood, or of a thick iron plate.

Socks.

The fock drawn in this figure is called a SPEAR SOCK, and is chiefly ufed in coarfe or ftony ground, which requires great force to break it up. Another form of the fock is reprefented in fig. 6. of the fame plate. This is called a FEATHER SOCK, and has a cutting edge CF on its furrow fide, extending back about ten inches, and to the right hand or furrow fide about fix. The ufe of this is to cut the fod below, and detach it from the ground, as the coulter detaches it from the unploughed land. This is of great ufe when the ground is bound together by knotted roots, but it is evident that it cannot be ufed to advantage in very ftony ground. In general, the feather fock is only fit for ground which has been under tolerable culture; but it greatly facilitates the labour of feparating the fod. It may reafonably be afked, why the feather is not much broader, fo as to cut the whole breadth of the furrow? This is fometimes done. But we muft recollect that the fod is not only to be pufhed afide, but alfo to be turned over. If it were completely detached by the feather, and chanced at any time to break on the back of the fock, it would only be pufhed afide; but by leaving a little of the fod uncut, it is held faft below while it is fhoved afide above, which cannot fail to twift it round. As the wreft advances, it eafily deftroys the remaining connexion, which in general is very flight and crumbling.

Proper breadth of the fole.

The breadth of the fole at the heel determines the width of the furrow. Nine inches will give enough of room for a horfe or man to walk in. A greater breadth

is

is of no use, and it expends force in pushing the earth aside. It is a mistake to suppose that a broad sole gives more room for the turned slice to stand on; for whatever is the breadth of the furrow, the successive slices will be left at their former distances, because each is shoved aside at the same distance. When the breadth of a slice exceeds its depth, and it is turned on its side, it will now stand on a narrow base, but higher than before, and therefore will stand looser, which the farmers desire. But in this case it generally falls on its back before it has been far enough removed, and is then pushed aside, and left with the grassy side down, which is not approved of. On the other hand, when the depth considerably exceeds the breadth, the sods, now turned on their sides, must be squeezed home to the ploughed land, which breaks them and tosses them up, making rough work. In wet clay soil, this is also apt to knead them together. On the whole, it is best to have the breadth and depth nearly equal. But all this is workmanship, and has no dependence on the width of the sole behind.

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We have already said that the sole is generally level from right to left at the heel. This was not the case formerly, but the wrest was considerably raised behind. It resulted from this form, that the furrow was always shallower on the right side, or there was left a low ridge of unstirred earth between the furrows. This circumstance alone was a bad practice; for one great aim of ploughing is the renewal of the superficial soil. In this way of ribbing the furrows, the sod tumbles over as soon as it is pushed to the top of the rib on the right of the *rut* made by the plough; the firmest parts of it fall undermost, and the rest crumbles above it, making the work appear neat; whereas it is extremely unequal,

It should be level.

Instruments of Husbandry.

and what most needs the influence of the weather to crumble it down is sheltered from it. Add to these circumstances, that the hollow is a receptacle for water, with a surface which can retain it, having been consolidated by the pressure of the plough. For all these reasons, therefore, it seems advisable to form the furrow with a flat or level bottom, and therefore to keep the heel of the wrest as low as the heel of the head. For the same reason it is proper to hold the plough with the land side perpendicular, and not to heel it over to that side, as is frequently done, producing the same ribbed furrow as an ill formed sole.

Length of the plough.

There is great variety of opinions about the length of the plough. If considered merely as a pointed instrument, or even as a cutting instrument acting obliquely on a given length of sod, there can be no doubt but that it will be more powerful as it is longer: that is, it will require less force to pull it through the ground. But it must also shove the earth aside, and if we double its length we cause it to act on twice as much earth at once; for when the plough has entered as far as the heel, the whole furrow side is acting together in pushing the earth to the side. Now it is found, that the force necessary for pushing a mass of earth horizontally along the rough ground is nearly equal to its weight. It would seem, therefore, that nothing is to be gained by making the base of the plough of a great length, except a greater facility in making the first penetration, and this is chiefly performed by the coulter and sock; and a great length renders the plough heavy and cumbersome, and, by causing it to act long on the sod, tends to knead and cake it.

Nothing very precise can be offered on this subject.

Some

Some ſenſible advantage is derived by making the plough taper, eſpecially forward, where it acts as a boring and cutting inſtrument; and for this purpoſe it is convenient to give the coulter a ſlope of 45 degrees. (This has alſo the advantage of throwing up the ſtones and roots, which it would otherwiſe drive before it through the firm ground.) And for the ſame reaſon the edge of the feather has a great ſlope, it being 10 inches long and only ſix inches broad. But if we purſue this advantage too far, we expoſe ourſelves to another riſk. It is ſometimes neceſſary to heel over the plough to the right in order to get over ſome obſtruction. In doing this, the coulter is neceſſarily raiſed for a moment, and the ſlanting cut now made by the feather becomes the directing groove for the plough. When the feather has a very long ſlope, this groove has force enough to guide the whole plough; and it is almoſt impoſſible for the ploughman to prevent it from running out of the ground to the land ſide *. The feather, therefore, ſhould not exceed ten or twelve inches in length.

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Slope of the coulter and of the feather.

But to return to the length of the plough, from which this obſervation has diverted us a little, we muſt add, that a long plough has a great advantage in the ſteadineſs of its motion, having a much more extenſive ſupport both on the land ſide and below, and being therefore leſs affected by its inequalities. Accordingly they are now made conſiderably longer than formerly; and

* This is often felt with the excellent plough deſcribed by Mr Arbuthnot of Surry, in the Tranſactions of the Society for the Encouragement of Arts, &c. London.

Instruments of Husbandry.

33 inches has been assumed as a proportion to 9 inches of breadth, in conformity to the most approved ploughs now in use.

The mouldboard.

We come now to treat of the mouldboard. This is the most delicate part of the plough, and is to be seen in the greatest variety in the works of different artists, each of whom has a nostrum of great value in his own opinion. It is here indeed that the chief resistances are exerted and must be overcome; and a judicious form of this part of the plough may diminish them considerably, while it performs the work in the best manner. Without pretending to say that the different resistances are susceptible of an accurate determination, we can still draw sufficient information from palpable rules of mechanics to direct us to what would be nearly the best possible form for a mouldboard. The task to be performed is to raise, push aside, and turn over to a certain degree, a slice already cut off from the firm ground. As we cannot provide for every inequality of the cohesion or tenacity of the earth, our safest way is to consider it as uniform: the weight of it is always so. As we cannot provide for every proportion between the tenacity and the weight, we must take an average or medium proportion which is not far from that of equality. Conceiving the slice at first as only tenacious, and without weight, it is an easy problem to determine the form which shall give it the intended twist and removal with the smallest force. In like manner we can proceed with a slice that has weight without tenacity. It is equally easy to combine both in any proportion; and it is easiest of all to make this combination on the supposition of equality of weight and cohesion. Supposing the slice like a brick, we know that it requires the greatest force

to

to begin to raiſe it on one edge, and that the ſtrain becomes leſs as it riſes, till its centre of gravity is perpendicularly above the ſupporting angle. It requires no force to raiſe it further; for on puſhing it beyond this poſition, it would fall over of itſelf, unleſs withheld by the tenacity of what is not yet raiſed. But on conſidering the form or plan of the ſock, we find that while the weight of the ſod reſiſts moſt ſtrongly, there is leſs of it in this ſituation actually riſing, and this nearly in the ſame proportion with the labour of raiſing it; and we ſee that after the ſod has attained that poſition in which it is ready to fall over, it has reached the wider part of the wreſt, and is now puſhed aſide, which requires nearly the ſame force as to raiſe it: and this continues to the end of the operation.

Instruments of Huſbandry.

When we take all theſe circumſtances into conſideration, it appears probable, that the compound reſiſtance does not change much from firſt to laſt. If this be really the caſe, it is an undoubted maxim that the whole operation ſhould proceed equably: if it does not, there muſt be ſome part of the ſod that makes a reſiſtance greater than the medium; and as the reſiſtances in all this claſs of motions increaſe nearly as the ſquares of the velocities with which they are overcome, it is demonſtrable that we ſhall loſe power if we render them unequal.

How to be formed.

Hence we deduce this maxim, *That as the plough advances through equal ſpaces, the twiſt and the lateral ſliding of the ſod ſhould increaſe by equal degrees.* And this determines *a priori* the form of the mouldboard. This principle occurred to Mr James Small, a ploughmaker in Berwickſhire, and he publiſhed a treatiſe on the ſubject in 1784. He has given ſeveral methods for conſtructing

Instruments of Husbandry.

constructing mouldboards, which he supposes are in conformity to his principle; but being merely a country artist, and unacquainted with science, his rules do not produce mouldboards having this property of equable operation, although they do not deviate far from it. His book is a very useful and instructive performance, and level to the capacity of those for whom it is intended; and we have here availed ourselves of the author's information on many points.

The high character which Small's ploughs have maintained for 28 years is a strong argument for the truth of the maxim. We shall, therefore, give such instructions as will enable any intelligent workman to construct such a mouldboard without any risk of failure; and if future theory or experience should discover any error in the principles from which this maxim is deduced, by showing that either the weight, the tenacity, or the lateral resistance, is exerted according to a different law from what has been assumed, the directions to be given are of such a nature that they adapt themselves with precision to these changes of principle, and will still produce a perfect and efficacious plough. Our readers will readily acknowledge that this is gaining a great point; because at present the instrument is constructed very much at random, and by a guess of the eye.

Plate XI.

Let us now return to the wedge formerly made use of for illustrating the action of the plough. Suppose it placed in a furrow already ploughed, and that the space before the line FE (fig. 1.), which is square from the line of motion FD, is covered with a piece of cloth or carpet, and that the point of the wedge enters upon it at F, and advances to D. It will evidently raise the cloth,

cloth, which will now cover the ſide of the wedge, forming the triangle *f* DE. The line *f* D is what formerly lay in the angle along the line FD, and *f* E formerly lay on FE. It is this line FE, therefore, that we are to raiſe, ſhove aſide, and twiſt round, by equal degrees, while the plough advances through equal ſpaces. Inſtruments of Huſbandry. Plate XI.

Now, if the length DF of the plough-wedge, reckoned from the point of the ſock to the heel, be 33 inches, and the breadth FE behind be 9 inches, the angle DEF or DE*f* will be nearly 74°. The conſtruction of the furrow ſide of the plough is therefore reduced to this very ſimple problem, "To make the angle DE*f* turn equably round the axis DE, while the angular point L advances equably from D to E.

This will be done by means of the following very ſimple tool or inſtrument. Let IHFK (fig. 7.) be a piece of hard wood, ſuch as oak, a foot long, three inches broad, and an inch thick. Plant on this another piece BHFC of the ſame breadth, four inches long, and half an inch thick. This will leave beyond it a flat 8 inches long. We ſhall call this the *ſtock* of the inſtrument. Let ABC be a piece of clean oak half an inch thick, 20 inches long, and 3 inches broad at the end BC. Let this be faſhioned like the ſtyle of a ſundial, having its angle ABC 74°. Let it have a part BCE ſquare, to the extent of 4 inches from C, and the reſt EA worked into the form of a ſtraight ſlender rod. Let EFG be a ſemicircle of clean plane tree, or of metal, 4 inches radius: faſten this by ſmall ſcrews to the ſquare part of the ſtyle CE, ſo that its centre may be at C. Let this ſemicircle be divided into 180 degrees, and numbered from G along the arch GFE, ſo that Deſcription of an inſtrument for this purpoſe.

Instruments of Hufbandry. that 0° may be at G, and 180° at E. Let this ftyle and femicircle turn round the line BC by means of fmall hinges. This inftrument may be called the mouldboard gage, or protractor. When the ftile is folded down on the ftock BIK, the point G will be at F; and, when it is raifed up to any angle, the degrees will be pointed out on the femicircle by the ftraight edge CF.

Nothing can be more obvious than the manner of employing this inftrument, once we have determined the moft proper pofition for the fod when the work is completed. Now it feems to be the opinion of the moft intelligent farmers, that the beft pofition of the fod is that reprefented in fig. 1. Plate XII.

Proper pofition of the fod. Plate XII. Fig. 1. reprefents a fection of the ground and the working parts of the plough, as viewed by a perfon ftanding ftraight before it. ABDC is the unploughed ground, and WB the coulter, kneed in Small's manner. FGKB is the fection of the plough (or rather of the whole fpace through which the plough has paffed, for no part of the plough has this fection). HOFE is the fection of a flice, pufhed afide and turned over, fo as to lean on the next. HE is that fide of the flice which formerly lay on KB. EF is the fide cut off by the coulter; and FO is the upper or graffy fide. The lower corners are fuppofed to be a little bruifed inwards, as muft generally happen.

The fod is pufhed 9 inches to the right hand, and it leans with its graffy fide on the preceding furrow, in an angle of about 50 degrees. In this pofition the grafs is turned down fo as to rot; and there is a hollow left below to allow the rain water to run freely off, and to receive the earth as it crumbles down by the

the weather: and if the harrow is dragged acroſs theſe ridges, it diſtributes along the ſurface the mould which was formerly at the bottom. The ſod has got a twiſt of 130 degrees: but it is evident, that after it has been turned 90 degrees, or even a little before this, it is ready to fall over of itſelf. It is ſufficient, therefore, that it be turned 90 degrees when the heel of the wreſt has reached it, and the remainder of the twiſt is given to it by the wing or flap of the mouldboard. This, then, dictates to us the manner of applying the inſtrument.

Instruments of Huſbandry.

Plate XII.

Divide the edge DE (fig. 2.) of the wreſt, or of a lath nailed on it, into 90 equal parts, and continue the diviſions backwards to G in the ſame line to 130. Number the diviſions backwards from the point of the ſock; then place the protractor on the edge of the wreſt with the point B of fig. 7. Plate XI. at the 90th diviſion (fig. 2. Plate XII.); that is, juſt at the heel, with the ſtock under the wreſt, and the ſtile raiſed to 90°, and preſs it home to the joint, ſo that the ſtock may be ſquare to the edge, and then the ſtyle will be in the poſition ſuiting that part of the mouldboard. In like manner ſlide the ſtock forwards to the 80th diviſion, and lower the ſtyle to 80°, and it will have the poſition which ſuits that part of the mouldboard. In the ſame way ſlide it forward to 70, 60, 50, &c. and lower the ſtyle to 70°, 60°, 50°, &c. and we ſhall have the poſition for theſe ſeveral parts of the mouldboard; and thus it may be formed to the very point of the ſock, becauſe the ſtraight edge of the wreſt may be continued ſo far. A block of wood may be hewed to fit theſe ſeveral poſitions of the protractor ſtyle; and thus, when placed with its ſtraight edge on the outer line of the wreſt, and cut away behind in the land-

How to form the mouldboard.

Instruments of Husbandry.

land-side plane, will be the exact shape of the plough-wedge. It would rise up indeed into a tall piece of singular shape, gradually tapering down to the point of the sock; but when cut off parallel to the ground, at the height of about 12 inches, it will form the mouldboard, the front or edge of the sheath, and the whole back of the sock except the feather, which is an extraneous piece. The wing or flap of the mouldboard is formed in the same manner, by sliding the stock of the protractor to 100, 110, 120, 130, and opening the stile to 100°, 110°, 120°, 130°. This will extend the top of the mouldboard to about 22 or 23 inches; but the lower part of the wing must be cut away, because it would push the sod too far aside after it has got the proper twist. The form of this part should be such as would exactly apply itself to a plank set at the heel of the wrest, parallel to the land side of the head, and leaning outward 40 degrees. This will be very nearly the case, if it be made a sweep similar to the edge of the sheath. Fig. 3. is a resemblance of the surface of the mouldboard: AD being the edge of the sheath, E the heel of the wrest, and EBC the wing or flap. When cut through in a perpendicular direction, the section is hollow; if cut horizontally it is convex; and if in the direction CE, making an angle of 74° with ED, it is straight. If the protractor be set on it at D, and gradually slidden backwards, the mouldboard will gradually open the style, and the style will skim its whole surface without any vacuity between them.

Plate XII.

This form is given to the mouldboard on the authority of the supposition that the sum of the resistances arising from weight and tenacity remains pretty constant in its whole length. This cannot be affirmed with

I confidence

confidence in any cafe, and is by no means true in all. In ftiff clay foils the effects of tenacity prevail, and in light or crumbling foils the weight is the chief refiftance. The advantage of this mode of conftruction is, that it can be adapted to any foil. If the difficulty of cutting and raifing the fod is much greater than that of fhoving it afide and turning it over, we have only to make the rife and twift more gentle towards the point of the fock, and more rapid as we advance; and it is eafy to do this according to any law of acceleration that we pleafe. Thus, inftead of dividing the edge of the wreft DE (fig. 4.) continued to G into 130 parts, draw a line G *g* perpendicular to it, and draw fome curve line D *g* convex towards DG, and divide this into equal parts in the points 10, 20, 30, 40, &c.; and then draw perpendiculars to the wreft edge, cutting it in 10, 20, 30, 40, &c. and apply the protractor to thefe points, It is evident that the divifions of the wreftline are bigger at D, and grow gradually lefs towards G; and therefore, becaufe each has 10° more twift than the preceding, the twift will be more rapid as it approaches the end of the mouldboard. This curve may be chofen fo as to produce any law of acceleration. On the contrary, we produce a retarded or diminifhed twift by making the curve concave towards DG, as reprefented by the dotted curve.

Inftruments of Hufbandry.

Plate XII.

The mathematical reader will obferve, that this conftruction aims at regulating the twift round the line of the wreft ED. This does not produce precifely the fame regulation round the line FD, which is the line of the plough's motion, and of the fod's pofition before it is ploughed over. The difference, however, is not worth attending to in a matter fo little fufceptible of precifion.

Instruments of Husbandry. sion. But the twist round the line FD may be regulated according to any law by this instrument with equal facility. Instead of placing the stock of the protractor square with the edge of the wrest, it may be placed square with the land side of the plough. To do this, draw a line BL (fig. 8.) across the stock from the point B, making the angle LBC 16°, and put a brass pin at L, making a hole in the style that it may not be prevented from folding down. Then, in using the instrument, let the points B and L rest against the edge of the wrest, and proceed as directed.

Plate XI.

A still greater variety of forms, and accommodation to particular views, with the same general dependence on principle, will be procured by giving the rod BA a motion round B in the plane of the style, so as to form a style of a variable angle.

A tool may even be constructed in which the rod BA might be a cutting knife: and the whole may be led along by a screw, while this knife turns round according to any law, and would gradually pare away the mouldboard to the proper form.

Thus have we reduced the fashioning the operative part of the plough to a rule which is certain. We do not mean by this, that a mouldboard made according to the maxim now given will make the best possible plough; but we have given a rule by which this part of the plough can be made unequivocally of a certain quality by every workman, whatever this quality may be, and this without being obliged to copy. No description of any curve mouldboard to be met with in books has this advantage; and we say that this rule is capable of any systematic variation, either with respect to the width of furrow, or the quantity or variation of its twist. We have

have therefore put it in the power of any intelligent person to make such gradual and progressive changes as may serve to bring this most useful of all instruments to perfection. The angle of the head and wrest, and the curve for dividing the wrest-line, can always be expressed in writing, and the improvements communicated to the public at large. Instruments of Husbandry.

After this description of the working parts of a plough, and directions for giving it the most effective form, it will not be improper to consider a little its mode of action, with the view of attaining a more distinct conception of what is done by the ploughman and the cattle, and to direct him in his procedure. Method of the plough's action.

Returning again to the wedge (fig. 1.), we see that it is pressed down at the point D, and as far back along the mouldboard as its surface continues to look upward, that is, all the way to the heel of the wrest. Behind this, the perpendicular sections of the mouldboard overhang, and look downward; and here, while pressing down the sod, the plough is pressed upwards. These two pressures tend to twist the plough round a transverse line somewhere between the heel and the point. The plough therefore tends to rise at the heel, and to run its point deeper into the ground. Upon the whole, the pressure downwards is much greater than the upward pressure. It is exerted over a much greater space, and is greater in most parts of that space. Behind, very little downward pressure is necessary, the sod being ready to fall down of itself, and only requiring a gentle touch to lay it in a proper position. Plate XI.

In like manner the plough is pressed backward by the resistance made to the coulter and sock, and part of the resistance made to the sloping side of the mouldboard:

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and it is pressed to the left by the other part of the pressure on the sock and mouldboard.

All these pressures must be balanced by the joint action of the cattle, the resistance of the bottom, and the resistance of the firm ground on the left hand or land side.

It is the action of the cattle, exerted on that point to which they are attached, which produces all these pressures. It is demonstrated by the principles of mechanics, that this force must not only be equal to the mean or compound force of these resisting pressures, but must also be in the opposite direction,

It is further demonstrated, that if a body be dragged through any resisting substance by a force acting on any point G, and in any direction whatever GH, and really moves uniformly in that direction, the force exerted exactly balances the resistances which it excites, both as to quantity and direction: And if the body advances without turning round the point by which it is dragged, the resistances on one side of this point are in equilibrio with those on the opposite side.

And, lastly, it is demonstrated, that when this equilibrium is obtained, it is indifferent to what point in the line GH the force is applied. Therefore, in fig. 3. the force acting in the direction HO may either be applied to the point of the beam H, or to the point N of the coulter, or to the point O of the sock.

Plate XII.

When therefore a plough advances steadily, requiring no effort of the ploughman to direct it, if the line of draught OM (fig. 5.) be produced backwards to the point G of the mouldboard, that point is the place round which all the resistances balance each other. This

This point may be called the *centre of resistance* and the *centre of action*. Instruments of Husbandry.

It would be of importance to determine this point by principle; but this can hardly be done with precision even in a plough of a known form: and it is impossible to do it in general for all ploughs, because it is different in each. It even varies in any plough by every variation of the proportion between the weight and the cohesion of the sod. We see how it can be found experimentally in any given uniform sod, viz. by producing backwards the line of draught. Then, if the draught rope, instead of being fixed to the muzzle of the beam, were fixed to this point, and if it were pulled in the same direction, the plough would continue to perform its work without any assistance from the ploughman, while the sod continued uniform. But the smallest inequality of sod would derange the plough so as to make it go entirely out of its path. Should the resistances between G and D prevail, the plough would go deeper, which would increase the resistances on that side where they already exceed, and the plough would run still deeper. Should the resistances behind G prevail, the heel would be pressed down, and the point would rise, which would still farther destroy the equilibrium, and, producing a greater deviation from the right path, would quickly throw the plough out of the ground.

For these reasons we must not think of attaching the draught to the centre of resistance; but must contrive a point of draught, such as shall restore the plough to its proper position when it has been driven out of it by any obstruction.

The muzzle or end of the beam is a point which will completely Muzzle of the beam.

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completely ſuit our purpoſe. *For ſuppoſe that the re*ſiſtance on the back of the ſock has prevailed, and the

Plate XII.

plough MNFD (fig. 5.) has taken the poſition *m n f d* repreſented by the dotted lines, the draught line GMO is brought down into the poſition *g m o*, diverging a little from GMO, and meeting the mouldboard in a point *g* conſiderably before G. By this means the reſiſtances on the hinder ſide of *g* are increaſed, and thoſe before it are diminiſhed, and the plough quickly regains its former poſition.

The point of draught.

From theſe obſervations it is plain, that whatever is the ſituation of the centre of reſiſtance, the point of draught may be ſo choſen that the action of the cattle ſhall be directly oppoſed to the reſiſtance of the ground, and that moreover the plough ſhall have no tendency either to go deeper or to run out. This is the uſe of the apparatus at the point of the beam called the

Plate XI.

muzzle, repreſented at H (fig. 4.) It turns round a bolt *i* through the beam, and can be ſtopped at any height by another pin *k* put through the holes in the arch *l m*. A figure is given of the muzzle immediately below, as it appears when looking down on it. The eye to which the draught rope is hooked is ſpread out horizontally, as ſhown by HK, and has ſeveral notches O in it, to either of which the hook can be applied. This ſerves to counteract any occaſional tendency which the plough may have to the right or left.

When the plough goes on ſteadily, without any effort of the ploughman, it is ſaid to be in trim, and to ſwim fair; the preſſure before and behind the centre of action being in equilibrio with each other. In order to learn whether a plough will be in this manner under management, hook the draught rope as high as poſſible.

In

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Of the plough in trim.

In this state the plough should have a continual tendency to rise at the heel, and even to run a little into the ground. Then hook the rope as low as possible. The plough should now press hard on the furrow with the heel, and have some tendency to run out of the ground. When both these are observed, the plough is properly constructed in this respect; if not, it must be altered, either by changing the position of the sock or that of the beam. Lowering the end of the beam will correct the tendency of the plough to go deeper; the raising the point of the sock will also have the same effect. But it is of considerable importance not to take the point of the sock out of the plane of the sod, and it is much better to make the alteration by the beam. The slope of the coulter has a considerable effect, but it cannot be placed very far from the inclination of 45° without the risk of choking the plough by driving the roots and stones before it. It is of great consequence to have the coulter fit exactly in the direction of the plough's motion; if it is in any other direction, it will powerfully twist the plough into its own track. As it must be fixed in the middle of the beam's thickness to have strength, it is removed a little from the plane of the land side, and it was the usual practice to point it to the left below to compensate for this; but this by no means removes the disposition to twist, and it exposes to the risk of catching a stone between its point and that of the sock, which must now be driven forward through the firm ground at a great expence of labour to the cattle. Mr Small has very ingeniously remedied this, by giving the coulter a short knee to the left immediately below the beam, and thus point-

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ing it downwards in the plumb of the land ſide. See fig. 1. Plate XII.

It is not without its uſe to know the abſolute force neceſſary for tilling the ground. This has been frequently meaſured with a ſpring ſteelyard. One of Small's ploughs worked by two horſes, when employed in breaking up ſtiff land which had been ploughed before winter, and much conſolidated by the rains, required a force of 360lbs. avoirdupois; and we may ſtate this as the ordinary rate of ſuch work; but moderately firm ſod, under good culture, requires at a medium 320lbs.

As we wiſh to embrace every opportunity of rendering this work uſeful to the public, we ſhall conclude this article with an account of a plough which has been recommended to public notice by the Scots Highland Society as extremely proper for a hilly country. The inventor, the Rev. Alexander Campbell miniſter of Kilcalmonill in Argyleſhire, was honouredwith the Society's gold medal, value 25l.

Plate XII. The Argyleſhire plough.

A, the ſock (fig. 6.); the land ſide of which ſupplies the place of the coulter, and the ſole of it ſerves for a feather; it is 18 inches long, and is made of a plate of iron 12 inches broad when finiſhed, and ſomewhat under half an inch thick.—B, the head; to be made of iron in a triangular form, 4 inches broad by 2 inches at the thickeſt part. There are 5 inches of the head fixed in the ſock.—C, the beam, 4 inches thick by 5 inches deep, gradually tapered thinner; the length 6 feet.—E, the ſheath, muſt be of the ſame thickneſs with the beam above and the head below, and is 5 inches broad. An iron ſcrew-bolt connects the beam and head behind the ſheath.—F, the handles are ſo made

made that the slope of the mouldboard, which is fixed [illegible] of them, may be the longer and more gradual. [illegible] are 5 feet 8 inches long, and 2 feet 4 inches asunder at the ends.——G, the mouldboard, consists of 7 rounded sticks 2 inches in diameter; the covert of them is in the plane of the sole, the rest in succession close to each other above it. This makes the mouldboard 14 inches broad. To prevent any earth from getting over the mouldboard, a thin deal 4 or 5 inches broad is fixed above it. The mouldboard, land-side, and sole of the plough, are clad with iron.—The length is 20 inches: this added to 18 inches, the length of the sock, makes the length from point to heel 3 feet 2 inches.—The muzzle or bridle OPH is also of a more convenient and better construction than those commonly in use. By means of the screw pins at L and M different degrees of land may be given to the plough; the iron rod LH being thereby moved sidewise in the socket LN, and up and down by OP. The rod is 30 inches long, one broad, and half an inch thick. It is hooked into a screwbolt at H. Two inches of the rod project at N, in the form of an eye, before the muzzle, to receive the hook of the crosstree.

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The advantages of this plough are said to be: It is not so liable to be interrupted or turned out of its course by stones, roots, &c. as other ploughs are; nor does it dip so deep as to be liable to be broken by large stones or flags. The motion of the muzzle is also thought an improvement. Another advantage it has over other ploughs is, its not being so liable to be choked up by stubble, &c. This we understand to be its chief excellency, and an object much desired in the construction of the plough. Upon the whole, we are informed,

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that this plough is lighter, less expensive, and less liable to go out of trim, than the ordinary plough, and that with it two horses can plough land which requires four with any other plough.

Objections to its construction.

Such are said to be the advantages of this construction; but we cannot help expressing our apprehension, that the uniting the coulter and feather at the point of the sock will expose the plough to great risks of being put out of order. When the upright edge strikes a stone obliquely, especially on the land-side, it must be violently twisted round the point of the head; and, having but a moderate thickness at this part, may be broken or permanently twisted. The plough will then be continually running out of its direction: and we apprehend that this defect cannot be amended without taking off the sock and putting it in the fire. When a coulter is bent by the same cause, the ploughman can either rectify it by altering the wedging, or he can straighten it in the field; and it must be observed, that the plough opposes much less resistance to the derangement of this sort of coulter than of the common one. In the common coulter the strain does not so much tend to twist the plough round the line of its motion, as to press it wholly to landward. The resistance to this is great; but a very moderate force will twist it round its line of motion. In either case, if the blow be given in that point of the coulter where the draught line crosses it, there will be no twist of the whole plough, but the point of the plough will be forced horizontally to or from the land. When the blow is out of this line, the strain tends to twist the beam or the plough. Experience will determine which of the two is the most hazardous.

hazardous. Models of these ploughs are to be seen in the hall of the Highland Society. *Instruments of Husbandry.*

The plough constructed in the following manner is still the most common and the most generally understood in Scotland; and, if properly made, is the best for answering all purposes, when only one is used; though others are, perhaps, more proper on some particular occasions. *Scots plough.*

The parts of which this plough is composed, are, the head, the beam, the sheath, the wrest, the mould-board, the two handles, the two rungs, the sock, and the coulter; the two last are made of iron, and all the rest of wood. *Description of the Scots plough.*

The HEAD is designed for opening the ground below. The length of the head from A to B is about 20 inches, and the breadth from A to D above five inches; C is the point upon which the sock is driven, and the length from B to C is about six inches; *a* is the mortise into which the larger handle is fixed, and *b* is the mortise into which the sheath is fixed. *Plate I. fig. 1.*

The head is that part of the plough which goes in the ground; therefore the shorter and narrower it is, the friction will be the less, and the plough more easily drawn; but the longer the head is, the plough goes more steadily, and is not so easily put out of its direction by any obstructions that occur. Twenty inches is considered as a mean length; and five inches as the most convenient breadth.

The SHEATH E is driven into the mortise B, and thus fixed to the head A B. It is not perpendicular to the head, but placed obliquely, so as to make the angle formed by the lines AB and EB about 60 degrees. The sheath is about 13 inches long, besides what is driven *Fig. 2.*

into

Instruments of Husbandry. into the mortise *b* (fig. 1.); about three inches broad, and one inch thick.

The sheath is fixed to the mouldboard, as in Plate II. fig. 5. E, in the same manner as the wrest is fixed to the head in Plate I. fig. 4.

The MOULDBOARD is designed to turn over the earth of the furrow made by the plough; and it is obvious, that, according to the position of the sheath, the mouldboard will turn over the earth of the furrow more or less suddenly. Besides, when it forms a less angle with the head than 60 degrees, the plough is in great danger of being *choked*, as the farmers term it.

Plate I. Fig. 3. The larger HANDLE, FA, is fixed to the head, by driving it into the mortise *a* (fig. 1.) It is placed in the same plane with the head; and its length from AF is about five feet four inches, and its diameter at the place where it is fixed to the beam is about two inches and a half, and tapers a little to the top F. About ten inches from A, there is a curve in the handle, which, when F is raised to its proper height, makes the lower part of it nearly parallel to the sheath EB. This curve is designed to strengthen the handle. The proper position to the handle is, when the top F is about three feet two inches higher than the bottom of the head AB.

The longer the handles, the plough is the more easily managed, because the levers are more distant from the centre of motion. The higher the top of the handles, the plough is the more easily raised out of the ground, provided they be no higher than the lower part of a man's breast.

Fig. 6. The BEAM is fixed to the larger handle and the sheath, all of which are placed in the same plane with the

the head. The length of it, from H to I, is about fix ... diameter is about four inches. When the ...l is in the ground, the beam fhould be juft high enough not to be incommoded by any thing on the furface. Inftruments of Hufbandry.

The pofition of the beam depends on the number of cattle in the plough. When two horfes are yoked, the beam fhould be placed in fuch a manner as to make the perpendicular diftance betwixt the bolt-hole of the beam and the plane of the head about 21 inches; when four horfes are yoked, two a-breaft, this diftance fhould only be about 18 inches.

The SOCK, BP, is fixed to the end of the head, and is about two feet long. In fitting the fock to the head, the point ought to be turned a little to the land or left fide; becaufe otherwife it is apt to come out of the land altogether. When turned to the left, it likewife takes off more land; when turned upwards, the plough goes fhallow; and when downwards, it goes deeper. Plate I. Fig. 3.

The COULTER is fixed to the beam, and is about two feet ten inches long, two inches and a half broad, fharp at the point and before, and thick on the back, like a knife. It is fixed and directed by wedges, fo as to make the point of it equal to, or rather a little before, the point of the fock, and upon a line with the left fide of the head. This oblique pofition enables it to throw roots, &c. out of the land, which requires lefs force than cutting or pufhing them forward. Fig. 8.

The WREST, BD, is fixed to the head, and is about 25 inches long, two broad, and one thick. It is fixed to the head at B, in fuch a manner as to make the angle contained between the lines AB and BD about 25 degrees. Fig. 7.

Instruments of Husbandry. grees. The wreſt is ſeldom or never placed in the ſame plane with the head, but gradually raiſed from the ſ... where it is fixed to it; that is, from B to K, as in fig. 7. The poſition of the wreſt determines the nature of the furrow. When the wreſt is wide and low ſet, the furrow is wide; and when it is narrow and high ſet, the furrow is narrow.

Plate II. Fig. 1. repreſents the two HANDLES, fixed together by the two rungs. The larger handle has already been deſcribed; the leſſer one is a few inches ſhorter, and does not require to be quite ſo ſtrong. The diſtance of the handles at the little rung depends on the poſition of the wreſt. Their diſtance at M and P is about two feet ſix inches. The leſſer handle is fixed to the mould-board at M, fig. 4. and to the wreſt KB, at L.

Fig. 5. repreſents the plough complete, by joining together fig. 8. Plate I. and fig. 4. Plate II. in the ſheath EB. The wreſt BK is ſuppoſed to make an angle with the head AB as in Plate I. fig. 4. and the handles joined together as in Plate II. fig. 1.

After having given ſuch a particular deſcription of all the parts and proportions of the Scots plough, it will eaſily appear how it ſeparates, raiſes, and turns over the earth of the furrow. If it had no coulter, the earth would open above the middle of the ſock, and in a line before the ſheath; but as the coulter opens the earth in a line with the left ſide of the head, if the ſoil has any coheſion, the earth of the furrow will be wholly raiſed from the left ſide, and, as the ſock moves forward, will be thrown on the right ſide of the ſheath, and by the caſting out of the mouldboard, or the raiſing of the wreſt, will be turned over.

Plate II. Fig. 6. The BRIDLE, or MUZZLE, is another article belong-

ing

ing to the plough. It is fixed to the end of the beam, and the cattle are yoked by it. The muzzle commonly used is a curved piece of iron, fixed to the beam by a bolt through it. ABC is the muzzle, AC the bolt by which it is fixed to the beam; D is the ſwingle-tree or croſs-tree, to which the traces are fixed; and B is a hook, or *cleek*, as it is commonly called, which joins the muzzle and ſwingle-tree. Instruments of Huſbandry.

Some uſe another kind of muzzle, ABCD. It is fixed to the beam by two bolts, and has notches by which the cleek of the ſwingle-tree may be fixed either to the right or the left of the beam. There are alſo different holes for the hind bolt to paſs through, by which the draught may be fixed either above or below the beam. AD is the fore bolt upon which the muzzle turns; on BC are four notches, betwixt any two of which the cleek of the ſwingle-tree may be fixed. When the cleek is fixed at B, the plough is turned towards the firm land, and takes off a broader furrow; and when fixed at C, it is turned towards the ploughed land, and takes off a narrower furrow. E and F are the holes on each ſide through which the hindmoſt bolt paſſes. When the bolt is put through the higheſt two, theſe holes being thereby brought to the middle of the beam, the fore part of the muzzle is raiſed above the beam, and the plough is made to go deeper; and when put through the loweſt two, the fore part of the muzzle is ſunk below the beam, and the plough is made to go ſhallower. This muzzle may be ſo conſtructed as to have the ſame play with the common one. A is the end of the beam; B a plate of iron ſunk into it, and, with a ſimilar one in the other ſide, is rivetted into it by bolts; C is the muzzle fixed to theſe plates Plate II. Fig. 2. Fig. 10.

of

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of iron by a bolt, which bolt may be put through a y of the holes marked on the plate B. From the construction of this muzzle it is plain, that it has the same play with the common one, and that by it the land of the plough may be altered at pleasure.

Properties of the Scots plough.

Of all forms, that of the Scots plough is the fittest for breaking up stiff and rough land, especially where stones abound; and no less fit for strong clays hardened by drought. The length of its head gives it a firm hold of the ground; its weight prevents it from being thrown out by stones; the length of the handles gives the ploughman great command to direct its motion; and by the length of its head, and of its mouldboard, it lays the furrow-slice cleverly over. This plough was contrived during the infancy of agriculture, and was well contrived: in the soils above described it has not an equal.

In what soil improper.

But in tender soil it is improper, because it adds greatly to the expence of ploughing, without any counterbalancing benefit. The length of the head and mouldboard increases the friction, and consequently it requires a greater number of oxen or horses than are necessary in a shorter plough. There is another particular in its form that resists the draught: the mouldboard makes an angle with the sock, instead of making a line with it gently curving backward. There is an objection against it no less solid, that it does not stir the ground perfectly: the hinder part of the wrest rises a foot above the sole of the head: and the earth that lies immediately below that hinder part, is left unstirred. This is ribbing land below the surface, similar to what is done by ignorant farmers on the surface.

These defects must be submitted to in a soil that requires

quires a ſtrong heavy plough; but may be avoided in a cultivated ſoil by a plough differently conſtructed. Of all the ploughs fitted for a cultivated ſoil free of ſtones, that already mentioned, which was introduced into Scotland about 20 years ago, by James Small in Blackadder mount, Berwickſhire, is the beſt. It is now in great requeſt; and with reaſon, as it avoids all the defects of the Scots plough. The ſhortneſs of its head and of its mouldboard leſſen the friction greatly: from the point of the ſock to the back part of the head it is only 30 inches; and the whole length, from the point of the beam to the end of the handles, between eight and nine feet. The ſock and mouldboard make one line gently curving; and conſequently gather no earth. Inſtead of a wreſt, the under edge of the mouldboard is one plane with the ſole of the head; which makes a wide furrow, without leaving any part unſtirred. It is of late commonly termed the *chain-plough*, becauſe it is drawn by an iron chain fixed to the back part of the beam immediately before the coulter. This has two advantages: firſt, by means of a muzzle, it makes the plough go deep or ſhallow; and, next, it ſtreſſes the beam leſs than if fixed to the point, and therefore a ſlenderer beam is ſufficient.

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Chain-plough. Plate III. fig. 1.

As we have already ſufficiently explained the ſpeculative principles upon which this plough is formed, we ſhall only remark, that it is proper for loams, for carſe clays, and, in general, for every ſort of tender ſoil free of ſtones. It is even proper for opening up paſture ground, where the ſoil has been formerly well cultivated.

A ſpiked ſock is uſed in the Scots plough. The difference between it and the feathered ſock will be

Of the ſock. Plate II.

beſt

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beſt underſtood by comparing their figures. Fig. 7. is the common ſock, and fig. 3. the feathered one.

From the conſtruction of the feathered ſock, it is obvious, that it muſt meet with greater reſiſtance than the common ſock. However, when the plough takes off the earth of the furrow broader than that part of the ſock which goes upon the head, it is more eaſily drawn than the plough with the common ſock; for the earth which the common ſock leaves to be opened by the wreſt, is more eaſily opened by the feather of the other ſock. In ley, the feathered ſock makes the plough go more eaſily, becauſe the roots of the graſs, which go beyond the reach of the plough, are more eaſily cut by the feather than they can be torn aſunder by the common ſock. The feathered ſock is alſo of great uſe in cutting and deſtroying root weeds. The common ſock, however, anſwers much better in ſtrong land.

It is proper here to add, that in fitting the feathered ſock to the head, the point of it ſhould be turned a little from the land, or a little to the right hand.

A chain-plough of a ſmaller ſize than ordinary, drawn by a ſingle horſe, is of all the moſt proper for horſe-hoeing, ſuppoſing the land to be mellow, which it ought to be for that operation. It is ſufficient for making furrows to receive the dung, for ploughing the drills after dunging, and for hoeing the crop.

A ſmall ſingle-horſe plough recommended for various purpoſes.

A ſtill ſmaller plough of the ſame kind may be recommended for a kitchen garden. It can be reduced to the ſmalleſt ſize, by being made of iron; and where the land is properly dreſſed for a kitchen garden, an iron plough of the ſmalleſt ſize drawn by a horſe will ſave much ſpade-work. In Scotland, forty years ago, a kitchen garden was an article of luxury merely, becauſe at that time there could be no cheaper food than oatmeal. At preſent, the farmer that maintains his own ſervants does ſo at double expence, as the price of oatmeal is doubled; and yet he has no notion of a kitchen garden more than he had thirty years ago. He never thinks, that living partly on cabbage, kail, turnip, carrot, would ſave much oatmeal; nor does he ever think, that change of food is more wholeſome, than vegetables alone, or oatmeal alone. We need not recommend potatoes, which in ſcanty crops of corn have proved a great bleſſing: without them, the labouring poor would frequently have been reduced to a ſtarving condition. Would the farmer but cultivate his kitchen garden with as much induſtry as he beſtows on his potato crop, he needed never fear want; and he can cultivate it with the iron plough at a very ſmall expence. It may be held by a boy of 12 or 13; and would be a proper education for a ploughman. But it is the landlord who ought to give a beginning to the improvement. A very ſmall expence would encloſe an acre for a kitchen garden to each of his tenants; and it would excite their induſtry, to beſtow an iron plough on thoſe who do beſt. Inſtruments of Huſbandry.

Nor is this the only caſe where a ſingle horſe plough may be profitably employed. It is ſufficient for ſeed-furrowing barley, where the land is light and well-dreſſed. It may be uſed in the ſecond or third ploughing of fallow, to encourage annual weeds, which are deſtroyed in ſubſequent ploughings.

The *Rotheram plough* is a machine of very ſimple conſtruction, and eaſily worked. AB is the beam, CD the ſheath, EBD the main handle, FR the ſmaller handle, Rotheram Plough, Plate V. fig. 3.

Instruments of Husbandry. handle, GH the coulter, KI the sock or share, NP the bridle, S the fly-band, and ML a piece of wood in place of a head. The whole of this plough should be made of ash or elm; the irons should be steeled and well tempered; and that part of the plough which is under ground in tilling should be covered with plates of iron. The difference between this and the common plough seems to consist in the bridle at the end of the beam, by which the ploughman can give the plough more or less land by notches at N, or make it cut deeper or shallower by the holes at P; in the coulter or share, which are so made and set as to cut off the new furrow without tearing; and in the mouldboard, which is so shaped as at first to raise a little, and then gradually turn over, the new cut furrow, with very little resistance. But the greatest advantage attending it, is its being so easy of draught, that it will do double the work of any common plough.

The Paring Plough, Plate V. fig. 4. The *paring plough* is an instrument used in several parts of England for paring off the surface of the ground, in order to its being burnt. Mr Bradley has given the following very perspicuous description of this instrument: From A to A is the plough-beam, about seven feet long, mortised and pinioned into the block B, which is of clean timber without knots. CC are the sheaths or standards, made flat on the inside, to close equally with the paring plate, and fastened to it with a bolt and key on each side, as at D. E is the paring plate of iron laid with steel, about four inches wide, and from 12 to 18 inches long. This plate must be made to cut on the sides, which are bolted to the standards as well as at the bottom part. FF are two iron braces to keep the standards from giv-

ing

ing way: these standards must be mortised near their outsides, and through the block. GG are the plough handles, which must be fixed slopeways between the beam and the standards. The pin holes in the beam, the use of which is to make this plough cut more or less deep, by fixing the wheels nearer to or farther from the paring plate, should not be above two inches asunder.

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The Four-coultered Plough, Plate V.

Fig. 1. represents the four-coultered plough of Mr Tull. Its beam is ten feet four inches long, whereas that of the common plough is but eight. The beam is straight in the common plough, but in this it is straight only from *a* to *b*, and thence arched; so that the line let down perpendicularly from the corner at *a* to the even surface on which the plough stands, would be 11½ inches; and if another line were let down from the turning of the beam at *b* to the same surface, it would be one foot eight inches and a half; and a third line let down to the surface from the bottom of the beam at that part which bears upon the pillow, will show the beam to be two feet ten inches high in that part. At the distance of three feet two inches from the end of the beam *a*, at the plough-tail, the first coulter, or that next the share, is let through; and at 13 inches from this, a second coulter is let through: a third at the same distance from that; and, finally, the fourth at the same distance from the third, that is, 13 inches, and from *a* to *b* is seven feet.

The crookedness of the upper part of the beam of this plough is contrived to avoid the too great length of the three foremost coulters, which would be too much if the beam was straight all the way; and they would be apt to bend and be displaced, unless they

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were very heavy and clumfy. Afh is the beft wood to make the beam of, it being fufficiently ftrong, and yet light. The fheat in this plough is to be feven inches broad. The fixing of the fhare in this, as well as in the common plough, is the niceft part, and requires the utmoft art of the maker; for the well-going of the plough wholly depends upon the placing this. Suppofing the axis of the beam, and the left fide of the fhare, to be both horizontal, they muft never be fet parallel to each other; for if they are, the tail of the fhare bearing againft the trench as much as the point, would caufe the point to incline to the right hand, and it would be carried out of the ground into the furrow. If the point of the fhare fhould be fet fo, that its fide fhould make an angle on the right fide of the axis of the beam, this inconvenience would be much greater; and if its point fhould incline much to the left, and make too large an angle on that fide with the axis of the beam, the plough would run quite to the left hand; and if the holder, to prevent its running quite out of the ground, turns the upper part of his plough towards the left hand, the pin of the fhare will rife up, and cut the furrow diagonally, leaving it half unploughed. To avoid this and feveral other inconveniences, the ftraight fide of the fhare muft make an angle upon the left fide of the beam; but that muft be fo very acute a one, that the tail of the fhare may only prefs lefs againft the fide of the trench than the point does. This angle is fhown by the pricked lines at the bottom of fig. 9. where *ef* is fuppofed to be the axis of the beam let down to the furface, and *gf* parallel to the left fide of the fhare: and it is the fubtenfe *eg* that determines the inclination which the point of the fhare muft

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must have towards the left hand. This subtense, says Mr Tull, at the fore-end of an eight-feet beam, should never be more than one inch and a half, and whether the beam be long or short, the subtense must be the same.

The great thing to be taken care of, is the placing the four coulters; which must be so set, that the four imaginary places described by their four edges, as the plough moves forward, may be all parallel to each other, or very nearly so; for if any one of them should be very much inclined to, or should recede much from, either of the other, then they would not enter the ground together. In order to place them thus, the beam must be carefully pierced in a proper manner. The second coulter-hole must be two inches and a half more on the right hand than the first, the third must be as much more to the right of the second, and the fourth the same measure to the right hand of the third; and this two inches and a half must be carefully measured from the centre of one hole to the centre of the other. Each of these holes is a mortise of an inch and a quarter wide, and three inches and a half long at the top, and three inches at the bottom. The two opposite sides of this hole are parallel to the top and bottom, but the back is oblique, and determines the obliquity of the standing of the coulter, which is wedged tight up to the poll. The coulter is two feet eight inches long before it is worn; the handle takes up sixteen inches of this length, and is allowed thus long, that the coulter may be driven down as the point wears away. As to the wheels, the left-hand wheel is 20 inches diameter, and that on the right hand two feet three inches, and the distance at which they are set from each other is two feet $5\frac{1}{4}$ inches.

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Patent Sward-cutter, Plates VI. and IX.

2. *The Patent Sward-cutter.*

The different parts of this instrument are represented by fig. 6. Plate VI. and fig. 1. and 2. Plate IX. AA, &c. a square frame three feet four inches from the fore to the hind part, by four feet three inches, the breadth of the machine within side; the timber (when of fir) four inches square, placed on two wheels BB three feet diameter, a little more or less (the old fore-wheels of a chaise may answer the purpose), to support the hind part of the machine.

CC, &c. are six strong pieces of wood, called *bulls*, three feet long, five inches and a half broad, the thickness six inches at E, and tapering to three inches at F. Into these bulls are fixed the cutting wheels, which are iron, 13 inches diameter, $\frac{3}{4}$ths of an inch thick at the centre, about an inch diameter, for piercing holes to fix the iron axles in; from that they are to be of such thickness, as to allow the edges to be well steeled. The wheels are fixed by two bolts going through the bulls, with eyes on one end for the axles of the wheels to run in, and nuts and screws on the other to make them very firm by being sunk in the bulls, to prevent their interfering with the weights LL, &c. resting on them.

GG, &c. are hollow pieces of wood, called *thorles*, each $3\frac{1}{2}$ inches long, which enclose the bolt MM, and keep the bulls CC, &c. at their proper distances, but may be made longer or shorter at pleasure, according as the sward requires to be cut in larger or smaller pieces. They are in two pieces bound together, and jointed by a strap of leather or cord, which allows them to be readily changed when the cutting wheels require to be kept at more or less distance.

The

The iron bolt MM goes through two pieces of wood or iron PP, feven inches long, clear of the wood, fupported by iron ftays fixed to the frame, and through all the bulls. It requires to be ftrong, as the draught of the horfes terminates there. Inftruments of Hufbandry.

HH, fig. 1. and 2. a cylinder or fegment of wood, feven inches diameter, called a *rocking-tree*, which goes acrofs the frame, and moves on the pivots fixed into it, one at each end, fupported by an iron bolt or piece of wood mortifed into the frame, eight inches high, as appears in fig. 1. and 2. to which fix chains or ropes are fixed by hooks, at different diftances, as you want your cuts, nine, eight, feven, or fix inches from one another, and are joined to the end of each bull in which the cutting wheels run; fo that when the rocking-tree is turned about by the lever I, fixed in the middle of it, all the bulls, with their cutting wheels, are raifed out of the ground at once, as in N° 3. by which means the machine may be turned, or moved from place to place with great eafe, without any danger of ftraining the wheels. Plate IX.

LLL, &c. fig. 6. Plate VI. and fig. 1. 2. Plate IX. are weights of freeftone, 26 inches long and fix inches broad; the under one four inches thick, the upper one three inches thick; weighing about 64lb. the under, and 48 the upper, each of them having two holes, through which iron fpikes, firmly fixed in the bulls, pafs, in order to keep them fteady.

When the ground is eafily cut, the under ftone may anfwer; when more difficult, the other ftone may be added; fo that every wheel may have feven ftone weight upon it, which has been found fufficient for the ftiffeft land and tougheft fward the machine has ever

Inftruments of Hufbandry. been tried on. Caft iron weights will anfwer fully better, but are more expenfive.

Plate IX. The lever I, fig. 1. 2. which ought to be five feet long, muft have a fliding rope on it; fixed to the back part of the frame; fo that when the cutting wheels are all taken out of the ground three or four inches, by the rocking tree's being turned partly round by the lever, the rope may be fixed to it by a loop over the pin R, fig. 2. (it ought to be placed three feet four inches from the extremity of the lever I.) Thus all the cutting wheels are kept out of the ground till the machine is turned; and then by moving the loop off the pin, it flips back towards the frame, and the lever is gently let back to its place, as in fig. 1. by which the cutting wheels are put into their former pofture, by the weights fixed on the bulls in which they run. The levers may be made of good tough afh.

Plate VI. PP, fig. 6. a fmall bolt of iron, with a hook on one end of it (one is fufficient), to ftrengthen the bolt MM to be hooked on the centre of it, and joined to the frame by a nut and fcrew.

The grooves in which the cutting wheels run, may be covered below at the hinder part with a plate of thin black iron, 6 inches long, 3 inches broad, having a flit in it where the wheels run, to prevent (if found neceffary) any grafs, weeds, or fmall ftones, from filling the grooves, and clogging the wheels.

To the frame fig. 6. are fixed (for a double-horfe fward-cutter) three fhafts, as in a waggon, of fuch length, ftrength, and diftance from one another, as any workman many think proper.

For a fingle-horfe fward-cutter (which has only four cutting wheels), a pair of fhafts are ufed, and may make

make the two ſides of the frame without any joinings. The width of the frame, in proportion to the double-horſe ſward-cutter, is as four to ſix. Inſtruments of Huſbandry.

It is recommended for a double-horſe ſward-cutter to have eight bulls and wheels, in order that when it is uſed to reduce hard clody ſummer-fallow, or land for barley, before the laſt furrow, or even after it, the whole weight (42 ſtone) employed in cutting the ſtiffeſt land and tougheſt ſward, may be applied to the 8 bulls then at 6 inches from one another. The 64lb. weights to be applied to 6 of the bulls, and two of the 48lb. weights to each of the additional bulls, which is a ſufficient weight for that purpoſe, and will effectually prevent a clod of more than ſix inches breadth from eſcaping being broke into pieces.

In the ſame manner, a ſingle-horſe ſward-cutter may have ſix bulls for the above-mentioned purpoſe; the 28 ſtone belonging to it divided thus: The 64lb. weights to four of the bulls, and two of the 48lb. weights to each of the additional bulls.

That the machine may come as cheap as poſſible to the public, the inventor is of opinion, that the expence of the two wheels and the iron axle (which is conſiderable) may be ſaved, by joining ſtrongly to the frame a piece of wood with a little curve at the extremity of it, reſembling the foot of a ſledge formerly much uſed in Scotland to carry in the corn from the field; the part of it reſting on the ground being kept 18 inches (the half diameter of the wheels) from the frame by a ſtrong ſupport of wood.

As the two outer bulls next the frame are apt to get under it, ſo as to prevent the cutting wheels from being taken out of the ground, a thin ſlip of iron fixed

to

to the infide of the frame, nearly oppofite to the back end of the bulls, of convenient length, will be found neceffary.

The original intention of this machine was to prepare old grafs ground for the plough, by cutting it acrofs the ridges, in the beginning of or during winter, when the ground is foft, in order to anfwer all the purpofes that Mr Tull propofed by his four-coulter plough above defcribed, and fo ftrongly recommended by him for bringing into tilth grafs ground that has been long refted. This the fward-cutter has been found to do much more effectually and expeditioufly: For Mr Tull's machine cuts the fward in the fame direction with the plough; and is liable, from every obftruction any of the coulters meet with, to be thrown out of its work altogether, or the inftrument broken; to which the fward-cutter, confifting of four, fix, or more cutting wheels, is never liable, from thefe being entirely independent of one another, cutting the ground acrofs the ridges before ploughing, and rendering that operation eafier to two horfes than it would be to three without its being cut. The furrow being cut acrofs, falls finely from the plough in fquares of any fize required, not under fix inches, in place of long flips of tough fward feldom and imperfectly broken by the four-coultered plough.

This inftrument is very fit for preparing ground for burnbating, as it will fave much hard labour.

It may be properly ufed in crofs-cutting clover of one or two years ftanding, to prepare the ground for wheat, if the land is ftiff and moift enough.

It may be applied to cutting and crofs-cutting pafture ground, intended to have manure of any kind put

upon

upon it to meliorate the grass. In this it will far exceed the scarificator mentioned in one of Mr Young's tours; as that instrument is liable, as well as the four-coultered plough, to be thrown out of its work when meeting with a stone or other interruption. This the sward-cutter is proof against, which is looked on as its greatest excellence. Instruments of Husbandry.

In preparing for barley, the sward-cutter excels a roller of any kind in reducing the large hard clods in clay land, occasioned by a sudden drought, after its being ploughed too wet; and it is likewise very proper for reducing such clay land when under a summer fallow. In this operation, the sward-cutter is greatly to be preferred to the cutting-roller, likewise mentioned by Mr Young in one of his tours; for the wheels of the latter being all dependent one on another, when one is thrown out by a stone, three or four must share the same fate. Besides, the cutting-roller has but seven wheels in six feet; whereas the sward-cutter has six in four feet three inches, at nine inches distant; and, if necessary, may have them so near as six inches.

After old grass ground is cut across with the sward-cutter and ploughed, it has a very uncommon and worklike appearance, from each square turned over by the plough being raised up an inch or two at the side last moved by the earthboard; so that the field, when finished, is all prettily waved, and resembles a piece of water when blown on by a gentle breeze. By this means a very great deal of the land's surface is exposed to the frost and other influences of the air, which cannot fail to have a good effect on it.

Two horses are sufficient for the draught of a double-

horse

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horſe ſward-cutter, and one horſe for a ſingle-horſe one. One man manages the machine and drives the horſes. He begins his operation by firſt meaſuring off 20 or 30 paces from the machine, leſs or more as he inclines, and there fixes a pole. He then cuts the field croſs, as near at right angles with the ridges as he can. When the cutting wheels are paſt the laſt furrow about a yard or ſo, and the machine is upon the utmoſt ridge of the field on which it muſt turn, he muſt ſtop the horſes; then take hold of the lever I, fig. 1. and by pulling it to him he raiſes the cutting wheels out of the ground, which are kept ſo by the loop of the rope being put over the pin R, in the lever I, fig. 2. till the machine is turned and brought to its proper place, which is done by meaſuring off the ſame diſtance formerly done on the oppoſite ſide of the field. When the cutting wheels are exactly over the outmoſt furrow, then, on the horſes being ſtopped, the rope is ſlipt off the pin R, and the lever returned to its former place, as repreſented fig. 1. which allows the weights LL, &c. to force the cutting wheels into the ground again. He then goes on until the interval betwixt the firſt and ſecond ſtroke of the machine is all cut. In this manner the field is to be finiſhed, after which you may begin to plough when you pleaſe. (N. B. There muſt be a pole at each ſide of the field.)

Plate IX.

It is of no conſequence whether the land to be ſward-cut is in crooked ridges or ſtraight, in flat ridges or in very high raiſed ones. Be the ſurface ever ſo uneven, the cutting wheels, being all independent of one another, are forced by their weights into every furrow or hollow.

One

One ſward-cutter will cut as much in one day as ſix ploughs will plough. Inſtruments of Huſbandry.

The land may lie ſeveral months in winter after being ſward-cut, when there is no vegetation to make the cuts grow together again before it is ploughed; but the ſooner it is ploughed after cutting the better, that it may have the benefit of all the winter's froſt, which makes it harrow better at ſeed time.

When the ground is harrowed, the harrows ought to go with the waves which appear after ploughing, not againſt them, as by that means they are leſs apt to tear up the furrows all cut into ſquares. This, however, need only be attended to the two firſt times of harrowing, as they are called.

Any common wright and ſmith may make the inſtrument. It is very ſtrong, very ſimple, and eaſily managed and moved from place to place; and, if put under cover, will laſt many years.

It was invented ſome time ago by the Honourable Robert Sandilands; and is repreſented in the plate as it has been lately improved by him, the price being at the ſame time reduced from 15l. or 16. to 5l. or 6l.

3. *The Cultivator.*

This inſtrument was invented by Mr William Leſter of Northampton; and that gentleman received, from the Society for the encouragement of Arts, the Society's ſilver medal. The purpoſe of this inſtrument is to pulverize tenacious ſoils that have been once ploughed, in a much more complete and rapid manner than can be accompliſhed by any other inſtrument. It is thus deſcribed, Plate XIII. fig. 3.—A, the beam; BB, the handles; CC, a croſs bar of a ſemicircular form con- The cultivator deſcribed.

taining

Instruments of Husbandry. taining a number of holes, which allow the two bars DD to be placed nearer or further from each other.

DD are two strong bars moveable at one end upon a pivot E, and extending from thence in a triangular form to the cross bar C. In these bars are square holes, which allow the shares F placed therein to be fixed to any height required.

The seven shares marked F, are shaped at their lower extremities like small trowels; the upper parts of them are square iron bars.

GGG are three iron wheels on which the machine is moved; they may be raised or lowered at pleasure.

H, the iron hook to which the swingle-tree and horses are to be fixed.

When the machine is first employed on the land, the bars DD are expanded as much as possible. As the soil is more loosened, they are brought nearer to the centre; the shares then occupy a less space, and the soil will consequently be better pulverized.

In working on a rough fallow, therefore, the cultivator should be set for its greatest expansion, and contracted in proportion as the clods are reduced. The inventor 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. It is requisite in some states of the soil to alter the breadth of the shares, but of this it is presumed that every farmer will be a proper judge. By the expansion and contraction of the cultivator, the points of the shares are in a small degree moved out of the direct line; but this is said to be so trifling as to prove no impediment to its working.

A certificate from Mr William Shaw of Cottenend, near Northampton, ſtates, that he had uſed Mr Leſ-ter's cultivator, upon a turnip fallow in ſummer 1800; and that he believes it to be a very uſeful implement for cultivating the land in a fallow ſtate by its working or ſcuffling off ſeven acres per day with ſix horſes. He adds, that from its property of contracting and expanding, it is calculated to work the ſame land in a rough or fine ſtate, by which means it unites the principles of two implements in one, and by the index on the axis it may be worked at any depth if required. Inſtruments of Huſbandry.

4. *The Brake.*

The brake is a large and weighty harrow, the purpoſe of which is to reduce a ſtubborn ſoil, where an ordinary harrow makes little impreſſion. It conſiſts of four ſquare bulls, each ſide five inches, and ſix feet and a half in length. The teeth are 17 inches long, bending forward like a coulter. Four of them are inſerted into each bull, fixed above with a ſcrew-nut, having 12 inches free below, with a heel cloſe to the under part of the bull, to prevent it from being puſhed back by ſtones. The nut above makes it eaſy to be taken out for ſharping. This brake requires four horſes or four oxen. One of a leſſer ſize will not fully anſwer the purpoſe: one of a larger ſize will require ſix oxen; in which caſe the work may be performed at leſs expence with the plough. Brake deſcribed. Plate III. fig. 2.

This inſtrument may be applied to great advantage in the following circumſtances. In the fallowing ſtrong clay that requires frequent ploughings, a braking between every ploughing will pulverize the foil, and render the ſubſequent ploughings more eaſy. In the month of March or April, when ſtrong ground is ploughed Uſe.

for

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for barley, especially if bound with couch-grass, a cross-braking is preferable to a cross-ploughing, and is done at half the expence. When ground is ploughed from the state of nature, and after a competent time is cross-ploughed, the brake is applied with great success, immediately after the cross-ploughing, to reduce the whole to proper tilth.

Let it be observed, that a brake with a greater number of teeth than above mentioned, is improper for ground that is bound together by the roots of plants, which is always the case of ground new broken up from its natural state. The brake is soon choked, and can do no execution till freed from the earth it holds. A less number of teeth would be deficient in pulverizing the soil.

4. *The Harrow.*

Harrows are too frequently considered as of no use but to cover the seed; but they have another use scarce less essential, which is, to prepare land for the seed. This is an article of importance for producing a good crop. But how imperfectly either of these purposes is performed by the common harrow, will appear from the following account of it.

Imperfection of the common harrow.

The harrow commonly used is of different forms. The first we shall mention has two bulls, four feet long and 18 inches asunder, with four wooden teeth in each. A second has three bulls, and 12 wooden teeth. A third has four bulls and 20 teeth of wood or iron, 10, 11, or 12 inches asunder. Now, in fine mould, the last may be sufficient for covering the seed; but none of them are sufficient to prepare for the seed any ground that requires subduing. The only tolerable form is that with iron teeth; and the bare description of its imperfections will show the necessity of a more perfect form. In the first place, this harrow is by far too light for ground new taken up from the state of nature, for clays hardened with spring drought, or for other stubborn soils: it floats on the surface; and after frequent returns in the same track, nothing is done effectually. In the next place, the teeth are too thick set, by which the harrow is apt to be choked, especially where the earth is bound with roots, which is commonly the case. At the same time, the lightness and number of teeth keep the harrow upon the surface, and prevent one of its capital purposes, that of dividing the soil: nor will fewer teeth answer for covering the seed properly. In the third place, the teeth are too short for reducing a coarse soil to proper tilth; and yet it would be in vain to make them longer, because the harrow is too light for going deep into the ground. Further, the common harrows are so ill constructed, as to ride at every turn one upon another. Much time is lost in disengaging them. Lastly, It is equally unfit for extirpating weeds. The ground is frequently so bound with couch-grass, as to make the furrow-slice stand upright, as when old ley is ploughed: notwithstanding much labour, the grass roots keep the field, and gain the victory.

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A little reflection, even without experience, will make it evident, that the same harrows, whatever be the form, can never answer all the different purposes of harrowing, nor can operate equally in all different soils, rough or smooth, firm or loose. The following, therefore, have been recommended; which are of three different forms, adapted for different purposes. They

 are

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are all of the same weight, drawn each by two horses. Birch is the best wood for them, because it is cheap, and not apt to split. The first is composed of four bulls, each four feet ten inches long, three inches and a quarter broad and three and a half deep; the interval between the bulls 11 inches and three fourths; so that the breadth of the whole harrow is four feet, The bulls are connected by four sheths, which go through each bull, and are fixed by timber nails driven through both. In each bull five teeth are inserted, ten inches free under the bull, and ten inches asunder. They are of the same form with those of the brake, and inserted into the wood in the same manner. Each of these teeth is three pounds weight: and where the harrow is made of birch, the weight of the whole is six *stone 14 pounds, Dutch.* *An erect* bridle is fixed at a *corner of the harrow, three inches high*, with four notches for drawing higher or lower. To this bridle a double tree is fixed for two horses drawing abreast, as in a plough. And to strengthen the harrow, a flat rod of iron is nailed upon the harrow from corner to corner in the line of the draught.

Improved harrows. Plate IV. fig. 1.

Fig. 2. The second harrow consists of two parts, connected together by a crank or hinge in the middle, and two chains of equal length, one at each end, which keep the two parts always parallel, and at the same distance from each other. The crank is so contrived, as to allow the two parts to ply to the ground like two unconnected harrows; but neither of them to rise above the other, more than if they were a single harrow without a joint. In a word; they may form an angle downward, but not upward. Thus they have the effect of two harrows in curved ground, and of one weighty

weighty harrow in a plain. This harrow is composed of six bulls, each four feet long, three inches broad, and three and a half deep. The interval between the bulls nine inches and a half; which makes the breadth of the whole harrow, including the length of the crank, to be five feet five inches. Each bull has five teeth, nine inches free under the wood, and ten inches asunder. The weight of each tooth is two pounds; the rest as in the former.

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The third consists also of two parts, connected together like that last mentioned. It has eight bulls, each four feet long, two inches and a half broad, and three deep. The interval between the bulls is eight inches; and the breadth of the whole harrow, including the length of the crank, is six feet four inches. In each bull are inserted five teeth, seven inches free under the wood, and ten inches and a half asunder, each tooth weighing one pound. The rest as in the two former harrows.

Fig. 3.

These harrows are a considerable improvement. They ply to curved ground like two unconnected harrows; and when drawn in one plane, they are in effect one harrow of double weight, which makes the teeth pierce deep into the ground. The imperfection of common harrows, mentioned above, will suggest the advantages of the set of harrows here recommended. The first is proper for harrowing land that has long lain after ploughing, as where oats are sown on a winter furrow, and in general for harrowing stiff land: it pierces deep into the soil by its long teeth, and divides it minutely. The second is intended for covering the seed: its long teeth lays the seed deeper than the common harrow can do; which is no slight advantage. By placing the seed

Properties of these harrows.

Instruments of Husbandry. considerably under the surface, the young plants are, *on the one hand, protected from too much heat, and,* on the other, have sufficiency of moisture. At the same time, the seed is so well covered that none of it is lost. Seed slightly covered by the common harrows wants moisture, and is burnt up by the sun; beside, that a proportion of it is left upon the surface uncovered. The third harrow supplies what may be deficient in the second, by smoothing the surface, and covering the seed more accurately. The three harrows make the ground finer and finer, as heckles do lint; or, to use a different comparison, the first harrow makes the bed, the second lays the seed in it, the third smooths the clothes. They have another advantage not inferior to any mentioned: they mix manure with the soil more intimately than can be done by common harrows; and upon such intimate mixture depends greatly the effect of manure, as has already been explained. To conclude, these harrows are contrived to answer an established principle in agriculture, That fertility depends greatly on pulverizing the soil, and on an intimate mixture of manure with it, whether dung, lime, marl, or any other.

Plate IV. The *Chain and Screw Harrow.* Fig. 6. is the plan of a harrow invented by Mr Sandilands, and to which he has given the name of the *chain and screw harrow.* Its properties are, that if your ridges be high, and you wish to harrow them from one end to the other, by lengthening the chain (which the screw commands), the harrow, when drawn along, forms an angle downwards, and misses none of the curve of the ridge, so far as it extends (which may be nine feet, the distance from A to B. The extent, in the contrary direction,

rection, is five feet six inches). When the crowns of the ridges have got what is thought a sufficient harrowing lengthwise, you shorten the chain by the screw, which forms an angle upwards; the harrow is then drawn by the horses, one on each side of the furrow; which completely harrows it, and the side of the ridges, if 18 feet broad.

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When you want to harrow even ground or high ridges across with the screw, you can bring the harrow to be horizontal, so as to work as a solid harrow without a joint.

The teeth are formed and fixed in the common manner, square, not in the fashion of coulters; and are nine or ten inches below the wood, and of such strength as it is thought the land requires. The teeth cut, or rather tear, the ground at every four inches without variation, though seemingly placed irregularly; and this without any risk of choking, except sometimes at the extreme angles, where the teeth are necessarily near each other; but which may be cleaned with the greatest ease, by raising them a little from the ground. The figures 1, 2, &c. point out where the 12 teeth on each side of the harrow are placed.

Where a strong brake-harrow is not necessary, by making the teeth shorter and lighter you may have 48 teeth, which will tear the ground at every two inches, cover the seed well, and make a fine mould.

It is recommended, that harrows for every purpose, and of any size, be made on the above principle; by which no tooth can ever follow the track of another, and all of them will be kept constantly acting.

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5. *The Roller.*

The roller. The roller is an inftrument of capital ufe in hufbandry, though, till of late years, fcarcely known in ordinary practice; and where introduced, it is commonly fo flight as to have very little effect.

Rollers are of different kinds; ftone, caft-iron, wood. Each of thefe has its advantages. We would recommend the laft, conftructed in the following manner: Take the body of a tree, fix feet ten inches long, the larger the better, made as near a perfect cylinder as poffible. Surround this cylinder with three rows of fillies, one row in the middle, and one at each end. Line thefe fillies with planks of wood equally long with the roller, and fo narrow as to ply into a circle. Bind them faft together with iron rings. Beech wood is the beft, being hard and tough. The roller, thus mounted, ought to have a diameter of three feet ten inches. It has a double pair of fhafts for two horfes abreaft. Thefe are fufficient in level ground; in ground not level, four horfes may be neceffary. The roller without the fhafts ought to weigh 200 ftone Dutch; and the large diameter makes this great weight eafy to be drawn.

Seafon for rolling. Rolling wheat in the month of April is an important article in loofe foil; as the winter rains preffing down the foil leave many roots in the air. Barley ought to be rolled immediately after the feed is fown; efpecially where grafs feeds are fown with it. The beft time for rolling a gravelly foil, is as foon as the mould is fo dry as to bear the roller without clinging to it. A clay foil ought neither to be tilled, harrowed, nor rolled, till the field be perfectly dry. And as roll-

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ing a clay ſoil is chiefly intended for ſmoothing the ſurface, a dry ſeaſon may be patiently waited for, even till the crop be three inches high. There is the greater reaſon for this precaution, becauſe much rain immediately after rolling is apt to cake the ſurface when drought follows. Oats in a light ſoil may be rolled immediately after the ſeed is ſown, unleſs the ground be ſo wet as to cling to the roller. In a clay ſoil, delay rolling till the grain be above ground. The proper time for ſowing graſs ſeeds in an oat field, is when the grain is three inches high; and rolling ſhould immediately ſucceed, whatever the ſoil be. Flax ought to be rolled immediately after ſowing. This ſhould never be neglected; for it makes the ſeed puſh equally, and prevents after-growth; the bad effect of which is viſible in every ſtep of the proceſs for dreſſing flax. The firſt year's crop of ſown graſſes ought to be rolled as early the next ſpring as the ground will bear the horſes. It fixes all the roots preciſely as in the caſe of wheat. Rolling the ſecond and third crops in looſe ſoil is an uſeful work; though not ſo eſſential as rolling the firſt crop.

Inſtruments of Huſbandry.

In the firſt place, rolling renders a looſe ſoil more compact and ſolid; which encourages the growth of plants, by making the earth adhere cloſe to every part of every root. Nor need we be afraid of rendering the ſoil too compact; for no roller that can be drawn by two or four horſes will have that effect. In the next place, rolling keeps in the moiſture, and hinders drought to penetrate. This effect is of great moment. In a dry ſeaſon, it may make the difference of a good crop, or no crop, eſpecially where the ſoil is light. In the third place, the rolling graſs ſeeds, beſide the foregoing

Effects of rolling.

 advantages,

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advantages, facilitates the mowing for hay; and it is to be hoped, that the advantage of this practice will lead farmers to mow their corn alfo, which will increafe the quantity of ftraw both for food and for the dunghill.

There is a fmall roller for breaking clods in land intended for barley. The common way is, to break clods with a mallet; which requires many hands, and is a laborious work. This roller performs the work more effectually, and at much lefs expence. Let a harrowing precede, which will break the clods a little; and after lying a day, or a day and a half, to dry, this roller will diffolve them into powder. This however does not fuperfede the ufe of the great roller after all the other articles are finifhed, in order to make the foil compact; and to keep out the fummer drought. A ftone roller four feet long, and fifteen inches diameter, drawn by one horfe, is fufficient to break clods that are eafily diffolved by preffure. The ufe of this roller in preparing land for barley is gaining ground daily, even among ordinary tenants, who have become fenfible both of the expence and toil of ufing wooden mells. But in a clay foil, the clods are fometimes too firm, or too tough, to be fubdued by fo light a machine. In that cafe, a roller of the fame fize, but of a different conftruction, is neceffary. It ought to be furrounded with circles of iron, fix inches afunder, and feven inches deep; which will cut even the moft ftubborn clods, and reduce them to powder. Let not this inftrument be confidered as a finical refinement. In a ftiff clay it may make the difference of a plentiful or fcanty crop.

6. The

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6. *The Fallow-cleansing Machine.*

The fallow-cleansing machine. Plate VI. fig. 1.

This was invented by Mr Aaron Ogden, a smith at Ashton-under-Line, near Manchester in Lancashire. It is intended for cleansing fallows from weeds, &c. which exhaust the riches of the soil. A, A, is the frame; B, the first roller; C, the second ditto; in which last are two cranks to move the arms D, D, which work the rake up the directors fixed on the plank E. The under side of the lower ends or shares of these directions are sharp, to cut the clods and let them come on the upper side. Each alternate heel of the share is longer than the intermediate one, that they may not have more than one-half to cut at once. At the back of the plank E are two screws to let it loose, that the directors may be set higher or lower. The shares are to penetrate the ground two or three inches, to raise the quicks till the rake I, I, fetches them into the cart H, where a man must be ready with a muck-hook to clear them backward when gathered. In the rake I are two teeth for every space of the directors, that stones, &c. may be gathered without damage. K, K, are two staples, by which the machine is drawn: under them at *h* are two hooks, placed low to raise the machine in turning, by the help of the traces; and the axle-tree of the cart should be fixed upon a pin, that it may turn like a waggon. F, F, are the triggers to throw the rake behind the roots. The long teeth at G, G, are to cleanse the roller C. I, I, is the rake which gathers up the weeds into the cart H, and is drawn above the trigger F by the working of the arms D, expressed by the dotted lines at *d d*, *i i i*. The triggers F, of which there is one on each side, move on the pivots *a*; so that when the

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Plate VI. fig. 2.

Fig. 3. R is another view of the directors, with the plank E

Fig. 5. on which they are fixed; and S is a section of a part of the plank, with one of the directors as fixed, in which

Fig. 3.

which may be ſeen the heel *m*, from whence to the point of the ſhare *n* is a ſharp cutting edge. See the ſame letters in figure R. At T is one of the long teeth to be ſeen at G; it is bent towards the roller C, which it ſerves to cleanſe. When the end of the rake *b*, after riſing above *c*, is puſhed, by the motion of the arms D, D, along the upper part *e*, *e*, of the trigger F, and comes to the end beyond *a*; as it falls, the part of the arm marked *o* reſts on the notch *p*, till it is again raiſed by the motion of the roller C with the rake. The roller C is to be one foot diameter, the ſpikes nine inches long, that they may go through the furrow (if the ſoil ſhould be looſe) into the hard earth, the more effectually to work the rake, which otherwiſe might be ſo overcharged as to cauſe the roller to drag without turning. In the rake-ends *b* there ſhould be pivots, with rollers or pullers on, to go in the groove, to take off the friction; and they would likewiſe take the triggers more ſurely as the rake comes back. The rake ſhould alſo be hung ſo far backward, that when it is fallen the arms of it may lie in the ſame plane or parallel with the directors, on which it comes up (which will require the frame to be two inches longer in the model). This will cauſe the rake to fall heavier, and drive the teeth into the roots, and bring them up without ſhattering. Theſe teeth muſt be made of ſteel, very fine, and ſo long as to reach down to the plank on which the directors are fixed, that is to ſay, ſix inches long (the directors are alſo to be made ſix inches broad above the plank). The rake-head ſhould alſo fall a little before the crank is at its extremity, which will cauſe the rake to puſh forward to let the teeth come into the roots. The rake-teeth muſt

Instruments of Husbandry. must drop in the same plane with the roller and wheels, or on the surface of the earth. No more space should be given from the roller C to the long teeth at G G than that the rake may just miss the spikes of the roller C and fall on the places before mentioned. As the first roller B was intended to cleanse the second C more than for any other use, it may be omitted when the machine is made in large, as Mr Ogden has lately found that the long teeth at GG answer the end alone, and this renders the machine about a sixth part shorter. Now, to suit any sort of earth, there should be to each machine three planks, with directors at different spaces to use occasionally: in the first, the spaces between the directors should be eight inches wide, in the second six, and in the third four. This will answer the same end as having so many machines.

As there may be some objections to the rake not leaving the roots when it has brought them up, Mr Ogden has several methods of cleansing it; but as he would make it as simple as possible, he chooses to let it be without them at present; but suppose it should bring some roots back again with it, it will probably lose them before it gets back to the extremity; whence they will lie light, and be of but little detriment to the others coming up. Mr Ogden would have the first machine made four feet six inches wide, the teeth divided into equal spaces, the outsides into half spaces.

7. *The new-invented Patent Universal Sowing Machine.*

Universal sowing machine. Plate VII. fig. 2. 3. and Plate VIII. fig. 9.

This machine, whether made to be worked by hand, drawn by a horse, or fixed to a plough, and used with it, is extremely simple in the construction, and not liable to be put out of order; as there is but one movement

movement to direct the whole, nor does it require any skill in working. It will sow wheat, barley, oats, rye, clover, cole-seed, hemp, flax, canary, rape, turnip, besides a great variety of other kinds of grain and seeds broad-cast, with an accuracy hitherto unknown. It is equally useful in the new husbandry, particularly when fixed to a plough; it will then drill a more extensive variety of grain, pulse, and seed (through every gradation, with regard to quantity), and deliver each kind with greater regularity than any drill-plough whatever. When used in this manner, it will likewise be found of the utmost service to farmers who are partial to the old husbandry, as, among many other very valuable and peculiar properties, it will not only sow in the broad-cast way with the most singular exactness, but save the expence of a seedsman; the seed being sown (either over or under furrow at pleasure), and the land ploughed, at the same operation.

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Perhaps a fair and decisive experiment for ascertaining the superior advantage of broad-casting or drilling any particular crop, was never before so practicable; as the seed may now be put in with the utmost degree of regularity, in both methods of culture, by the same machine; consequently, the seed will be sown in both cases with equal accuracy, without which it is impossible to make a just decision.

The excellence of this machine consists in spreading any given quantity of seed over any given number of acres with a mathematical exactness, which cannot be done by hand; by which a great saving may be made in seeding the ground, as well as benefiting the expected crop.

There has always been a difficulty in sowing turnip seed

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feed with any degree of exactness, both from the minuteness of the feed, and the smallness of the quantity required to be sown on an acre. Here the machine has a manifest advantage, as it may be set to sow the least quantity ever required on an acre; and with an accuracy the best seedsman can never attain to.

It will also sow clover, cole, flax, and every other kind of small seed, with the utmost degree of regularity.

It will likewise broad-cast beans, pease, and tares, or drill, them with the greatest exactness, particularly when constructed to be used with a plough.

Another advantage attending the use of this machine is, that the wind can have no effect on the falling of the seed.

Of the Machine when made to be used without a Plough, and to be drawn by a Horse.—It may in this case be made of different lengths at the desire of the purchaser. The upper part AAAA, contains the hoppers from which the grain or seed descends into the spouts. The several spouts all rest upon a bar, which hangs and plays freely by two diagonal supports BB; a trigger fixed to this bar bears a catch-wheel; this being fixed on the axle, occasions a regular and continual motion, or jogging of the spouts, quicker or slower in proportion to the pace the person sowing with it drives; and of course, if he quickens his pace, the bar will receive a greater number of strokes from the catch-wheel, and the grain or seed will feed the faster. If he drives slower, by receiving fewer strokes, the contrary must take place. In going along the side of a hill, the strength of the stroke is corrected by a spring which acts with more or less power, in proportion as the machine is

Plate VII. fig. 2.

more or less from the horizontal poſition, and counteracts the difference of gravity in the bar, ſo that it preſſes, in all ſituations, with a proper force againſt the catch-wheel. This ſpring is unneceſſary if the land be pretty level. At the bottom of the machine is placed an apron or ſhelf in a ſloping poſition; and the corn or ſeed, by falling thereon from the ſpouts above, is ſcattered about in every direction under the machine, and covers the ground in a moſt regular and uniform manner. Inſtruments of Huſbandry.

To ſow the corn or ſeed in drills, there are moveable ſpouts (ſee fig. 8.), which are fixed on or taken off at pleaſure, to direct the ſeed from the upper ſpout to the bottom of the furrow. Plate VIII.

The machine is regulated for ſowing any particular quantity of ſeed on an acre by a braſs ſlider, A, fig. 7. fixed by ſcrews againſt a braſs bridge on each of the ſpouts. The machine is prevented from feeding while turning at the ends, by only removing the lever E, fig. 3. out of the channel G, to another at H, on the right hand of it, which carries back the bar from the catch-wheel, and occaſions the motion of the ſpouts to ceaſe, and at the ſame time brings them upon a level by the action of the diagonal ſupporters; ſo that no corn or ſeed can fall from them. Plate VII.

The machine in this form is particularly uſeful for broad-caſting clover upon barley or wheat; or for ſowing any other kind of ſeed, where it is neceſſary that the land ſhould firſt be harrowed exceedingly fine and even.

Manner of uſing the Machine, when drawn by a Horſe.—Place the machine about two feet from the ends of the furrows where you intend it ſhall begin to ſow.

Instruments of Husbandry. Plate VII.

fow. Fill the hoppers with feed, and drive it forwards with the outfide wheel in the firft furrow. When you are at the end of the length, at the oppofite fide of the field, lift the lever E, fig. 3. into the channel H, and the machine will inftantly ftop fowing. Drive it on about two feet, and then turn. Fill the hoppers again if neceffary; then remove the lever back again into the channel G, and in returning, let the outfide wheel of the machine go one furrow within the track which was made by it, in paffing from the oppofite end; as for example, if the wheel paffed down the eighth furrow from the outfide of the field, let it return in the feventh; and in every following length let the outfide wheel always run one furrow within the track made by the fame wheel: becaufe the breadth fown is about nine inches lefs than the diftance between the wheels.

Let the machine be kept in a perpendicular fituation. If the farmer wifhes to fow more or lefs feed on any one part of the field than the other, it is only raifing the handles a little higher, or finking them a little lower than ufual, and it will occafion a fufficient alteration; and fhould the laft turn be lefs in breadth than the machine, thofe fpouts which are not wanted may be taken up from the bar, and prevented from feeding, by turning the knob above them.

Alfo, when the land required to be fown has what is called a *vent*, that is, when the fides of the field run in an oblique line to the furrows, which by this means are unequal in length; the fpouts muft be taken up or let down in fucceffion by turning the knobs, as that part of the machine where they are placed arrives at the ends of the furrows. This is done while the machine is going forwards.

If

If the land be tolerably level, the machine may be fixed by the ſcrew in the front, and the machine may then be uſed by any common harrow boy. Inſtruments of Huſbandry.

Method of regulating the Machine.—In each ſpout is fixed a bridge (ſee fig. 5. Plate VII.), with an aperture in it, B, for the grain or ſeed to paſs through. This aperture is enlarged or contracted by a ſlider, A, which paſſes over it; and, when properly fixed for the quantity of ſeed deſigned to be ſown on an acre, is faſtened by means of two ſtrong ſcrews firmly againſt the bridge. This is made uſe of in ſowing all kinds of ſeed, where it is required to ſow from one buſhel upwards on an acre. To ſow one, two, three gallons, or any of the intermediate quantities, as of clover, cole-ſeed, &c. the braſs plate, fig. 4. is placed between the bridge and the ſlider, with the largeſt aperture B downwards, which aperture is enlarged or contracted by the ſlider as before. To ſow turnips, the ſame plate is placed between the bridge and the ſlider, with its ſmalleſt aperture A downwards, and the hollow part about the ſame aperture inwards. Plate VIII.

Fig. 6. is a view of the regulator, by which the apertures in the ſeveral ſpouts are all ſet exactly alike, with the utmoſt eaſe, to make them feed equally. The extreme height of the largeſt aperture is equal to the breadth AB, and the breadth at C is equal to the height of the ſmalleſt aperture uſed, viz. that for turnips. The ſide AC is divided into 60 equal parts, and on it moves the ſlider or horſe D; which being placed at any particular degree, according to the quantity of ſeed required to be ſown on an acre, is fixed upon it, by a ſcrew on the ſide of the ſlider or horſe. When this is done, the end of the regulator is put

 through

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through the aperture in the bridge or plate (whichever is intended to be ufed), and the flider againft the bridge in the fpout, raifed by it, till it ftops againft the horfe on the regulator: then the flider is faftened againft the bridge firmly by the two fcrews; care being taken at the fame time that it ftand nearly fquare.

By this means the fpouts (being all fixed in the fame manner) will feed equally.

It is eafy to conceive that the fize of the apertures, and confequently the quantity of feed to be fown on an acre, may be regulated with a far greater accuracy than is required in common practice.

The fpouts may be regulated with the utmoft nicety, in five minutes, to fow each particular feed, for the whole feafon. But a little practice will enable any perfon, who poffeffes but a very moderate capacity, to make the fpouts feed equally, even without ufing the regulator *.

Of

* Proper directions are given with each machine for ufing it, as alfo for fixing the fliders to fow any particular quantity of corn or feed on an acre, fo as to enable any perfon to fet the fpouts.

The prices of the machine (exclufive of the packing cafes) are as follow. If conftructed to be ufed with a fingle-furrow plough; the wheel, with the axle and cheeks fteeled, ftrap, regulator, brafs-plates for broad-cafting or drilling turnips, lucerne, tares, wheat, barley, &c. and every article neceffary for fixing it included, three guineas and a half. If made with a fpring (for fowing on the fide of a hill, where the flope is confiderable), but which is very rarely neceffary, five fhillings more. If made to be fixed to any double-furrow plough, four guineas and a half.

The large machine, fig. 3. Plate VII. when made to broad-caft feven furrows at a time and to be drawn by a horfe, eight guineas and a half. If conftructed to fow five furrows at a time, and to be ufed by hand, fix guineas. Thefe are alfo five fhillings more if made with a fpring.

Of the Machine, when made to be used by Hand.—The difference of the machine in this case is, that it is made lighter, with but three spouts, without shafts, and is driven forwards by the handles. It hath also a bolt in front, which being pushed in by the thumb, releases the machine; so that it can then easily be placed in a perpendicular position. This alteration is necessary to keep the handles of a convenient height, in sowing up and down a hill, where the slope is considerable; and is done while the machine is turning at the end of the length. The method of regulating and using it is the same as when made to be drawn by a horse.

Of the Machine, when constructed to be used with a Plough.—This is, without doubt, the most useful application of the machine; and it can be fixed without difficulty to any kind of plough, in the same manner as to that represented in fig. 2. Plate VII.

The advantages arising from the use of it are great and numerous; for, beside the increase in the crop, which will be ensured by the seeds being broad-cast with a mathematical nicety, a large proportion of seed (the value of which alone, in a few months, will amount to more than the price of the machine) and the seedsman's labour will be saved. The seed may likewise be sown either under or over furrow; or one cast each way, as is practised by some farmers. The seeds also, being cast by the machine upon the fresh ploughed land, may be immediately harrowed in, before the mould has lost any part of its moisture; which in a dry season will greatly promote the crop. In drilling any kind of grain, pulse, or seed, it possesses every property that can be wished for in the best drill-plough, nor will it (as most of them do) bruise the seed, or feed irregularly.

Instruments of Husbandry. gularly. The construction of the machine is the same as the large ones, except being made with one hopper and spout instead of several, and the apron moveable instead of being fixed, as may be seen by inspecting fig. 1. Plate VIII. The only alteration necessary to make the machine broad-cast or drill is, in the former case to place the apron B, fig. 2. Plate VII. at the bottom of the machine, upon the hooks FF, sloping either towards the furrows or the unploughed land, according as it is intended to sow the seed, either over or under furrow. Whenever the apron is required to be shifted, it is done in less than a second of time; as it only requires to be moved up or down with the hand, when a catch fixes it.

To prepare it for drilling, instead of the apron, place the long spout, fig. 8. Plate VIII. upon the brackets, on the front of the machine, by the ears AA, to receive the seed from the upper spout, and fasten the lower end of it, by a small cord, to that hook upon which the apron is hung for broad-casting which is next the plough (see fig. 1. Plate VIII.); the seed will then be directed by the long spout to the centre of the furrow, near the heel of the plough. The spring for correcting the strength of the stroke, is necessary only when they are required to go along the side of a considerable declivity. The machine, when fixed to a plough, does not require the smallest degree of skill in using, as nothing is necessary but to keep the hopper filled, which will contain a sufficient quantity of seed to go upwards of 140 rods, before it will want refilling, when three bushels and a half are sown on an acre. The accuracy with which it will broad-cast, may in some measure be conceived, by considering that the seed regularly descends upon the apron or ſhelf, and is from thence ſcattered upon the ground, in quantity exactly proportioned to the ſpeed of the plough: alſo that each caſt ſpreads to the third furrow: and by this means ſhuts upon the laſt. In this manner it is continually filling up till the whole field is completely covered; ſo that it is impoſſible to leave the ſmalleſt ſpace without its proper quantity of ſeed.

Inſtruments of Huſbandry.

When the plough is wanted for any other purpoſe, the machine, with the wheel at the heel of the plough for giving it motion, can be removed or replaced at any time in five minutes.

Fig. 9. repreſents the machine fixed to a double-furrow creaſing plough, and prepared for drilling. As this plough may not be generally known, it will not be improper to obſerve, that it is chiefly uſed for creaſing the land with furrows (after it has been once ploughed and harrowed); which method is neceſſary when the ſeed is to be ſown broad-caſt upon land that has been a clover ley, &c. becauſe, if the ſeed be thrown upon the rough furrows, a conſiderable part of it will fall between them, and be unavoidably loſt, by lying too deep buried in the earth. This mode anſwers extremely well, and partakes of both methods of culture; the ſeed, though ſown broad-caſt, falling chiefly into the furrows. Plate VIII.

The machine is very uſeful for ſowing in this manner; as the ſeed is broad-caſt, with an inconceivable regularity, at the time the land is creaſed. The advantages it likewiſe poſſeſſes for drilling all ſorts of grain or ſeed with this plough, are too evident to need mentioning.

The machine, when conſtructed to be uſed with a

Instruments of Husbandry double-furrow plough, is made with two upper and two long ſpouts for drilling, two aprons for broad-caſting, and with a double hopper; but in other reſpects the ſame as when intended for a ſingle-furrow plough: it is uſed in all caſes with the greateſt eaſe imaginable.

The interval between the points of the two ſhares of a creaſing plough is uſually ten inches; the beam about nine feet long; and the whole made of a light conſtruction.

Plate VII. *A more particular explanation of the figures.*—Fig. 2. The machine fixed to a Kentiſh turn wreſt plough. A, The machine. B, The apron upon which the ſeed falls and rebounds upon the land, in broad-caſting. C, Lid to cover the hopper. D, Wheel at the heel of the plough. E, Strap. FF, Hooks, upon which the apron turns by a pivot on each ſide. G, Stay, to keep the machine ſteady. H, Lever, to prevent it from ſowing.

Fig. 3. The machine conſtructed to be drawn by a horſe. AAAA, The hoppers. BB, The diagonal ſupporters. CCCC, The upper ſpouts. D, The apron or ſhelf upon which the ſeed falls from the upper ſpouts. E, The lever, which carries back the bar, and prevents the machine from ſowing. FF, Staples upon the handles, through which the reins paſs, for the man who conducts the machine, to direct the horſe by. I, Screw, to fix the machine occaſionally. N. B. The knobs (by turning which each particular ſpout may be taken from off the bar, and thereby prevented from feeding) are over each upper ſpout; but, to prevent confuſion, are not lettered in the Plate.

Plate VIII. Fig. 1. is the ſame machine with that in fig. 2. Plate VII.

VII. The dotted lines, expreffing the fituation of the long fpout, when the apron is removed, and the machine adapted for drilling. Inftruments of Hufbandry.

Fig. 2. Alfo the fame machine, with the front laid open to fhow the infide. A, The catch-wheel fixed upon the axle. BB, The axle upon which the machine hangs between the handles of the plough. C, The pulley, by which the ftrap from the wheel at the heel of the plough turns the catch-wheel. D, the bar, upon which the upper fpout refts, fufpended by the diagonal fupporters EE, bearing againft the catch-wheel by the trigger F, and thereby kept in motion while the plough is going. G, The apron in a floping pofition, upon which the corn or feed falls from the upper fpout, and is fcattered by rebounding upon the land. It turns upon pivots, and by this means throws the feed either towards the right hand or left at pleafure. Plate VIII.

Fig. 3. The upper fpout.

Fig. 4. The plate which is placed between the bridge and the flider, for fowing fmall feeds. The aperture A being downwards for fowing turnips; the larger one B downwards for fowing clover, &c.

Fig. 5. The bridge, fixed in the upper fpouts. A, The flider, which contracts or enlarges the different apertures. B, The aperture in the bridge, through which the feed paffes, when fowing any quantity from one bufhel upwards on an acre.

Fig. 6. The regulator, made of brafs. D, The flider or horfe which moves upon it, and is fixed at any particular degree by a fcrew in its fide.

Fig. 7. reprefents the movement in the machine fig. 3. Plate VII. AAAA, Cleets, between which the up-

ıstruments f Husbandry. per fpouts reft. BB, The diagonal fupporters, by which the bar with the upper fpouts hang. C, The catch-wheel. DD, The axle. E, The trigger upon the bar, which bears againft the catch-wheel. FF, Stays from the back of the machine, by which the bar plays.

late VIII. Fig. 8. The long fpout. AA, The ears by which it hangs.

Of the Thrafhing Machine.

We have already mentioned, that from the remoteft antiquity the practice prevailed and ftill prevails in Afia, of treading out the corn from the ear by means of the feet of cattle. In the United States of America, where human labour is very expenfive, the fame mode of proceeding is ftill adopted. It alfo exifts in the fouthern parts of Europe. Mr Young fpeaks of it as practifed in the province of Languedoc and other parts, in the following terms *.—" *Languedoc.* Through all the fouthern parts of this province they tread out the corn with horfes and mules; a man in the centre of the thrafhing-floor in the open air drives them round, and other men fupply the floor and clear away the ftraw. In fome converfation I had on this method between Narbonne and Niffan, I was affured it was far preferable to the ufe of flails; that 24 mules or horfes, and 12 men, would *depique*, as they term it, 150 feptiers of wheat in a day; that fome farms produce 2000 feptiers of corn. What would flails do for fuch a quantity! I examined the wheat, and did not find it more damaged

* *Travels*, vol. ii.

damaged than with flails; but the climate is to be remembered, which makes the grain much harder than any with us. Seeing some flails going also, I demanded the reason, and was told that the master would sometimes have particular parcels of straw thrashed so, to get the corn that was left in it, if he suspected too much; at others, the labourers desire to do it for themselves, which is sometimes granted.

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"*Provence.*—Seeing a large quantity of the president's wheat spread on cloths for drying in the sun, and inquiring what it meant; I found it was washed, as all is, of which the best bread is made; owing, beyond all doubt, to the mode of threshing, which renders it so foul, that this operation is necessary."

The softness of the grain in our northern climates, together with the superior cleanness of the operation, appears to have introduced at an early period, and to have rendered universal, the practice of separating the grain from the chaff and straw, by means of the flail, consisting of two sticks loosely attached to each other at one end by a rope; the one being held in the hands, while with the other the sheaves of corn are beaten with repeated strokes. The laborious, tedious, and expensive nature of this operation, long induced farmers to wish that some mode could be contrived by means of mechanism, to abridge the toil of beating out the grain by flails. Accordingly, we understand that various attempts were made by ingenious men to construct a thrashing machine.

In particular, about the middle of the late century, Mr Menzies (of Culterallers, we believe, in the upper part of Clydesdale) constructed one which consisted of a number of flails moved by a water wheel. A Mr Stirling of Perthshire, contrived and used another upon the

Instruments of Husbandry. the principles of the flax mill. About the year 1773, a Mr Ilderton at Alnwick erected a machine which acted upon the principle of rubbing or pressing out the corn. At the same time a Mr Oxley at Flodden framed one with skutchers, but of a defective nature, and possessing little * velocity. The late Sir Francis Kinloch of Gilmerton, Bart. brought to Scotland a model of Mr Ilderton's machine, which he sent to be tried by means of the water-wheel of a barley mill, belonging to Mr Andrew Meikle, civil engineer at Houston mill, near Haddington. It was torn to pieces in the trial, and when tried anew upon a larger scale, the same accident occurred. Mr Meikle himself, however, invented the new machine which is at present in use, and which is now known and employed not only in Britain, but also on the continent of Europe, and in America. We have learned with regret, that, like many other improvers of this most important of all arts, Mr Meikle has derived little or no emolument from his invention. The machine has received various improvements, or at least, alterations: but the following is, we believe, upon the whole, one of the most approved forms of its construction. N° 1. N° 2. and N° 3. are drawn to one-fourth of an inch to a foot, and N° 4. and N° 5. are drawn to one-half inch to a foot.

Plate XVI. N° 1. A, The conical wheel, commonly called the horse-wheel, working into a cast-iron pinion C, fixed on the axle D. On said axle is hung or fixed a spur-wheel E, working into a cast-iron pinion H, wedged on the drum spindle S, for driving the drum GGG. On the

* *Farmer's Magazine*, June 1803.

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the other end of the drum ſpindle is fixed a ſmall conical pinion, ſix inches diameter, working two conical wheels, 12 inches diameter, O, fixed upon wrought iron ſpindles XX; on each end of ſpindles is fixed a pinion of ſix inches diameter, O, working a wheel of 12 inches diameter; the one fixed on the axle, for driving or moving the ſhaker F; the other end for driving the caſt-iron feeding rollers I. On the ſaid feeding roller are two ſmall ſpindles K, each with a ſquare ſocket going on the end of the ſpindles or gudgeons, fixed in the ſaid feeding rollers I. On the ſaid ſpindles K are fixed two ſmall pinions ZZ, of equal diameter, for turning of the upper roller I, being about four inches diameter. PP, The two top rails of drum and ſhaker framing, ſupported by the poſts *tt*, in N° 2. LLL, The beams for ſupporting the horſe-wheel axle B. Theſe beams are commonly ſupported from the barn wall, and ſtone pillars built for ſupporting the roof of horſe courſe. *m*, *m*, *m*, *m*, The four levers fixed round the upright axle B that the horſes are yoked to. *n*, *n*, *n*, *n*, *n*, *n*, The arms of the horſe-wheel A. In N° 2. Plate XVII. and N° 3. Plate XVIII. is a wheel R, for ſupporting the arms of horſe-wheel A, &c. S, Bolſter and framing for ſupporting the foot of upright ſhaft.

The ſaid reference for N° 1. deſcribes N° 2. and N° 3.

N° 4. exhibits the corn-bruiſers. Plate XIX.

a, Caſt-iron fly-wheel fixed on the end of one of the rollers *d d*, wrought by a handle *b*. This machine is wrought with a handle, either from the fly or from the caſt-iron ſpur-wheel, C, working the pinions *e e* on the end of the rollers. The handles on the ſpur-wheel *f* may be taken off, and wrought eaſily with one man, Inftruments of Hufbandry.

from the handle on the fl, h. The hopper, b, is fupported between the pofts ff, with a feeding board at the bottom, moved up and down with a pinion of four teeth fixed on the end of one of the rollers, for feeding and fpreading the corn equally between the rollers, dd, where the corn paffes through into a drawer or box e. The rollers dd are regulated by two iron fcrews going through the two pofts ff, to anfwer the bruifing of all kinds of grain.

Plate XIX.

N° 5. is the ftraw-cutter.

A, The fly wrought by the handle B. On the fame axle the fly is on there is an endlefs face-wheel C, working two pinions DD. Thefe pinions are fixed on the end of two fmall iron fpindles, going through the wooden rollers covered with pierced iron, for feeding forward the ftraw through the opening X, where the ftraw or hay is cut by the three knives EEE, fcrewed to the arms of the fly-wheel A. The iron frame F moves from the centre P, with a round eye on each end of the upper roller fpindle, to move the upper roller up and down according to the thicknefs of the feed of the ftraw or hay.

In addition to thefe, fome other inftruments are ufed in agriculture.

Of thefe we may mention the corn fan or *fanners*, which every farmer in Scotland and the north of England poffeffes, and ufes for the feparating his grain from the chaff. It confifts of an oblong wooden box, one end of which is clofe and fomewhat rounded, while the upper half of the other or fquare end is open. The fans are thin pieces of wood fixed to an axle fituated within the box at its rounded end. The axle is turned fwiftly by a handle on the outfide of the box, and

and the fans produce a brisk breeze or stream of air which comes out of the open end of the box. The grain is put into a wooden basket at the top of the box. This basket is of the form of a truncated pyramid with its narrow end lowest. The aperture at its bottom is slightly covered by a false bottom, which is made to move to and fro, when the axle is turned on which the fans are placed, and thus lets down the grain gradually in front of the fans. The heavy grain falls across the steam of air produced by the fans, and is received into a measure placed below, through an aperture at the front of the box. The lighter grain is blown towards the open end of the box, and is taken out from time to time. The chaff is blown entirely out of the box. Instruments of Husbandry.

Carriages of various sorts are also used by farmers; but as these are not peculiar to this, more than to many other branches of business, we account it unnecessary to give a particular description of them. It may be proper, however, to take notice of a most unprofitable practice in many parts of England of using teams or waggons drawn by a great number of horses in farming business. The experience of the most respectable farmers and others, appears now to have demonstrated that the most advantageous mode in which draught horses can be used, consists of employing them in single carts, and that the weight of an additional cart is more than compensated by other circumstances. The following judicious remarks upon the subject have been made by different writers.—" The horses of Cumberland ‡ are not of a large size; one fifteen hands high, of

‡ *Annals of Agriculture*, vol. xxiv.

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of a light form, that will anſwer either for riding or drawing, ſeldom draws leſs in a ſingle-horſe cart than 11 cwt. The common load for a draught horſe of that ſize, is 15 cwt. The carriers from Brompton to Newcaſtle, over a hilly country, carry frequently 18 cwt. We met a boy 18 years old, a carrier from Longton to Newcaſtle, driving five carts, in which were four tons, in each cart 16 cwt. A ſingle horſe cart carries ten pigs of lead of twelve ſtone each, which is 11 cwt. It may therefore be fairly concluded, that a common load for a ſingle horſe cart will be about 15 bwt.

"In moſt countries a two-horſe cart ſeldom carries more than 20 cwt; nor a three-horſe cart more than 30 cwt. In Cumberland, a boy or girl drives two ſingle-horſe carts that carry 30 cwt. Of courſe two horſes yoked in ſingle-horſe carts, will draw as much as three horſes yoked in one cart.

"A common carrier at Carliſle, who many years employed a waggon, has laid it aſide, and now uſes ſingle-horſe carts only; as he finds he can by that means carry much greater weights.

"The ſuperior goodneſs of the roads in Cumberland may in a great meaſure be attributed to the univerſal uſe of ſingle-horſe carts. Wherever waggons are uſed they are the deſtruction of roads, eſpecially in hilly countries where they are obliged to lock the wheels; the banks are in a manner ploughed up with them, and the nine-inch wheels are in reality no more than three-inch wheels, by the artful mode of laying on the middle courſe of tire. Inſtead of being nearly exempted from tolls, every horſe drawing in a waggon ought to pay treble of what ſhould be exacted from a horſe drawing in a ſingle-horſe cart. Of what uſe are waggons except

to

to deſtroy the roads? It is clear that the ſame number of horſes yoked in ſingle-horſe carts will draw more than when yoked ſix or eight together. Single-horſe carts are eaſier loaded and unloaded, are much more handy for almoſt every purpoſe; and ſix or eight may be driven by a man and a boy, which is a trifling additional expence. If a middle-ſized Cumberland horſe draws 15 cwt. a large ſtrong waggon-horſe will as eaſily draw 20 cwt. and which we know is done in ſome parts of the kingdom.

"Few countries can produce examples of greater draughts by a ſingle horſe, on a common road, than Dumbartonſhire. A waggon containing eighty ſtone of hay, 16 lb. to the ſtone, each pound containing 23½ ounces at an average, is an ordinary draught of one horſe to Glaſgow, &c at the diſtance of twelve and fourteen miles. Sometimes the load is 100 ſtone, which is equal to at leaſt 16 cwt. average. Draughts for a ſingle horſe from Leven printfields to Glaſgow, at the diſtance of eighteen or nineteen miles, at one rake, are ſtill greater. The waggon is commonly loaded with goods from 20 to 30 cwt. The ſame horſe generally goes loaded twice a week to Glaſgow, and returns loaded. The waggons employed by the printfields are covered, and conſequently heavier than common waggons for hay or corn.

"Two-horſe carts have gone much into diſuſe, becauſe two horſes in ſeparate carts will carry at leaſt one-third more weight, and with greater eaſe. Whatever part of the load is before the centre of gravity, which is always in the axle, reſts conſtantly on the horſe yoked in the ſhafts. Going down a hill, this burden muſt be greatly increaſed, and always in proportion to the ſteepneſs of the deſcent. But this is not all the evil. Unleſs the

Instruments of Husbandry. line of the draught of the foremoſt horſe be always in the line from the hook of his hams to the middle line of the axle, he will be pulling down the other horſe's back, or, in other words, will be giving him more weight to carry. The traces are generally fixed about the pin of the teams, which throws the line of the fore horſe's draft (behind that pin) a conſiderable angle above the axle. From which it is plain that the horſe in the traces muſt either not draw at all, or muſt bring additional weight on the other horſes; which is always in proportion to the force with which he draws, and the largeneſs of the angle which the line of his draught makes with the line betwixt the hook of his hams and the axle of the cart. Beſides, unleſs the driver be more careful than ordinary to keep the trace horſe to his duty, the other poor animal has not only this great weight to carry, but all the load to draw. In the long plough with four horſes the ſame reaſoning holds (only ſubſtituting the muzzle of the plough for the axle of the cart), as far as the drawing is concerned; and even in a plough with two horſes, unleſs the back-ropes are ſo adjuſted that the theats are in a ſtraight line from the hook of the hams to the ſwingle-tree, the better a horſe draws, the more weight he muſt bring on his back. Skilful farmers indeed ſay that the weight of the furrow muſt in ſome degree reſt on the horſes necks, by means of the back ropes. This may be a reaſon for the theats being ſtraight, but not for their being bent upwards."

SECT.

SECT. II.

OF PREPARING LAND FOR CROPPING, BY REMOVING OBSTRUCTIONS AND BRINGING THE SOIL INTO A PROPER STATE.

1. *Of removing Stones.*

Importance of removing ftones.

It is of the utmoft importance to have land effectually cleared of ftones, before undertaking any agricultural operation upon it; for by means of them there is frequently more expence incurred in one feafon, by the breaking of ploughs and the injury fuffered by the cattle and harnefs, than would remove the evil. It has alfo been obferved that the foil round a large ftone is commonly the beft in the field. It may be confidered as purchafed at a low rate by removing the ftone. At any rate, fuch ftones muft be removed before the ground can be properly cultivated: for whether a large ftone occupy the furface, or lie beneath it, but within reach of the plough, a confiderable fpace around it cannot be ftirred by that inftrument, and is therefore ufelefs. Even the reft of the field where ftones abound muft be laboured in a more flow and tedious manner, on account of the caution neceffary to avoid the danger which they produce.

The ftones which impede the improvement of land are, 1ft, loofe ftones, or fuch as are thrown up to the furface by the plough; and, 2dly, fitfaft ftones, which are either upon or immediately below the furface, but are of fuch magnitude that they cannot be ftirred by

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Modes of removing ftones.

the plough. The firft kind of ftones may ufually be eafily removed by being gathered and carried off. When land is laid down for hay, fuch ftones are often improperly thrown in heaps into the furrows, where they ever after continue to interrupt the plough, or are dragged again by the harrows over the land. Inftead of proceeding in this manner, they ought to be carried wholly off the field in carts at the drieft feafon of the year, and placed in fituations in which they may be rendered ufeful to the farm. In this point of view, ftones are fometimes of confiderable value for making concealed drains, or for making and repairing the roads through a farm, and alfo for the repairs of fome kinds of fences.

The only writer upon agriculture who has in any cafe objected to the propriety of clearing land of fmall ftones, is probably Lord Kaimes. In fome parts of the fouth of Scotland, and particularly in Galloway, the foil is faid to be compofed in a great meafure of gravel, and of ftones of a fmooth furface, as if worn by the running of water. After being ploughed, the whole furface of every field appears to be compofed of loofe ftones lying almoft in contact with each other. Some induftrious farmers, with great labour, collected and removed the ftones from a few of their fields, with a view to their improvement; and the refult is faid to have been, that the fucceeding crops were wholly blighted in the tender blade, and never came to maturity. The ftones upon the furface were fuppofed to have prevented the exhalation of the moifture from the fhallow and extremely porous and open foil which they covered: and they were alfo fuppofed to have contributed to fofter the young plants, by reflecting powerfully from their fmooth fur-

faces

faces the sun's rays in every direction around them: but when they were removed, the soil, in that bleak climate, became at once too cold and too dry for any purpose of agriculture. The farmers, therefore, who had with so much toil and cost removed the stones from part of their lands, could think of no better remedy than, with equal toil, to bring them all back again, and carefully replace them upon their fields. It is added, that the soil immediately resumed its wonted fertility. The truth of this anecdote has never been contested; and there is no doubt that it has long been current in the south of Scotland, both previous to its publication by Lord Kaimes, and after that period, among a class of persons who are very unlikely to have been acquainted with his writings. It is possible that the replacing the stones was the best remedy for the want of fertility in the soil which its cultivators had within their reach: but it is probable that they might have found it of more importance to have covered the surface of their land with a substantial coat of clay marl, or even with almost any kind of earth or clay obtained from the bogs and swamps that usually abound in these countries, providing only they could obtain a quantity of lime to add to it. In this way, possessing land whose bottom was very pervious to moisture, they might have obtained a soil suited to every purpose of agriculture; whereas, in its present state, it must remain for ever unfit to be touched by the scythe.

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With regard to large or sitfast stones which cannot be removed by any ordinary effort, they usually either appear fully above the surface or are concealed immediately under it. For the sake of discovering concealed stones, it is said to be a custom in Yorkshire,

 when

Preparation of Land. when they intend to reduce waſte and rude land under the plough, in the firſt place, carefully to go over the whole ſurface with ſharp prongs, which at the diſtance of every 12 or 14 inches they thruſt into the ground to the depth of above a foot, and wherever a ſtone meets the prong they mark the ſpot with a twig, a bit of wood, or ſome other object. They afterwards trace all the marks, and remove every ſtone before they touch the land with the plough.

Concerning the modes which have been adopted for removing large ſtones out of the way of the plough; one of the ſimpleſt is the following: A pit or hole is dug beſide the ſtone, 16 or 18 inches deeper than the height or thickneſs of the ſtone. A number of men are then aſſembled, who tumble it into the pit. It is immediately covered up with a part of the earth that came out of the hole; and the reſt of the earth is ſcattered over the field, or employed in bringing to a level with the reſt of the ſoil the ſpot where the ſtone formerly lay. As the ſtone now remains at a greater depth than the plough can reach, it is no longer an impediment to agriculture. In performing this operation, however, the workmen muſt attend to the nature of the ſoil, and take care that the weight of the ſtone do not bring down the ſide of the pit, which might be attended with dangerous conſequences. To obviate any hazard of this kind, it is always proper to have at hand a ſtout plank, which ought to be laid acroſs the pit or hole, immediately under the neareſt corner or edge of the ſtone. With this precaution, a ſingle man may uſually perform the whole operation of burying ſtones or pieces of rock of very great ſize and weight.

By the above operation, however, the ſtones are utterly

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terly loſt; whereas they may ſometimes be of conſiderable value for fences or other buildings. When this is the caſe, they muſt be broken to pieces before they are removed. With this view it is to be obſerved, that a great variety of ſtones have ſome thin veins, which being found, wedges can be driven into them by large hammers, ſo that they may be eaſily broken. For ſuch operations ſpades and pick-axes are neceſſary to clear away the earth, and a large and a ſmall lever to turn the ſtones out of the ground. Hammers and wedges are alſo requiſite, with carts, to remove the fragments from the field. In the Statiſtical Account of Scotland, (vol. xix. p. 565. pariſh of Maderty), we are told that "the Rev. Mr Ramſay, the preſent incumbent, who occupies a piece of land full of ſitfaſt ſtones, conſtructed a machine for the purpoſe of raiſing them. It operates on the principles of the pulley and cylinder, or wheel and axis, and has a power as one to 24; it is extremely ſimple, being a triangle, on two ſides of which the cylinder is fixed; it can be eaſily wrought and carried from place to place by three men. A low four-wheeled machine of a ſtrong conſtruction is made to go under the arms of the triangle, to receive the ſtone when raiſed up. This machine has been already of great uſe in clearing ſeveral fields of large ſtones in this place and neighbourhood."

It is evident, that the machine here deſcribed is only valuable for getting ſtones out of the way in the groſs and unbroken; and, accordingly, we learn that ſtone fences are almoſt unknown in the pariſh of Maderty.

Where ſtones are valuable, therefore, and the operation of breaking them with hammers and wedges is eparation of Land.

found impracticable or too laborious, it will be necessary to blast them with gunpowder. To perform this operation properly, however, considerable experience is requisite; for it is said, that a skilful workman can in most instances, by the depth and position of the bore, contrive to rend stones into three equal pieces without causing their fragments to fly about. In time of war, however, the expence of gunpowder is apt to become very great. With a view to diminish the cost of that article, it has been suggested, that it is proper to perform the operation not with gunpowder alone, but with that article of a good quality, mixed up with about one-third of its bulk of quicklime in fine powder. We are assured that this composition possesses as much force as an equal quantity of pure gunpowder, and it is even alleged, that the proportion of quicklime may be increased with advantage. How the strength of gunpowder should be so much augmented by the addition of quicklime, we do not know. Perhaps it may add to the force of the explosion by undergoing a chemical decomposition of its parts, as it has of late been suspected, that this mineral is by no means a simple or uncompounded body.

Where a field is very greatly overrun with concealed stones, the most effectual method of getting quit of them, and of rendering it permanently arable, consists of trenching it wholly by the spade. Nor is this always the most expensive mode of proceeding. The trenching can be done at the rate of from 3l. to 4l. per Scots acre, which is one-sixth larger than an English acre, allowing at the same time the stones or their price at the quarry to the labourers. In this way, the expence of ploughing the field is saved. The soil is deepened

deepened to the utmoſt extent of which it is capable, and can be laid out in the form moſt convenient for cultivation. In Dr Anderſon's report of the ſtate of agriculture in Aberdeenſhire, it is ſaid that the expence of trenching an acre to the depth of from 12 to 14 inches, where the ſtones are not very large and numerous, runs from 4d. to 6d. a fall, which is from 2l. 13s. to 4l. per Scots acre. Ground that has been formerly trenched, is ſometimes done as low as 2d. per fall, or 1l. 6s. 6d. per acre. Hence, in conſequence of the practice of trenching ground by the ſpade being not unfrequent in Aberdeenſhire, workmen have become expert, and by competition have rendered the price extremely moderate. It is to be wiſhed that the ſame practice were more frequent in other parts of the country, as it would have a tendency to introduce a taſte for the moſt correct and perfect of all modes of labouring the ſoil, and would alſo occupy a conſiderable part of the population of the country, in the moſt innocent and healthful of all employments, that of agriculture. Preparation of Land.

2. *Of Draining.*

It has already been remarked, that the preſence of moiſture is of the utmoſt importance to the ſucceſs of vegetation. At the ſame time, as muſt neceſſarily happen with every powerful and active agent, the too great abundance of water is no leſs pernicious to many plants, than an entire want of it. When it ſtagnates upon the ſoil, it decompoſes or rots the roots and ſtems of the moſt valuable vegetables. Even when it does not remain on a ſpot round the whole year, its temporary ſtagnation during the winter renders the land unproductive. Sea- Importance of draining.

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ſons of tillage are often loſt, and in wet years the crop muſt always be ſcanty and precarious. When in graſs, the land can only produce the coarſeſt and moſt hardy vegetables, which can reſiſt the chill or cold ſtate of the ſoil, or the fermentation which is often produced by ſudden warmth while the water remains upon the ground. Hence ariſes the importance of draining, by which arable land is rendered manageable, is made to dry gradually and early in the ſpring, and the corn is increaſed in quantity and weight; and by which, in paſture lands, the graſſes are made to change their colour and to loſe their coarſe appearance, and the finer kinds of plants are enabled to flouriſh. Even the climate is, by means of draining, very conſiderably improved. It is rendered leſs cold during the winter, and by diminiſhing in hot weather the exhalations from the ſoil, its ſalubrity both to animal and vegetable life is greatly increaſed. Every kind of grain comes earlier to maturity. The harveſt is leſs precarious, and the diſeaſes are baniſhed which aroſe from a damp ſoil and a humid atmoſphere.

Land is rendered wet by rain or by ſprings.

The water which ſtagnates upon the ſurface of a ſoil may originate from two cauſes. It may deſcend upon it in the form of rain, or it may aſcend from ſprings or reſervoirs of water in the bowels of the earth. The rules for draining land which is rendered too wet for the purpoſe of agriculture are different, according to the cauſes which occaſion the wetneſs. We ſhall firſt take notice of the moſt approved modes of draining, when the exceſſive moiſture is occaſioned by rain or ſurface water ſtagnating upon the land; we ſhall afterwards ſtate the plan of draining to be adopted, when the wetneſs ariſes from ſprings or water ariſing out of the earth;

and, laſtly, we ſhall give an account of the mode of draining what are called landlocked bogs, from their being ſituated upon a lower level than the adjacent country.

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§ 1. *Of Draining Lands rendered wet by the ſtagnation of rain water upon their ſurface.*

To relieve land from rain water that is apt to ſtagnate upon it, two kinds of drains have been adopted. Of theſe, ſome are called *open drains*, from their being expoſed to view in their whole length. The other kind receives the appellation of *hollow drains*, from their being covered, ſo that their exiſtence is not apparent to a ſtranger, nor is any part of the land loſt in conſequence of their being made. Hollow draining is ſometimes avoided on account of the great immediate expence with which it is attended, and in ſome ſituations it is altogether inadequate to the object in view. There are ſome ſoils that being chiefly compoſed of a ſtiff clay, poſſeſs ſo great a degree of tenacity as to retain water upon every trifling depreſſion of their ſurface, till evaporation carries it off. It is in vain to attempt to drain ſuch ſoils by hollow channels below ground, as the water will never be able to filtrate through the ſoil ſo as to reach the drain. In ſuch ſituations, therefore, open draining is the only mode that can be adopted for clearing the ſoil of ſurface water.

Drains are open or hollow.

Hollow drains, when inapplicable.

It alſo ſometimes happens that on ordinary ſoils, hollow drains would ſpeedily be rendered uſeleſs. This muſt take place where the admiſſion of ſurface water cannot be avoided, and, from the figure of the adjoining lands, muſt be very greatly augmented in time of heavy rains. In ſuch caſes, a cloſe or hollow drain

Preparation of Land. drain would ſpeedily be choked up by the ſand, and ſoil brought down by ſudden and violent torrents. In theſe ſituations, therefore, open drains can alone prove uſeful.

Draining of clay ſoils. Soils formed of a tenacious clay can only be drained by being laid up properly in ridges which are high in the middle, and have furrows at each ſide for carrying off the water. The great art of preſerving land of this deſcription, therefore, free from ſuperfluous moiſture, conſiſts of laying out every field in ſuch a direction as that all the furrows between the ridges may have a gradual deſcent to a common ditch or drain for carrying off the water. Where at any particular ſpot the regularity of the deſcent is interrupted, croſs furrows muſt be kept open with the ſame view. The ridges muſt alſo be laid up in ſuch a form as to allow the water to deſcend from the ſummit in the middle to the furrows on each ſide. If the ridges, however, are too high in the centre, there will be a danger that in heavy rains the ſoil may be waſhed from the ſummit down into the furrows, which would produce the double evil of impoveriſhing the centre of every ridge, and of choking up the furrows, and rendering them unfit to drain the land.

The diſtinguiſhed ſucceſs of the Flemiſh huſbandmen, and alſo of the farmers in the central countries of England where this kind of ſoil abounds, ſufficiently demonſtrates the practicability of preſerving it in a due degree of dryneſs for the moſt valuable purpoſes of agriculture. In theſe Engliſh counties, and in Flanders, the general mode of drying land conſiſts of ploughing it up in high and broad ridges, from 20 to 30, and even 40 feet wide, with the centre or crown three or four

four feet higher than the furrows. By attentively preferving the furrows in good order, and free from ftagnating water, the land is kept in a dry ftate, and all kinds of crops flourifh.

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Draining in the Carfe of Gowrie.

The mode of ridging and crofs-furrowing the clay foil of the Carfe of Gowrie, Perthfhire, has been thus defcribed by George Paterfon, Efq. of Caftlehuntly in that county. "There are certain large common drains which pafs through the diftrict in different directions, fufficiently capacious to receive the water drained from the fields by the ditches which furround them, and of fuch a level as to carry it clear off, and to empty their contents into the river Tay. There are alfo ditches which furround every farm, or pafs through them as their fituation may require, but in fuch manner as to communicate with every field upon the farm. Thefe ditches are made from two to four feet wide at top, and from one and a half to one foot at bottom; a fhape which prevents their fides from falling in: but even then they muft be cleanfed and fcoured every year at a confiderable expence. If the fields be of an uniform level furface, the common furrows between the ridges, provided they be fufficiently deepened at their extremities, will ferve to lay the grounds dry; but, as it feldom happens that any field is fo completely free of inequalities, the laft operation, after it is fown and harrowed in, is to draw a furrow with the plough through every hollow in the field which lies in fuch a direction that it can be guided through them, fo as to make a free communication with any of the ditches which furround the farm, or with any of the furrows between the ridges, which may ferve as a conductor to carry the water off to the furrounding ditches. When this track is once opened

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opened with the plough, it is widened, cleared out, and ſo ſhaped with the ſpade, that it may run no riſk of filling up. Its width is from ſix inches to a foot, according to its depth, which muſt depend upon the level of the field; but the breadth of a ſpade at bottom is a good general rule. It frequently happens that there are inequalities in ſeveral parts of the ſame field, which do not extend acroſs it, or which do not paſs through it in any direction that a plough can follow; but which may extend over two ridges, or one ridge, or even part of a ridge. Such require an open communication to be made with any furrow, which may ſerve as a conductor to carry off the water, which is always made with the ſpade. All theſe open communications are here called *gaas*, and to keep them perfectly clear 'is a very eſſential object of every Carſe farmer's attention."

"It is the general practice in the Carſe to have head-ridges, as they are called, at the two extremities of each field; that is, the ground upon which the plough turns, is laid up as a croſs ridge, higher in the middle and falling off at each ſide, ſo that a gaa is made in the courſe of the inner furrow, with which the whole furrows between the longitudinal ridges communicate, and into which they pour all their ſurface water, which is carried off by gaas or openings cut through the head ridges, and emptied into the adjoining ditches which convey the water to the main drain. Beſides all this, an experienced Carſe farmer takes care that his lands be carefully ploughed, and laid up equally without inequalities that can hold water, and that the ridges be gradually rounded, ſo that the ſurface

water

water may neither lodge nor run ſo rapidly off as to injure the equal fertility of the field." Preparation of Land.

With regard to the general rule for making open drains, it may be obſerved, that their depth and wideneſs muſt always in ſome meaſure be left to the judgement of each particular huſbandman, that they may be varied according to the variety of ſoils and ſituations. Upon the whole, however, the width at bottom ought to be one-third of that at top, that, by being ſufficiently ſloped, the ſides may be in no danger of falling in. The fall or declivity alſo ſhould be ſuch as may carry off the water, without ſtagnation, and along with it any graſs and other looſe and light ſubſtances that may get into the ditch. At the ſame time, care ought to be taken to lead the drain in ſuch a direction down any ſteep declivity that may occur in an oblique manner, that the water may not have too rapid a motion, as it would otherwiſe be apt to form inequalities in the bottom, and to wear down the ſides. In moſs and very ſoft ſoils drains require to be of conſiderable width, on account of their tendency to fill up; and their breadth at top muſt exceed that at the bottom in a greater degree than the proportion already mentioned. In all caſes in which a ditch is intended for a drain only, and not to be uſed as a fence, none of the earth thrown out of it ought to be allowed to remain upon the ſides, but ſhould be ſpread abroad upon the land, or uſed in filling up the neareſt holes. When this is not done, the utility of the drain is injured by the ſurface water being prevented from reaching it, and by the tendency which this weight of earth has to cauſe the ſides to fall in; the difficulty of ſcouring or cleaning it is thus alſo much increaſed. If it be neceſſary, however, to Rules for making open drains.

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use the ditch, and the earth thrown out of it, as a fence, a deep furrow ought to be made along the back of the mound of earth, with openings in convenient places into the ditch for tranſmitting to it the water collected in the furrow.

In plantations, open drains are the only kind that can be uſed, as the roots of the trees would be apt to choke up covered drains. In paſtures, ſmall and narrow open cuts, made with the plough or otherwiſe, are often extremely uſeful, to carry off ſtagnating water and a part of the rain as it falls. The only objection to them is, that they are eaſily ſtopt by the trampling of the cattle; but, on the other hand, they are eaſily reſtored. Concerning all open drains, indeed, it muſt be remembered, that they require to be cleaned out at leaſt once a-year; and when this proceſs is neglected for any length of time, it becomes more difficult, and the drains loſe their effect. Hence, though open drains are originally cheaper, yet, by the neceſſity of annual repairs, they ſometimes become ultimately more expenſive than covered or hollow drains, to the conſideration of which we ſhall next proceed.

Nature and hiſtory of hollow drains.

Hollow drains, in which the water is allowed to flow along a bed of looſe ſtones, or other porous materials that are covered with a bed of earth in which the operations of the plough can proceed, bear a near reſemblance to that part of the conſtitution of nature by which water flows in various channels along beds of porous ſtrata in the bowels of the earth, and coming to the ſurface in various ſituations, ſupplies ſprings and the conſtant flow of rivulets and of the largeſt ſtreams. The practice of hollow draining was known in a very remote antiquity. It is ſaid that the preſent Perſians,

as

as formerly mentioned, are supplied by means of hollow drains with water in their most fertile fields, though they know not from whence the water is brought, and are unacquainted with the arts by which a more ingenious people, in former times, contrived to deprive one part of the soil of its superfluous moisture with a view to enrich another. The ancient Roman writers, Cato, Palladius, Columella, and Pliny, particularly mention the practice of hollow draining. They knew the kind of soils in which these drains are useful, and the propriety of directing them obliquely across the slope of the field. They filled them half way up with small stones, and for want of these with willow poles, or even with any coarse twigs or other similar materials twisted into a rope. They also fortified the heads of their drains with large stones, and their mouths or outlets with a regular building; and they carried the whole drain to the depth of three or four feet. Preparation of Land.

As already mentioned, hollow drains are of little value in a soil that consists of a stiff clay, and are chiefly useful where, from whatever cause the wetness may result, the soil is sufficiently porous to allow the moisture to percolate to an internal drain.

If the field proposed to be drained lie on a declivity, great care should be taken to make hollow drains in a direction sufficiently horizontal to prevent a too rapid fall of the water, which might wear the bottom uneven, and have the effect to choke, or, as it is sometimes called, to *blow up* the drain, whereby in certain spots in the field artificial springs would be formed. Rules for making hollow drains.

Concerning the season for executing drains, discordant opinions are entertained. Some prefer winter, others summer. Where much work is to be accomplished, Preparation of Land. complished, a choice of seasons may not indeed be left to the husbandman. Some farmers, however, when they have the choice of time, always prefer summer for this employment, being then able to execute the cuts in a neater manner without that kneading of the soil which takes place in winter, which they think hurts the usefulness of the drain, by ever after preventing the water from easily finding its way to it; besides, that it is easier to bring the stones or other materials to the spot in summer than in winter. Others, however, prefer draining in winter, because in the case of a clay soil the labour is at that season much easier; and also because labourers are then usually most easy to be obtained.

The depth and width usually adopted for hollow draining is very various, according to the nature of the soil and the situation of the field. When the practice first came into general use, three feet is said to have been the common depth; but, for many years past, it is said that hollow drains seldom exceed 30 or 32 inches, and that more drains are of two feet, or 26 inches deep, than of any other. One general rule, however, cannot be neglected with safety, that the depth must be sufficient to prevent the materials with which the drain is filled from being affected by the feet of horses in a furrow while ploughing; twenty-four inches is perhaps too little for this purpose. A horse's foot in a furrow is usually at the depth of four inches or more. If ten inches additional be allowed for the materials employed in filling the drain, there will remain only nine or ten inches to support the foot of a horse exerting his strength in the act of ploughing, which upon a porous soil seems scarcely sufficient.

 What

What are called *main drains*, which are thofe intended to receive the water of feveral other drains, muft always be fomewhat deeper than the reft, having more water to convey. As to the widenefs of hollow drains, moft farmers have of late been folicitous to render them as narrow as poffible, becaufe by this means a great faving takes place of the materials ufed for filling them. If the ftones are coupled at the bottom of the drain, that is, made to lean towards each other, fo as to conftitute a triangle, of which the bottom of the drain forms the bafe, the width need not be greater than one foot; nor perhaps is it even neceffary to exceed this breadth where large ftones are thrown in promifcuoufly. That the ditches or cuts which are meant to be converted into hollow drains may be executed with neatnefs and care, a point of much importance to their ufefulnefs, it is thought prudent that the workmen fhould not be paid according to the extent of ground which they open, but as day labourers. This, however, is more particularly the cafe with regard to filling the drains, an operation in which a ftill greater degree of attention is neceffary.

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The materials ufed for filling drains have been various, according to the fubftances which different farmers have been able to obtain. Stones, however, are the moft common, and alfo the beft of all materials, on account of their permanency. If ftones from quarries are to be ufed, and the drain formed like conduit at the bottom, the trench muft be made at the loweft part 16 inches wide, containing two fide ftones about fix inches afunder, and the fame in height, with a cap or flat ftone laid over, which fecures the cavity. Such hollow drains are commonly ufed for permanent currents

Materials with which hollow drains may be filled.

Preparation of Land. rents of water from ſprings, and are more expenſive than where no ſuch ſteady current exiſts, and the ſtones are either thrown in promiſcuouſly, or laid down ſo as to form triangular cavities. Small ſtones, however, ought not to be uſed for the bottom of a drain. Whether the ſtones are large or ſmall, they ought to be very clean, having no clay or earth adhering to them, and of the moſt hard and permanent quality that can be procured, with as little tendency as poſſible to moulder or decay in conſequence of alternate changes from wet to dry. They ought alſo to be laid in carefully, ſo as not to tumble down any earth, which might choke up their interſtices. The whole ſubject, however, will be better underſtood by a ſtatement of the way in which drains have been filled with ſucceſs by intelligent perſons.

The following directions are given by T. B. Bayley, Eſq. of Hope, near Mancheſter: "Firſt make the main drains down the ſlope or fall of the field. When the land is very wet, or has not much fall, there ſhould in general be two of theſe to a ſtatute acre; for the ſhorter the narrow drains are, the leſs liable they will be to accidents. The width of the trench for the main drains ſhould be 30 inches at top, but the width at the bottom muſt be regulated by the nature and ſize of the materials intended to be uſed. If the drain is to be made of bricks, 10 inches long, 3 inches thick, and 4 inches in breadth, then the bottom of the drain muſt be 12 inches; but if the common ſale bricks are uſed, then the bottom muſt be proportionably contracted. In both caſes there muſt be an interſtice of one inch between the bottom brick and the ſides of the trench, and the vacuity muſt be filled up with ſtraw, ruſhes, or looſe loofe mould. For the purpofe of making thefe drains, I order my bricks to be moulded 10 inches long, 4 broad, and 3 thick; which dimenfions always make the beft drain." Preparation of Land.

The method which this gentleman purfues in conftructing his main drains is ftated by him to be the following: When the ground is foft and fpongy, the bottom of the drain is laid with bricks placed acrofs. On thefe, on each fide, two bricks are laid flat, one upon the other, forming a drain fix inches high, and four broad, which is covered with bricks laid flat.—When the bottom of the trench is found to be a firm and folid body, fuch as clay or marl, he formerly thought that it might not be neceffary to lay the bottom with brick; but in this he has candidly acknowledged that he was quite wrong. By the runs of water, the alternate changes from wet to dry, and the accefs of air, thefe hard bottoms were rendered friable, crumbled away, and let in all the drains, and allowed them to choke up, that were not fupported by a bottom laid with brick or ftone. When ftones are ufed inftead of bricks, Mr Bayley thinks that the bottom of the drain fhould be about eight inches in width; and in all cafes the bottom of main drains ought to be funk four inches below the level of the narrow ones, whofe contents they receive, even at the point where the latter fall into them.

The main drains fhould be kept open or uncovered till the narrow ones are begun from them, after which they may be finifhed; but before the earth is returned upon the ftones or bricks, it is advifable to throw in ftraw, rufhes, or brufhwood, to increafe the freedom of the drain. The fmall narrow drains fhould be cut

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at the diſtance of 16 or 18 feet from each other, and ſhould fall into the main drain at very acute angles, to prevent any ſtoppage. At the point where they fall in, and 8 or 10 inches above it, they ſhould be made firm with brick or ſtone. Theſe drains ſhould be 18 inches wide at the top, and 16 at bottom.

A mode of draining clay ſoils wet by rain or ſurface water, practiſed by Sir Henry Fletcher, Bart. with great ſucceſs, ſeems worthy of being here ſtated. The upper ſoil is of good quality; but being ſituated in a mountainous part of the country, the frequent rains kept the upper ſoil ſo full of water, that it produced only a coarſe graſs worth 3s. per acre. The inferior ſoil of clay was of great depth. The mode of draining which has been ſucceſsfully practiſed upon it is the following: "On graſs lands he digs 22 inches, or 2 feet deep; the firſt ſpadeful is of the turf, taken ſo deep, as where it ſeparates from the clay, which is dug carefully out, and preſerved unbroken graſs ſide up, and laid on one ſide of the cut; then, with a very ſtrong ſpade, 18 inches long, 6 inches wide at top, and 2 at the bottom, he digs a ſpadeful in the clay, which the men ſpread about the land, on the ſide of the drain oppoſite to where the turfs were laid, as far as poſſible from the drain, ſo as none may get in again. A ſcoop, to clear out the fragments in the bottom, follows, which are alſo ſpread in like manner. They are then ready for filling; and in doing this, he takes three ſtones of a thin flat form, two of which are placed againſt the ſides of the drain, meeting at bottom; and the third caps the other two. Thus, a hollow triangular ſpace is left to convey the water, which is ſubject to no accidents that can fill it up or impede the current.

current. Stones always ſink deeper in the ground; and in the common method, this frequently cauſes ſtoppages by their being partly buried in the clay: but the triangle, when it ſubſides, does it regularly, and keeps its form and the paſſage for the water clear. One cart-load of ſtones, in this way, will do a conſiderable length of drain. They are carefully laid down by the ſide of the cut, with a ſhovel or baſket, and if there are any ſmall refuſe ſtones left on the ground after the drain is ſet, they are thrown in above. The ſtones being thus fixed, the ſods are then trimmed to the ſhape of the drain, and laid on them with the graſs ſide downwards, and none of the clay uſed in filling up.

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The expence is a halfpenny per yard, the men earning 2s. and 2s. 6d. per day, at 10 yards diſtance from drain to drain. At 6 yards diſtance they anſwered well, but would not operate a cure, if more than 7 yards aſunder. At this laſt diſtance, therefore, the expence of draining an Engliſh acre, at ½d. per yard. would amount to 1l. 9s. 2d. the ſtones being not more than half a mile diſtant.

Not only ſtones and bricks, but alſo wood and other materials have been uſed for filling drains. Upon this point, Lord Petre expreſſes himſelf thus: "The drains filled with wood, and covered as uſual with ſtraw or ruſhes, are preferable to ſtones or any other kind of materials; the reaſon is, as the wood decays, the water continues to paſs. When filled with ſtones, and the drains ſtop up, which muſt be expected to take place in time, the earth becomes quite ſolid round the ſtones, and as they do not decay, the filtering of the water is for ever obſtructed: not ſo when buſhes or wood are

 uſed;

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used; continual filtering and draining are then for ever to be perceived; and by repeating the operation a second time, cutting the drains transversely of the old ones, the benefit of the filterings through the rotten wood is secured, and the spewing up of old, broken, and damaged drains corrected and carried off. Moreover, as bushes form a much greater number of cavities than either stones or poles, they are less liable to stop up, and encourage filtering more than larger and more solid bodies. A load of bushes containing 120 faggots, will do about 360 rods; and a load of straw containing 120 bottles, the same: the load of bushes is generally worth about 14s. and the straw 18s. per load. I therefore calculate this expence about 12s. per acre, ditches a rod apart." "

Richard Preston, Esq. of Blackmore, prefers, on twenty years experience, black thorns to every other material for filling drains. Wood is sometimes used with this view, in the following manner: Two billets are placed at opposite sides of the drain, and each is made to rest upon the opposite side to that on which its lower part stands, so as to form with each other a St Andrew's cross. The upper part of the cross is filled with brushwood, laid longitudinally, above which straw is placed cross-ways, and the mould is thrown in over all.. This kind of drain is said to have continued running in Berwickshire for 30 years, and it is recommended by the author of the Agricultural Report of the county of Caermarthen, in Wales. He says, "The completest method I have yet known, is to cut the strongest willows, or other aquatic brushwood, into lengths of about 20 inches, and place them alternately in the drain, with one end against one side of the bottom,

tom, and the other leaning againſt the oppoſite ſide. Having placed the ſtrong wood in this manner, I fill the ſpace left between them on the upper ſide with the ſmall bruſhwood, upon which a few ruſhes or ſtraw being laid, as before mentioned, the work is done. Willow, alder, aſp, or beech boughs, are exceedingly durable if put into the drain green, or before the ſap is dried; but if they are ſuffered to become dry, and then laid under ground, a rapid decay is the conſequence. I have ſeen willow taken out of a bog, after lying there thirty years, and its bark was as freſh and ſappy as if it had been recently cut from the hedge; and it is well known that beech laid green in the water will continue ſound for any length of time."

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Another method of uſing wood conſiſts of fixing at every foot diſtance in the drain, a ſtick in the form of a ſemicircular arch, and of laying upon theſe longer branches or twigs longitudinally. Thus is a curved cavity, or arch, formed beneath, capable of ſupporting any weight of earth. For this purpoſe young wood is recommended, and in particular the prunings of larch.

Inſtead of wood or ſtone, in many places, it has of late become cuſtomary to fill the loweſt part of drains with ſtraw, and with that view to make uſe of wheat ſtubble as the cheapeſt kind of ſtraw. On this ſubject, Mr Vancouver, in his Report of the Eſſex huſbandry, remarks, that when the ſoil is a very cloſe and retentive clay, the drains ſhould be made proportionally near to each other, ſhallow, and filled with ſtraw only, it being totally unneceſſary to uſe wood or any more durable material upon land where the ſides of the drains are not likely to crumble in. He aſſerts that drains

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formed in this manner, through the tough and retentive clays, will be found in a short time after the work is finished, to afford over the straw, with which the drain was filled, an arch of sufficient strength to support the incumbent weight of the soil, and the casual traffic of the field. "In 12 or 18 months it may be observed that the straw, being of one uniform substance, is all rotted, and carried away, leaving a clear pipe through the land in every drain, into which the passage of the water may have been much facilitated, by a due attention to the filling of the drains with the most friable and porous parts of the surface the field might have afforded."

An improvement in filling hollow drains with straw, consists of twisting the straw into a rope, said to have been devised by Mr Bedwell, of Essex. The rope of straw is formed as large as a man's arm, and is placed at the bottom of the drain. The expence of draining an English acre of land with this material in Essex, is said to stand thus:

For cutting and raking together an acre of wheat stubble, generally sufficient for an acre of drains, - -	L. 0	2	0
Digging eight score rods of drains,	0	13	4
Filling them up with stubble, -	0	2	8
Extra work with the common spade, on an average a day's work for a man, -	0	1	4
	L. 0	19	4

As in some situations it is an object of great importance to save the expence of materials commonly used in filling drains, a variety of devices have with that view been

been adopted. One of these is of the following nature. A drain is first dug to the necessary depth, narrow at bottom. Into the trench is laid a smooth tree, or cylindrical piece of wood, 12 feet long, 6 inches diameter at the one end, and 5 at the other, having a ring fastened into the thickest end. After strewing a little sand upon the upper side of the tree, the clay or toughest part of the contents of the trench is first thrown in upon it, and thereafter the remainder of the earth is fully trod down. By means of a rope through the ring the tree is then drawn out to within a foot or two of the smaller or hinder end, and the same operation is repeated till the whole drain is complete. Such a drain is said to have conducted a small run of water a considerable way under ground for more than 20 years without any sign of failure.

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Sod or pipe drains.

What is called the sod or pipe drain consists of a trench dug to a proper depth; after which a last spadeful is taken out in such a way as to leave a narrow channel, which can be covered by a sod or turf dug in grass land and laid over it, the grass side downwards. Such drains are said to continue hollow, and to discharge well for a great number of years. Mosses are said to be drained in Lancashire nearly in the same manner, by leaving shoulders about a foot and a half from the bottom of the trench, and laying across these pieces of dryed peat or turf, cut into lengths of 16 inches, and 8 or 9 inches in breadth.

In Buckinghamshire, in grass lands, the sod drain is thus made: When the line of drain is marked out, a sod in form of a wedge is cut, the grass side being the narrowest, and the sods being from 12 to 18 inches in length. The drain is then cut to the depth required, but

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but is contracted to a very narrow bottom. The sods are then set in with the grass side downwards, and pressed as far as they will go. As the figure of the drain does not suffer them to go to the bottom, a cavity is left, which serves as a water course; and the space above is filled with the earth thrown out.

Another invention for draining land is described in the agricultural report of the county of Essex. It consists of a draining wheel of cast iron, that weighs about 4 cwt. It is 4 feet in diameter, the cutting edge or extremity of the circumference of the wheel is half an inch thick, and it increases in thickness towards the centre. At 15 inches deep it will cut a drain, one half of an inch wide at the bottom, and 4 inches wide at the top. The wheel is so placed in a frame, that it may be loaded at pleasure, and made to operate to a greater or less depth, according to the resistance made by the ground. It is used, in winter, when the soil is soft; and the wheel tracks are either immediately filled with straw ropes and lightly covered over with earth, or they are left to crack wider and deeper till the ensuing summer; after which the fissures are filled with ropes of straw or of twisted twigs, and lightly covered with the most porous earth that is at hand. Thus, upon grass or ley lands, hollow drains are formed at a trifling expence, which answer extremely well. It is said that 12 acres may be fully gone over with this draining wheel in one day, so as to make cuts at all necessary distances.

On sheep pastures a still simpler mode of removing surface water is said to be practised in some places. Wherever the water is apt to stagnate, a deep furrow is turned up with a stout plough. Thereafter, a man

with

with a ſpade pares off the looſe ſoil from the inverted ſod, and ſcatters it over the field, or caſts it into hollow places. The ſod thus pared and rendered thin, or brought to the thickneſs of about three inches, is reſtored to its original ſituation, with the graſſy ſide uppermoſt, as if no furrow had been made. A pipe or opening is thus formed beneath it two or three inches deep in the bottom of the furrow, which is ſufficient to diſcharge a conſiderable quantity of ſurface water which readily ſinks into it. Theſe furrows, indeed, are eaſily choked up by any preſſure, or by the growth of the roots of the graſs; but they are alſo eaſily reſtored, and no ſurface is loſt by means of them.

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Duration of hollow drains.

With regard to the duration of hollow drains, or the length of time that the water will continue to flow in them, and thereby to preſerve the ſoil in a proper ſtate of dryneſs, it muſt neceſſarily depend, in a great degree, upon the nature of the materials with which they are filled, and the care that has been taken to prevent their being choked up by any acceſſion of ſoft ſoil. Independent of this laſt circumſtance, a drain filled with ſtones, like the channel which ſupplies a natural ſpring, may endure for ever. Wood, with which many drains have of late years been filled, periſhes at certain periods according to its nature; but it does by no means follow, that the drain ſhould loſe its effect in conſequence of the deſtruction of the wood. If the earth over it form itſelf into an arch, the water will ſtill continue to flow. Accordingly, it is ſaid, that drains filled with buſhes and ſtraw have been known to run well after 40 years.

§ 2

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§ 2. *Of Draining Lands rendered wet by springs.*

Drains when the wetnefs is caufed by fprings.

Having thus ftated the various modes that have been moft fuccefsfully adopted for draining lands of a fuper-abundant moifture caufed by rain or furface water, we fhall proceed to confider the way in which a foil may ufually be drained when its undue wetnefs is the confe-quence of natural fprings, or of water arifing out of the bowels of the earth.

Nature of fprings.

To underftand the principles upon which land, ren-dered wet by fprings, may be drained for the purpofes of agriculture, it is neceffary to attend to the materials of which the globe we inhabit is compofed, and to the manner in which large quantities of water find their way into its bowels. The earth upon which we tread is by no means an uniform mafs of matter. It confifts of various layers or ftrata of different fubftances, one placed over the other. Thefe layers or ftrata are fel-dom fituated horizontally, but almoft always defcend towards one fide or the other. One part of a ftratum or layer often afcends and appears on the furface, while the other end or fide of it defcends obliquely to a great depth into the earth. Having done fo, it fre-quently again bends upwards towards the furface; and indeed affumes almoft all the variety of irregular forms and bearings that the imagination can conceive; fome-times fuddenly breaking off and giving place to other ftrata or layers, and fometimes continuing at one cor-ner while the greater part of it ceafes. Thefe ftrata or layers, of which the earth is compofed, may be con-fidered, with a view to the explanation of our prefent fubject, as of two kinds. Some of them are porous, and allow water to pafs through their fubftance, and to

fill

fill up all their cavities and interſtices, ſuch as ſand, gravel, ſome marls, and various kinds of porous rocks. Other layers, on the contrary, do not ſuffer water to enter into them; ſuch as clay, or gravel with much clay mixed with it, and rocks of a cloſe and compact nature, without any fiſſures or clefts in them.

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It is next to be remarked, that it is chiefly upon high mountains that water exiſts, or is formed, in very great abundance. Not only do the mountains catch and break the paſſing clouds, which depoſite upon them the greateſt portion of their watery contents, but they would ſeem to have a power, when neither rain nor clouds appear in the ſky, of condenſing, attracting, or ſomehow forming water from the atmoſphere. In the great burning deſerts of Africa rain is ſcarcely known. The inhabitants build their houſes of clods of earth or of lumps of ſalt. A drizzling ſhower, which is apt to come once in ſeveral years, endangers every dwelling; and two hours heavy rain would lay a whole city in ruins; yet even there, wherever mountains exiſt, that is to ſay, naked rocks which abound in a few diſtricts of this wilderneſs, water is almoſt always found in their vicinity; and, in conſequence of the water, ſpots covered with the moſt luxuriant verdure are ſeen like iſlands amidſt the dreary tracts of moveable and unproductive ſand.

The upper part of mountains is very frequently covered with a layer of gravel, or looſe and open rock, into which water readily penetrates. Theſe porous layers or ſtrata deſcend gradually into the bowels of the earth, and convey along with them the water which they contain, and have received from the clouds. Under the porous ſtratum or layer of gravel are uſually

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ly layers of clay or of folid rock, through which the water cannot pafs, but along the upper part of which it flows. After defcending, however, a certain length obliquely down towards the plain country, the layers of porous gravel ufually pafs under new layers or ftrata of clay and other impervious materials. Thus, as the water in the gravel is confined between clay above and clay or rock below, and muft defcend along the gravelly channel which is pervious to it, ftreams of water are formed in the bowels of the earth, which have their origin in high gravelly foils, and their outlets at any place in the low country, where any part of the beds of gravel or porous rock, along which they flow, happens to approach the furface, forming fprings and rivulets, and, by their union or conflux, mighty rivers, which continue fteadily to water the furface of the earth. Hence alfo, in very many fituations, by digging pits into the earth, we at laft reach a layer of pervious gravel or rock, containing a ftream of water brought, perhaps, from the fummit of a diftant mountain; and fuch pits can be ufed as wells for fupplying water for every domeftic purpofe.

We have faid that the upper part of the face of a mountain is often covered with a bed of porous or gravelly fubftances capable of taking in water. Upon the furface, at a certain diftance down the hill, a bed of clay begins. The water received above into the layer of gravel continues to defcend with that layer for a confiderable fpace below the bed of clay; and thereafter the gravel fuddenly ftops, and the clay above unites with the clay beneath, or with fome other impervious ftrata upon which the gravel all the way refted. In this fituation, as the water contained in the gravel can proceed no farther, it hangs within the ſide of the hill as in a bag of clay; and a reſervoir is formed of water within the earth. When this bag or natural reſervoir is full, the water contained in it is preſſed upwards againſt the clay by which it is covered. It moiſtens this clay, and finds its way by chinks through all its weaker parts or pores. Thus a belt of ſoft and ſpouty land is formed upon the ſide of the hill; the mode of draining which is very eaſy. If a hole is dug into the earth near the bottom of the bag or reſervoir of water, ſo as to reach the layer of gravel, the water will inſtantly flow freely out, and, being no longer reſtrained, it will ceaſe to preſs upon the layer or ſtratum of clay that covers it, or to force a paſſage through its chinks; and the ſoil will conſequently be drained.

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Principle on which land made wet by ſprings is drained.

Let it be ſuppoſed, that the porous ſtratum or layer of gravel, inſtead of ſtopping on the ſide of a hill, deſcends into a plain or level country, the water all the while paſſing along in its bowels; and that the gravel has a layer of clay below and another layer of clay above it. After it has reached and paſſed to a conſiderable diſtance along the valley, if the layer of gravel either ſuddenly ſtop and allow the layers of clay to come together, or if the gravel have too little thickneſs and capacity to allow the water which flows within it to paſs eaſily along, it will neceſſarily, from the new ſupplies of water which are continually deſcending, be preſſed upwards againſt the layer of clay which covers it: as, in the former caſe, the clay will be ſoftened, and the water will filtrate through all its weaker parts till it reach the ſurface, which it will keep conſtantly wet, and where it will ſtagnate in conſequence

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ſequence of the flat and level form of the country. Over the ſofteſt places, a coarſe verdure will ſpread, and the roots of the plants intertwining, will form ſhaking quagmires. In other places, the moſs plants, being the only ones which can thrive in the moiſt and ungenial ſoil which is thus produced, will rapidly ſpring up, and a moſs will be formed altogther unfit for any purpoſe of agriculture. To drain ſuch a ſoil, it is evidently only neceſſary to dig a pit or hole through the upper ſtratum of clay into the gravel, to give a free vent or iſſue to the water; which having thus found an eaſy paſſage to the open air, will ceaſe to preſs upon the incumbent layer of clay, or to render it moiſt. This clay will therefore ſpeedily become dry and collapſe; the moſs plants will wither, provided the ſurface is properly drained; and the whole ſoil will become ſolid and fit to be cultivated.

It ſometimes happens, as already noticed, that a piece of territory which lies low is rendered extremely wet by rain and ſpring water coming from adjacent high grounds, and lodging upon its ſurface, while, at the ſame time, it is ſo completely ſurrounded by eminences, or land-locked, that it cannot be drained at a moderate coſt; the conſequence of which is, that the water ſtagnates, and a moſs or bog is formed. The practical mode of draining ſuch a bog will be afterwards explained. In the mean time it may be remarked in paſſing, that the principles which we have already ſtated concerning the manner in which the globe is made up of various ſtrata, indicate the way in which ſuch a bog may be drained at a cheap rate. It is only neceſſary to dig a pit at the loweſt part of it, down through the clay, or other impervious layer that holds up the water, till a porous ſtratum

stratum is reached capable of conveying away the surface water down the country below ground to the sea, or to such rivers as it may chance to be connected with.

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The whole art of draining land where the wetness is occasioned by water pressing upwards from the bowels of the earth, depends upon these principles. It is an art whose importance is not yet sufficiently appretiated, because imperfectly understood, and because it has not yet been carried in practice to its full extent. It is probable, however, that at no remote period it will be held in universal estimation, on account of the command of those hidden streams that are contained in the bowels of the earth, which it will give to mankind for the purposes of an improved agriculture, and for the service of commerce in filling canals and giving motion to every kind of machinery. A dispute exists about the original discovery of this art. The celebrated writer upon agriculture, Dr James Anderson of Aberdeen, in his "Essays on Agriculture and Rural Affairs," published in 1775, was undoubtedly the first person who explained to the world the nature of the art of draining land rendered wet by springs, and the principles upon which it ought to proceed; having been led to the investigation many years before, by his having fortunately succeeded in draining a bog by a sinking a pit in it through the clay till an opening was made into the gravel or porous stratum, from which the water rushed up vehemently. In the mean while, it had happened that Mr Joseph Elkington, possessor of a farm in England called Princethorp, in the parish of Stretton upon Dunsmore, and county of Warwick, almost as early as Dr Anderson, had accidentally discovered that land might be drained in many situations by making a small hole into the earth.

Dispute about the first discoverer of the mode of draining land made wet by springs.

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Being a man of considerable natural ingenuity, though, it is said, of little literature, he had the address to take advantage of the discovery he had made, with a view to the improvement of his affairs. He therefore commenced the trade of a drainer of land; and by the novelty of draining land by a small hole bored often at a considerable distance from the wettest part of it, and by conducting himself in a mysterious manner, he acquired great reputation, and was extensively employed. This employment he appears to have merited, as his operations were attended with very great success. After the establishment of the Board of Agriculture, its members, who appear to have been unacquainted with Dr Anderson's publication, supposed Mr Elkington to be the only discoverer and possessor of the art of draining land wet by springs in the way now mentioned; and upon their recommendation, parliament bestowed a reward of 1000l. upon him. It was surely an unfortunate circumstance, that the first premium granted uppon the recommendation of this board, should have proceeded upon a error, as it undoubtedly did; for although Mr Elkington had the merit of being the first who introduced this art extensively into practice, there is no doubt that Dr Anderson, by whom also it was discovered, was the first who explained its principles to the public, and that at a period when Mr Elkington's secret remained with himself. After all, however, it is not to be supposed that the theory of this art was absolutely unknown, although these persons appear to have been the first who proposed to apply it extensively to the purposes of agriculture. It is said that the practice is very ancient in Italy, when a well is dug, to avoid the expence of going to a great depth, by bor-

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ing with an auger in the bottom of the pit, in the hope of reaching the porous ſtratum which contains the water. And in Germany it appears, as will be afterwards noticed, that the practice has long exiſted of draining land-locked bogs, by letting down the water by means of a pit through the impervious clay, to a porous ſubſtratum.

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We ſhall now proceed to ſtate the moſt approved practical modes of draining land that is rendered wet by ſprings, or water aſcending out of the earth; and as the Board of Agriculture inſtructed Mr John Johnſton, land ſurveyor, to inſpect Mr Elkington's principal drainings of this ſort, and to give an account of them, we ſhall give all due attention to the contents of the report made out by that gentleman, which is underſtood to have been executed with much fidelity and accuracy; though we ſhall alſo exhibit, at the ſame time, the practice of other intelligent perſons upon the ſame ſubject.

Practical rules for draining land made wet by ſprings.

In the practice of this art it will readily occur, that it is of the utmoſt importance to obtain a knowledge of the internal ſtructure of the earth, and of the manner in which its various layers or ſtrata ſucceed, and are uſually intermingled with each other. This object, however, can only be attained in any conſiderable degree of perfection by obſervation and experience. There are ſeveral ways, however, by which a man of ſagacity and reflection may greatly abridge the difficulty of this ſtudy, ſo as in a ſhort time to enable himſelf to practice the art of draining with conſiderable ſucceſs. The ſureſt way of aſcertaining the inclination of the different ſtrata, or the way in which they lie upon each other and the direction in which

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they defcend into the earth, confifts of examining the bed of the neareft rivers, and the appearance of their banks when fteep and broken, fo as to lay bare the different ftrata of earth adjoining to them. Pits, quarries, and wells, that have been dug in the neighbourhood, may alfo be examined with the fame view. Rufhes, fmall elder bufhes, and other plants which grow on the wetteft foils, alfo frequently afford fymptoms of the line under which an internal refervoir of water is placed, and is preffing upwards from wanting a free paffage below ground.

To drain the fide of a hill.

It is often of much importance, even in fheep countries, to drain the fide of a hill, not only becaufe wet land is more unproductive than that which is properly drained, but becaufe the fuperabundance of moifture is apt to introduce and to keep up among the flock that deftructive and incurable difeafe, the *rot*, for which draining is an almoft infallible preventive. It is cheaply executed in fuch fituations, becaufe the drains for collecting and leading off the water, may ufually be left uncovered. Let it be fuppofed then, that in confequence of internal fprings at a certain diftance down the declivity of a hill, or upon any other defcending furface, the ground becomes wet and fpouty, and unwholefome for fheep, and unfit for agriculture; the beft mode of proceeding with a view to drain it is this. It ought to be recollected, that the caufe of the wetnefs is this: The rain water at the fummit of the high ground is received into a porous ftratum of gravel, with which it defcends down the fide of the hill, till it comes to be covered with a clayey foil. After defcending under the covering of clay to fome diftance, the gravel or porous under foil fuddenly ceafes; the clay becomes deeper, and touches

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touches the rock or another inferior bed of clay. In this situation, the water, unable to descend farther, regorges and presses upwards upon the clayey soil which covers it, rendering it moist and swampy in every part, and oozing through all its weaker crannies. Thus it forms a belt of moist ground along the face of the hill, from which the water perhaps descends and damages every part. To drain this declivity, begin at the bottom and carry up a ditch towards the wet ground. As the object is to let out the water at the lowest point of the reservoir or natural bag in which it is contained, by making an opening into the gravel there, it will be proper, as the ditch proceeds upwards, frequently to bore holes with an auger of about two inches diameter to a considerable depth, that is, about 15 feet, though sometimes it is necessary to go to twice that depth. As long as the water is not found by boring, the ditch must be carried upwards, and new auger holes formed; when at last the auger by boring reaches the lowest part of the gravel or reservoir of water, the water will immediately rush forth with considerable violence at the hole formed by it, and will continue ever after to run without any danger of choking up. When the bottom of the reservoir of water or layer of gravel is thus found, another ditch ought to be drawn across the head of the former along the face of the hill, so as to form the figure of the letter T. In the upper ditch or drain that runs along the face of the hill, auger holes ought to be bored at short distances, to let out the whole water from the interior reservoir or stratum of gravel. The whole process will be easily understood from considering Plate XV. Care ought always to be taken in digging the upper drain along the face of the hill, Preparation of Land. to form it in ſuch a way as that the water may deſcend in it towards the ditch firſt formed, which is intended to convey it down the hill to the neareſt brook. The old practice or mode of draining ground in this ſituation before the uſe of the auger was underſtood, and before men had reflected upon the way in which water is often confined in the earth, conſiſting of digging a trench wherever the ſpouty land commenced. As this was not deep enough to reach the evil, that is, to penetrate to the reſervoir of water, it produced only a partial remedy. Other parallel ditches of the ſame kind were therefore cut the whole way down the declivity, and being filled with looſe ſtones and connected with a deſcending ditch, each carried off only a portion of ſurface water, leaving the ſoil ſtill cold in conſequence of the wetneſs of the bottom.

In performing the operation already deſcribed, ſome difficulties are apt to occur in conſequence of the irregularities with which the ſtrata are often placed in the earth. In boring in the aſcending trench, in the firſt part of the operation, with a view to diſcover the loweſt point at which the water may be let out from the internal reſervoir, the operator is ſometimes apt to be miſled by finding water before he has come high enough to reach the place at which the porous ſtratum ſtops. This ariſes from its ſometimes happening that at the bottom of the reſervoir ſmall leakages occur, and a portion of the water finds its way downwards through crannies in the earth to ſome diſtance from the main reſervoir. When the auger in boring meets theſe leakages, they are apt to be miſtaken for the main body of water, and the operator can only guard himſelf againſt ſuch errors, by forming an eſtimate of the quantity of wa-

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ter which the adjoining high grounds ought to afford. If the quantity of water that follows the auger be very trifling, while the extent of high ground is great, he may be aſſured that he has not yet reached the great cauſe of the wetneſs of the ſoil. It alſo ſometimes happens that the croſs drain carried along the face of the hill, may in ſome places be below the level of the reſervoir of water, while it is upon it at other places. In this caſe, when the auger by boring in the croſs trench brings no water, it will be neceſſary to bore above it, and to conduct the water that is there obtained by a ſmall cut into the general croſs trench.

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It ſometimes happens that hills are compoſed of alternate ſtrata, of rock and ſand and clay, which reſt horizontally or nearly ſo upon each other, and penetrate and form the maſs of the hill. In ſuch caſes the ſoil above the ſand or rock is often dry and productive, while the clay is wet and ſwampy. In this caſe, the higheſt part of the hill being generally porous, receives the rain water, which deſcends through it till it meets the impervious clay, which forces it to flow to the ſurface, which it renders wet. Having overflowed the upper clay ſurface, it is immediately abſorbed by the next porous ſtratum; and deſcending into it in like manner, again iſſues at the lower ſide of it, and injures the ſurface of the next bed of clay, as it did that of the firſt. To drain a hill ſide of this deſcription, it is neceſſary to make a trench along the upper ſide of every belt of ruſhy or boggy ſoil to receive the water from the ſuperior porous ſoil, and to lead the whole water thus obtained by one or more ditches downwards to the bottom.

Where a ſoil is compoſed of intermixed varieties, with

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clay predominating, it is ſometimes very difficult to drain, as it is apt to form itſelf into a variety of hollow reſervoirs, each of which holds water like a cup, while, at the ſame time, theſe hollows being full of porous materials, the ſurface of the ſoil is ſufficiently regular. Thus, in wet ſeaſons, patches of moiſt unwholeſome ſoil are formed, not by ſprings for which they may be miſtaken, but by rain water held up by clay in theſe disjoined cavities. They can only be drained by ſeparate covered cuts, communicating in the ſhorteſt way poſſible with one or more main drains.

To drain a bog by letting the water aſcend freely.

With regard to the drainage of bogs, it has already been remarked, that they are either ſuch as can have their water carried off by a communication, at a tolerable expence, with ſome adjoining lower ground; or they are land-locked, ſo as not to admit of being drained in this way. With regard to the former, or thoſe which can be drained by trenches for conducting the water to an adjoining low country or river, they may be rendered wet in two ways: 1ſt, By ſprings oozing out of the adjoining higher ground, in a regular line along the upper ſide of the wet ſurface, which afford water that ſtagnates upon the ſurface of the inferior ground, forming it into a bog. To render free from water a bog of this kind, nothing more is neceſſary than merely to drain the upper adjoining ſwampy ground in the way that has been already ſtated, and to convey away to a diſtance the water produced by it, in regular, open, or hollow drains.—The ſecond claſs of bogs rendered wet by ſprings, conſiſts of thoſe in which the many ſprings that appear are not confined to one regular direction along the upper ſide, but burſt out everywhere, forming ſhaking quagmires, over which it is

dangerous

dangerous for cattle to paſs. The upper part of ſuch bogs uſually conſiſts of peat-earth. Below that is found a bed of clay, extremely wet and ſoft, through the crannies of which ſmall quantities of water are continually oozing. When the loweſt part of ſuch a bog is found, or the place in which it will be moſt convenient to convey away the water, little more is uſually neceſſary than to dig proper trenches, and to bore with the auger through the ſtratum of clay to the porous ſtratum containing the water. To drain an extenſive bog, it will uſually be neceſſary to dig a trench from end to end of it, with croſs trenches at conſiderable diſtances, the bottom of the whole being frequently penetrated with the auger, ſo as to allow a free paſſage for the water to aſcend; the effect of which will be, that the nature of the ſurrounding ſoft ſoil will ſpeedily be altered, in conſequence of the water being removed from beneath it. It will become dry and ſolid, and ſoon fit for bearing the plough. The ſame effect would follow although only a ſingle perforation were made through the inferior ſtratum of the bog; and accordingly Mr Elkington is ſaid ſometimes to have ſucceeded, while he drained a bog, in raiſing the water from it conſiderably above its own level, for any purpoſe for which it may be required. This was done by rearing around the perforation, a building of brick, puddled around and within with clay, to the top of which the water roſe, and was from thence conveyed away in pipes or otherwiſe.

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That the whole of this important ſubject, of draining land rendered wet by ſprings, may be better underſtood, we ſhall give an account of it as deſcribed by Dr Anderſon, in his Eſſays publiſhed in 1775, already mentioned.

Dr Anderſon's rules for draining ſpouty land.

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mentioned. Suppofing, fays he, a defcending ftratum of fand or gravel fhould be difcontinued, and that the ftratum above it fhould be of a coherent clayey nature; in this cafe, the water being pent in on every fide, and being accumulated in great quantities, muft at length force a paffage for itfelf in fome way, and preffing ftrongly upon the upper furface, if any one part is weaker than the reft, it would burft forth, and form a fpring; but if the texture of every part of this ftratum were equally ftrong, the water would fqueeze through many fmall crannies, and would ooze out in numberlefs places, fo as to occafion that kind of wetnefs that is known by the name of a fpouting clayey foil.

The cure in this cafe is eafily effected.—For if a ditch of a confiderable fize is opened towards the lowermoft part of the fpouting ground, fo deep as to penetrate through the upper ftratum of clay, and reach to the gravel, the water will rife up through it at firft with very great violence, which will gradually decreafe as the preffure from the water behind is diminifhed; and when the whole of the water accumulated in the fubterraneous refervoir is run off, there being no longer any preffure upon the clay above it, the whole foon becomes as dry as could be defired, and continues fo ever afterwards, if the ditch is always kept open. This the doctor fays he can affert from experience, having rendered fome fields of this kind that were very wet quite dry by this method of treating them. The attentive obferver, he adds, will readily perceive, that if any field that is wet from this caufe admits of being ploughed, it will be in equal danger of being hurt by being raifed into higher ridges, with the other kind of damp ground before mentioned. For as the depth of earth

earth above the reſervoir would be ſmaller in the deep furrows than anywhere elſe, there would of conſequence be leſs reſiſtance to the water in that place, ſo that it would ariſe there in greater abundance. And if, in this caſe, a farmer ſhould dig a drain in each furrow, as a conſiderable quantity of water would riſe into them, in ſome caſes the ground might be improved, or even quite drained thereby, eſpecially if they ſhould have accidentally reached the gravel in any one place; although at an expence much greater than was neceſſary. "I take notice of this circumſtance, ſays he, in ſome meaſure to prevent the prejudice that ſome inattentive obſervers might entertain againſt what was ſaid before of this method of draining, from their having accidentally ſeen ſome fields that may have been bettered by it. Preparation of Land.

"Bogs are only a variety of this laſt-mentioned kind of wet ground; and, therefore, ought in general to be drained after the ſame manner with them. Clay is a ſubſtance that ſtrongly reſiſts the entrance of water into it: but when it is long drenched with it, it is, in proceſs of time, in ſome meaſure diſſolved thereby; loſes its original firmneſs of texture and conſiſtence; and becomes a ſort of ſemi-fluid maſs, which is called a *bog*; and as theſe are ſometimes covered with a ſtrong ſcurf of a particular kind of graſs, with very matted roots, which is ſtrong enough to bear a ſmall weight without breaking, although it yields very much, it is in theſe circumſtances called a *ſwaggle*. But, whatever be the nature of the bog, it is invariably occaſioned by water being forced up through a bed of clay, as juſt now deſcribed, and diſſolving or ſoftening, if you will, a part thereof. I ſay only a part; becauſe whatever may be the

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the depth of the bog or fwaggle, it generally has a partition of folid clay between it and the refervoir of water under it, from whence it originally proceeds: for if this were not the cafe, and the quantity of water were confiderable, it would meet with no fufficient refiftance from the bog, and would iffue through it with violence, and carry the whole femi-fluid mafs along with it. But this would more inevitably be the cafe, if there was a cruft at the bottom of the bog, and if the cruft fhould ever be broken, efpecially if the quantity of water under it were very confiderable: and as it is probable, that, in many cafes of this fort, the water flowly diffolves more and more of this under cruft, I make no doubt but that, in the revolution of many ages, a great many eruptions of this kind may have happened, although they may not have been deemed of importance enough to have the hiftory of them tranfmitted to pofterity. Of this kind, although formed of a different fubftance, I confider the flow of the Solway mofs in Northumberland to have been; which, upon the 16th of November 1771, burft its former boundaries, and poured forth a prodigious ftream of femi-fluid matter, which in a fhort time covered feveral hundred acres of very fine arable ground. Nor will any one, who is acquainted with the nature of mofs,—who knows its refemblance to clay in its quality of abforbing and retaining water, and its very eafy diffufibility therein, be furprifed at this; as from all thefe properties, it is much better adapted for forming an extenfive bog, and therefore in greater danger of producing an extenfive devaftation by an irruption of the water into it, than thofe that are formed of any kind of clay whatever.

"If the bog, or fwampy ground, is upon a declivity, the ditch ought to be carried across the field about the place where the lowest springs arise. But if the surface of the ground is level or nearly so, so as to form soft quagmires, interspersed through the whole of the field, it will be of little consequence in what part the drain is opened; for if it is dug up so deep as to allow the water to rise in it with freedom, it will issue through that opening, and the field will be left perfectly dry. Preparation of Land.

" But as it may frequently happen that the stratum of gravel should be at a considerable depth beneath the surface of the earth, and as it may be sometimes even below the level of the place into which the drain must be emptied, it might sometimes be extremely difficult to make a ditch so deep as to reach the bed of sand or gravel. But it is lucky for us that this is not absolutely necessary in the present case; as a drain of two or three feet deep, will be equally effectual with one that should go to the gravel. All that is necessary, in this case, is to sink pits in the course of the drain, at a moderate distance from one another, which go so deep as to reach the gravel; for as the water there meets with no resistance, it readily flows out at these openings, and is carried off by the drain without being forced up through the earth; so that the ground is left entirely dry ever after.

" I have likewise drained several fields in this way: and as I have generally found the appearances pretty much alike, I shall, for the information of the inexperienced reader, give a short account of them.

" If you attempt to make your pit in one of these soft quaggy places where the water is found in great abundance, you will meet with very great difficulty in forming

Preparation of Land. forming it; for as the ſubſtance of which it is compoſed is ſoft, it will always flow into the hole as faſt as you dig it; on which account I would adviſe, not to attempt to make the pit in the ſwaggle, but as near it in the ſolid earth as you conveniently can. However, if it is pretty firm, and of no great extent, it is ſometimes practicable to make a pit in the ſoft bog at the drieſt time of the year. This I have ſometimes practiſed, which gave me an opportunity of obſerving the nature of theſe bogs more perfectly than I otherwiſe would have had. In the trials of this kind that I have made, this ſoft quaggy ground has ſeldom been above three or four feet deep; below which I have always found a ſtratum of hard tough clay uſually mixed with ſtones, and ſo firm that nothing but a mattock or pick-axe could penetrate it: and as this is comparatively ſo much drier than the ground above it, an inexperienced operator is very apt to imagine that this is the bottom that he is in ſearch of. In digging through this ſtratum, you will frequently meet with ſmall ſprings oozing out in all directions; ſome of them that might fill the tube of a ſmall quill, and others ſo ſmall as to be ſcarce perceptible: but without regarding theſe, you muſt continue to dig on without intermiſſion till you come to the main body of the reſervoir, if I may ſo call it, that is contained in the rock, gravel, or ſand; which you will generally find from two to four feet below the bottom of the ſwaggle, and which you will be in no danger of miſtaking when you come to it: for, if there has been no opening made before that in the field, as ſoon as you break the cruſt immediately above the gravel or rock, the water burſts forth like a torrent, and on ſome occaſions riſes like a *jet d'eau*, to a conſiderable height above

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the bottom of the ditch; and continues to flow off with great impetuoſity for ſome time, till the pent-up water being drained off, the violent boiling up begins to ſubſide, and the ſtrength of the current to abate; and, in a ſhort time, it flows gently out like any ordinary ſpring; —allowing it to remain in this ſtate, the quaggy earth begins to ſubſide, and gradually becomes firmer and firmer every day; ſo that, in the ſpace of a few months, thoſe bogs which were formerly ſo ſoft as hardly to ſupport the weight of a ſmall dog, become ſo firm that oxen and horſes may tread upon them without any danger of ſinking, at the very wetteſt ſeaſon of the year. I have had a field of this nature, that, by having only one ſuch pit as I have now deſcribed opened in it, was entirely drained to the diſtance of above a hundred yards around it in every direction. But as it is poſſible that the ſtratum in which the water runs may be in ſome places interrupted, it will be in general expedient to make ſeveral of theſe pits, if the field is of great extent; always carrying the drain forward through the lowermoſt part of the field, or as near the quag as you conveniently can; and ſinking a pit wherever you may judge it will be moſt neceſſary. But if the ſtratum of gravel is not interrupted, there will be no violent burſt of water at opening any of theſe after the firſt, as I have frequently experienced. To keep theſe wells from cloſing up after they are made, it is always expedient to fill them up with ſmall ſtones immediately after they are made, which ought to riſe to the height of the bottom of the drain.

"I have often imagined that the expence of digging theſe pits might be ſaved by boring a hole through this ſolid ſtratum of clay with a large wimble made

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on purpofe; but as I never experienced this, I cannot fay whether or not it would anfwer the defired end exactly.

"If the whole field that is to be drained confifts of one extenfive bog, it will require a long time before the whole work can be entirely finifhed, as it will be impoffible to open a drain through it till one part of it is firft drained and become folid ground. In a fituation of this kind, the undertaker, after having opened a drain to convey the water from the loweft part of the bog, muft approach as near to the fwampy ground as he can, and there make his firft pit; which will drain off the water from the neareft parts of the bog. When this has continued open for fome time, and that part of the bog is become fo folid as to admit of being worked, let him continue the ditch as far forward through it as the fituation it is in will admit of, and there fink another pit; and proceed gradually forward in the fame manner; making crofs cuts where neceffary, till the whole be finifhed.

"In this manner may any bog or tract of fpouting ground of this nature be rendered dry at a very inconfiderable expence; and as there can be no other method of draining ground of this fort effectually, I recommend the ftudy of it to the attention of every diligent farmer who may have occafion for it. Let him firft be extremely cautious in examining all the circumftances of his particular fields, that he may be certain which of the claffes above enumerated it may be ranked with; and when he is perfectly fure of that, he may proceed without fear, being morally certain of fuccefs.

We fhall add the fubftance of a paper on this fubject,

ject, for which the author received the silver medal of the Society instituted for the encouragement of Arts, Manufactures, and Commerce. That author is Mr John Wedge of Bickenhill, near Coventry, who is not only a great farmer himself, but had likewise been employed by the earl of Aylesford in the management of several estates. Encouraged by his lordship's liberality, Mr Wedge informs the society, that he had been employed for some years in draining large portions of land, of which part was in the earl's occupation, and part in his own, as tenant to his lordship. The principles upon which he proceeded, as well as his mode of procedure, he states in the following terms:

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Mr Wedge's mode of draining.

In every country there are large portions of land that, in wet seasons, have always what may be called a *dry surface*, and other portions of land that have always a *moist* or *wet surface*; the former of these admitting all the water which falls upon them to sink freely through their pores to various depths, till falling on clay, or some other unctuous earth, whose pores will not permit it to pass through, it is there held up to a height proportioned to the quantity of water which comes upon it, and the facility with which that water is discharged. Thus, held up to various heights, it serves as a fountain to distribute its water (either by veins of sand, pebbles, or rock, according to the formation of the different under strata) on the neighbouring lands; and there forms bogs and other varieties of wet surface, on a basis that will be always found to consist of marl or clay, or some mixture thereof. The effect of water thus distributed may be divided into two classes. The first class, where the water is thrown out by a body of marl or clay, &c. upon the surface of descend-

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ing ground, and in the valley (there held up by clay alſo) forms bogs or ſwamps. The ſecond claſs, where the water is held up by marl or clay, as before, having above that marl or clay a ſtratum of ſand, or pebbles, through which the water paſſes; and above thoſe ſands or pebbles another ſtratum of marl or clay, through the weakeſt parts of which the water, by a continual preſſure from its fountain, forces a paſſage upwards; and thus, through the weakeſt parts of the marl or clay, furniſhes a continual ſupply of water on the ſurface, for the formation or growth of bogs, &c. in proportion as this water is more or leſs abundantly ſupplied by its fountain or head, namely, the higher lands, into which rain-water freely paſſes, as before deſcribed. There are alſo different ſoils, under different circumſtances, which may form a third claſs of land for draining; ſuch as ſtrong deep ſoils, or open light ſoils, having near the ſurface a body of marl or clay. In either of theſe caſes, the water which falls on the ſurface muſt for reaſons which are ſelf-evident, keep ſuch lands, in rainy ſeaſons, conſtantly wet and cold; and it ſhould be obſerved, that a mixture of all the three before-deſcribed claſſes of wet land ſometimes occurs in one field, by ſudden alterations of the under ſtrata, and thereby perplexes the operator, by requiring all the different modes of draining in the ſame field.

If it be admitted that bogs are thus formed and fed, their cure may be effected with certainty: The firſt claſs, by cutting through the ſtratum (be it ſand, pebbles, or rock), that conveys the water to the bog, and carrying off that water by a cloſe drain to ſome proper place, where the level admits of its diſcharge: The ſecond claſs, by ſinking a drain to any convenient depth

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in the upper clay; and then digging or boring with a large auger, at a ſmall diſtance on one ſide of this drain, through the remaining part, be it (the upper clay) ever ſo deep, into the under ſtratum of ſand, pebbles, or rock, through which the water paſſes; which will then ruſh up into the drain ſo made, with a velocity proportioned to the height of the land or fountain whence it is ſupplied. As this drain advances through the land, holes muſt be dug or bored, as before, every ſeven yards, or at ſuch diſtance as the ſtrength of the ſprings may require; and the whole of the water thus brought up by tapping the ſprings, is carried off by the drain made in the upper clay, which muſt be a cloſe one, to its proper level, and there diſcharged.

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By both theſe methods of draining, large tracts of land, under favourable circumſtances, may be cured with one drain. The beſt place for fixing theſe drains is where the ſtratum that conveys the water comes neareſt to the ſurface; and the beſt method of aſcertaining that, is to bore or dig in different parts through the different under ſtrata.

The third claſs may be eaſily cured by cloſe drains, at ſuch diſtances and depths as will beſt carry off the ſurface-water. It may not be improper to obſerve, that where the different ſtrata or meaſures crop out, that is, become gradually more and more ſhallow in ſome certain direction (as is often the caſe, till, one after the other, they all preſent themſelves in ſucceſſion on the ſurface of the earth), draining may often be much more eaſily and better effected by croſſing with the drain the different ſtrata or meaſures, where the levels and other circumſtances will admit.

Some of the land drained was part of a common, in

Preparation of Land. the pariſh of Church Bickenhill, in the county of Warwick; part of it was covered with moſs and ling, had a peaty ſurface, about ſix inches deep, and produced little or no graſs: in all wet ſeaſons it was filled quite to the ſurface, and often overflowed, with water. Some of the land was much more unſound, deeper of peat, and covered with moſs, in moſt parts nine inches long; another part was an abſolute bog in all ſeaſons.

Having dug or bored with a large auger into ſeveral parts of the land, Mr Wedge found peat, gravel, and ſand mixed, and a quickſand almoſt uniformly. The quickſand in every part, after getting an inch or two into it, ſeemed almoſt as fluid as water. Judging from this, that no materials for a drain could be laid in the quickſand, but what it would immediately bury, he dug a trench almoſt to the quickſand, leaving gravel, &c. of ſufficient ſtrength to bear up the materials for a hollow drain; theſe materials were two ſides and a coverer of ſtone, with a peat-turf on the top to keep out the ſoil. At every ſeven yards forward, by the ſide of this drain, he dug a hole in the quickſand as deep as it would permit. From theſe holes the water roſe freely into the hollow drain, and was by it diſcharged at a proper level. It may be proper to remark, that the ſtone made uſe of for this drain, and all others here mentioned, was a red ſand and rag-ſtone, which eaſily ſplit into proper ſizes for the purpoſe, and is very durable; it coſt about ſixpence per ton getting, excluſive of carriage. The drain thus formed ran on the whole rather freely, and made the land dry for a few yards on each ſide thereof, but was far from having the effect he improperly expected; for it evidently appears that the drain could only take a very ſmall portion of the water from

from fo large a quickfand, which it did not penetrate more than two inches; and that it could drain only to its own depth, or, at moft, to that depth in the fountain which fupplied the quickfand. His purpofe was then defeated; and his motive for mentioning this error cannot, he hopes, be miftaken. Preparation of Land.

He now did what he fays he ought to have done before, that is, he examined the different ftrata to a greater depth, particularly on the bog, and at the upper edges thereof, and found the bog to be what has been defcribed under the firft clafs. He therefore determined to attempt the cure in the manner before prefcribed for that clafs, namely, to cut through the whole of the ftratum (in this inftance, of quickfand), through which he found the water pafs. This he effected as follows: The fummer being dry, and favourable for the purpofe, and having previoufly made his main open drain, he began his main clofe drain the firft week in June 1791, three feet wide, on the declivity near the edge of the great bog. In the firft operation he dug through the peat, the hard fand, and gravel, and one fpade's graft (about nine inches deep, and feven inches wide) into the quickfand the whole length of this drain, which was 73 perches, of eight yards to the perch, in length. The drain thus dug ran copioufly, not lefs than 60 gallons per minute. In this ftate he left it about nine days: the effect of it was rapid, both above the drain and on the bog below. Upon examination, he now found about three inches on the top of the fpade's graft, which had been made into the quickfand, perfectly dry. He then dug out thefe three inches of dry fand, to nearly the whole width of the drain, three feet; and at the fame time dug out, as before, another fpade's graft,

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from the top of the quickſand, as near the middle of the drain as poſſible. This was left to run a few days, as before, and had the ſame effect; namely, three or four inches more of the top of the quickſand became dry and hard. The ſame operation was repeated again and again with the ſame effect, till the purpoſe of getting through this quickſand was completed, ſo far at leaſt as the level of the main open drain would permit. The ſtream of water continued increaſing during the whole operation; the bog below the drain was quite dry, and the land above perfectly ſo. The drain which was firſt made, and continued running for ſome time during the progreſs of the main cloſe drain, became gradually dry; and has not, ſince that drain was finiſhed, diſcharged one ſingle drop of water. Great care was neceſſary, in making the main cloſe drain, to keep the ſtream of water in the middle of it, otherwiſe the current would have undermined the ſides, as it ſometimes had done, and cauſed them to fall in. For this reaſon it was neceſſary, when the dry ſand was taken from the top of the quickſand, immediately to take out a ſpade's graft from the middle thereof, in order to divert the current from the ſides.

The main cloſe drain thus made was three feet wide at top, about nine feet deep on the average, and, bevelling a little from the top, it was about one foot ten inches wide at the bottom. The ſtone and other materials were put into this drain in the following manner: 1. Where the drain went through the quickſand into the ſtratum of clay below it, as in moſt places it did, the bottom, and in ſome inſtances the ſides, wanted no particular ſecurity; but where it did not go quite through the quickſand, which the level of his main

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open drain in fome places would not admit, the bottom of the drain was covered half an inch thick with ling; then peat turfs, one foot wide and three or four inches thick, were cut in convenient lengths, and placed on their edges on each fide of the bottom of the drain, forming two fides of a trough of peat; then fide ftones about eight inches high, and a ftone coverer, were put in upon the ling between the peat turfs; a large peat turf, near two feet wide and four inches thick, was then cut and firmly placed over the whole: this left in the bottom of the drain an open fpace, of more than fix inches fquare, for the water to pafs. The whole was then completed by filling in the upper part of the drain.

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In this way Mr Wedge drained for about 80l. thirty acres of land, which from being of no value whatever, became worth at leaft 14 fhillings per acre of yearly rent. He likewife hollow-drained nine acres by the method prefcribed for the third clafs of wet land. Thefe drains were made a few yards below that part of each field where the dry and wet land feparate, about 22 inches deep, with fides and a coverer of ftone, and ling on the top of it, to keep the earth from running in. The length of thefe drains was 880 yards, and the expence of labour and materials three halfpence per yard. The drains, in wet weather, difcharge a large quantity of water; and will, he has no doubt, anfwer the intended purpofe. Thus far relates to land in his own occupation.

Nine acres of the land in the earl of Aylesford's occupation was almoft an entire pulp. This bog was of the fecond clafs, namely, water paffing through a quickfand, and confined by a ftratum of clay below, and

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another ſtratum of clay above it. The water thus confined, being preſſed by its fountain, and forced up through the weakeſt parts of the clay, had formed a bog of irregular thickneſs on the ſurface, in ſome places ſix feet deep, in others not more than two. As there is a conſiderable fall in this land from eaſt to weſt, he thought it expedient to put two drains into it; and this appears to him to have been neceſſary, from a conſideration that both theſe drains continue to run in the ſame proportions as when firſt opened. The manner in which theſe drains were executed was, by digging through the different upper ſtrata, and as deep into the clay as the main open drain would admit; then digging or boring through the remaining part of that clay into the quickſand, at the diſtance of about ſix yards, in a progreſſive manner.

The water riſing rapidly through theſe holes into the cloſe drains, has effected a complete cure of this land, every part of which will now bear a horſe to gallop upon it. Theſe drains diſcharge 3660 gallons an hour; which is much leſs than they did at firſt, as muſt be the caſe in all bogs. This land will be worth 20s. per acre. The draining coſt 25l.; and the length of the under-ground drains is eight hundred and fourteen yards.

Mr Wedge had juſt finiſhed (January 1792) draining another piece of land, about forty-three acres. As this was intended to anſwer two purpoſes, one, to drain the land, the other to give an additional ſupply of water to a mill-pool, and as a circumſtance aroſe in the execution of the work which frequently happens in draining land, namely, a ſudden alteration in the poſition of the under ſtrata; a deſcription thereof will not probably

bably be thought tedious. This draining was begun at the level of a mill-pool, and continued, without any great difficulty, to the diſtance of about thirty-two chains, in the manner before deſcribed as a cure for the ſecond claſs of boggy land: but at or near that place the under ſtrata altered their poſition; the quickſand which conveyed the water now became of twice its former thickneſs; and the clay, which had hitherto been above that quickſand, for ſome diſtance diſappeared. From the quickſand thus becoming ſo much deeper, he could not, with the level of the mill-pool, cut through it; nor indeed, from the wetneſs of the ſeaſon, would ſuch an operation have been proper. He therefore continued a ſhallow drain to ſome diſtance, making ſide-holes into the quickſand, which ran freely; but as this could not cure the whole of the bog below, he branched out another drain (which was made by the method deſcribed for curing the ſecond claſs of wet or boggy land), by ſinking a cloſe drain through the upper ſtrata into the upper clay, and then, at a ſmall diſtance on one ſide of this cloſe drain, boring a hole with an auger through the remaining part of that clay into the quickſand; and at every eight yards, as this cloſe drain advanced, ſtill boring other holes, in the manner before deſcribed: through many of theſe holes the water ruſhed with great rapidity. The water diſcharged by theſe drains into the mill-pool is 168 gallons per minute, or 3780 hogſheads in a day; which is after the rate of 1,379,700 hogſheads in a year.

About ſix acres of this land were always ſound; about twelve acres on the north ſide were an abſolute pulp, and the remaining twenty-ſix acres very unſound. The whole is now ſound, and will when cultivated be worth

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worth 16s. per acre. This land would have been drained at a much leſs expence into the main open drain; but then the water, which was much wanted for the mill, would have been loſt. Theſe cloſe drains are in length 1452 yards, and coſt 100l. of which about 30l. ought to be charged to the mill.

§ 3. *Of Draining Land-locked Bogs or Lands, where a declivity cannot be obtained to carry off the water.*

Draining of land-locked bogs.

With regard to the drainage of land-locked bogs, which are often ſituated ſo much lower than the ground around them, that the cutting a main drain would coſt more than the value of the land when drained; the mode of proceeding, with a view at once cheaply and effectually to relieve them from the ſuperfluous moiſture which renders them uſeleſs to agriculture, is the following: A ſpot in the middle or loweſt part of the bog muſt be ſelected, towards which all the drains muſt be conducted, as radii to a common centre. When this central is ſpot is properly cleared out to the top of the clay, or retentive ſubſtratum, which in this caſe muſt not be affected by water from below, but only by ſurface or rain water, a number of perforations muſt be made with the auger, to give an outlet downwards for the water, which will be abſorbed by the porous ſtratum below. A conduit ſhould be formed over the auger holes, by looſe ſtones, placed in ſuch a manner as to prevent their being afterwards filled up by any rubbiſh: or rather auger holes may not be ſufficient; and it may be a preferable plan to make a large pit, or well, in the loweſt part of the bog, dug through into the porous ſubſtrata. This pit ought to be filled with large ſtones, and the drains from the reſt of the

field

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till conducted to that spot, as mentioned in the following quotation from the Agricultural Report of Hertfordshire.—" If a pit is sunk 20 or 30 feet deep in the middle of a field, through the Hertfordshire red, flinty, and impervious clay, into the chalk below; when the usual quantity of chalk is taken out, the pit shaft is filled up with the flint taken out of the chalk and clay, and the top drainage of this part of the field is much shortened for ever afterwards, by making principal drains from the part of the field above the level of the top of the pit terminate therein, as the superabundant moisture will escape through the flints in the pit shaft to the chalk below. And if a drain is carried into a limestone quarry, it is seldom necessary to carry it further.

" In dells or hollows, of considerable extent, covered with an impervious stratum, and from which there is no natural drainage, such as the valley between Mold, the shire-town of Flintshire, and the adjoining high land, a pit about four feet diameter, and 15 feet deep, more or less, as the case may require, is sunk through the impervious superstratum, into a pervious stratum of gravel, and the rain water, and that of some adjoining springs, are carried from the surface thereby; the pit is railed round to prevent cattle from falling into it. I must here remark, that though in this, as well as in many other instances that may be given, the top water escaped through the pervious substratum, the effect might have been directly the contrary. I therefore recommend the impervious superstratum, in all such cases, to be perforated by bore-rods, as the hole made by them is easily stopped up."

In Dr Nugent's travels through Germany, published in

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German mode of draining land-locked bogs.

in 1768, a mode of draining marshes upon similar principles is described, as having been practised in that country. He had only seen it performed on moor grounds, though it is also successful with regard to lakes. "It is the nature, says he, of moors in general, that beneath the turf or moss there is a loam which hinders the moisture from penetrating; and this indeed is what makes the marsh, and causes the luxuriant growth of the turf or moss: but this loam or clay is only a stratum, and far from being of an immense depth; under it is generally a sand, or some other stony or loose soil.

"Here reason readily informs us, that a middling morass may be drained by perforating the clay, and thus making way for the moisture to penetrate. In order to this, a pit is dug in the deepest part of the moor, till they come below the obstructing clay, and meet with such a spongy stratum as, in all appearance, will be sufficient to imbibe the moisture of the marsh above it. Into this pit the ebbing of the morass is conveyed through a trench, and both the trench and the pit are filled up after the first drain with large broad stones, setting them edgewise, so as to leave interstices for carrying off the water; then such stones are laid over breadthwise, and these covered with loose earth like that on the surface: when no such stones are to be had, strong piles are rammed down the sides of the trench, and broad boards laid across; and these are covered with earth to a height fit for culture. This is a matter of no great expence, the pit being as near the morass as the water will admit, and the trenches but short; then they have a drain unperceived, which leaves the surface of the trenches for the plough: and in middling standing marshes, especially in such moors as are only wet and damp, this method, though sometimes slow, never fails taking effect; and many tracts are thereby made serviceable to the farmer or grazier."

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Draining in Roxburghshire.

The writer of the Roxburghshire Agricultural Report represents himself as having successfully adopted a similar mode of draining. In that part of the country, such of the waste lands, as are capable of being drained so as to become arable, have, at the distance of from one to six feet below the surface, a large stratum or seam of a black slaty or metallic substance, generally from 20 to 25 feet in thickness. Below this is a layer of whinstone rock of unknown depth. The black slaty or metallic substance has no chinks or fissures, and is impenetrable to water; but the whinstone rock beneath it abounds with chinks and fissures, and will swallow up any quantity of water poured into its bosom. The uppermost surface of the soil is of a light mossy nature, upon which the water stagnates in winter, so as to swell and enlarge it to a considerable degree. In the spring months, when dried by the sun and the wind, the moss becomes tolerably firm, and produces a coarse unprofitable grass, mixed with short heather; neither of which are of any value as food for sheep or cattle. In the year 1784 the writer of the Report ploughed up 20 acres of the waste lands of the above description, a part of them being situated on a level. This last part was gathered in small ridges, and ploughed pretty deep, and the stones removed. Thus it lay till midsummer 1785; but, during the spring, the sheep and cattle were frequently driven upon it to tread it to a firm consistence. At midsummer it was gathered up again; and, to get the water out of the hollows of the ridges,

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a pair of boring rods were obtained, which were put down through the ſlaty ſubſtance to the whinſtone rock at ſundry places. This effectually anſwered the purpoſe. The tops of the holes were kept open with baſkets of looſe ſtones over them, which were allowed to remain or removed at pleaſure, as the weather proved more or leſs wet. In ſpring 1786 the land was in condition to be ſown almoſt as early as any other part of the farm, the winter rains having found their way down into the whinſtone rock through the ſlaty ſubſtance. The land ſpeedily became and continued very valuable.

Draining of quarries and mines.

We may here add, that the modes of draining now ſtated are alſo valuable for other purpoſes than thoſe of agriculture. Quarries, for example, and marl pits may often be cleared of water, by cutting off the ſprings by which they are incommoded, or by letting down the water into the next porous ſtratum. The ſame may be often done, with regard to deep mines, the working of which may frequently be thus greatly facilitated. A colliery, for example, in Yorkſhire had been wrought for ſeveral years, and the water was raiſed from it about 60 yards by a ſteam engine. The proprietors having bored about ten yards farther, to aſcertain the thickneſs of a ſeam of coals; as ſoon as the boring rods were withdrawn, the water from the works, which uſually ran acroſs that place, began to ſink into the holes made by the rods; and, continuing to do ſo, the ſteam engine became uſeleſs, as its pump had no longer any water to draw. It muſt be obſerved, that the ſituation was higher than the neareſt valleys, or the level of the ſea; but this example ſhows of what extenſive importance a knowledge of the principles upon which the above modes of draining proceed may hereafter become. Preparation of Land.

3. *Of rendering Mosses fit for Cultivation.*

In many parts of the country a very serious obstruction to the cultivation of large portions of territory arises from the existence of mosses. It is, therefore, of much importance to consider their nature, and how they are to be rendered fertile.

Nature and origin of mosses. With regard to the nature and origin of moss, the celebrated Dr Anderson, whose works we have already frequently quoted, advances this opinion, that moss is a vegetable, or an assemblage of vegetables, growing or living below, while at the top it is dead. Hence, he distinguishes moss into two kinds; quick moss, from which peats are dug, on which no vegetables grow, and in which no animals exist, while in its natural situation; and dead moss, which frequently covers the former, and upon which heath and fog and coarse grasses grow, and insects and other animals are found. Mr Headrick * states various objections to this opinion, some of which appear to have great force. Thus, it is observed, that the moss here supposed to be alive below the soil, has every mark of utter deadness and partial dissolution. When tossed about in a very dark night, it emits light like half-rotten wood, giving rise to frequent terrors in those who live in the vicinity of peat bogs. It also seems a strange circumstance, and contrary to the whole analogy of nature, to suppose that a vegetable should grow, should form ligneous fibres, and acquire

* *Communications of the Board of Agriculture*, vol. ii.

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acquire inflammability, without the influence of the sun, or contact with the air, during any period of its growth. The true hiſtory of the origin of moſſes ſeems to be this: What are called the moſs plants, amount to about three hundred in number. They are extremely hardy, and are capable of flouriſhing in the moſt cold and bleak ſituations, providing only they are ſurrounded by abundance of ſtagnating water. Accordingly, wherever water ſtagnates in a moderate quantity, they grow up, and, by ſpreading themſelves around, they increaſe the ſtagnation. When they have ariſen in this manner, with the water around them, to a conſiderable height, the lower part of their ſtems being continually ſoaked or macerated in water, ceaſe to vegetate, and give forth their juices to the ſurrounding fluid. As the moſs plants are extremely aſtringent, and contain large quantities of the gallic acid and tanning principle, the moſs water acquires theſe qualities, or becomes aſtringent, in a great degree, and prevents any proceſs of putrefaction from taking place, or the ſtems of the moſs plants from ſuffering any proper proceſs of rottenneſs, or chemical decompoſition. Hence it is, that moſs water has ſometimes been uſed for tanning leather, in the ſame manner as the liquor of oak bark. In the mean time, while the ſtems of the moſs plants remain in this manner dead, but prevented from rotting, or becoming the habitation of animals which cannot live in a vegetable aſtringent liquor, the tops of the plants that are at the ſurface of the water continue to grow, or new plants riſe upon the ſummits of the dead ones, and continue their aſcending progreſs; the whole being perhaps a ſort of paraſitical plants, which can grow upon each other.

In this way, a moſs proceeds, riſing higher and higher, till

till from the nature of the adjoining country, and the declivities in it, the water cannot ſtagnate to any greater depth. After the moſs has come to this height, its farther growth is prevented: its plants, unable to live or grow without abundance of water, wither and die; the upper part of them being expoſed to the action of the air, ſuffers an ordinary proceſs of decompoſition, like other vegetable remains, and is converted into a ſort of ſoil, upon which a few plants and reptiles are ſometimes found; while at a ſmall depth, that is to ſay, below the ſurface of the ſtagnating water, the whole ſtems of the ancient moſs plants continue macerated in their own liquor, and preſerved from putrefaction by it.

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There are, however, two general kinds of moſſes; black moſs, and whitiſh or yellow moſs. The black moſs is originally of a mahogany colour, but ſpeedily becomes black upon expoſure to the air. The yellowiſh, or foggy moſs, is much leſs compact than the former, and retains a light or yellowiſh colour after it is dried. It does not appear to be in ſuch a perfect ſtate of maceration as the black moſs, has leſs variety of plants, and is never ſo ſolid. It is uſually produced in low warm ſituations, and appears to have grown rapidly; whereas, the black moſs is moſt commonly found in cold elevated lands, and ſeems to have conſiſted of a greater number of leſs luxuriant plants. Thus, moſs may be regarded as bearing ſome reſemblance to timber, which is always of a compact grain, and cloſe texture, in proportion to the ſeverity of the climate of which it is the product, or rather in proportion to the length of time which it has taken to grow.

Black and yellow moſs.

From what has been here ſtated, it will not be diffi-

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But moſſes not only ariſe in particular ſituations, in conſequence of theſe operations of nature; they are alſo produced as the reſult of certain exertions of human induſtry. In almoſt all our moſſes in this country great numbers of trees of various ſorts are found. They remain, like the inferior parts or roots of moſs plants, infuſed

Moſſes produced by cutting down foreſts.

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fafed and macerated in the mofs water, but not rotted. The trees and fhrubs found at the bottom of moffes in Scotland, exhibit, perhaps, the whole variety of the native trees and fhrubs. Of trees, are found the oak, the elm, the birch, the willow, the alder, and the fir. Of fhrubs, we find the hazel, the dwarf willow, the gall plant, and laftly, the heath plant. This laft is of fo hardy a nature, that it often continues to rife upon the mofs during the whole period of its exiftence. Now, if it fhould be fuppofed, that at any time extenfive forefts of thefe trees were fuddenly cut down by the exertions of man, they would undoubtedly produce a ftagnation of water, and a bleaknefs of climate, that would render the fituation fit only to be inhabited by mofs plants, which would, therefore, fpeedily rife up, and form a peat-bog, in which multitudes of trees and fhrubs would be found foaked in their own juice, and in the aftringent liquor refulting from the maceration of the ftems of the mofs plants. That in ancient times old forefts were thus deftroyed by the efforts of man, we have every reafon to believe. Not only in this country, but alfo in England and Ireland, there are found in moffes vaft numbers of trees ftanding with their ftumps erect, and their roots piercing the ground in a natural pofture as when growing. Many of thofe trees are broken or cut off near the roots, and lie along, and this ufually in a north-eaft direction. People who have been willing to account for this, have ufually refolved it into the effect of the deluge in the days of Noah; but this is a very wild conjecture, and is proved falfe by many unanfwerable arguments. The waters of this deluge might indeed have wafhed together a great number of trees, and buried them under loads of earth;

 but

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Beſides, theſe trees are not all in their natural ſtate, but many of them have the evident marks of human workmanſhip upon them, ſome being cut down with an axe; ſome ſplit, and the wedges ſtill remaining in them; ſome burnt in different parts, and ſome bored through with holes. Theſe things are alſo proved to be of a later date than the deluge, by other matters found among them, ſuch as utenſils of ancient people, and coins of the Roman emperors.

It appears from the whole, that all the trees which we find in this foſſil ſtate, originally grew in the very places where we now find them, and have only been thrown down and buried there, not brought from elſewhere. It may appear indeed an objection to this opinion, that moſt of theſe foſſil trees are of the fir kind; and that Cæſar ſays expreſsly, that no firs grew in Britain in his time: but this is eaſily anſwered by obſerving that theſe trees, though of the fir kind, yet are not the ſpecies uſually called the *fir*, but pitch tree; and Cæſar has nowhere ſaid that pitch trees did not grow in England. Norway and Sweden yet abound with theſe trees; and there are at this time whole foreſts of them in many parts of Scotland, and a large number of them wild upon a hill at Wareton in Staffordſhire to this day.

In Hatfield marſh, where ſuch vaſt numbers of the foſſil trees are now found, there has evidently once been a whole foreſt of them growing. The laſt of theſe

these was found alive, and growing in that place, within 70 years last past, and cut down for some common use. Preparation of Land.

It is also objected by some to the system of the firs growing where they are found fossil, that these countries are all bogs and moors, whereas these sorts of trees grow only in mountainous places. But this is founded on an error; for though in Norway and Sweden, and some other cold countries, the fir kinds all grow upon barren and dry rocky mountains, yet in warmer places they are found to thrive as well on wet plains. Such are found plentifully in Pomerania, Livonia, Courland, &c.; and in the west parts of New England there are vast numbers of fine stately trees of them in low grounds. The whole truth seems to be, that these trees love a sandy soil; and such as is found at the bottoms of all the mosses where these trees are found fossil. The roots of the fir kind are always found fixed in these; and those of oaks, where they are found fossil in this manner, are usually found fixed in clay; so that each kind of tree is always found rooted in the places where they stand in their proper soil; and there is no doubt to be made but that they originally grew there. When we have thus found that all the fossil trees we meet with once grew in the places where they are now buried, it is plain that in these places there were once noble forests, which have been destroyed at some time; and the question only remains how and by whom they were destroyed. This we have reason to believe, by the Roman coins found among them, was done by the people of that empire, and that at the time when they were established or establishing themselves here.

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Their own hiſtorian tells us, that when their armies purſued the wild Britons, theſe people always ſheltered themſelves in the miry woods and low watery foreſts. Cæſar expreſsly ſays this; and obſerves, that Caſſibelan and his Britons, after their defeat, paſſed the Thames, and fled into ſuch low moraſſes and woods that there was no purſuing them: and we find that the Silures ſecured themſelves in the ſame manner when attacked by Oſtorius and Agricola. The ſame thing is recorded of Venutius king of the Brigantes, who fled to ſecure himſelf into the boggy foreſts of the midland part of this kingdom: and Herodian expreſsly ſays, that in the time of the Romans puſhing their conqueſts in theſe iſlands, it was the cuſtom of the Britons to ſecure themſelves in the thick foreſts which grew in their boggy and wet places, and when opportunity offered, to iſſue out thence and fall upon the Romans. The conſequence of all this was the deſtroying all theſe foreſts; the Romans finding themſelves ſo plagued with parties of the natives iſſuing out upon them at times from the foreſts, that they gave orders for the cutting down and deſtroying all the foreſts in Britain which grew on boggy and wet grounds. Theſe orders were punctually executed; and to this it is owing that at this day we can hardly be brought to believe that ſuch foreſts ever grew with us as are now found buried.

The Roman hiſtories all join in telling us, that when Suetonius Paulinus conquered Angleſea, he ordered all the woods to be cut down there, in the manner of the Roman generals in England: and Galen tells us, that the Romans, after their conqueſt, kept their ſoldiers in Britain conſtantly employed in cutting down foreſts,

draining

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draining of marſhes, and paving of bogs. Not only the Roman ſoldiers were employed in this manner, but all the native Britons made captives in the wars were obliged to aſſiſt in it: and Dion Caſſius tells us, that the emperor Severus loſt no leſs than 50,000 men in a few years time in cutting down the woods and draining the bogs of this iſland. It is not to be wondered at, that ſuch numbers executed the immenſe deſtruction which we find in theſe buried foreſts. One of the greateſt ſubterranean treaſures of wood is that near Hatfield; and it is eaſy to prove, that theſe people, to whom this havock is thus attributed, were upon the ſpot where theſe trees now lie buried. The common road of the Romans out of the ſouth into the north, was formerly from Lindum (Lincoln) to Segelochum (Little Burrow upon Trent), and from thence to Danum (Doncaſter), where they kept a ſtanding garriſon of Criſpinian horſe. A little off on the eaſt, and north-eaſt of their road, between the two laſt named towns, lay the borders of the greateſt foreſt, which ſwarmed with wild Britons, who were continually making their ſallies out, and their retreats into it again, intercepting their proviſions, taking and deſtroying their carriages, killing their allies and paſſengers, and diſturbing their garriſons. This at length ſo exaſperated the Romans, that they were determined to deſtroy it; and to do this ſafely and effectually, they marched againſt it with a great army, and encamped on a great moor not far from Finningly: this is evident from their fortifications yet remaining.

There is a ſmall town in the neighbourhood called *Oſterfield;* and as the termination *field* ſeems to have been given only in remembrance of battles fought near the towns whoſe names ended with it, it is not impro-

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bable that a battle was fought here between all the Britons who inhabited this foreſt and the Roman troops under Oſtorius. The Romans ſlew many of tho Britons, and drove the reſt back into this foreſt, which at that time overſpread all this low country. On this the conquerors, taking advantage of a ſtrong ſouth-weſt wind, ſet fire to the pitch-trees, of which this foreſt was principally compoſed; and when the greater part of the trees was thus deſtroyed, the Roman ſoldiers and captive Britons cut down the remainder, except a few large ones which they left ſtanding as remembrances of the deſtruction of the reſt. Theſe ſingle trees, however, could not ſtand long againſt the winds, and falling into the rivers which ran through the country, interrupted their currents; and the water then overſpreading the level country, made one great moraſs, and gave origin to the moſſes or moory bogs, which were afterwards formed there, by the workings of the waters, the precipitation of earthy matter from them, and the putrefaction of rotten boughs and branches of trees, and the vaſt increaſe of water moſs and other ſuch plants which, as we have already mentioned, grow in prodigious abundance in all ſuch places. Thus were theſe burnt and felled trees buried under a new formed ſpongy and watery earth, and afterwards found on the draining and digging through this earth, or moſs, again.

Hence it is not ſtrange that Roman weapons and Roman coins are found among theſe buried trees; and hence it is that among the buried trees ſome are found burnt, ſome chopped and hewn; and hence alſo it is that the bodies of the trees all lie by their proper roots, and with their tops lying north-eaſt, that is, in that direction in which a ſouth-weſt wind would have blown them.

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them down: hence alſo it is, that ſome of the trees are found with their roots lying flat, theſe being not cut or burned down, but blown up by the roots afterwards when left ſingle; and it is not wonderful, that ſuch trees as theſe ſhould have continued to grow even after their fall, and ſhoot up branches from their ſides which might eaſily grow into high trees. (*Phil. Tranſ.* N° 275.)

By this ſyſtem it is alſo eaſily explained why the moor ſoil in the country is in ſome places two or three yards thicker than in others, or higher than it was formerly, ſince the growing up of peat earth or bog ground compoſed of moſs plants is well known, and the ſoil added by overflowing of waters is not a little.

As the Romans were the deſtroyers of this great and noble foreſt, ſo they were probably alſo of the ſeveral other ancient foreſts; the ruins of which furniſh us with the bog wood of Staffordſhire, Lancaſhire, Yorkſhire, and other counties. But as the Romans were not much in Wales, in the Iſle of Man, or in Ireland, it is not to be ſuppoſed that foreſts cut down by theſe people gave origin to the foſſil wood found there; but though they did not cut down theſe foreſts, others did; and the origin of the bog wood is the ſame with them and with us. Holinſhed informs, that Edward I. being unable to get at the Welſh becauſe of their hiding themſelves in boggy woods, gave orders at length that they ſhould all be deſtroyed by fire and by the axe; and doubtleſs the roots and bodies of trees found in Pembrokeſhire under ground, are the remains of the execution of this order. The foſſil wood in the bogs of the iſland of Man is doubtleſs of the ſame origin, though we have

not

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not any accounts extant of the time or occaſion of the foreſts there being deſtroyed; but as to the foſſil trees of the bogs of Ireland, we are expreſsly told† that Henry II. when he conquered that country, ordered all the woods to be cut down that grew in the low parts of it, to ſecure his conqueſts, by cutting away the places of reſort of rebels.

The tendency of our climate to produce in cold and damp ſituations moſs plants, which gradually form around themſelves a liquor which is the enemy of all putrefaction, may be conſidered as a fortunate circumſtance, upon the whole, for the preſervation of the health of men and animals, as well as contributing to other valuable purpoſes. In conſidering the nature of moſs, "I cannot diſmiſs the ſubject (ſays Mr Headrick) without ſuggeſting my admiration at the beneficence of Providence, in having provided the moſs plants for the ſituations in which they grow: they afford an immediate ſupply of fuel, and are the ſource from which pit-coal derives its origin, though trees, and all the plants which abound in oils and carbon, alſo contribute to the ſupply of pit-coal. Were the places now occupied by moſſes diveſted of vegetables, or ſtored with vegetables of a different character, they would become noiſome fens, which, by the emiſſion of putrid gaſſes, would ſpread all around them peſtilence and death. Moſſes emit no noxious gaſſes, but rather, by growing at the ſurface, where the plants are acted upon by the ſun's rays, they perpetually throw out oxygen, and thus contribute to the ſalubrity of the atmoſphere. The only defect with which they are chargeable is, forming magazines of moiſture, which by its exhalation generates cold, and ſpreads rheumatiſm and intermitting

mitting fevers among all the animals within its reach. The perpetual evaporation of this moisture not only tends to chill the moss, but it descends in hoar-frost and mildews upon all the lands that are lower in point of situation. These last-mentioned disadvantages are more than amply compensated by the consideration that moss is not only an inexhaustible magazine of manure for other soils, but may be converted into a most fertile soil itself. After it is so converted, none of the defects already stated are any longer applicable to it."

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This gentleman analyzed chemically some specimens of moss. He found that a small portion of Berkshire peat of great hardness exhibited, when pounded in a mortar and infused in warm water, a liquor that had some slight marks of acidity by test paper. Gypsum and sulphat of magnesia appeared to exist in it. A purified potash produced an abundant precipitation of various substances. A portion of this peat being burned, gave forth at the close of the operation a sulphureous smell and flame. The white ashes, after some days, assumed a rusty colour, from iron contained in them. Being washed, the liquor appeared to contain sulphates of lime, magnesia, alumine, and iron. Black hard peat of Swinridge moor, in Ayrshire, when burned, gave brown ashes which were attracted by the magnet. An infusion of them in water exhibited no mark of acid or of alkali, and the ingredients contained in it appeared to be the same as in the Berkshire peat. Foggy or yellow peat yielded a smaller quantity of ashes, which were white, and did not obey the magnet.

Moss water obtained by squeezing light peats contained gallic acid and tanning principle in great quantities.

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tities. Quicklime appeared to be the moſt powerful agent in precipitating every ſubſtance from the moſs water, and in rendering moſs a compact and ſolid ſubſtance; a fact which, as will be afterwards noticed, has been ſucceſsfully taken advantage of in practice.

There are two ways in which a tract of territory that is covered by moſs may be reduced under the dominion of the plough, or rendered fit for the purpoſes of agriculture. The one conſiſts of altogether removing the moſſy ſubſtance, or the whole wrecks of the moſs plants that have been accumulating for ages, and endeavouring thereafter to cultivate the ſubſoil. The other mode conſiſts of converting the ſubſtance of the moſs into vegetable mould fit for bearing crops of grain.

The firſt of theſe plans has been adopted with regard to the moſs of Kincardine; and the other has been ſucceſsfully practiſed by Mr Smith of Swinridgemuir, in Ayrſhire, and in imitation of him by various other perſons in different diſtricts of the country. To each of theſe we ſhall give attention.

Moſs of Kincardine removed by human labour.

The moſs of Kincardine is a remarkable tract of ground in the ſhire of Perth, in Scotland, which deſerves particular notice, both as a topographical curioſity or ſubject of natural hiſtory, and for the information, equally uncommon and important, which it affords, reſpecting agricultural improvement, and the promotion of induſtry and population.

The moſs of Kincardine is ſituated in the pariſh of the ſame name, comprehended between the rivers Forth and Teith, and in that diſtrict of Perthſhire called *Monteith*. The moſs begins about a mile above the confluence of theſe rivers; from thence it extends in

length

length about four miles, and from one to two in breadth; and before the commencement of the operations (an account of which is to be given), comprehended near 2000 Scots acres, of which about 1500 belong to the estate of Blair Drummond, the property of the late Lord Kaimes, by his marriage with Mrs Drummond of Blair Drummond.

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As mosses are not all of the same nature; before entering upon the improvements made in Kincardine moss, it will be proper to give a short description of that moss, and of the subjacent soil which is the object of those improvements.

The moss lies upon a field of clay, which is a continuation of those rich extensive flats in the neighbourhood of Falkirk and Stirling, distinguished by the name of *carses*. This clay, which is one uniform homogeneous mass sinking to a great depth, is found near the surface, consists of different colours, and is disposed in layers. The uppermost is gray; the next is reddish; and the lowest, which is the most fertile, is blue. Through the whole mass not a pebble is to be found. The only extraneous bodies it contains are sea-shells, which occur in all the varieties peculiar to the eastern coast of Scotland. They are disposed sometimes in beds, sometimes scattered irregularly at different depths. By attending to these circumstances, it cannot be doubted that the sea has been the means of the whole accumulation, and that it was carried on in a gradual manner by the ordinary ebb and flow of the tide. Upon any other supposition, why should there not have been a congeries of all the different materials that compose the surface of the surrounding heights? But to whatever cause the origin of this accumulation of clay

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may be afcribed, certain it is that no foil whatever is more favourable to vegetation, or carries more abundant crops of every kind.

The furface of the clay, which, upon the retreat of the fea, had been left in an almoft level plane, is everywhere thickly covered with trees, chiefly oak and birch, many of them of a great fize. Thefe trees feem to have been the firft remarkable produce of the carfe; and it is probable they were propagated by diffemination from the furrounding eminences. They are found lying in all directions befide their roots, which ftill continue firm in the ground in their natural pofition; and from impreffions ftill vifible, it is evident they have been cut with an axe or fome fimilar inftrument. For the cutting of wood, the two common purpofes are, either to apply it to its proper ufe, or that the ground it occupies may be cultivated. In the prefent cafe, however, neither of thefe ends had been propofed, fince the trees, by being left juft as they were cut, were not only entirely loft, but the ground was rendered totally unfit for cultivation. Hence it is evident, that the downfal of this wood muft be afcribed to fome more extraordinary caufe; and to none more probably than to that expedient, which, as we learn from Dion Caffius and other hiftorians, the Romans put fo extenfively in practice to diflodge from their forefts the ancient inhabitants of the Britifh iflands, as already explained.

This hypothefis acquires no fmall degree of force from a circumftance that occurred in May 1768, when a large round veffel of thin brafs and curious workmanfhip, 25 inches in diameter, and 16 inches in height, was difcovered upon the furface of the clay buried un-

2 der

der the mofs. This veffel, found upon the eftate of John Ramfay, Efq. of Ochtertyre, was by that gentleman prefented to the Antiquarian Society of Edinburgh; in whofe mufeum it remains depofited for prefervation. And in a lift of the various donations prefented to that fociety, publifhed by them in 1782, it is there denominated a *Roman camp kettle*.

Betwen the clay and the mofs is found a ftratum nine inches thick, partly dark brown and partly of a colour approaching to black. This is a vegetable mould, accumulated probably by the plants that covered the ground previous to the growth of the wood, and by leaves from the trees thereafter. The difference of colour muft be owing to a difference in the vegetable fubftances that compofe it. The brown mould is highly fertile; the other, efpecially in a dry feafon, is very unproductive. The crop that had occupied this mould when the trees were felled is found ftill entire. It confifts chiefly of heath; but feveral other fmaller plants are alfo very diftinguifhable.

Immediately above this ftratum lies the mofs, to the height, upon an average, of feven feet. It is compofed of different vegetables arranged in three diftinct ftrata. Of thefe the firft is three feet thick. It is black and heavy, and preferable to the others for the purpofe of fuel. It confifts of bent grafs (*agroftis*), which feems to have grown up luxuriantly among the trees after they were felled. The fecond ftratum alfo is three feet thick. It is compofed of various kinds of moffes, but principally of bog-mofs (*fphagnum*). It is of a fallow or iron colour, and remarkably elaftic. It is commonly called *white peat*; and for fuel is confidered as much inferior to that above mentioned. The third ftratum is compofed

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posed of heath and a little bent grass, but chiefly of the deciduous parts of the former. It is about a foot thick, and black.

By far the greatest part of the moss in question is, upon an average, full seven feet deep, and has in all probability lain undisturbed since its formation: this is called the *High Moss*. The remainder, called the *Low Moss*, lies to a considerable breadth around the extremities of the high; and is, upon an average, not above three feet in depth, to which it has been reduced by the digging of peats. These are formed of that stratum of the moss only that lies four feet below the surface and downwards; the rest is improper for the purpose, and is thrown aside.

Before the introduction of the plan which is now pursued, two methods chiefly were employed to gain land from the moss. 1st, The surrounding farmers marked off yearly a portion of the low moss next to their arable land, about 15 feet broad. This they removed with carts and spread upon their fields, some acres of which they for that end left unsown. Here it lay till May or June; when, being thoroughly dry, it was burnt to ashes to serve as a manure. By this means they added to their farms about half a rood of land yearly. But this plan proved unsuccessful; for by the repeated application of these ashes, the soil was rendered so loose that the crops generally failed. 2dly, Many farmers were wont to *trench down* the low moss, and to cover it *furrow deep* with clay taken out of the trench. This, though commendable as an attempt to improve, proved likewise an unavailing method; because in a dry season the superficial covering of clay retains so little moisture that the crop commonly fails.

It

It has been attempted to cover the moſs with clay brought from the adjacent grounds. But what from the neceſſary impoveriſhment of the ground from which the clay was carried, and the ſoftneſs of the moſs, this was ſoon found to be impracticable. Preparation of Land.

Draining has alſo been propoſed as another mode of improvement; and it muſt be acknowledged, that, by means of draining, many moſſes have been converted both into arable and meadow grounds, which in the end became intereſting improvements. But in a moſs, ſuch as that of Kincardine, this method would be ineffectual; as for ſeveral feet deep it is of ſuch a nature, that upon being dried, and divided into parts, it would blow with the wind like chaff; and when thrown aſide in the operation of digging peats, it lies for years without producing a ſingle vegetable, except only a few plants of ſorrel.

Hence it was thought evident, that all attempts to *improve* this moſs muſt ever prove abortive; and that the object to be had in view was the acquiſition of the valuable ſoil lying underneath; to which end nothing leſs was requiſite than the total removal of the moſs.

By the methods above deſcribed from 100 to 200 acres of moſs had been removed. When the preſent plan was introduced, there ſtill remained covered with moſs from 1300 to 1400 acres of carſe clay—a treaſure for which it muſt be ever intereſting to dig.

In the year 1766 Lord Kaimes entered into poſſeſſion of the eſtate of Blair Drummond. Long before that period he was well acquainted with the moſs, and often lamented that no attempt had ever been made to turn it to advantage. Many different plans were now propoſed; at length it was reſolved to attempt, by means of water as

Preparation of Land. as the moſt powerful agent, entirely to ſweep off the whole body of moſs.

That moſs might be floated in water, was abundantly obvious; but to find water in ſufficient quantity was difficult, the only ſtream at hand being employed to turn a corn mill. Convinced of the ſuperior conſequence of dedicating this ſtream to the purpoſe of floating off the moſs, Lord Kaimes having made an agreement with the tenant who farmed the mill, and the tenants thirled conſenting to pay the rent, he immediately threw down the mill, and applied the water to the above purpoſe.

In order to determine the beſt manner of conducting the operation, workmen were now employed for a conſiderable time upon the low moſs both by the day and by the piece, to aſcertain the expence for which a given quantity of moſs could be removed. It was then agreed to operate at a certain rate per acre; and in this manner ſeveral acres were removed.

But this was to be a very expenſive proceſs. The ground gained might, indeed, be afterwards let to tenants; but every acre would require an expenditure from 12l. to 15l. before it could be ready for ſowing; ſo that the acquiſition of the whole, computing it at a medium to be 1350 acres, would ſink a capital of nearly 20,000l. ſterling.

One other method ſtill remained; namely, to attempt letting portions of the moſs, as it lay, for a term of years ſufficient to indemnify tenants for the expences incurred in removing it. For ſome time both theſe plans were adopted; but ſeveral reaſons made the latter preferable: 1. The quantity of water to be had was ſmall; and being alſo uncertain, it was very inconvenient

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nient for an undertaker; neither were there any houses near the spot, which occasioned a great loss of time in going and coming: but when a man should live upon the spot, then he could be ready to seize every opportunity. 2. The moss was an useless waste. To let it to tenants would increase the population of the estate, and afford to a number of industrious people the means of making to themselves a comfortable livelihood.

In the mean time it was determined, till as many tenants should be got as could occupy the whole water, to carry on the work by means of undertakers.

But before proceeding farther, it will be necessary to describe the manner of applying water to the purpose of floating the moss.

A stream of water sufficient to turn a common corn-mill will carry off as much moss as 20 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, 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 100 yards; the more regularly this inclination is observed throughout, the less will the moss

 be

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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, 10 feet broad; the greateſt diſtance from which he can heave his ſpadeful into the drain. This he repeatedly does till the entire maſs 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, a receptacle equally convenient and capacious; upon the fortunate ſituation of which, happily forming for ſeveral miles the ſouthern boundary of the eſtate, without the interpoſition of any neighbouring proprietor, depended the very exiſtence of the whole operations.

When the moſs is entirely removed, the clay is found to be encumbered with the roots of different kinds of trees ſtanding in it as they grew, often very large: their trunks alſo are frequently found lying beſide them. All theſe the tenants remove, often with great labour. In the courſe of their operations they purpoſely leave upon the clay a ſtratum of moſs ſix inches thick. This, in ſpring, when the ſeaſon offers, they reduce to aſhes, which in a great meaſure enſures 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 a powder, fitting it for the ſeed in March and April. A crop of oats is the firſt, which ſeldom fails of being plentiful, yielding from eight to ten bolls after one.

In the year 1767 an agreement was made with one tenant for a portion of the low moſs. This, as being the

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the first step towards the intended plan, was then viewed as a considerable acquisition. The same terms agreed upon with this tenant have ever since been observed with all the rest. They are as follow:

The tenant holds eight acres of moss by a tack of 38 years; he is allowed a proper quantity of timber, and two bolls of oatmeal to support him while employed in rearing a house; the first seven years he pays no rent; the eighth year he pays one merk Scots; the ninth year two merks; and so on with the addition of one merk yearly till the end of the first 19 years; during the last five years of which he also pays a hen yearly. Upon the commencement of the second 19 years, he begins to pay a yearly rent of 12s. for each acre of land cleared from moss, and 2s. 6d. for each acre not cleared, also two hens yearly: A low rent indeed for so fine a soil; but no more than a proper reward for his laborious exertions in acquiring it.

In the year 1768 another tenant was settled. These two were tradesmen; to whom the preference was always given, as having this great advantage to recommend them, that even when deprived of water they need never want employment. The motives that induced these people to become settlers were, 1st, The prospect of an independent establishment for a number of years, 2dly, The moss afforded them great abundance of excellent fuel; to which was added the comfortable consideration, that, while busied in providing that necessary article, they had the double advantage of promoting, at the same time, the principal object of their settlement.

Notwithstanding these inducements, still settlers offered slowly: to which two circumstances chiefly con-

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tributed : 1ſt, The whole farmers ſurrounding the moſs threw every poſſible obſtruction in their way. 2dly, By people of all denominations the ſcheme was viewed as a chimerical project, and became a common topic of ridicule. The plan, however, ſupported itſelf; and in the year 1769 five more tenants agreed for eight acres each; and thus 56 acres of low moſs were diſpoſed of. From the progreſs made by the firſt ſettlers, and the addition of theſe, the obloquy of becoming a moſs tenant gradually became leſs regarded; ſo that in the year 1772 two more were added; in 1773, three; and in 1774, one; in all 13: which diſpoſed of 104 acres; all the low moſs to which water could then be conveyed. As water is the main ſpring of the operation, every tenant, beſides the attention neceſſary to his ſhare of the principal ſtream, collected water by every poſſible means, making ditches round his portion of the moſs, and a reſervoir therein to retain it till wanted.

The tenants in the low moſs having now begun to raiſe good crops, in the year 1774 ſeveral perſons offered to take poſſeſſions in the high moſs, upon condition that acceſs to it ſhould be rendered practicable. The high moſs wanted many advantages that the low poſſeſſed. To the low moſs, lying contiguous to the ſurrounding arable lands, the acceſs was tolerably good; but from the arable lands the high moſs was ſeparated by 300 or 400 yards of the low, which, even to a man, affords but indifferent footing, and to horſes is altogether impracticable. The low moſs is in general only three feet deep; the high moſs is from ſix to twelve feet in depth.

It will appear at firſt ſight, that without a road of communication

communication the high mofs muft forever have proved unconquerable. Without delay, therefore, a road was opened to the breadth of 12 feet, for feveral hundred yards in length, by floating off the mofs down to the clay. Preparation of Land.

This being effected, and at the fame time an opening given to admit water, in the year 1775 twelve tenants agreed for eight acres of high mofs each. In confideration of the greater depth of this part of the mofs, it was agreed, that during the firft 19 years they fhould pay no rent; but for the fecond 19 years the terms of agreement were the fame as thofe made with the tenants in the low mofs. To the above-mentioned tenants every degree of encouragement was given; as upon their fuccefs depended, in a great meafure, the difpofal of the great quantity of mofs ftill remaining. But their fuccefs, however problematical, was fuch, that next year, 1776, fix more took eight acres each; in 1777, one; in 1778, four; in 1779, three; in 1780, one; in 1781, one; in 1782, one:—In all, including thofe upon the low mofs, 42 tenants, occupying 336 acres.

Though for fome time the difpofal of the high mofs went but flowly on, it was not for want of tenants; but the number of operators was already fufficient for the quantity of water; to have added more would evidently have been imprudent.

In the year 1783 Mr Drummond entered into the poffeffion of the eftate of Blair Drummond, and went fully into the plan adopted by his predeceffor for fubduing the mofs. At this time there ftill remained undifpofed of about 1000 acres of high mofs. As water was the great defideratum, it was determined,

 that

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that to obtain that neceſſary article neither pains nor expence ſhould be wanting. Steps were accordingly taken to aſcertain in what manner it might be procured to moſt advantage.

Meanwhile, to prepare for new tenants, a ſecond road parallel to the former, at the diſtance of half a mile, was immediately begun and cut, with what water could be got, down to the clay, 12 feet broad and 2670 yards long, quite acroſs the moſs. This opening was previouſly neceſſary, that operators might get a drain formed in the clay to direct the water; and it was to remain as a road that was abſolutely neceſſary, and which relieved ſettlers from an expence they were unable to ſupport. Theſe preparations, the progreſs of the former tenants, and the proſpect of a farther ſupply of water, induced 10 more to take poſſeſſions in the year 1783: in the year 1784, 18 more took poſſeſſions; and in 1785 no fewer than 27:—in all 55 tenants in three years: which diſpoſed of 440 acres more of the high moſs.

As the introduction of an additional ſtream to the moſs was to be a work both of nicety and expence, it was neceſſary to proceed with caution. For this reaſon ſeveral engineers were employed to make ſurveys and plans of the different modes by which it might be procured. In one point they all agreed, that the proper ſource for furniſhing that ſupply was the river Teith, a large and copious ſtream that paſſes within a mile of the moſs; but various modes were propoſed for effecting that purpoſe.

To carry a ſtream from the river by a cut or canal into the moſs was found to be impracticable; and Mr Whitworth

Whitworth, * gave in a plan of a pumping machine, which he was of opinion would anſwer the purpoſe extremely well. Preparation of Land.

Soon after this Mr George Meikle of Alloa, a very ſkilful and ingenious millwright, gave in a model of a wheel for raiſing water entirely of a new conſtruction, of his own and his father's invention jointly. This machine 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 that generally accompany genius and knowledge, not only gave it the greateſt praiſe, but declared that, for the purpoſe required, it was ſuperior to the machine recommended by himſelf, and adviſed it to be adopted without heſitation.

The better to explain this machine, two ſketches are annexed, to the firſt of which the following letters refer. The explanation of the ſecond will be found upon the ſketch.

a, Sluice through which is admitted the water that moves the wheel. Plate XXI.

b, *b*, Two ſluices through which is admitted the water raiſed by the wheel.

c, *c*,

* This gentleman was ſuperintendant of the London water works, and an engineer of great reputation in England. He was ſeveral years employed in Scotland in completing the great canal.

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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 = 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 to avoid the high road from Stirling, and the private approach to the houſe.

Sketch ſecond contains a plan of the ciſtern, and exhibits the manner in which the water is filled into the buckets.

The diameter of the wheel to the extremities of the float-boards is 28 feet; the length of the float-boards 10 feet. The wheel makes nearly four revolutions per minute; in which time it diſcharges into the ciſtern 40 hogſheads of water. But this is not all the wheel is capable of performing; for by ſeveral accurate trials by Meſſrs Whitworth and Meikle, in the reſult of which, though made ſeparately, they perfectly agreed, it was found that the wheel was able to lift no leſs than 60 hogſheads per minute; but that the diameter of the pipes through which the water deſcends from the ciſtern would not admit a greater quantity than what they already receive.

To a perſon at all converſant in hydraulics, the reſemblance of this to the Perſian wheel muſt be obvious: and indeed it is probable, that from the Perſian wheel the firſt idea of this machine was derived. But admitting this, ſtill the ſuperiority of the preſent wheel is, in most respects, so conspicuous, as to entitle it to little less praise than the first invention. For, 1st, In the Persian wheel, the buckets being all moveable, must be constantly going out of order: In this wheel they are all immoveable, consequently never can be out of order. 2dly, Instead of lifting the water from the bottom of the fall, as in the Persian wheel, this wheel lifts it from the top of the fall, being from four or five feet higher; by which means some additional power is gained. 3dly, By means of the three sluices (*a*, and *b*, *b*, fig. 1.) in whatever situation the river may be, the quantity of the water to be raised is so nicely adjusted to that of the moving power, as constantly to preserve the wheel in a steady and equable motion. In short, as a regulator is to a watch, so are these sluices to this wheel, whose movements would otherwise be so various, as sometimes to carry the water clear over the cistern, sometimes to drop it entirely behind, but seldom so as fully to discharge the whole contents of the buckets into the cistern.

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It is however but candid to remark, that this machine labours under a small defect, which did not escape the observation of Mr Whitworth; namely, that by raising the water about 3½ feet higher than the cistern where it is ultimately delivered, a small degree of power is lost. To this, indeed, he proposed a remedy; but candidly confessed, that as it would render the machine somewhat more complex, and would also increase the friction, he thought it more advisable to keep it in its present state. At the same time he justly observed, that as the stream by which the wheel is moved is at all times copious and powerful, the small loss of power occasioned

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This ftream is detached from the Teith at the place where that river approaches neareft to the mofs. The furface of the latter is about 15 feet higher than that of the former; the ciftern is therefore placed 17 feet above the furface of the ftream fo as to leave a declivity fufficient to deliver the water upon the furface of the mofs.

The pipes through which the water defcends from the ciftern are compofed of wooden barrels hooped with iron, 4 feet long and 18 inches in diameter within.

In thefe pipes, having been conveyed under ground for 354 yards from the ciftern, the water at once emerges into an open aqueduct. This aqueduct, which was formed according to a plan by Mr Whitworth, is conftructed wholly of earth or clay; and in order to keep the water on a level with the furface of the mofs, it is for nearly two thirds of its courfe elevated from 8 to 10 feet above the level of the adjacent grounds; the bafe being 40 feet broad, the fummit 18 feet, and the water courfe 10 feet broad. It commences at the termination of the pipes; from whence extending above 1400 yards, it difcharges the water into a canal formed for its reception on the furface of the mofs.

For raifing the water to this height, there were two reafons: 1ft, That not only where it was delivered on the mofs, but even after being conveyed to the moft diftant corners, it might ftill retain fufficient power to tranfport the mofs to the river Forth. 2dly, That refervoirs of a fufficient height might be formed in the mofs to retain the water delivered during the night.

In confequence of Mr Whitworth's advice, a contract

tract was entered into with Mr Meikle in fpring 1787; and by the end of October in that year, the wheel, pipes, and aqueduct, were all completely finifhed; and what, in fo complex and extenfive an undertaking, is by no means common, the different branches of the work were fo completely executed, and fo happily adjufted to each other, that upon trial the effect anfwered the moft fanguine expectations. The total expence exceeded 1000l. fterling. Preparation of Land.

To induce the proprietor to embark in this undertaking, the mofs tenants had of their own accord previoufly come under a formal engagement to pay the intereft of any fum that might be expended in procuring a fupply of water. But he was determined they fhould not enjoy by halves the fweets of this long wifhed for acquifition. With a view, therefore, not only to reward their paft induftry, but to roufe them to future exertions, he at once fet them free from their engagement; nor has any intereft ever been demanded.

This new fupply was a moft acceptable boon to the mofs tenants. In order to make an equitable diftribution, the water raifed through the day was allotted to one divifion of operators; that raifed during the night to another. To retain the latter, a canal was formed, extending almoft three miles through the centre of the mofs. From place to place along the fides are inferted fluices to admit water to the refervoirs of the poffeffors; each fluice having an aperture proportioned to the number of operators to be fupplied from the refervoir which it fills. For the water raifed through the day no refervoirs are neceffary; as it is immediately ufed by the divifion to which it is allotted.

This

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This additional ſtream, though highly beneficial, yet is not more than ſufficient to keep 40 men at conſtant work. But ſuch a quantity as would give conſtant work is not neceſſary: the operators muſt be often employed in making and repairing their drains, grubbing up roots of trees, &c.; ſo that a quantity ſufficient to give five or ſix hours work per day to the whole inhabitants is as much as would be wanted. But as the quantity procured was ſtill inſufficient for this purpoſe, a ſmall ſtream that deſcended from the higher grounds was diverted from its courſe and brought into the moſs. From want of level this ſtream could not be delivered to the greateſt advantage; namely, upon the ſurface of the moſs. Yet by making, at a conſiderable expence, a drain half a mile long, and a reſervoir for the night water, it was rendered of much importance: and during the whole winter months, as well as in ſummer, after every fall of rain, it kept 15 perſons fully employed.

In the year 1787, two more tenants agreed for eight acres each; in 1788, four; in 1789, eight; in 1790, four tenants, all agreed for the ſame number of acres.

The whole moſs was now diſpoſed of, except that part called *Flow Moſs*, which comprehends about 400 acres. Here it is twice the uſual breadth, ſo fluid that a pole may be thruſt with one hand to the bottom; and the interior part, for near a mile broad, is three feet above the level of all the reſt of the moſs. Hitherto the many and various difficulties that preſented themſelves had been overcome by perſeverance and expence. But here the extraordinary elevation of the moraſs, joined to its great fluidity, ſeemed to exclude

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all poſſibility of admitting a ſtream of water; and it was the general opinion that the moſs operations had now arrived at their *ne plus ultra*, and that this moraſs was doomed to remain a nuiſance for ages to come.

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But the proprietor had now advanced ſo far that he could not ſubmit to retreat: and he conſidered himſelf as, in ſome meaſure, pledged to the country for the completion of this undertaking. To detail the various methods practiſed to introduce a ſtream of water into that moraſs, would prove tedious. It is ſufficient to ſay, that after a thouſand unſucceſsful efforts, attended with much trouble and conſiderable expence, the point at laſt was gained, and a ſtream of water was brought in, and carried fairly acroſs the centre of the moraſs.

The greateſt obſtacle was now indeed overcome; but ſtill another remained of no ſmall moment, namely, the diſcouragement given to ſettlers from the total impoſſibility of erecting habitations upon the ſurface of this moraſs. To find a remedy for this evil was difficult. Happily a reſource at laſt occurred. This was to bargain with a certain number of the old tenants, whoſe habitations were neareſt, to take leaſes of portions of the moraſs. But as ſome additional aid was here neceſſary, it was agreed that 12l. ſterling ſhould be gradually advanced to each tenant till he ſhould accompliſh the clearing of an acre, for which he or his ſucceſſor is bound to pay 12s. of yearly rent, equal to five per cent. upon the ſum advanced. When this point ſhall be gained, they are bound to diſpoſe, as moſt agreeable to themſelves, either of their old or of their

new

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new poffeffion; for which, when once an acre is cleared, purchafers will not be wanting.

In confequence of the above arrangement, during the year 1791 no fewer than 35 of the old tenants agreed, upon the forefaid conditions, for eight acres each of the flow mofs. Thus 1200 acres are now difpofed of to 115 tenants. But when thefe 35 tenants fhall each have cleared their acre, then, according to agreement, 35 additional tenants will fpeedily be acquired; and the mofs will then contain in all 150 families.

To the leafes at firft granted to the tenants in the high mofs, it was afterwards determined to add a further period of 19 years (making in all 57 years), during which they are to pay one guinea per acre; a rent not greater than the land is worth even at prefent, but greatly below its probable value at that diftant period. This, it is hoped, will prove to the tenants a fufficient incitement to continue their operations till their poffeffions are completely cleared from mofs.

Having now gone through, in detail, the whole progrefs of the colony for many years after its firft fettlement in the year 1767, it ftill remains to take a general view of the effects produced by that eftablifhment.

For feveral years, at firft, the water was ufed chiefly to carry off mofs, in the forming of new roads, and preparing refervoirs; which confiderably retarded the principal object, of gaining land. Neverthelefs there have been cleared full 300 acres of excellent land, producing wheat, barley, oats, and clover, yielding from fix to twelve bolls after one.

From the nature of the undertaking, there is good reafon to fuppofe that the operations will yearly advance

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vance with greater rapidity; especially as the greater number of the settlers have only of late begun to operate. Many, besides maintaining their families otherwise by occasional employments, have in the high moss cleared in a year one rood of land; some have cleared two, some three roods, and in the low moss an acre.

It was a remark often made, even by persons of some observation, that by collecting together such a number of people, Kincardine would be overstocked; and the consequence would be their becoming a burden on the parish: for as the bulk of them were labourers not bred to any trade, and possessed of little stock, it was foreseen, that, for some time, they could not afford to confine themselves solely to the moss, from which the return must be slow; but behoved, for immediate subsistence, to work for daily hire. Happily these predictions have proved entirely groundless; for such is the growing demand for hands in this country, that not only do the whole of these people find employment whenever they choose to look for it, but their wages have been yearly increasing from the time of their first establishment. In short, they have proved to the corner where they are set down a most useful nursery of labourers; and those very farmers who, at first, so strongly opposed their settlement, now fly to them as a sure resource for every purpose of agriculture. Still they consider the moss operations as their principal business; none pay them so well; and when they do leave it to earn a little money, they return with cheerfulness to their proper employment. Many of them already raise large quantities of grain, and have no occasion to go off to other work; which will soon be

Preparation of Land. the cafe with the whole. Their original ftock, indeed, did not often exceed 25l. and fome had not even 10l.; but what was wanting in ftock was compenfated by induftry.

Of the whole inhabitants full nine-tenths are Highlanders, from the neighbouring parifhes of Callander, Balquhidder, &c.; a fober, frugal, and induftrious people, who, inured to hardfhips in their own country, are peculiarly qualified to encounter fo arduous an undertaking. From this circumftance, too, arifes a very happy confequence; that wearing a different garb and fpeaking a different language from the people amongft whom they are fettled, they confider themfelves in a manner as one family tranfported to a foreign land: and hence upon all occafions of difficulty, they fly with alacrity to each others relief. Neither ought it to be forgotten, that, from their firft fettlement to the prefent day, not a fingle inftance has occurred amongft them of theft, bad neighbourhood, or of any other mifdemeanour, that required the interpofition of the civil magiftrate. Nor, however poor in circumftances, has any one of them ever ftooped to folicit affiftance from the funds of the parifh appropriated to that purpofe.

Though few of the tenants entered with a large ftock, one only has been obliged to leave the mofs from incapacity to proceed. Many indeed have fpent their fmall ftocks, and even run a little in debt: but in this cafe they have been permitted to fell their tacks upon the following conditions: 1ft, That the purchafer fhall be a good man; 2dly, That the feller fhall take another poffeffion. By this manoeuvre a new inhabitant is gained; while the old one, relieved from debt, and

and aided by paſt experience, recommences his operations with double ſpirit upon a new poſſeſſion. The monied man again has at once a houſe and a piece of ground, the want of which chiefly ſtartled new beginners.

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Some have even made a kind of trade of ſelling; inſomuch, that from the year 1774 to the year 1792, no fewer than fifty ſales took place, producing in all the ſum of 849l. ſterling. This proved from time to time a moſt ſeaſonable recruit to the colony, and gave new vigour and ſpirits to the whole.

The number of the ſettlers is productive of an excellent effect; that although ſome are generally abſent, enough ſtill remain to occupy the water conſtantly. In a favourable day, there may be ſeen hundreds, men, women, and children, labouring with the utmoſt aſſiduity. The women declare they can make more by working at the moſs than at their wheel; and ſuch is the general attachment to that employment, that they have frequently been diſcovered working by moonlight.

Another happy conſequence ariſing from their numbers is the great quantity of moſs they conſume for fuel. There are in all 115 families. Each family requires at an average 10 dargues * of peats yearly. Each dargue uncovers a ſpace equal to 10 ſquare yards of clay: ſo that, by caſting peats, the moſs tenants gain yearly about 6 roods of land.

The advantage, too, of providing their fuel with ſo little trouble, is very great. They require yearly 1150 dargues

* A dargue (or darg) of peats, is the quantity that one man can caſt and two can wheel in a day to the field where they are ſpread out to dry.

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dargues of peats; which, as each dargue when dried and ſtacked is valued at five ſhillings, are worth 287l. 10s. ſterling; a ſum which otherwiſe muſt have been expended on the prime coſt and carriage of coals.—Many of them caſt peats for ſale; and 100l. worth are yearly diſpoſed of in the town of Stirling, the village of Down, &c.

Though moſs work be laborious, it is at the ſame time amuſing. The operator moves the moſs five feet only at a medium; and the water, like carts in other caſes, carrying it off as faſt as it is thrown in, excites him to activity. Still he muſt ſubmit to be wet from morning to night. But habit reconciles him to this inconvenience; while his houſe and arable land fill his eye and cheer his mind. Nor is it found that the health of the inhabitants is in the ſmalleſt degree injured either by the nature of the work or the vicinity of the moſs.

The quantity of moſs that one man can move in a day is ſurpriſing; when he meets with no interruption, ſeldom leſs than 48 cubic yards, each weighing 90 ſtones. The weight, then, of moſs moved per day is no leſs than 4320 ſtones. A cubic yard is moved into the water, and of courſe carried into the river Forth for one farthing. It follows, that the expence of moving 48 cubic yards is one ſhilling. But the ſame quantity moved to the ſame diſtance by carts would coſt 24 ſhillings. Hence the advantage derived from the poſſibility of floating moſs in water, and the great importance of having water for that purpoſe.

The moſs, when contraſted with the rich lands ſurrounding, appeared, eſpecially before the improvements, a very dreary ſpot; one wide unvaried wild, totally

totally unproductive, unfit even to furnish sustenance to any animal, except here and there a few wretched straggling sheep. Besides, it entirely cut off all connexion betwixt the farms on either side; among which no intercourse was practicable but by a circuit of several miles.

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The scene was soon greatly changed. The following are the numbers of the inhabitants who some years ago resided in the moss; also of their cows and horses, and of the acres gained by them from the moss, together with their produce.

Men - -	115
Women - -	113
Boys - -	199
Girls - -	193
Total	620

Number of cows, at least, -	115
Ditto of horses and carts - -	34
Ditto of acres cleared from moss -	300

The produce in bolls cannot be exactly ascertained: but, considering the goodness of the soil, may be fairly stated at eight bolls per acre. *Inde* 2400 bolls.

As oats are the staple commodity, the calculation shall be confined to that grain. According to the fiars of Stirlingshire, crop 1790, carse oats are valued at 14s. per boll. *Inde* 2400 bolls at 14s. is 1680l. Of late this price has at times been doubled.

A tract of ground so considerable, formerly a nuisance to the country, thus converted into a fertile field filled with inhabitants, comfortable and happy, cannot surely be surveyed with an eye of indifference by any

 person

paration Land. perſon whoſe mind is at all ſuſceptible of feeling or of public ſpirit.

An excellent gravelled road, 20 feet wide and a mile and a half long, is now carried quite acroſs the moſs. By this means, in the firſt place, a ſhort and eaſy intercourſe is eſtabliſhed between two conſiderable parts of the eſtate, formerly as little connected as if ſeparated by a lake or an arm of the ſea. Secondly, The inhabitants of the moſs, to whom, hitherto, all paſſage with carts or horſes was impracticable for at leaſt one half of the year, have now obtained the eſſential advantage of being able, with eaſe, to tranſport all the different commodities at every ſeaſon of the year. This road was entirely formed by the hands of the moſs tenants, and gravelled by their own carts and horſes: a work which, it will not be doubted, they performed with much alacrity; when it is conſidered that, to the proſpect of procuring a laſting and material benefit to themſelves, there was joined the additional inducement of receiving an immediate ſupply of money, the whole being done at the proprietor's expence.

The poſſeſſions are laid off in the manner beſt fitted for the operations; and are divided by lanes running in ſtraight lines parallel to each other. Parallel to theſe again the drains are carried; and this ſtraight direction greatly facilitates the progreſs of the water with its load of moſs. Upon the bank of moſs fronting the lanes, the operation of floating is begun; and twenty or thirty people have been ſometimes ſeen heaving moſs into the ſame drain. That the water might be the more conveniently applied, the lanes include between them the breadth of two poſſeſſions only. The new houſes are erected upon

each

each ſide of theſe lanes at the diſtance of 100 yards from each other. Preparation of Land.

Before the formation of lanes and roads, and while yet no ground was cleared, the firſt ſettlers were obliged to erect their houſes upon the ſurface of the moſs. Its ſoftneſs denied all acceſs to ſtones; which, at any rate, are at ſuch a diſtance as would render them too expenſive. Settlers, therefore, were obliged to conſtruct their houſes of other materials. Upon the low moſs there is found for this purpoſe great plenty of ſod or turf, which accordingly the tenants uſe for the walls of their houſes. For the rudeneſs of the fabric nature in ſome meaſure compenſates, by overſpreading the outſide with a luxuriant coating of heath and other mooriſh plants, which have a very pictureſque appearance.

But upon the high moſs there is no ſod to be found. There the tenant muſt go differently to work. Having choſen a proper ſituation for his houſe, he firſt digs four trenches down to the clay, ſo as to ſeparate from the reſt of the moſs a ſolid maſs, containing an oblong rectangular area, ſufficiently large for his intended houſe. This being done, he then ſcoops out the middle of the maſs, leaving on all ſides the thickneſs of three feet for walls; over which he throws a roof, ſuch as that by which other cottages are commonly covered.

Upon the ſofteſt parts of the moſs, even theſe walls cannot be obtained. In ſuch places the houſes are built with peat dug out of the moſs, and cloſely compreſſed together while in a humid ſtate *. It is neceſſary

* This does not apply to the moraſs, upon the ſurface of which, it has already been obſerved, it is impoſſible to erect houſes in any ſhape.

paration Land. fary even to lay upon the furface a platform of boards to prevent the walls from finking; which they have frequently done when that precaution was neglected. After all, to ftamp with the foot will fhake the whole fabric as well as the mofs for fifty yards around. This, at firft, ftartled the people a good deal; but cuftom foon rendered it familiar.

The colonifts have now made confiderable advancement in rearing better habitations for their comfort and convenience. Their huts of turf are but temporary lodgings. As foon as they have cleared a little ground, they build houfes of brick: when the proprietor a fecond time furnifhes them with timber gratis. It has alfo been found neceffary to relieve them entirely from the payment of the burdenfome tax upon bricks; a tax which furely was never intended to fall on fuch poor induftrious adventurers; and which, without this affiftance, would have proved a moft effectual bar to the employment of thefe materials.

There are now erected in the mofs 69 brick houfes, fubftantially built with lime. The total expence amounted to 1033l. fterling. And it is a very comfortable circumftance, that the money expended upon thefe houfes is moftly kept in circulation among the inhabitants themfelves; for as a number of them have learned not only to manufacture but alfo to build bricks, and as others who have horfes and carts furnifh the carriage of lime and coals, they thus interchange fervices with each other.

With a view to excite the exertion of the colonifts, the following premiums were alfo offered: 1. To the perfon who fhall in the fpace of one year remove the greateft quantity of mofs down to the clay, a plough of of the beſt conſtruction. 2. To the perſon who ſhall remove the next greateſt quantity, a pair of harrows of the beſt kind. 3. For the next greateſt quantity, a ſpade of the beſt kind, and 10lb. of red clover ſeed. But as theſe premiums, if conteſted for by the whole inhabitants, could reach but a very few of the number, they were therefore divided into ſix diſtricts according to their ſituation; and the above premiums were offered to each diſtrict.

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The eſtabliſhment of this colony was no doubt attended with a very conſiderable ſhare of expence and difficulty; for the undertaking was altogether new, and there were many prejudices againſt it, which it was neceſſary to overcome. At the ſame time it was noble and intereſting: it was to make a valuable addition to private property: it was to increaſe the population of the country, and to give bread to a number of people; many of whom having been turned out of their farms and cottaries in the Highlands, might otherwiſe, by emigration, have been loſt to their country; and that too at a time when, owing to the great enlargement of farms, depopulation prevails but too much even in the low countries. And it was to add to the arable lands of the kingdom, making many thouſand bolls of grain to grow where none ever grew before.

Theſe conſiderations have hitherto preponderated with the proprietors againſt the various obſtacles that preſent themſelves to the execution of ſo extenſive an undertaking. Should their example tend in any degree to ſtimulate others, who both in Scotland and in England poſſeſs much ground equally uſeleſs to the country, to commence ſimilar improvements, it would

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eparation of Land. be a most grateful consideration superadded to the pleasure already arising from the progress of the infant colony.

On account of the importance of the subject, we have here inserted the above detail, which was written some years ago, of the improvements carried on in the moss of Kincardine, commonly called *Moss Flanders*. But after all, it will probably hereafter be thought, that the great efforts of ingenuity, and of persevering industry, which were requisite in the above operation, might all have been avoided, and the work much easier performed, had the art been found out of converting moss into fruitful soil, according to the plan practised, and undoubtedly brought to great perfection in Ayrshire, by the gentleman already mentioned, John Smith, Esq. of Swinridge muir, near Beith. On a part of a moss in this gentleman's property, a quantity of lime had been spread in consequence of the miring of some carts in wet weather; to relieve which, their load was laid over the ground in their neighbourhood, though this was accounted at that period an absurd operation, as it was believed that lime would have the effect of consuming and rendering mossy ground useless for ever. The proprietor, Mr Smith, was then in the army, towards the close of the American war. On returning home the succeeding summer, and being informed of the accident, he was surprised to find that as good a crop grew upon the patch of moss on which the lime had been scattered, as upon another spot that had been pared and burned, in consequence of instructions that he had transmitted home for that purpose, from having perused some treatises in which burning of moss was recommended. He also remarked, that upon the places

Mr Smith's mode of improving moss.

which

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which had neither been burned nor limed, nothing grew, and that the crop upon the burned ſoil was inferior to that where the lime had been laid, being almoſt choked with ſorrel. Mr Smith purſued the hint thus obtained: He reclaimed by means of lime every portion of moſs in his own poſſeſſion, and having ſatiſfied his tenants of the utility of the practice, he allowed them to dig limeſtone gratis, and gave them the refuſe of his coal at prime coſt to burn it. Thus, in a ſhort time, every part of the moſs upon his eſtate was reduced under cultivation, and rendered highly valuable.

When Mr Smith began his operations, he met the fate of innovators in agriculture, that is, he was ridiculed by all his neighbours. His ſucceſs, however, at length made ſome converts, and though the new ſyſtem at firſt advanced ſlowly, it was at laſt univerſally approved of, and extenſively imitated. The reſult has been, that what was once the worſt land in the country, is now become the moſt productive and fertile.

The following is a conciſe ſtatement of Mr Smith's practice, and conſequently of the Ayrſhire practice, of actually converting moſs into vegetable mould; capable of bearing rich crops of corn, hay, potatoes, &c. which we ſhall give in the words of Mr Headrick *.

"1. When they enter upon the improvement of a moſs in its natural ſtate, the firſt thing to be done is, to mark and cut main or maſter drains, eight feet in width, by four and a half in depth, and declining to two and a half at bottom; theſe coſt 1s. per fall of ſix Scots ells. In ſome inſtances, it will be found neceſſary

* *Communications to the Board of Agriculture*, vol. ii.

Preparation of Land. cessary to cut those drains much deeper, consequently at a greater expence. These drains almost in every instance can be, and are so conducted, as to divide the field into regular and proper enclosures. They always make it a rule to finish off as much of a drain as they have broken up, before they leave it at night; because, if a part is left dug, suppose half way, the oozing of water from the sides would render the bottom so soft, that they could neither stand upon it nor lift it with the spade. When the moss is so very soft, that the pressure of what is thrown out of the drain may cause its sides to fall in again, they throw the clods from the drain a considerable way back, and sometimes have a man to throw them still further back, by a spade or the hand; for this reason too, they always throw the stuff taken from a drain as equally as possible on each side of it. In digging the drains, the workmen stand upon small boards to prevent them from sinking, and move them forward as the work advances.

"When the moss lies in a hollow, with only one outlet, it is necessary to lead up a drain, so as to let the water pass this outlet, and then conduct it along the lowest or wettest part of the moss: this middle drain is afterwards sloped, and the stuff thrown back into the hollows that may occur; upon it the ridges are made to terminate on each side, while a ring drain, serving the purpose of a fence, is thrown round the moss at the line where the rising ground commences. This can generally be so managed as to divide the moss into a square field, leaving straight lines for the sides of the contiguous fields. The ring drain intercepts the surface water from the higher grounds, and conducts it into the lower part of the outlet, while the sloped drain

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in the centre receives and discharges all the water that falls upon the mofs.

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After the mofs collapfes in confequence of liming and culture, it is often neceffary to clean out thefe drains a fecond time, and to dig them to a greater depth: their fides become at laft like a wall of peat, which few animals will venture to pafs.

" 2. The drains being thus completed, they mark out the ridges, either with a long ftring or with three poles fet in a line. Mr Smith has tried feveral breadths of ridges, but now gives a decided preference to thofe that are feven yards in breadth. The ridges are formed with the fpade in the following manner: In the centre of each intended ridge, a fpace of about two feet is allowed to remain untouched; on each fide of that fpace a furrow is opened, which is turned over fo as completely to cover that fpace, like what is called *veering* or *feering* of a gathered ridge; the work, thus begun, is continued by cutting furrows with the fpade, and turning them over from end to end of the ridge on each fide, until they arrive at the divifion furrows. The breadth of the flices thus cut, may be about 12 inches, and each piece is made as long as it may fuit to turn over: the ridge when finifhed, has the appearance of having been done with a plough. The divifion furrow is two feet in breadth, which if neceffary to draw off fuperfluous water, is partly cut and thrown upon the fides, or into hollows in the ridges on each fide. The depth of the divifion furrows is regulated by circumftances fo as not to lay the ridges at firft too dry, but at the fame time, to bleed, as it were, the mofs, and conduct the fuperfluous water into the mafter drains.

" 3. The next operation is to top-drefs the ridges

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with lime. The fooner this is done after the ridges are formed, the better. When the mofs appears dry, experienced farmers throw on the lime, but do not clean out the divifion furrows until the enfuing winter. When it is foaked in water, they clean the divifion furrows as foon as the lime is ready, and after the water has run off apply the lime immediately. It is of great importance to have the lime applied while the mofs is ftill moift, and the lime in as cauftic a ftate as poffible. For this purpofe, they have the lime conveyed from the kiln in parcels, flaked and laid on as faft as the ridges are formed. Being dropped from carts, and flaked at the neareft acceffible ftation, it is carried to the mofs by two men on light handbarrows, having a hopper and bottom of thin boards, and there fpread with fhovels as equally as poffible. During the firft and fecond years, the crop is generally carried off in the fame way. In fome places where a mofs is covered with coarfe herbage, and acceffible by carts in dry weather, I faw them give a good dofe of lime to the mofs before it was turned up with the fpade, and another after the ridges were formed. It is furprifing how quickly they execute thefe operations with the handbarrows. In other places where coarfe boards can be procured, they lay a line of them along the crown of a ridge, and convey the lime upon them in wheelbarrows.

" The proportion of lime allowed to the acre is various, being from three to eight chalders. Improvers are much lefs fparing of this ingredient now than formerly, and much greater proportions have been applied with good effect. Suppofe 120 bolls, or 480 Winchefter bufhels, of flaked or powdered lime allowed

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to every Scots acre, this would cost at the sale kilns 40s.; and thus the reader may be enabled to calculate the expence of lime in this district at every given proportion: But most of the farmers here burn lime for themselves in vast kilns of sod, and think they have it much cheaper than it could be got from a sale kiln. In many places, limestone abounds so much, that houses, fences, and roads are constructed with it; and when a farmer burns the limestone within his premises, he at least saves the expence of carriage.

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"In some cases, after the limestone is laid on, they go over the ground with hoes, or with spades, hacking and maggling the clods, and mixing the lime more completely with the superficial soil; but where there is much to do, and hands are scarce, they never think of these operations.

"4. The field thus prepared is ready to receive the seed, which is sown at the proper season whether it be *wet* or *dry*, and harrowed in with a small harrow drawn by two men. Four men will with ease harrow at least five or six roods per day, two and two dragging the harrow by turns, and two breaking and dividing the mould with spades. When the lime has been applied early the preceding summer, a good crop of oats may generally be expected; but if it has been recently applied, the first crop of oats frequently misgives, as the lime has not time to combine with the moss, and form it into a soil.

"The early Dutch or Polish oats are always preferred by moss improvers, as the common Scots or late oats are too apt to run into straw, and lodge before the grain arrives at maturity. The same proportion of seed is allowed per acre that is usual in other places. The

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The great desideratum is, to procure plants which will throw up a sufficient quantity of herbage, so as to shield the surface from the winds and sun's rays, and thus to keep it moist during the first summer after a moss is reclaimed.

This desideratum is effectually supplied by the potato, which thrives well on moss at all times, whether recently opened up and limed, or at any future period of its cultivation; only it requires a proportion of stable dung. It is now become the general practice in Ayrshire, to plant potatoes on those mosses which have been but recently turned up and limed; and where dung can be procured, it is generally the first crop on all their mosses.

"The method of planting potatoes, whether they be the first crop or succeed the first crop of oats, is by lazy beds. If they be the first crop, the moss having been delved into ridges, and limed as before directed, spaces of from five to six feet in breadth are marked out across the ridges, having intervals of about two feet, from which the moss is taken to cover the sets. These spaces or beds are covered over with a thin *stratum* of dung, laid upon the surface of the lime at the rate of about sixteen tons to the Scots acre. The cuttings of the potatoes are laid or placed upon the said beds, about ten or twelve inches asunder; and the whole are covered over with moss, taken from the intervals which are thus converted into ditches, to be followed by another covering about the time the potato plants begin to make their appearance, the covering in the whole amounting to about four or five inches; at the same time the division furrows are cleaned out to cover the sets that are contiguous to them. The

The whole field is thus divided into ſpaces or lazy beds, like a chequered board. During ſummer, they cut the moſs with hoes, and draw it up a little towards the ſtems of the plants. Few weeds appear, except what are conveyed by the dung. This is the practice univerſally followed when potatoes are planted on moſs for the firſt time; but after the moſs is finely pulverized and reduced, they either plant them in rows acroſs the ridges, or plant and dreſs them with the plough in the uſual manner.

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"Potatoes planted as the firſt crop never miſgive, and they are the beſt and moſt certain method at once to reclaim a moſs, not owing ſo much perhaps to the dung aiding the putrid fermentation which the lime has already excited, as to their roots puſhing and dividing the moſs, while their leaves ſhelter it from the ſun, cauſe a ſtagnation of air, and thus keep it in that degree of moiſture which is moſt favourable to the action of lime upon moſs. The practice of making potatoes the firſt crop is now univerſally followed, in ſo far as the farmers can command dung. The produce is from 40 to 60 bolls per acre, the potato meaſure being eight Wincheſter buſhels a little heaped to the boll. Moſſes that are fully reclaimed yield from 60 to 70 bolls of potatoes at an average, and in ſome places where manures are abundant, they have been known to yield from 80 to 100 bolls per acre, of the above meaſure.

"Mr Smith is about to try yams upon his moſſes, from the opinion that prevails among ſome of the Mid-Lothian farmers, where this plant is much cultivated, that they require little or no dung, and that the ſuperior breadth of their leaves will prove more favourable than thoſe of potatoes, for ſheltering the ground.

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"When the potato crop is removed, the ridges are again put into their original form; in doing which, care is taken to preſerve the mould that is acquired uppermoſt; this is done by moving the ſubfurrow on each ſide with a ſtrong ſpade, half way into the intermediate ditch from which the lazy beds were covered, and ſcattering the mould equally over the whole ſurface. This operation coſts 18s. per acre. It is not eaſy to calculate the expence of planting the potatoes, forming the lazy beds, &c. as this is ſeldom executed by contract; but the lazy beds being thus reduced, the land is ready for a crop of corn.

"Though a crop of oats frequently miſgives upon moſs that has been but recently limed, yet in other caſes, when the lime has lain ſeveral months upon the land, it proves a good crop, and is ſufficient to cover all the expence with a little profit. The crops of ſucceeding years are ſufficient to afford from their ſtraw putreſcent manure for ſuch land in order that it may be cleaned with potatoes, and prepared for graſs ſeeds.

"But after potatoes of the firſt year, with the ſlight operation of reducing the lazy beds, from 10 to 12 bolls of oats are at an average produced per acre. The oats are excellent, and yield from 18 to 20 pecks of meal per boll; they would ſell upon the ground for 10l. or 12l. per acre. The ground continues to yield oats of the ſame quality for ſeveral years, without any apparent diminution of fertility, and without receiving any additional manure: the only apparent bar to the continuance of this crop is, the ſoil becoming graſſy. When the graſs begins to contend with the crop for pre-eminence, the land is thrown into paſture, and would let ever af-

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ter in that ftate at from 20s. to 25s. per acre. Daifies, white clover, &c. &c. now fpring up in moffes, where their exiftence was never before fufpected; at the fame time, thiftles and other weeds for fome time infeft the pafture.

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" The better practice is, to take another crop of potatoes with a little dung and lime, and give it a trench-delving, to bury the weeds and bring up new foil; after the potatoes to fow barley and grafs feeds.

" Rye-grafs is univerfally fown here, and it attains amazing perfection upon mofs properly prepared; along with this, white and yellow clover are fometimes fown, and thrive remarkably well. Red clover has been tried, but did not fucceed, and is hence difcredited for mofs-lands: perhaps it may have been unjuftly cenfured, becaufe it is certain that the feafons in which it was tried, proved very unfavourable to red clover in all parts of the country, moft of it having died during winter.

" 5. We have already defcribed the levelling of the lazy beds. All future delvings of the mofs are performed from one end of the ridge to the other; by this method the flices that had been cut and turned over in the firft operation of forming the ridge, are again cut acrofs, and conftantly reduced into fmaller pieces, till they moulder into earth.

" The expence of delving a mofs for the firft time, where the furface is tolerably fmooth, is 2½d. per fall, or 1l. 13s. 4d. per Scots acre; but where inequalities occur, which muft be thrown down by the fpade into hollows, it cofts about 2l. per acre. If there be eminences, which muft be removed into hollows by wheelbarrows running upon boards, the firft expence is great-eparation f Land. er according to circumſtances. The ſecond delving, where potatoes have not intervened, coſts from 1l. to 1l. 6s. per Scots acre, the diviſion furrows being at the ſame time cleaned out. The third delving and cleaning of the diviſion furrows coſts 1l. per acre; but the moſs is now ſo friable, that it may be wrought with the the greateſt eaſe and rapidity. At the above rates, an ordinary workman will earn 1s. 6d. per day, and an able and experienced one, from that to 2s. 6d. per day. They uſe a ſtrong ſpade, edged with ſteel, and have always a gritſtone near them for ſharpening the ſpade. In the evenings they repair its edge upon a grindſtone; and when the ſteel is worn away, they lay it again with new ſteel. Sometimes the moſs is ſo ſoft that they walk upon boards while they are turning it over.

" Mr Smith has found, by long experience, that it is improper to make the ridges too high or too narrow: when they are too high, they throw the water off from their ſides without admitting it to penetrate their ſubſtance; the top of courſe gets too dry: when too narrow, there is a loſs of ſurface from too many diviſion furrows. The breadth already mentioned is found to be the beſt: and when the improvement is completed, the ridges appear like ſegments of wide circles, with a clean well-defined diviſion furrow between each of them. The moiſture is thus cauſed ſlowly to filtrate through the moſs rendered friable by lime until it reaches the diviſion furrows, and is diſcharged. As the moſs ſubſides for ſome time, and cloſes in towards the furrows, it is generally neceſſary to clean theſe out before winter, and at the time the crop is ſown, until the moſs acquire ſolidity.

" Some moſſes may be ploughed the ſecond year to within

within two bouts or four slices of the division furrows, and every operation performed by the force of horses, except turning over with the spade the narrow stripes next to the division furrows. In other mosses it requires three years before this can be done; and it seldom happens but every moss may be wrought by the plough after it has been wrought four years by the spade. When moss is wrought by the spade, it seems of no consequence whether it be wrought wet or dry; but when it is wrought by the plough, opportunities must be watched, as horses cannot walk upon it for some years during wet weather.

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"6. With respect to the quality of the potatoes thus produced upon mosses, I do not scruple to pronounce it most excellent. Potatoes have been tried with dung alone; but they are always watery, and frequently hollow or rotten in the heart: those raised upon mosses that have been well limed, are frequently so dry and farinaceous, that it is difficult to boil them without reducing them to powder; and they are often obliged to lift them with spoons: they come clean out of the ground; keep remarkably well in heaps covered with moss in the field; and are remarkably well flavoured.

"No such disease as the curl was ever known among moss potatoes; and, indeed, if Dr Coventry's opinion be true, that the curl is caused by overloading the sets with too much earth, or from the earth becoming too hard around them; no such thing can take place in moss. But to whatever cause the curl may be owing, it is certainly propagated by diseased seed; it would, therefore, appear advantageous to transfer the potatoes raised upon moss as seed for solid land. They have a

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remarkably good ſpecies of potato in this diſtrict, which was brought from Virginia to Largs about eight years ago; and whether it be owing to the beneficial nature of a moſſy ſoil, or to its own intrinſic merits, this potato has long been ſo much diſtinguiſhed by the good quality and large quantity of its produce, that it has ſuperſeded the uſe of every other ſpecies. There ſeems to be no occaſion for moſs improvers to change their ſeed. Some perſons in this diſtrict, who have but ſmall patches of moſs, have kept them conſtantly in potatoes more than ten years, without changing the ſeed, and without any ſenſible diminution either in the quantity or quality of the crop."

4. *Of bringing Land into Culture from a State of Nature.*

Before attempting to bring under cultivation land that has hitherto remained in a totally rude ſtate, the firſt conſideration with a prudent man ought undoubtedly to be, how far he is able to ſupport the expence of the undertaking. If conducted with ſkill, it will in almoſt all practicable caſes pay well; but a ſtout capital is neceſſary, becauſe, if only half meaſures are followed, the whole expence is apt to be loſt. This remark, however, is only made with regard to enterpriſes made upon a great ſcale; for ſmall portions, eſpecially of a dry mooriſh ſoil, may undoubtedly be improved by neighbouring farmers at a moderate coſt.

The firſt ſtep to be taken towards the improvement of waſte lands is, to drain them from all ſuch wetneſs as might have a tendency to injure their fertility when brought into a ſtate of cultivation. There are few inſtances of waſte lands, eſpecially in the neighbourhood of hills, in which ſome degree of draining is not requiſite.

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fite. Till proper drains are formed and completed, it is impoffible for an improver to form a correct plan for directing his future procedure, becaufe it frequently happens that the wetnefs of a foil, efpecially at the foot of mountains, is occafioned by very powerful fprings, which, if let out or tapped by a fkilful mode of draining, and their waters united into a common current, might form a ftream of confiderable importance. In all fuch cafes, fuch a ftream ought to be ufed for the purpofe of flooding or watering the inferior lands. The plough ought to be abftained from, and no farther or more expenfive improvement adopted upon thefe lower grounds. The important art of flooding lands, or of irrigation, will be afterwards explained. In the mean time, it may be here remarked, that there is fcarcely a piece of wafte territory in this country which does not contain fpontaneous proofs of the value of irrigation. We everywhere fee firm fpots by the fides of torrents, which from temporary flooding acquire a beautiful verdure that proves a remarkable contraft to the drearinefs of the furrounding wafte; and wherever little rills are found not confiderable enough to cut a regular bed for their waters, but which fpread at times over the mountains fides, we obferve their courfe univerfally marked by a track of green, in confequence of the deftruction of the heath in thefe fpots by the temporary overflowing of the water. Wherever by any means a ftream can in like manner be made to overflow at times, or to fpread itfelf abroad upon the whole furface of the ground, the heath and coarfer plants will pafs away, and give place to the finer herbage by which cattle or fheep are fupported.

When the draining is finifhed, the lands which canaration Land. not become objects of irrigation may be fertilized by lime, or by means of the practice of paring and burning.

To improve a moor by lime, let it be opened in winter. A strong dose of caustic lime ought as soon as possible to be laid upon the surface of the land in a state of fine powder, that it may attach itself to every part. The lime will consume the roots of heath and of coarse grasses, and in a few months render the soil extremely friable. Lime has the effect of utterly destroying heath, and of converting it into a valuable manure. Economy in the use of this ingredient, therefore, is extremely misapplied. Accordingly, some skilful farmers lay one dose of lime upon the land before it is ploughed, and another after it, that the furrow-slices and the whole tops and roots of the heath and other plants being wholly surrounded by this caustic ingredient, may be sooner reduced into a state of friable mould.

In spring, after the frost is over, a slight harrowing will fill up all the interstices in the furrows with mould to keep out the air and rot the turf or sod. Thus the land may be suffered to lie during the following summer and winter, which will tend more to rot this kind of moorish turf than if it had been laid open to the air by ploughing. Next April let it be cross-ploughed, braked, and harrowed, till it be sufficiently pulverized for turnip-seed; at the same time, as much manure as can possibly be obtained ought to be given to it, and the manure mixed with the soil.

Swampy lands, and a soil covered with rushes, ant-hills, and coarse grasses, may be treated advantageously in a manner somewhat different. Where lime is to be found in abundance, it is proper to pare the surface,

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and to collect the whole turf into heaps in different parts of the field, and make it up into compoſt with lime. The whole heaps in ſuch caſes ought to be thoroughly moiſtened, and the maſs to be well turned and mixed. In this way all the roots and coarſe herbage will be deſtroyed, and gradually reduced into a moſt valuable manure, for enriching the ſoil over which it ought to be ſpread, and thereafter ploughed in. Preparation of Land.

The ſecond mode of improving waſte lands of every kind is by paring and burning the ſurface. When land is pared, a thin ſod is taken off, either by a paring ſpade, or paring plough, over the whole ſurface. The ſods being dried, are collected into ſmall heaps and burnt, and the aſhes are ſcattered over the field. This practice has been found ſo obviouſly uſeful in the firſt inſtance, at leaſt, that it has been extended by many farmers to all ſoils upon breaking them up from graſs, though formerly cultivated and in good order, eſpecially where lime cannot eaſily be obtained. At the ſame time, as the propriety of the practice is ſtill greatly diſputed, it may be proper to adopt this opportunity of taking ſome general notice of the ſubject. By one ſet of writers, ſays the Rev. Mr Arthur Young *, the practice is pronounced to be contrary to every principle; that it is a waſteful extravagant operation which diſſipates what ſhould be retained, annihilates oils and mucilage, calcines ſalts, and reduces fertile organic matter into aſhes of very weak efficacy; that the vegetable particles which are brought into play at once for the production of a ſingle crop, by leſs deſperate management, might

* *Communications to the Board of Agriculture*, vol. ii.

paration of Land. might be husbanded to the support of many. On the contrary, the advocates for this operation assert that these objections are all founded on vain reasoning and speculative theory; that practice the most decided, and experience the most extended, pronounce it to be an admirable system; and that the mischiefs often quoted as flowing from it are to be attributed merely to the abuse of the method, and are by no means necessarily connected with it.

"I must without the least hesitation declare, says this writer, that the latter of these opinions is that to which I subscribe. To trust to reasoning in matters of agriculture is a most dangerous reliance: I shall leave others to detail their philosophical speculations, and rest what I have to offer solely on the practice, various and extensive, of numerous agriculturists, and on the common husbandry of many spacious districts.

"These agree in declaring (and it is most particularly to be had in remembrance, for the enemies of the practice admit it), that by paring and burning you may command two or three good corn crops in succession. The fact cannot be denied; for whether you examine the peat of the Cambridgeshire fens, or the fallow chalk soils of the downs and wolds of Hampshire, Gloucestershire, or the east riding of Yorkshire, it is known that bad farmers do act thus absurdly; they get indeed great crops, but they too often take them in succession, to the injury of the soil, though not to its ruin, unless that can be esteemed the ruin of land, which enables the tenant to pay double rent for it. Such farmers have been in the habit of burning for wheat, and then taking two crops of spring-corn, all good. Now it might be asked, how is it possible that that husbandry can produce

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all the evils detailed above, which enables a ſoil naturally poor and weak to give two or three good crops of corn? Their argument evidently proves too much; the effect ſhows that there is a powerful cauſe or agent in burning which they do not underſtand, which eſcapes from the retort of the chemiſt, and from the *rationale* of the theoriſt. That operation or manure which will give a good crop of wheat will give a good crop of turnip or cabbage; and he who, having made this commencement for the food of ſheep on the land, and knows not how to go on, preſerving the advantage he has gained, is a novice in the art of huſbandry. The farmers that are railed at know it as well as their philoſophical inſtructors; but avarice, united with the baneful effect of ſhort or no leaſes, makes them practiſe againſt their judgments.

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"Paring and burning will on all ſorts of land give turnip or cabbage; theſe fed on the land by ſheep, will ſecure barley or oats, and ſeeds; the ſeeds, fed with ſheep, whether for a ſhort or a longer duration, will ſecure another crop of corn adapted to the ſoil; and in this ſtage of the progreſs, the ſoil will have gained much more than it has loſt. To inſtance caſes which I have ſeen, and quote authorities for theſe aſſertions, would be tireſome. I can aſſure the Board, that inſtances might be produced from more than half the counties of the kingdom.

"It has often been contended, that burning leſſens the ſoil. If this happen any where, it muſt be in peat: yet in the fens of Cambridgeſhire this huſbandry has been repeated once in eight years for a century and a half; and the proofs of a loſs of depth are extremely vague in every inſtance I have met with, and hardly to

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be diſtinguiſhed from that undoubted ſubſidence which takes place in drained bogs of every deſcription. In all other ſoils the aſſertion may be ſafely and poſitively denied: I have calcined pared turf, not calcareous, after careful ſeparation and weighing, and in a heat far exceeding what is ever given in burning in the field, and, reweighing, found the loſs too minute to attribute to any thing but loſs of water intimately combined, but driven off by heat; and re-expoſing the earth to the atmoſphere free from rain, found an increaſe rather than a diminution of weight. The vegetable particles only are reduced to aſhes: theſe, in any method of putrefaction, would diſſolve; and combining with water, be exhaled by heat or abſorbed by the veſſels of plants. In aſhes theſe are in a more fixed ſtate relatively to the influences of the atmoſphere; and that plants feed on them, the great crops which ſucceed offer abundant proof.

"In addition to theſe circumſtances is the capital one of deſtroying inſects, grubs, and weeds: theſe are apt to abound moſt in the richer ſoils; no reaſon for abſtaining from this huſbandry on ſuch.

"I venture, therefore, to conclude, that paring and burning with a proper courſe of crops, is ſafe on any ſoil, and eſſentially neceſſary on ſome, as I ſhall preſently ſhew.

"*Clay.*—The gentlemen who have objected to paring and burning, have not given many reaſons peculiarly appropriate to this ſoil; the only one that merits the leaſt attention is, the aſſertion, that it converts what is properly ſoil into pieces of unfertile brick: the fact is not ſo; for every one who has burnt clay for *manure* knows, that though there be many lumps of the ſubſtance which they allude to, yet that the maſs of the heap conſiſts of aſhes, properly ſo called; but when the tenacity of this ſoil is conſidered (which is one of its greateſt evils), it will be found, that bricks are an excellent addition to the ſoil, to looſen and open its ſtubborn adheſion. Preparation of Land.

"Heaps of clay-aſhes, amounting to many hundreds of loads, have been burnt, and applied to great profit on this ſoil. By paring and burning, therefore, you have on it the common manure found in vegetable aſhes; and you have in addition a ſubſtance which acts mechanically. Hitt, who wrote from practice, and abounds with many juſt obſervations, remarks, 'I recommend burning of the ſurface as the cheapeſt manure, and moſt effectual of any; for it not only adds ſalts to the ſoil (which the burning of graſs roots produces) but it opens part of the ſtratum of clay next the ſoil ſo much that the roots of vegetables can afterwards feed therein; for when the turf of a piece of land has been burnt in heaps at four or five yards apart, though all the aſhes be taken away with ſome of the earth, and ſpread over the other parts of the land; yet neither corn nor turnips will grow ſo vigorouſly there, as on thoſe places that were only opened by heat."

Even upon good loams, on which the practice is moſt condemned, this writer ſupports it upon the authority of his own experience, as well as upon the experience of ſome reſpectable farmers. With regard to ſandy ſoils, he alleges that he has ſeen them alſo improved by it in Suffolk and in Cambridgeſhire. With regard to chalk, he obſerves, that it is the common method of breaking up downs in every part of England. On the Cottiſwold hills in Glouceſterſhire, it is the common

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mon husbandry, and often repeated. In Hampshire and Warwickshire the same husbandry prevails, and the sheep walks and warrens on the wolds of the east riding of Yorkshire and of Lincolnshire have thus been brought most profitably into culture. With regard to peat, he states, that "whatever variety of sentiments there may be for this method on other soils, here there can be none. The universal practice from the flat fens of Cambridgeshire to the swelling bogs of Ireland, on the mountainous moors on the north of England, and on the rough sedgy bottoms in almost every part of the kingdom, when fresh lands are broken up by men of real practice and observation, is to begin by paring and burning.'"

The following remarks upon the subject, in the Report of the Agriculture of the county of Northumberland, by J. Bayley and G. Culley, are worthy of attention. "Paring and burning is not much practised in the eastern and northern parts of the county: in the middle and southern parts it is most prevalent; but, even there, it is confined to old swards, and coarse, rough, rushy, and heathy lands. For the first breaking up of such ground, it is certainly very convenient, and preferable to any other mode we have ever seen; but though we are fully convinced of its beneficial effects in such situations, yet we have our doubts whether it could be used with advantage upon lands that have lain a few years in grass, and that would produce good crops of grain immediately on being ploughed out, which is not the case with coarse rough heathy lands, or even very old swards on rich fertile soils; it being found that crops on the latter are frequently very much injured by *leaping* for two or three years, which paring and burning entirely obviate, and ensure full crops to the farmer,

mer, who need not be under any apprehenſion of his ſoil being ruined by it, provided he purſue the following courſe: 1. Turnips; 2. Oats; 3. Fallow well limed for turnips; 4. Barley ſown up with clover and graſs ſeeds, and depaſtured with ſheep for three or four years. It is the injudicious cropping, more than the ill effects derived from paring and burning, that has been the chief cauſe of bringing ſuch an odium on this practice, which is certainly an excellent one in ſome ſituations, and when properly conducted; but, like the fermented juice of the grape, may be too often repeated and improperly applied.

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"The popular clamour againſt this practice, "that it deſtroys the ſoil," we can by no means admit; and are inclined to believe, that not a ſingle atom of ſoil is abſtracted, though the bulk of the ſod or turf be diminiſhed. This ariſes from the burning of the roots or vegetable ſubſtances, which, by this proceſs, afford a conſiderable portion of alkaline ſalts, phlogiſtic or carbonic matter, and probably other principles friendly to vegetation; as we find thoſe aſhes produce abundant crops of turnips, which fatten ſtock much quicker than thoſe after any other dreſſing or manure we have ever ſeen; and the ſucceeding crops of corn are ſo very luxuriant as to tempt the injudicious cultivator to purſue it too far; who, for the ſake of a temporary gain, may be ſaid to rip it up, as the boy did his gooſe that laid golden eggs."

In the Annals of Agriculture various inſtances are exhibited of the ſucceſsful uſe of this practice, as well as of the abuſe of it. In one paper upon the ſubject * the

* Vol. xxviii.

Preparation of Land. the editor himſelf remarks, when ſpeaking of a diſtrict of Hampſhire which he ſurveyed, that "the argument commonly heard is, that it leſſens the ſtaple of a thin ſoil: but facts are clear againſt this; for if it were true, there are ſoils that would have been much more than leſſened, for they would have been all gone centuries ago. The practice is known to have been of great antiquity, and not to be executed but in proportion as a *turf* is formed; the preſident de la Tour d'Aigues ſhowed me lands in Provence that had been pared and burnt probably for 2000 years, and he juſtly ridiculed the idea of waſting the ſoil. The queſtion is, whether you ſhall rot or burn the vegetable particles? and that method is apparently the beſt which produces the beſt crops. Every man with his eyes open, in this country, will ſee the crops given by paring; the practice is the baſis of all the good crops I have ſeen, and they have many that would do credit to much richer countries."

John Dalton, Eſq. an experienced agriculturiſt, in a communication addreſſed to the Board of Agriculture *, expreſſes himelf thus: "The beſt method I ever found of converting graſs-land into tillage is unqueſtionably by paring and burning: you get into a good courſe of huſbandry at once, turnips, barley, &c. &c. and it is a mere chimera to ſuppoſe that the ſoil is diminiſhed by it. I have myſelf pared and burned the ſame field twice in the courſe of 15 years, and could never diſcover that the ſoil was in the ſmalleſt degree diminiſhed by the operation."

Upon

* *Communic.* vol. iii.

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General opinion as to paring and burning.

Upon the whole, whatever judgment may be pronounced with regard to the practice of paring and burning, when applied to lands which have been previously cultivated, there appears to be no doubt, that it is the best of all modes of breaking up a fresh, rude, and hitherto untouched soil. The only hazard in the performance of it is, that the men accustomed to the work rarely cut deep enough on peaty soils to destroy the ling root and branch. It is better, when practicable, to plough and burn the furrow; and, when not practicable, to add something to the common price for having the work done to a greater depth. The effect of this operation is prodigious on these soils; it destroys the spontaneous growth quicker and more effectually than any other method: a whole year's tillage and fallowing are inferior in this respect. It furnishes a manure which is very well adapted to the nature of the ground; for it has been found on abundance of trials, that no manure exceeds the ashes of chimnies in mountainous countries wherein the surface of those mountains is the fuel of the people; a fact that holds true in proportion to the depth to which they are dug; the ashes of the pure *heavy* black bog being the best of all. But the singular advantage of this mode of breaking up is the suddenness with which a black moor becomes green under a flour ng crop of cabbage, rape, or turnip. It may be burnt in a north-east drying wind, in the spring, and in July covered with useful vegetation.

It is believed, that the practice of paring and burning was originally introduced in situations in which lime or proper fuel for burning limestone could not readily be obtained. It is observed, however, by a judicious wri-

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ter in the Annals of Agriculture*, that "experience has proved that the addition of lime to the ashes of the pared surface operates more beneficially than if spread in any other manner. The larger the quantity, the greater the effect, and probably the greater the *proportional* effect; that is, six chaldrons an acre will do more than twice the good of three chaldrons; the chemical effect both in neutralizing the acids found in all these soils, and also in destroying the roots left of the spontaneous growth depending in some measure on the effect taking place suddenly. It has been known, that eight chaldrons an acre laid on at once, have converted a moor to meadow worth 25s. an acre; but the same moor under one chaldron per acre per annum for eight years, has not been worth 7s. 6d. an acre. The effect of lime on all soils long in cultivation is problematical, and does not answer the expence in one case in ten; but in new moor lands, the effect is prodigious and hardly credible. Laid on ling mountains without tillage, without paring, or other operation than merely cutting the ling, and spreading the lime, such moors have been changed from 1s. to 20s. per acre; but the quantity has been 15 and 20 chaldrons per acre. The best guide in laying on lime is the expence; a prudent man would be cautious of going further than 40s. an acre, and at the extreme 3l.; even at 40s. the total expence of the improvement will run high."

After paring and burning when the ashes are spread, which is supposed to be in the month of May, the field should be ploughed true, but shallow, in order not to bury

* Vol. xx.

bury the ashes too deep; then harrowed very well till fine, and ploughed shallow again cross. This, with a second good harrowing, will mix and incorporate the soil and ashes so well, that it is scarcely possible to miss a crop of turnips if any rain at all fall during the month of June.

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Course of crops for improving waste lands.

The most important point in all attempts to improve waste lands, consists of adopting a proper course of crops after the land is broke up. This is indeed the keystone of the arch; and if this object be not attended to with singular care, and correct views adopted concerning it, the whole improvement will infallibly fail in profit, and perhaps prove a ruinous speculation. It ought to be observed then, that although the use of lime, or of paring and burning with or without the addition of lime, may do much towards the temporary production of crops upon a new soil, yet that such stimulating manures must not be relied on as sources of permanent fertility. The great object, therefore, with every improver of lands, ought to be to consider well in what manner he may most readily obtain the command of large quantities of dung, for the purpose of putting the soil truly and substantially into good heart or condition. If this is not done, he has only exchanged bad grass for bad crops, and has obtained no real advantage by the change. That course of crops, therefore, ought to be adopted, which affords the most abundant subsistence for a great number of cattle or of sheep. With this view, turnips are the readiest resource, because they succeed well upon a new soil, with little or no dung. The turnip crop, therefore, which ought always to be the first after breaking up, may be wholly consumed upon the soil by sheep or

 calves;

Preparation of Land. calves: the land will thus be enriched by their dung with little trouble or expence. The benefit arifing from this mode of proceeding is fo great, that it ought not to terminate with a fingle year, but ought to be followed by another crop of turnips during the fecond year, to be confumed upon the land in like manner; and fome improvers have even advantageoufly proceeded the length of taking a third crop of turnips, though probably it might prove more advantageous, as the land is new dunged, to take a crop of cabbages during the third year, always remembering, that the whole dung produced by the cattle fed upon this crop, ought to be reftored to the new foil. After thefe green crops, the land will be in excellent condition for laying down with grafs feeds. The moft correct mode of fowing grafs feeds, in fuch a cafe, no doubt, is to put upon the ground no other crop at the fame time with themfelves; but, as barley fucceeds extremely well after turnips, and is, at the fame time, in other refpects, the kind of grain that is moft advantageoufly ufed along with grafs feeds, a crop of barley thinly fown may be taken at the fame time.

If the land that has thus been brought under the plough forms part of a cold, bleak, and mountainous region, the beft plan that can be adopted for rendering it profitable, is that which brings it moft fpeedily and perfectly into condition to become a valuable pafture for fheep. When this, therefore, is the object in view, which in all fuch fituations it ought to be, rye-grafs need not be ufed as one of the grafs feeds; and, at all events, a crop of hay ought not to be taken, as this would tend to exhauft the foil, and to retard the fpeedy formation of a clofe and rich pafture. If the lands, however, are

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in such a situation, that they may be expected to be used with advantage for the frequent production of crops of grain, a crop of hay may be taken as increasing the quantity of food for cattle, and thereby giving an additional command of manure; and the land may, after another year or two, be restored to tillage. Preparation of Land.

5. *Forming Ridges.*

The first thing that occurs on this head, is to consider what grounds ought to be formed into ridges, and what ought to be tilled with a flat surface. Dry soils, which suffer by lack of moisture, ought to be tilled flat, which tends to retain moisture. And the method for such tilling, is to go round and round from the circumference to the centre, or from the centre to the circumference. This method is advantageous in point of expedition, as the whole is finished without once turning the plough. At the same time, every inch of the soil is moved, instead of leaving either the crown or the furrow unmoved, as is commonly done in tilling ridges. Clay soil, which suffers by water standing on it, ought to be laid as dry as possible by proper ridges. A loamy soil is the middle between the two mentioned. It ought to be tilled flat in a dry country, especially if it incline to the soil first mentioned. In a moist country, it ought to be formed into ridges, high or low according to the degree of moisture and tendency to clay. Of ridges.

In grounds that require ridging, an error prevails, that ridges cannot be raised too high. High ridges labour under several disadvantages. The soil is heaped upon the crown, leaving the furrows bare: the crown is too dry, and the furrows too wet: the crop, which Evils attending too high ridges

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is always beſt on the crown, is more readily ſhaken with the wind, than where the whole crop is of an equal height; the half of the ridge is often covered from the ſun, a diſadvantage which is far from being ſlight in a cold climate. High ridges labour under another diſadvantage, in ground that has no more level than barely ſufficient to carry off water: they ſink the furrows below the level of the ground; and conſequently retain water at the end of every ridge. The furrows ought never to be ſunk below the level of the ground. Water will more effectually be carried off by leſſening the ridges both in height and breadth: a narrow ridge, the crown of which is but 18 inches higher than the furrow, has a greater ſlope than a very broad ridge, where the difference is three or four feet.

Ridges on declivities.

Next, of forming ridges where the ground hangs conſiderably. Ridges may be too ſteep as well as too horizontal: and if to the ridges be given all the ſteepneſs of a field, a heavy ſhower may do irreparable miſchief. To prevent ſuch miſchief, the ridges ought to be ſo directed croſs the field, as to have a gentle ſlope for carrying off water ſlowly, and no more. In that reſpect, a hanging field has greatly the advantage of one that is nearly horizontal; becauſe, in the latter, there is no opportunity of a choice in forming the ridges. A hill is of all the beſt adapted for directing the ridges properly. If the ſoil be gravelly, it may be ploughed round and round, beginning at the bottom and aſcending gradually to the top in a ſpiral line. This method of ploughing a hill requires little more force than ploughing on a level; and at the ſame time removes the great inconvenience of a gravelly hill, that rains go off too quickly; for the rain is retained in

every

every furrow. If the foil be fuch as to require ridges, they may be directed to any flope that is proper. Preparation of Land.

In order to form a field into ridges that has not been formerly cultivated, the rules mentioned are eafily put in execution. But what if ridges be already formed, that are either crooked or too high? After feeing the advantage of forming a field into ridges, people were naturally led into an error, that the higher the better. But what could tempt them to make their ridges crooked? Certainly this method did not originate from defign; but from the lazinefs of the driver fuffering the cattle to turn too haftily, inftead of making them finifh the ridge without turning. There is more than one difadvantage in this flovenly practice. Firft, the water is kept in by the curve at the end of every ridge, and fours the ground. Next, as a plough has the leaft friction poffible in a ftraight line, the friction muft be increafed in a curve, the back part of the mouldboard preffing hard on the one hand, and the coulter preffing hard on the other. In the third place, the plough moving in a ftraight line, has the greateft command in laying the earth over. But where the ftraight line of the plough is applied to the curvature of a ridge in order to heighten it by gathering, the earth moved by the plough is continually falling back, in fpite of the efforts of the moft fkilful ploughman. Crooked ridges.

The inconveniences of ridges high and crooked are fo many, that one would be tempted to apply a remedy at any rifk. And yet, if the foil be clay, it would not be advifable for a tenant to apply the remedy upon a leafe fhorter than two nineteen years. In a dry gravelly foil, the work is not difficult nor hazardous. Altering ridges.

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When the ridges are cleaved two or three years successively in the course of cropping, the operation ought to be concluded in one summer. The earth, by reiterated ploughings, should be accumulated upon the furrows, so as to raise them higher than the crowns: they cannot be raised too high, for the accumulated earth will subside by its own weight. Cross ploughing once or twice, will reduce the ground to a flat surface, and give opportunity to form ridges at will. The same method brings down ridges in clay soil: only let care be taken to carry on the work with expedition; because a hearty shower, before the new ridges are formed, would soak the ground in water, and make the farmer suspend his work for the remainder of that year at least. In a strong clay, we would not venture to alter the ridges, unless it can be done to perfection in one season. On this subject Dr Anderson has the following observations *.

Inconveniences in the common methods of levelling.

"The difficulty of performing this operation properly with the common implements of husbandry, and the obvious benefit that accrues to the farmer from having his fields level, has produced many new inventions of ploughs, harrows, drags, &c. calculated for speedily reducing the fields to that state; none of which have as yet been found fully to answer the purpose for which they were intended, as they all indiscriminately carry the earth that was on the high places into those that were lower; which, although it may in some cases render the surface of the ground tolerably smooth and level, is usually attended with inconveniences far

* *Essays on Agriculture*, vol. i. p. 146.

far greater, for a confiderable length of time, than that which it was intended to remove.

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Vegetable mould becomes inert by being long buried

"For experience fufficiently fhows, that even the beft vegetable mould, if buried for any length of time fo far beneath the furface as to be deprived of the benign influences of the atmofphere, lofes its *vis vitæ*, if I may be allowed that expreffion; becomes an inert lifelefs mafs, little fitted for nourifhing vegetables; and conftitutes a foil very improper for the purpofes of the farmer. It therefore behoves him, as much as in him lies, to preferve, on every part of his fields, an equal covering of that vegetable mould that has long been uppermoft, and rendered fertile by the meliorating influence of the atmofphere. But, if he fuddenly levels his high ridges by any of thefe mechanical contrivances, he of neceffity buries all the good mould that was on the top of the ridges in the old furrows; by which he greatly impoverifhes one part of his field, while he too much enriches another; infomuch that it is a matter of great difficulty, for many years thereafter, to get the field brought to an equal degree of fertility in different places; which makes it impoffible for the farmer to get an equal crop over the whole of his field by any management whatever: and he has the mortification frequently, by this means, to fee the one half of his crop rotted by an over-luxuriance, while other parts of it are weak and fickly, or one part ripe and ready for reaping, while the other is not properly filled; fo that it were, on many occafions, better for him to have his whole field reduced at once to the fame degree of poornefs as the pooreft of it, than have it in this ftate. An almoft impracticable degree of attention in fpreading the manures may indeed in fome meafure get the

better

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better of this: but it is so difficult to perform this properly, that I have frequently seen fields that had been thus levelled, in which, after thirty years of continued culture and repeated dressings, the marks of the old ridges could be distinctly traced when the corn was growing, although the surface was so level that no traces of them could be perceived when the corn was off the ground.

" But this is a degree of perfection in levelling that cannot be usually attained by following this mode of practice; and, therefore, is but seldom seen. For all that can be expected to be done by any levelling machine, is to render the surface perfectly smooth and even in every part, at the time that the operation is performed: but as, in this case, the old hollows are suddenly filled up with loose mould to a great depth, while the earth below the surface upon the heights of the old ridges remains firm and compact, the new raised earth after a short time subsides very much, while the other parts of the field do not sink at all; so that in a short time the old furrows come to be again below the level of the other parts of the field, and the water of course is suffered in some degree to stagnate upon them; insomuch that, in a few years, it becomes necessary once more to repeat the same levelling process, and thus renew the damage that the farmer sustains by this pernicious operation.

Levelling sometimes not to be attempted.

" On these accounts, if the farmer has not a long lease, it will be found in general to be much his interest to leave the ridges as he found them, rather than to attempt to alter their direction; and, if he attends with due caution to moderate the height of these old ridges, he may reap very good crops, although perhaps

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at a somewhat greater expence of labour, than he would have been put to upon the same field, if it had been reduced to a proper level surface, and divided into straight and parallel ridges. Preparation of Land.

"But, where a man is secure of possessing his ground for any considerable length of time, the advantages that he will reap from having level and well laid out fields, are so considerable as to be worth purchasing, if it should be even at a considerable expence. But the loss that is sustained at the beginning, by this mechanical mode of levelling ridges, if they are of considerable height, is so very great, that it is perhaps doubtful if any future advantages can ever fully compensate it. I would therefore advise, that all this levelling apparatus should be laid aside; and the following more efficacious practice be substituted in its stead: A practice that I have long followed with success, and can safely recommend as the very best that has yet come to my knowledge.

" If the ridges have been raised to a very great height, as a preparation for the ensuing operations, they may be first *cloven*, or *scalded* out, as it is called in different places; that is, ploughed so as to lay the earth on each ridge from the middle towards the furrows. But if they are only of a moderate degree of height, this operation may be omitted. When you mean to proceed to level the ground, let a number of men be collected, with spades, more or fewer as the nature of the ground requires, and then set a plough to draw a furrow directly across the ridges of the whole field intended to be levelled. Divide this line into as many parts as you have labourers, allotting to each one ridge or two, or more or less, according to their number, Best method of levelling.

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number, height, and other circumſtances. Let each of the labourers have orders, as ſoon as the plough has paſſed that part aſſigned him, to begin to dig in the bottom of the furrow that the plough has juſt made, about the middle of the ſide of the old ridge, keeping his face towards the old furrow, working backwards till he comes to the height of the ridge; and then turn towards the other furrow, and repeat the ſame on the other ſide of the ridge, always throwing the earth that he digs up into the deep old furrow between the ridges, that is directly before him; taking care not to dig deep where he firſt begins, but to go deeper and deeper as he advances to the height of the ridge, ſo as to leave the bottom of the trench he thus makes acroſs the ridge entirely level, or as nearly ſo as poſſible. And when he has finiſhed that part of the furrow allotted to him that the plough has made in going, let him then go and finiſh in the ſame manner his own portion of the furrow that the plough makes in returning. In this manner, each man performs his own taſk through the whole field, gradually raiſing the old furrows as the old heights are depreſſed. And, if an attentive overſeer is at hand, to ſee that the whole is equally well done, and that each furrow is raiſed to a greater height than the middle of the old ridges, ſo as to allow for the ſubſiding of that looſe earth, the operation will be entirely finiſhed at once, and never again need to be repeated.

"In performing this operation, it will always be proper to make the ridges, formed for the purpoſe of levelling, which go acroſs the old ridges, as broad as poſſible; becauſe the deep trench that is thus made in each of the furrows is an impediment in the future operations,

tions, as well as the height that is accumulated in the middle of each of these ridges; so that the fewer there are of these, the better it is. The farmer, therefore, will do well to advert to this in time, and begin by forming a ridge by always turning the plough to the right hand, till it becomes of such a breadth as makes it very inconvenient to turn longer in that manner; and then, at the distance of twice the breadth of this new-formed ridge from the middle of it, mark off a furrow for the middle of another ridge, turning round it to the right hand, in the same manner as was done in the former, till it becomes of the same breadth with it; and then, turning to the left hand, plough out the interval that was left between the two new-formed ridges. By this mode of ploughing, each ridge may be made of 40, 50, or 60 yards in breadth, without any great inconvenience; for although some time will be lost in turning at the ends of these broad ridges, yet as this operation is only to be once performed in this manner, the advantage that is reaped by having few open furrows, is more than sufficient to counterbalance it. And, in order to moderate the height that would be formed in the middle of each of these great ridges, it will always be proper to mark out the ridges, and draw the furrow that is to be the middle of each, some days before you collect your labourers to level the field; that you may, without any hurry or loss of labour, clear out a good trench through the middle of each of the old ridges; as the plough, at this time, going and returning nearly in the same track, prevents the labourers from working properly without this precaution.

" If these rules are attended to, your field will be at once reduced to a proper level, and the rich earth that formed

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formed the surface of the old ridges be still kept upon the surface of your field; so that the only loss that the possessor of such ground can sustain by this operation, is merely the expence of performing it."

Dr Anderson afterwards makes a calculation of the different expences of levelling by the plough and by the spade, in which he finds the latter by far the cheapest method.

Proper direction of the ridges.

Let it be a rule to direct the ridges north and south, if the ground will permit. In this direction, the east and west sides of the ridges, dividing the sun equally between them, will ripen at the same time.

Narrow ridges an advantage.

It is a great advantage in agriculture, to form ridges so narrow, and so low, as to admit the crowns and furrows to be changed alternately every crop. The soil nearest the surface is the best; and by such ploughing, it is always kept near the surface, and never buried. In high ridges, the soil is accumulated at the crown and the furrows left bare. Such alteration of crown and furrow is easy where the ridges are no more but seven or eight feet broad. This mode of ploughing answers perfectly well in sandy and gravelly soils, and even in loam; but it is not safe in clay soil. In that soil, the ridges ought to be 12 feet wide, and 20 inches high; to be preserved always in the same form by casting, that is, by ploughing two ridges together, beginning at the furrow that separates them, and ploughing round and round till the two ridges be finished. By this method, the separating furrow is raised a little higher than the furrows that bound the two ridges. But at the next ploughing, that inequality is corrected, by beginning at the bounding furrows, and going round and round till the ploughing of the two ridges be completed at the feparating furrow. Preparation of Land.

6. *Of Cleaning Ground.*

For this purpofe a new inftrument, termed a *cleaning harrow*, has been introduced by Lord Kaimes, and is ftrongly recommended *. It is one entire piece like the firft of thofe mentioned above, confifting of feven bulls, four feet long each, two and one-fourth inches broad, two and three-fourths deep. The bulls are united together by fheths, fimilar to what were mentioned above. The intervals between the bulls being three and three-fourths inches, the breadth of the whole harrow is three feet five inches. In each bull are inferted eight teeth, each nine inches free below the wood, and diftant from each other fix inches. The weight of each tooth is a pound, or near it. The whole is firmly bound by an iron plate from corner to corner in the line of the draught. The reft as in the harrows mentioned above. The fize, however, is not invariable. The cleaning harrow ought to be larger or lefs according as the foil is ftiff or free. Cleaning harrow. Plate IV. fig. 5.

To give this inftrument its full effect, ftones of fuch a fize as not to pafs freely between the teeth ought to be carried off, and clods of that fize ought to be broken. The ground ought to be dry, which it commonly is in the month of May.

In preparing for barley, turnip, or other fummer-crop, begin with ploughing and crofs ploughing. If the

* In his *Gentleman Farmer*; to which performance the practical of this treatife is materially indebted.

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Plate IV. fig. 1. 2. 3.

the ground be not fufficiently pulverized, let the great brake be applied, to be followed fucceffively with the 1ft and 2d harrows. In ftiff foil, rolling may be proper, once or twice between the acts. Thefe operations will loofen every root, and bring fome of them to the furface. This is the time for the 3d harrow, conducted by a boy mounted on one of the horfes, who trots fmartly along the field, and brings all the roots to the furface: there they are to lie for a day or two, till perfectly dry. If any ftones or clods remain, they muft be carried off in a cart. And now fucceeds the operation of the cleaning harrow. It is drawn by a fingle horfe, directed by reins, which the man at the oppofite corner puts over his head, in order to have both hands free. In this corner is fixed a rope, with which the man from time to time raifes the harrow from the ground, to let the weeds drop. For the fake of expedition, the weeds ought to be dropt in a ftraight line crofs the field, whether the harrow be full or not; and feldom is a field fo dirty, but that the harrow may go 30 yards before the teeth are filled. The weeds will be thus laid in parallel rows, like thofe of hay raked together for drying. A harrow may be drawn fwiftly along the rows, in order to fhake out all the duft; and then the weeds may be carried clean off the field in carts. But we are not yet done with thefe weeds; inftead of burning, which is the ordinary practice, they may be converted into ufeful manure, by laying them in a heap with a mixture of hot dung to begin fermentation. At firft view, this way of cleaning land will appear operofe; but, upon trial, neither the labour nor expence will be found immoderate. At any rate, the labour and expence ought not to be grudged; for if a field be once thoroughly cleaned, the feafons muft be very crofs, or the farmer very indolent, to make it neceffary to renew the operation in lefs than 20 years. In the worft feafons, a few years pafture is always under command; which effectually deftroys triennial plants, fuch as thiftles and couch-grafs. Preparati of Land.

7. *On the Nature of different Kinds of Soils, and the Plants proper to each.*

1. Clay, which is in general the ftiffeft of all foils, and contains an unctuous quality. But under the term *clays*, earths of different forts and colours are included. One kind is fo obftinate, that fcarcely any thing will fubdue it; another is fo hungry and poor, that it abforbs whatever is applied, and turns it into its own quality. Some clays are fatter than others, and the fatteft are the beft; fome are more foft and flippery. But all of them retain water poured on their furface, where it ftagnates, and chills the plants, without finking into the foil. The clofenefs of clay prevents the roots and fibres of plants from fpreading in fearch of nourifhment. The blue, the red, and the white clay, if ftrong, are unfavourable to vegetation. The ftony and loofer forts are lefs fo; but none of them are worth any thing till their texture is fo loofened by a mixture of other fubftances, and opened, as to admit the influence of the fun, the air, and frofts. Among the manures recommended for clay, fand is of all others to be preferred; and fea fand is the beft of all, where it can be obtained. This moft effectually breaks the cohefion. Clay foil.

The reafon for preferring fea fand is, that it is not

 formed

Preparation of Land. formed wholly (as moſt other ſands are) of ſmall ſtones; but contains a great deal of calcareous matter in it, ſuch as ſhells grated and broken to pieces by the tide, and alſo of ſalts. The ſmaller the ſand is, the more eaſily it penetrates the clay; but it abides leſs time in it than the larger.

The next beſt ſand is that waſhed down by rains on gravelly ſoils. Thoſe which are dry and light are the worſt. Small gritty gravel has alſo been recommended by the beſt writers on agriculture for theſe ſoils; and in many inſtances we have found it to anſwer the purpoſe.

Shell marl, aſhes, and all animal and vegetable ſubſtances, are very good manures for clay; but they have been found moſt beneficial when ſand is mixed with them. Lime has been often uſed; but the writer of this ſection would not recommend it, for he never found any advantage from it ſingly, when applied to clays.

The crops moſt ſuitable for ſuch lands are, wheat, beans, cabbages, and rye-graſs. Clover ſeldom ſucceeds, nor indeed any plants whoſe roots require depth and a wide ſpread in the earth.

Chalky ſoil. 2. Chalk. Chalky ſoils are generally dry and warm, and if there be a tolerable depth of mould, fruitful; producing great crops of barley, rye, peaſe, vetches, clover, trefoil, burnet, and particularly ſainfoin. The latter plant flouriſhes in a chalky ſoil better than any other. But if the ſurface of mould be very thin, this ſoil requires good manuring with clay, marl, loam, or dung. As theſe lands are dry, they may be ſown earlier than others.

When your barley is three inches high, throw in 10lb.

10lb. of clover, or 15lb. of trefoil, and roll it well. The next summer mow the crop for hay; feed off the aftermath with sheep; and in winter give it a top-dressing of dung. This will produce a crop the second spring, which should be cut for hay. As soon as this crop is carried off, plough up the land, and, in the beginning of September, sow three bushels of rye per acre, either to feed off with sheep in the spring or to stand for harvest. If you feed it off, sow winter vetches in August or September, and make them into hay the following summer. Then get the land into as fine tilth as possible, and sow it with sainfoin; which, with a little manure, once in two or three years, will remain and produce good crops for 20 years together.

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3. Light poor land, which seldom produces good crops of any thing till well manured. After it is well ploughed, sow three bushels of buck-wheat, per acre, in April or May: When in bloom, let your cattle in a few days to eat off the best, and tread the other down; this done, plough in what remains immediately. This will soon ferment and rot in the ground; then lay it fine, and sow three bushels of rye per acre. If this can be got off early enough, sow turnips; if not, winter vetches to cut for hay. Then get it into good tilth, and sow turnip-rooted cabbages, in rows three feet apart. This plant seldom fails, if it has sufficient room, and the intervals be well horse-hoed; and you will find it the best spring feed for sheep when turnips are over.

Light poor soil.

The horse-hoeing will clean and prepare the land for sainfoin; for the sowing of which April is reckoned the best season. The usual way is to sow it broad-cast, four bushels to an acre; but the writer

 prefers

Preparation of Land. prefers fowing it in drills two feet afunder; for then it may be horfe-hoed, and half the feed will be fufficient.

The horfe-hoeing will not only clean the crop, but earth up the plants, and render them more luxuriant and lafting.

If you fow it broad-caft, give it a top-dreffing in December or January, of rotten dung or afhes, or, which is ftill better, of both mixed up in compoft.

From various trials, it is found that taking only one crop in a year, and feeding the after-growth, is better than to mow it twice. Cut it as foon as it is in full bloom, if the weather will permit. The hay will be the fweeter, and the ftrength of the plants lefs impaired, than if it ftand till the feed is formed.

Light rich land. 4. Light rich land, being the moft eafy to cultivate to advantage, and capable of bearing moft kinds of grain, pulfe, and herbage, little need be faid upon it. One thing, however, is very proper to be obferved, that fuch lands are the beft adapted to the drill hufbandry, efpecially where machines are ufed, which require fhallow furrows to be made for the reception of the feed. This, if not prone to couch-grafs, is the beft of all foils for lucerne; which, if fown in two feet drills, and kept clean, will yield an aftonifhing quantity of the moft excellent herbage. But lucerne will never be cultivated to advantage where couch-grafs and weeds are very plentiful; nor in the broad-caft method, even where they are not fo; becaufe horfe-hoeing is effential to the vigorous growth of this plant.

Coarfe rough land. 5. Coarfe rough land. Plough deep in autumn; when it has lain two weeks, crofs-plough it, and let it lie rough through the winter. In March give it another good

good ploughing; drag, rake, and harrow it well, to get out the rubbish, and sow four bushels of black oats per acre, if the soil be wet, and white oats if dry. When about four inches high, roll them well after a shower: This will break the clods; and the fine mould falling among the roots of the plants will promote their growth greatly. Preparat of Lan

Some sow clover and rye-grass among the oats, but this appears to be bad husbandry. If you design it for clover, sow it single, and let a coat of dung be laid on in December. The snow and rain will then dilute its salts and oil, and carry them down among the roots of the plants. This is far better than mixing the crops on such land, for the oats will exhaust the soil so much, that the clover will be impoverished. The following summer you will have a good crop of clover; which cut once, and feed the after-growth. In the winter plough it in, and let it lie till February: Then plough and harrow it well; and in March, if the soil be moist, plant beans in drills of three feet, to admit the horse-hoe freely. When you horse-hoe them a second time, sow a row of turnips in each interval, and they will succeed very well. But if the land be strong enough for sowing wheat as soon as the beans are off, the turnips may be omitted.

Culture of particular Plants.

SECT. I.

CULTURE OF PARTICULAR PLANTS.

The articles hitherto inſiſted on, are all of them preparatory to the capital object of a farm, that of raiſing plants for the nouriſhment of man and of other animals. Theſe plants are of two kinds; culmiferous and leguminous; differing widely from each other. Wheat, rye, barley, oats, rye-graſs, are of the firſt kind: of the other kind are, peaſe, beans, clover, cabbage, and many others.

Culmiferous plants. Culmiferous plants, ſays Bonnet, have three ſets of roots. The firſt iſſue from the ſeed, and puſh to the ſurface an upright ſtem; another ſet iſſue from a knot in that ſtem; and a third from another knot, nearer the ſurface. Hence the advantage of laying ſeed ſo deep in the ground as to afford ſpace for all the ſets.

Leguminous plants. Leguminous plants form their roots differently. Peaſe, beans, cabbage, have ſtore of ſmall roots, all iſſuing from the ſeed, like the undermoſt ſet of culmiferous roots; and they have no other roots. A potato and a turnip have bulbous roots. Red clover has a ſtrong tap-root. The difference between culmiferous and leguminous plants, with reſpect to the effects they produce in the ſoil, will be noticed afterwards, in the ſection concerning rotation of crops. As the preſent ſection is confined to the propagation of plants, it falls naturally to be divided into three articles: firſt, Plants cultivated

cultivated for fruit; ſecond, Plants cultivated for roots; third, Plants cultivated for leaves. Culture partícul Plants

I. *Plants Cultivated for Fruit.*

1. Wheat and Rye.

Anciently when the ſummer fallow was almoſt the only means employed for reſtoring the exhauſted fertility of the ſoil, this practice was univerſally adopted throughout Europe as a preparation for wheat. In France, excepting the Netherlands, the practice ſtill continues; and in our own country it is ſtill uſed to a conſiderable extent. The great loſs, however, both of time and labour, which is occaſioned by a ſummer fallow, has induced intelligent huſbandmen to make great exertions for the purpoſe of avoiding the neceſſity of it, as a preparation for this valuable but exhauſting crop. For this purpoſe, extraordinary tillage and extraordinary manure have been ſubſtituted for ſummer fallow. As it is found that wheat does not ſucceed ſo well, if ſown on land immediately after dunging, as it does when a previous crop is taken after the dung; an inducement has thereby been held out, to ſubſtitute to fallows thoſe green crops for which the drill huſbandry is beſt adapted. In the neighbourhood of Edinburgh, accordingly, a crop of potatoes is frequently made uſe of inſtead of a fallow; but, as potatoes greatly exhauſt the ſoil, this practice is only adopted in conſequence of the great command of manure which the neighbourhood of the city gives to the farmers. In other ſituations a leſs exhauſting crop muſt be uſed. Turnips, though otherwiſe ſuitable, are, in the general caſe, excluded, becauſe they cannot be advantageouſly con-

 ſumed

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fumed till it is too late in the feafon to fow wheat. It has frequently been afferted, that of all the drilled crops, beans are moft valuable as a preparation for wheat. An important experiment upon this fubject was made by the duke of Grafton, of which an account is given in a letter from his grace to Mr Young, dated in Auguft, 1799 *. "Being arrived at the eighth year of that experiment, which I undertook at your defire, it appears to me that this may be a proper time to communicate to you the refult of the trial.

"You will recollect, that the object was to find out, Whether that fort of land ufually met with in the common fields of Northamptonfhire and the adjacent counties, would or would not bear alternately a crop of wheat, and then of beans, and *vice verfa* of beans, and then of wheat; after giving it, as in the open fields, a light dreffing of muck, viz. from twelve to fifteen loads per acre every third year, without rendering the land poorer than when it was firft undertaken. In order to afcertain this point as accurately as poffible, I pitched upon a field of moderate land, rather of a ftiffifh nature; better than the worft, and much inferior to the beft, in our open fields. The method I then purfued was the following: After having manured it in the manner fpecified above, I fowed the firft year a moiety of the field with wheat, and the other part with beans; and every feafon fince I have been changing the crops, making them alternate from beans to wheat, and from wheat to beans each year, never having admitted a fallow.

It

* *Annals of Agriculture*, vol. xxxiii.

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"It would give me more satisfaction if I could have furnished you with the measured particulars of each year's produce from both crops, but unluckily I have mislaid the paper. I can only, therefore, relate from memory, that the difference between these crops, and those of the same grain on other parts of the farm, was not such, on an average of those years, as would be worth regarding. The third and sixth years, being the farthest from the mucking, were, of course, the worst produce, though not remarkably so; and I will venture to pronounce, that the crops have kept up, on an average, with the seasons, and have been but little inferior to the produce of the other fields on my farm. My farmer assures me, from accounts he has kept, that the best end of the land, has, on the average, yielded four quarters of wheat per acre, and the poorer end three quarters and a half. He is further of opinion, that the land, in point of heart, is neither improved nor worse, for any agricultural purpose, than it was when first we began. According to my judgment, the course of husbandry has rather been favourable to the field; for the thorough hand-hoeing of the bean crop every other spring has rendered it so clean, that in the present wet year, there is scarcely any weed grown through the wheat crop, although it was laid flat five weeks ago.

"I have stated these facts as plainly and as clearly as I could in order to be understood, and I leave to others to draw their deductions.

"This experiment by no means goes to prove that there may be no spots where a summer fallow may not come into an eligible course; but I think I may say, that it is not necessary for land of a quality like mine.

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mine. To bring it into practice in the open common fields, I well know, that many circumſtances are to be conſidered; and among theſe, I ſhall be aſked where the farmer is, in ſuch a caſe, to keep his ſheep, as in farms of that nature he has ſo little paſture, and would be diſtreſſed was he to loſe the manure from the folding of theſe ſheep. This becomes a new queſtion, and deſerves conſideration. Much, I conceive, may be ſaid upon it; and, if I miſtake not, ſome means may be found to obviate the objection.

"I omitted mentioning one circumſtance, which may merit the attention of a farmer; it is this: Whether, after the given coat of muck every third year, the wheat crop, which preceded that of beans, had a claim to a preference to that which was ſown after the beans; and here I do not heſitate to give my opinion in favour of the latter. I apprehend, that the hoeing of the beans cleared the lands of ſuch weeds as might have been brought on with the muck, and ſtill left the ground in good heart for the wheat.

"I wiſh to add, that a neighbouring farmer has, on ſeeing the effect of this culture of mine, carried it into practice with a little alteration; for he has mucked his field every ſecond year in the winter, and ſowed it in ſpring, with the bean crop preceding that of wheat. Nor has he, any more than myſelf, had to complain that the bean crop, directly on the mucking, ran ſo much into height as to weaken the ſtem, and prevent its being properly kidded. Indeed this is the general notion of farmers in this part of the country; taken up, I believe, entirely from a groundleſs tradition, and not at all from proof.—P. S. The wheat was cut yeſterday, and the reapers tell me that it is fair in hand, lighter

than

than laſt year's, but heavier than that of the ſeaſon before."

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Upon this intereſting ſubject of preparing land for wheat, the moſt important diſcovery undoubtedly is, the uſe of red clover for that purpoſe, upon a ſoil that is tolerably open. It binds the ſoil, and gives to it a degree of tenacity which is extremely ſuitable to wheat; at the ſame time, that the roots of the plant rotting in the earth afford a valuable manure: and in whatever way clover may act as a preparation for this grain experience leaves no doubt of its beneficial effects. The wheat ought to be ſown upon the firſt year's clover after a ſingle ploughing. To do it every juſtice, the clover ought to be only once mown. The after crop ought to be fed upon the land, which ought not to be overſtocked with cattle, that a conſiderable quantity of the green crop may be ploughed in. In the uſe of clover, however, ſome caution is neceſſary. Mr Young remarks *, that "all good farmers in England know, from long experience, that the common red clover is no friend to clean farming, if ſown with a ſecond or third crop of corn. In the courſe, 1ſt, Turnips or cabbages; 2d, Barley or oats; 3d, Clover; 4th, Wheat; the land is kept in garden order. But, if after that fourth crop the farmer goes on and ſows, 5th, Barley or oats; 6th, Clover; 7th, Wheat; the land will be both foul and exhauſted. In a word, clover is beneficial to the really good and clean farmer, only to the extent of his turnips, cabbages, and fallow; and never ought to be ſown but on land previouſly cleaned by thoſe hoeing crops

* *Travels*, vol. ii.

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crops or fallow. As to fallow, no Frenchman ever makes it but for wheat; consequently the culture of clover is excluded. I have often seen it sown in this course 1st, Fallow; 2d, Wheat; 3d, Barley; 4th, Oats; 5th, Clover; 6th, Clover; 7th, Wheat; 8th, Oats; and the land inevitably full of weeds. I may venture to assert, that clover thus introduced or even in courses less reprehensible, but not correct, will do more mischief than good, and that a country is better cultivated without than with it. Hence, let the men, emulous of the character of good farmers, consider it as essential to good husbandry to have no more clover than they have turnips and cabbages, or some other crop that answers the same end, and never to sow it but with the first crop of corn: By these means their land will be clean, and they will reap the benefits of the culture without the common evils.

"I have read in some authors an account of great German farmers, having such immense quantities of clover as are sufficient to prove the utter impossibility any preparation: these quantities are made a matter of boast. We know, however, in England, in what manner to appreciate such extents of clover."

As a great part of our island consists of a clayey soil, which is the least of all suited to green or drilled crops, many skilful farmers are still of opinion, that upon such soils the use of summer fallow cannot with propriety be relinquished; and, as others, from a love of old practices, are unwilling in any case to relinquish it, we shall here give a general account of the mode of practising it.

Fallowing for wheat.

Any time from the middle of April to the middle of May, the fallowing may commence. The moment should

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ſhould be choſen, when the ground, beginning to dry, has yet ſome remaining ſoftneſs: in that condition, the ſoil divides eaſily by the plough, and falls into ſmall parts. This is an eſſential article, deſerving the ſtricteſt attention of the farmer. Ground ploughed too wet, riſes, as we ſay, *whole-fur*, as when paſture-ground is ploughed: where ploughed too dry, it riſes in great lumps, which are not reduced by ſubſequent ploughings; not to mention, that it requires double force to plough ground too dry, and that the plough is often broken to pieces. When the ground is in proper order, the farmer can have no excuſe for delaying a ſingle minute. This firſt courſe of fallow muſt, it is true, yield to the barley-ſeed; but as the barley-ſeed is commonly over the firſt week of May, or ſoóner, the ſeaſon muſt be unfavourable if the fallow cannot be reached by the middle of May.

As clay ſoil requires high ridges, theſe ought to be cleaved at the firſt ploughing, beginning at the furrow, and ending at the crown. This ploughing ought to be as deep as the ſoil will admit: and water-furrowing ought inſtantly to follow; for if rain happen before water-furrowing, it ſtagnates in the furrow, neceſſarily delays the ſecond ploughing till that part of the ridge be dry, and prevents the furrow from being mellowed and roaſted by the ſun. If this firſt ploughing be well executed, annual weeds will riſe in plenty.

About the firſt week of June, the great brake will looſen and reduce the ſoil, encourage a ſecond crop of annuals, and raiſe to the ſurface the roots of weeds moved by the plough. Give the weeds time to ſpring, which may be in two or three weeks. Then proceed to the ſecond ploughing about the beginning of July; which

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which muſt be croſs the ridges, in order to reach all the ſlips of the former ploughing. By croſs-ploughing the furrows will be filled up, and water-furrowing be ſtill more neceſſary than before. Employ the brake again about the 10th of Auguſt, to deſtroy the annuals that have ſprung ſince the laſt ſtirring. The deſtruction of weeds is a capital article in fallowing: yet ſo blind are people to their intereſt, that nothing is more common than a fallow field covered with charlock and wild muſtard, all in flower, and 10 or 12 inches high. The field having now received two harrowings and two brakings is prepared for manure, whether lime or dung, which without delay ought to be incorporated with the ſoil by a repeated harrowing and a gathering furrow. This ought to be about the beginning of September, and as ſoon after as you pleaſe the ſeed may be ſown.

As in ploughing a clay ſoil it is of importance to prevent poaching, the hinting furrows ought to be done with two horſes in a line. If four ploughs be employed in the ſame field, to one of them may be allotted the care of finiſhing the hinting furrows.

Dreſſing loam for wheat.

Loam, being a medium between ſand and clay, is of all ſoils the fitteſt for culture, and the leaſt ſubject to chances. It does not hold water like clay; and when wet, it dries ſooner. At the ſame time, it is more retentive than ſand of that degree of moiſture which promotes vegetation. On the other hand, it is more ſubject to couch-graſs than clay, and to other weeds; to deſtroy which, fallowing is ſtill more neceſſary than in clay.

Beginning the fallow of this kind of ſoil about the firſt of May, or as ſoon as barley ſeed is over, take as

2 deep

deep a furrow as the foil will admit. Where the ridges are fo low and narrow as that the crown and furrow can be changed alternately, there is little or no occafion for water-furrowing. Where the ridges are fo high as to make it proper to cleave them, water-furrowing is proper. The fecond ploughing may be at the diftance of five weeks. Two crops of annuals may be got in the interim, the firft by the brake and the next by the harrow; and by the fame means eight crops may be got in the feafon. The ground muft be cleared of couch-grafs and knot-grafs roots, by the cleaning harrow defcribed above. The time for this operation is immediately before the manure is laid on. The ground at that time being in its loofeft ftate, parts with its grafs roots more freely than at any other time. After the manure is fpread, and incorporated with the foil by braking or harrowing, the feed may be fown under furrow, if the ground hang fo as eafily to carry off the moifture. To leave it rough without harrowing has two advantages: it is not apt to cake with moifture, and the inequalities make a fort of fhelter to the young plants againft froft. But if it lie flat, it ought to be fmoothed with a flight harrow after the feed is fown, which will facilitate the courfe of the rain from the crown to the furrow. Culture of particular Plants.

A fandy foil is too loofe for wheat. The only chance for a crop is after red clover, the roots of which bind the foil. Rye is a crop much fitter for fand foil than wheat; and like wheat, it is generally fown after a fummer fallow. Dreffing a fandy foil.

Laftly, Sow wheat as foon in the month of October as the ground is ready. When fown a month more early, it is too forward in the fpring, and apt to be hurt Time for fowing.

by

Culture of particular Plants.

by froſt: when ſown a month later, it has not time to take root before froſt comes on; and froſt caſts it out of the ground.

Setting of wheat,

Setting of wheat, may be here noticed as being a method which by ſome is reckoned one of the greateſt improvements in huſbandry that took place during the late century. It ſeems to have been firſt ſuggeſted by planting grains in a garden from mere curioſity, by perſons who had no thought or opportunity of extending it to a lucrative purpoſe. Nor was it attempted on a larger ſcale, till a little farmer near Norwich began it upon leſs than an acre of land. For two or three years only a few followed his example; and theſe were generally the butt of their neighbours merriment for adopting ſo ſingular a practice. They had, however, conſiderably better corn and larger crops than their neighbours: this, together with the ſaving in ſeed, engaged more to follow them: while ſome ingenious perſons, obſerving its great advantage, recommended and publiſhed its utility in the Norwich papers. Theſe recommendations had their effect. The curioſity and inquiry of the Norfolk farmers (particularly round Norwich) were excited, and they found ſufficient reaſon to make general experiments. Among the reſt was one of the largeſt occupiers of land in that county, who ſet 57 acres in one year. His ſucceſs, from the viſible ſuperiority of his crop, both in quantity and quality, was ſo great, that the following autumn he ſet 300 acres, and has continued the practice ever ſince. This noble experiment eſtabliſhed the practice, and was the means of introducing it generally among the intelligent farmers in a very large diſtrict of land; there being few who now ſow any wheat, if they can procure hands

a capital improvement in agriculture.

to ſet it. It has been generally obſerved, that although the ſet crops appear very thin during the autumn and winter, the plants ſide-ſhoot and ſpread prodigiouſly in the ſpring. The ears are indiſputably larger, without any dwarfiſh or ſmall corn; the grain is of a larger bulk, and ſpecifically heavier per buſhel than when ſown. Culture of particular Plants.

The lands on which this method is particularly proſperous, are either after a clover ſtubble, or on which trefoil and graſs ſeeds were ſown the ſpring before the laſt. Theſe grounds, after the uſual manuring, are once turned over by the plough in an extended flag or turf, at ten inches wide; along which a man, who is called a *dibbler*, with two ſetting-irons, ſomewhat bigger than ramrods, but conſiderably bigger at the lower end, and pointed at the extremity, ſteps backwards along the turf, and makes the holes about four inches aſunder every way, and an inch deep. Into theſe holes the droppers (women, boys, and girls) drop two grains, which is quite ſufficient. After this, a gate buſhed with thorns is drawn by one horſe over the land, and cloſes up the holes. By this mode, three pecks of grain are ſufficient for an acre; and being immediately buried, the grain is equally removed from vermin or the power of froſt. The regularity of its riſing gives the beſt opportunity of keeping it clear from weeds, by weeding or hand-hoeing. Method.

Wheat-ſetting is a method peculiarly beneficial when corn is dear; and, if the ſeaſon be favourable, may be practiſed with great benefit to the farmer. Sir Thomas Beevor of Hethel-Hall in Norfolk, found the produce to be two buſhels per acre more than from the wheat which is ſown; but having much leſs ſmall corn Peculiar advantages.

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intermixed with it, the fample is better, and always fetches a higher price, to the amount generally of two fhillings per quarter.

This method, too, faves to the farmer and to the public fix pecks of feed wheat in every acre; which, if nationally adopted, would of itfelf afford bread for more than half a million of people.

Add to thefe confiderations, the great fupport given to the poor by this *fecond* harveft, as it may be called, which enables them to difcharge their rents and maintain their families without having recourfe to the parifh.—The expence of fetting by hand is now reduced to about fix fhillings per acre; which, in good weather, may be done by one dibbler, attended by three droppers, in two days. This is five fhillings per day; of which if the dibbler gives to the children fixpence each, he will have himfelf three fhillings and fixpence for his day's work, which is much more than he can poffibly earn by any other labour fo eafy to himfelf. But put the cafe, that the man has a wife who dibbles with him, and two or three of his own children to drop to him, you fee his gains will then be prodigious, and enough to enfure a plenty of candidates for that work, even in the leaft populous parts of the country.

It is, however, to be obferved with regard to this method, that in feafons when feed-corn is very cheap, or the autumn particularly unfavourable to the practice, it muft certainly be leffened. In light lands, for inftance, a very dry feed time prevents dibbling; as the holes made with the inftruments will be filled up again by the mould as faft as the inftrument is withdrawn. So, again, in a very wet feafon, on ftrong and ftiff clays, the feeds in the holes cannot be well and properly co-

vered

vered by the bushes drawn over them. But these extremes of dry and wet do not often happen, nor do they affect lands of a moderately consistent texture, or both light and heavy soils at the same time; so that the general practice is in fact never greatly impeded by them.

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Propagating of wheat by dividing and transplanting its roots. In the Philosophical Transactions for 1768, we meet with a very important experiment, of which the following is an abstract. On the 2d of June 1766, Mr C. Miller sowed some grains of the common red wheat; and on the 8th of August a single plant was taken up and separated into 18 parts, and each part planted separately. These plants having pushed out several side-shoots, by about the middle of September; some of them were then taken up and divided, and the rest of them between that time and the middle of October. This second division produced 67 plants. These plants remained through the winter, and another division of them, made between the middle of March and the 12th of April, produced 500 plants. They were then divided no further, but permitted to remain. The plants were in general stronger than any of the wheat in the fields. Some of them produced upwards of 100 ears from a single root. Many of the ears measured seven inches in length, and contained between 60 and 70 grains.

Propagating of wheat by dividing the roots.

The whole number of ears which, by the process above mentioned, were produced from one grain of wheat, was 21,109, which yielded three pecks and three quarters of clean corn, the weight of which was 47lb. 7 ounces; and from a calculation made by counting the

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number of grains in an ounce, the whole number of grains was about 576,840.

By this account we find, that there was only one general divifion of the plants made in the fpring. Had a fecond been made, Mr Miller thinks the number of plants would have amounted to 2000 inftead of 500, and the produce thereby been much enlarged.

The ground was a light blackifh foil, upon a gravelly bottom; and, confequently, a bad foil for wheat. One half of the ground was well dunged, the other half had no manure. There was, however, not any difference difcoverable in the vigour, or growth, or produce, of the plants.

It muft be evident, that the expence and labour of fetting in the above manner by the hand, will render it fcarcely practicable upon a large fcale fo as to be productive of any utility. A correfpondent of the Bath Society, therefore, (Robert Bogle, Efq. of Daldowin, near Glafgow, with a view to extend the practice, has propofed the ufe of the harrow and roller until fome better implements be invented. This method occurred to him from attending to the practice ufual with farmers on certain occafions, of harrowing their fields after the grain is fprung up. Upon inveftigating the principles upon which thefe practices are founded, he found them confined merely to that of pulverizing the earth, without any attention to Mr Miller's doctrine. They faid, " that after very heavy rains, and then exceffive dry weather, the furface of their lands was apt to be caked, the tender fibres of the young roots were thereby prevented from pufhing, and of courfe the vegetation was greatly obftructed; in fuch inftances,

Method propofed by Mr Bogle

they

they found very great benefit from harrowing and rolling." Culture of particular Plants.

These principles he acknowledges to be well founded, fo far as relates to pulverizing; but contends, that the benefit arifing from harrowing and rolling is not derived from pulverizing entirely, but alfo from fubdividing and enabling the plants to tiller (as it is termed), or fide-fhoot. "The harrow (he obferves) certainly breaks the incruftation on the furface, and the roller crumbles the clods; but it is alfo obvious, that the harrow removes a great many of the plants from their original ftations; and that if the corn has begun to tiller at the time it is ufed, the roots will be, in many inftances, fubdivided, and then the application of my fyftem of divifibility comes into play. The roller then ferves to plant the roots which have been torn up by the harrow."

But on this the Society obferve, that the teeth of a harrow are too large to divide roots fo fmall and tenacious as are thofe of grain; and whenever fuch roots (however tillered) ftand in the line any tooth makes, they will, if fmall, be only turned on one fide by the earth yielding to their lateral preffure, or, if large, the whole root will probably be drawn out of the ground. The principal ufes, therefore, derived from harrowing and rolling thefe crops are, opening the foil between the plants, earthing them up, breaking the clods, and clofing the earth about their roots. Objections.

In a fubfequent letter, Mr Bogle, without contefting thefe points, further urges the fcheme of propagating wheat by dividing and tranfplanting its roots. "I have converfed (fays he) much with many practical farmers, who all admit that my plan has the appearance not only of being practical, but advantageous. I have

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also seen, in the ninth number of Mr Young's Annals of Agriculture, the account of an experiment which strongly corroborates my theory. It was made by the Rev. Mr Pike of Edmonton. From this, and other experiments which have been made under my own eye, I foresee clearly, that the system is practicable, and will certainly be productive of great benefit, should it become general. Besides the saving of nine-tenths of seed in the land sown broad-cast, other very important advantages will attend the setting out of wheat from a seed-bed: such as an early crop; the certainty of good crops; rendering a summer-fallow unnecessary; saving dung; and having your wheat perfectly free from weeds without either hand or horse-hoeing. Five hundred plants in April produced almost a bushel of grain. My gardener says, he can set one thousand plants in a day, which is confirmed by the opinion of two other gardeners. Mr Miller found no difference in the produce of what was planted on lands that had dung, and on what had none, except where the land was improper for wheat at all."

Practicability of the scheme asserted.

Bath Society's observations.

On this letter we have the following note by the society: "Mr Bogle will see, by the Society's premium book this year, that by having offered several premiums for experiments of the kind he so earnestly recommends, we wish to have his theory brought to the test of practice. Our reason for this, as well as for printing Mr B's letter, was rather to excite decisive trials by ingenious persons, than from any expectation of the practice ever becoming a general one. General, indeed, it never can be. A sufficient number of hands could not be found to do it. Unkindly seasons at the time of transplanting and dividing the roots would frequently

ntly endanger and injure, if not deſtroy, the crops. But admitting the mode generally practicable, we very much doubt whether all the advantages he has enumerated would be derived from this mode of culture. Why ſhould dividing and tranſplanting the roots of wheat cauſe the crop to be early, or afford a *certainty* of its being *a good one?* We cannot think that *leſs manure* is neceſſary in this method than either in drilling or broad-caſt; nor can we by any means admit, ſuch crops would 'be perfectly free from weeds without either hand or horſe-hoeing.' We readily agree with Mr Bogle, that by this mode of culture on a general ſcale, an immenſe quantity of ſeed-corn would be annually ſaved to the nation; and in this, we believe, the advantage, were it practicable, would principally conſiſt."

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Upon the ſame ſubject, and that of harrowing all kinds of corn, we are informed, Mr Bogle afterwards communicated to the Society his thoughts more at large, together with authentic accounts which were made at his inſtance, and which were attended with very great ſucceſs. Theſe muſt undoubtedly be regarded as of very great importance, and accordingly the Society, conceiving his ſyſtem may be attended with conſiderable advantages if brought into general practice, have given, at the end of their third volume, a few of his leading principles. Mr Bogle ſtates,

Further obſervations of Mr Bogle.

1. That he has known many inſtances of very great crops having been obtained by harrowing fields of corn after they were ſprouted; and therefore recommends the practice very warmly.

2. That he has alſo received an authentic account of

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one inſtance where the ſame good effects were produced by ploughing the field.

3. On the ſyſtem of tranſplanting, he ſtates, that a very great proportion of the ſeed will be ſaved, as a farmer may have a nurſery, or ſmall patch of plants, from which his fields may be ſupplied; he calculates that one acre will yield plants ſufficient for 100 acres.

4. That a very great increaſe of crops may be obtained by this method, probably a double crop, nay perhaps a triple quantity of what is reaped either by drilling or by the broad-caſt huſbandry.

5. That a great part of the labour may be performed by infirm men and women, and alſo by children, who are at preſent ſupported by the pariſh charity; and that of courſe the poor's rates may be conſiderably reduced.

6. That the expence will not exceed from 20s. to 30s. per acre, if the work be performed by able-bodied men and women; but that it will be much lower, if that proportion of the work which may be done by employing young boys and girls ſhould be allotted to them.

7. That in general he has found the diſtance of nine inches every way a very proper diſtance for ſetting out the plants at; but recommends them to be tried at other ſpaces, ſuch as 6, 8, or even 12 inches.

8. That he conceives an earlier crop may be obtained in this manner than can be obtained by any other mode of cultivation.

9. That a clean crop may alſo be procured in this way; becauſe if the land be ploughed immediately before the plants are ſet out, the corn will ſpring much quicker from the plants than the weeds will do from

their

feeds; and the corn will thereby bear down the growth of the weeds.

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10. That fuch lands as are overflowed in the winter and fpring, and are of courfe unfit for fowing with wheat in the autumn, may be rendered fit for crops of wheat by planting them in the fpring, or even in the fummer.

11. That he has known inftances of wheat being tranfplanted in September, October, November, February, March, April, and even as late as the middle of May, which have all anfwered very well.

12. That he has known an early kind of wheat fown as late as the middle of May, which has ripened in very good time; and from that circumftance he conceives, if the plants fhould be taken from that early kind, the feafon of tranfplanting might be prolonged at leaft till the 1ft of July, perhaps even later.

13. That he has reafon to think wheat, oats, and barley, are not annuals, but are perennials, provided they are eaten down by cattle and fheep, or are kept low by the fcythe or fickle; and are prevented from fpindling or coming to the ear.

14. That one very prevalent motive with him in profecuting this plan, is, that he is of opinion it may enable government to devife means of fupporting the vagrant poor, both old and young, who are now to be met with everywhere, both in towns and in the country, and who are at prefent a burden on the community: but if fuch employment could be ftruck out for them, a comfortable fubfiftence might be provided for them by means of their own labour and induftry; and not only fave the public and private charitable contributions, but may alfo render that clafs of people ufeful and profit-

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able subjects; instead of their remaining in a useless wretched, and perhaps a profligate and vicious course of life.

Lastly, Mr Bogle has hinted at a secondary object which he has in view, from this mode of cultivation, which he apprehends may in time, with a small degree of attention, prove extremely advantageous to agriculture.—It is, that, in the first place, the real and intrinsic value of different kinds of grain may be more accurately ascertained, by making a comparison of it with a few plants of each kind set out at the same time, than can be done when sown in drills or broad-cast; and when the most valuable kinds of wheat, oats, or barley, are discovered, he states, that in a very short time (not exceeding four or five years) a sufficient quantity of that valuable kind may be procured to supply the kingdom with seed from a single grain of each kind; for he calculates, that 47,000 grains of wheat may be produced by divisibility in two years and three months.

Observation of the Bath Society.

Upon these propositions the Society observes, "That although Mr Bogle appears to be too sanguine in his expectations of seeing his plan realized in *general practice*, it certainly merits the attention of gentlemen farmers. We wish them to make fair experiments, and report their success. All grand improvements have been, and ever will be, progressive. They must necessarily originate with gentlemen; and thence the circle is extended by almost imperceptible degrees over provinces and countries. At all events, Mr Bogle is justly entitled to the thanks of the Society, and of the public, for the great attention he has paid to the subject."

There is perhaps no part of Great Britain where wheat

wheat is cultivated to more perfection than in Norfolk. Mr Marshal informs us, that the species raised in that county is called the *Norfolk red*, and weighs heavier than any other which has yet been introduced, though he owns that its appearance is much against the assertion, it being a long thin grain, resembling rye more than well-bodied wheat. About 15 or 20 years ago a new species was introduced, named the *Kentish cosh*; against which the millers were at first very much prejudiced, though this prejudice is now got over. A remarkable circumstance respecting this grain is, that though upon its introduction into the county the *cosh* or husk be perfectly white, yet such is the power either of the soil or of the mode of cultivation to produce what the botanists call *varieties*, that the grain in question is said to lose every year somewhat of the whiteness of its husks, until they become at last equally red with those of the former kind. The southern and south-eastern parts of the county generally enjoy a stronger and richer soil than the more northerly, and therefore are more proper for the cultivation of that species of grain. In the northern parts are some farms of very light soil, where the farmers sow only a small quantity of wheat; and these light lands are called *barley farms*.

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Culture of wheat in Norfolk.

The greatest part of the wheat in Norfolk is sown upon a second year's ley: sometimes it is sown upon a first year's ley; sometimes on a summer fallow; after peas, turnips, or buck harvested or ploughed under. The practice adopted by those who are looked upon as superior husbandmen in the county of Norfolk is as follows: The second year's leys having finished the bullocks, and brought the flock cattle and horses through

Succession of crops.

Culture of particular Plants.

Rice-balking, a particular mode of culture explained.

through the fore part of summer, and the first year's leys having been made ready to receive his stock, the farmer begins to break up his old land or ley ground by a peculiar mode of cultivation named *rice-balking*, in which the furrow is always turned toward the unploughed ground, the edge of the coulter passing always close by the edge of the flag last turned. This is done at first with an even regular furrow; opportunity being taken for performing the operation after the surface has been moistened by a summer shower. In this state his summer leys remain until towards the end of harvest, when he harrows and afterwards ploughs them across the balks of the former ploughing, bringing them now up to the full depth of the soil. On this ploughing he immediately harrows the manure, and ploughs it in with a shallow furrow. The effects of this third ploughing are to mix and effectually pulverize the soil and manure; to cut off and pulverize the upper surfaces of the furrows of the second ploughing; and thus, in the most effectual manner, to eradicate or smother the weeds which had escaped the two former ones. Thus it lies until the seed time, when it is harrowed, rolled, sown, and gathered up into ridges of such width as the farmer thinks most proper. Those of six furrows are most common, though some very good farmers lay their wheat land into four-furrow, and others into ten-furrow ridges; "which last (says our author) they execute in a style much superior to what might be expected from wheel-ploughs." They excel, however, in the six-furrow ploughing; of which Mr Marshal gives a particular account. When ploughing in this manner, they carry very narrow furrows; so that a six-furrow ridge, set out by letting the off-horse return in

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the first-made furrow, does not measure more than three feet eight or nine inches.

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When wheat is cultivated after the first year's ley, the seed is generally sown upon the flag or furrow turned over. After pease, one or two ploughings are given; the other parts of the management being the same with that after the second year's ley already mentioned. After buck harvested he seldom gives more than two, and sometimes but one, ploughing. In the former case he spreads his manure on the stubble, and ploughs it in with a shallow furrow; harrows, rolls, sows, and gathers up the soil into narrow work. The manure is in like manner spread on the stubble after once ploughing, and the seed is then sown among the manure; the whole ploughed in together, and the soil gathered up into narrow ridges, as if it had undergone the operations of a fallow. An inconvenience attending this practice is, that the buck which is necessarily shed in harvesting springs up among the wheat, and becomes a weed to it, at the same time that the rooks, if numerous, pull up both buck and wheat, leaving several patches quite bare. This is obviated in a great measure by first ploughing in the manure and self-sown buck with a shallow furrow, in consequence of which the buck vegetates before the wheat.

It is likewise a favourite practice with the Norfolk farmers to raise wheat after buck ploughed under. They plough under the buck by means of a broom made of rough bushes fixed to the fore tackle of the plough between the wheels, which bears down the plant without lifting the wheels from the ground. Sometimes, when the buck is strong, they first break it down with a roller going the same way that the plough is intended.

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ed to go; afterwards a good ploughman will cover it so effectually that fcarce a ftalk can be feen. Sometimes the furface of the ground is left rough, but it is more eligible to harrow and roll it. The practice of fummer-fallowing feldom occurs in Norfolk; though fometimes, when the foil has been much worn down by cropping, and overrun by weeds, it is efteemed a judicious practice by many excellent hufbandmen, and the practice feems to be daily gaining ground. After turnips the foil is ploughed to a moderate depth, and the feed fown over the firft ploughing: but if the turnips be got in early, the weeds are fometimes firft ploughed in with a fhallow furrow, and the feed ploughed under with a fecond ploughing, gathering the foil into narrow ridges.

Manuring the ground in Norfolk

With regard to the manuring of the ground for wheat in Norfolk, that which has been recently clayed or marled is fuppofed to need no other preparation any more than that which has received 15 or 20 loads of dung and mould for turnips; the firft year's ley having been teathed in autumn, and the fecond fed off. Where the foil is good, and the wheat apt to run too much to ftraw, it is the practice of fome judicious farmers to fet their manure upon the young clover, thereby depriving the wheat in fome degree of its ranknefs; but it is moft common to fpread it upon the broken ground; or, if the feed be fown upon the turned furrow, to fpread it on the turf and plough it under; or to fpread it on the ploughed furface, and harrow it in with the feed as a top-dreffing. A fmaller quantity of manure is generally made ufe of for wheat than for turnips. From eight to ten cart loads (as much as three horfes can conveniently draw) are

reckoned

reckoned fufficient for an acre; three or four chaldrons of lime to one acre, or 40 bufhels of foot to the fame quantity of ground; or about a ton of rape-cake to three acres.

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In this county they never begin to fow wheat till after the 17th of October, and continue till the beginning of December, fometimes even till Chriftmas. They give as a reafon for this late fowing, that the wheat treated in this manner is lefs apt to run to ftraw than when fown earlier. The feed is generally prepared with brine, and candied in the ufual manner with lime. The following method of preparing it is faid to be effectual in preventing the fmut. "The falt is diffolved in a very fmall quantity of water, barely fufficient for the purpofe. The lime is flaked with this folution, and the wheat candied with it in its hotteft ftate, having been previoufly moiftened with pure water." According to our author's obfervation, the crops of thofe farmers who ufe this preparation are in general more free from fmut than thofe who make ufe of any other.

Time of fowing.

Of preparing the feed.

The practice of dibbling or fetting of wheat has not as yet become general throughout Norfolk, the common broad-caft method being ufually followed, except on the Suffolk fide of the county. Some few make ufe of dibbling and fluting rollers; but drilling is almoft entirely unknown, notwithftanding the great aptitude of foil for the practice. Ploughing in the feed under furrow is the favourite mode of the Norfolk farmers, and is performed in the following manner: "The land having been harrowed down level, and the furface rendered fmooth by the roller, the head ploughman (if at leifure) marks out the whole piece in narrow flips of about a ftatute

Method of fowing.

Ploughing the feed in defcribed.

Culture of particular Plants.

ſtatute rood in width. This he does by hanging up a plough in ſuch a manner, that no part of it except the heel touches the ground; and this makes a ſure mark for the ſeedſman, which he cannot by any means miſtake. In caſe the ploughs are all employed, the ſeedſman himſelf marks the ground, by drawing a piece of wood or other heavy body behind him. Mr Marſhal prefers this to the Kentiſh method of ſetting up ſticks in the form of a lane, as being leſs liable to produce miſtakes.

Inſtruments for dibbling wheat deſcribed.

In thoſe places where wheat is dibbled, they make uſe of iron inſtruments for the purpoſe. The acting part is an egg-ſhaped knob, ſomewhat larger than a pigeon's egg; the ſmaller end is the point of the dibble, the larger having a rod of iron riſing from it about half an inch ſquare, and two feet and a half long; the head being received into a croſs piece of wood reſembling the crutch of a ſpade or ſhovel, which forms the handle The dibbler uſes two of theſe inſtruments, one in each hand; and, bending over them, walks backward upon the turned furrows, making two rows of holes in each of them. Thoſe rows are uſually made at the diſtance of four inches from each other; the holes being two and a half or three inches diſtant, viz. four in each length of the foot of the dibbler. The great art in making theſe lies in leaving them firm and ſmooth in the ſides, ſo that the looſe mould may not run in to fill them up before the ſeeds are depoſited. This is done by a circular motion of the hand and wriſt; making a ſemi-revolution every ſtroke; the circular motion beginning as the bit enters, and continuing until it is entirely diſengaged from the mould. The operation is not perfect unleſs the dibbles come out clean and wear bright.

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gight. It is ſomewhat difficult to make the holes at equal diſtances; but more eſpecially to keep the two ſtraight and parallel to each other, ſome practice being required to guide the inſtruments in ſuch a manner as to correſpond exactly with each other; but though couples have been invented to remedy this inconvenience to keep them at a proper diſtance, the other method is ſtill found to be preferable. A middling workman will make four holes in a ſecond. One dibbler is ſufficient for three droppers; whence a man and three children are called a *ſet*. The dibbler carries on three flags or turned furrows; going on ſome yards upon one of the outſide furrows, and returning upon the other, after which he takes the middle one; and thus keeps his three dibblers conſtantly employed, and at the ſame time is in no danger of filling up the holes with his feet. The droppers put in two or three grains of wheat into each hole; but much time and patience is neceſſary to teach them to perform the buſineſs properly and quickly. An expert dibbler will hole half an acre in a day; though one third of an acre is uſually reckoned a good day's work. The ſeed is covered by means of a buſh harrow; and from one buſhel to ſix pecks is the uſual quantity for an acre. Notwithſtanding the advantages of ſaving ſeed, as well as ſome others which are generally reckoned undeniable, it is here aſſerted by ſome very judicious farmers, that dibbling of wheat on the whole is not really a profitable practice. It is particularly ſaid to be productive of weeds unleſs dibbled very thick: which indeed may probably be the caſe, as the weeds are thus allowed a greater ſpace to vegetate in. Mr Marſhal himſelf is of opinion, that "the dibbling of wheat ap-

Objections againſt the practice of dibbling.

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pears to be peculiarly adapted to rich deep ſoils, which three or four pecks dibbled early may ſpread ſufficiently for a full crop; whereas light, weak, ſhallow ſoils, which have lain two or three years, and have become graſſy, require an additional quantity of ſeed, and conſequently an addition of labour, otherwiſe the plants are not able to reach each other, and the graſſes of courſe find their way up between them, by which means the crop is injured and the ſoil rendered foul."

Culture of wheat in the midland diſtrict.

The ſame author has likewiſe given an account of the method of cultivating wheat practiſed in other Engliſh counties. In the midland diſtrict, including part of Staffordſhire, Derbyſhire, Warwick, and Leiceſterſhire, we are informed that the ſpecies uſually ſown is that called *Red Lammas*, the ordinary red wheat of the kingdom: but of late a ſpecies named the *Eſſex dun*, ſimilar to the *Kentiſh white coſh* of Norfolk, and the *Hertfordſhire brown* of Yorkſhire, has been coming into vogue. Cone-wheat, formerly in uſe in this diſtrict, is now out of faſhion. Spring wheat is cultivated with remarkable ſucceſs, owing principally to the time of ſowing; viz. the cloſe of April. Our author was informed by an excellent farmer in theſe parts, that by ſowing early, as in the beginning of March, the grain was liable to be ſhrivelled, and the ſtraw to be blighted; while that which was ſown towards the end of April, or even in the beginning of May, produced clean plump corn. At the time he viſited this county, however, it ſeemed to be falling into diſrepute; though he looks upon it, in ſome ſituations, eſpecially in a turnip country, to be eligible. In the ordinary ſucceſſion in this part of the kingdom, wheat

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gaines after oats; and there is perhaps nine-tenths of the wheat in this diſtrict ſown upon oat-ſtubble. Our author has alſo ſeen a few examples of wheat being ſown upon turf of ſix or ſeven years leying; and ſeveral others on clover ley once ploughed, as well as ſome after turnips. The beſt crops, however, produced in this, or, as he thinks, in any other diſtrict, are after ſummer fallow. The time of ſowing is the month of October, little being ſown before Michaelmas; and in a favourable ſeaſon, little after the cloſe of the month. Much ſeed is ſown here without preparation. When any is made uſe of, it is the common one of brine candied with lime. The produce is very great, the medium being full three quarters per acre, ſometimes four or five; and one farmer, in the year 1784, had on 50 acres of land together, no leſs than 45 buſhels per acre.

Culture of particular Plants.

In the Vale of Glouceſter, the *cone-wheat*, a variety of the *triticum turgidum*, is cultivated, as well as the lammas and ſpring wheats. It is not, however, the true cone wheat which is cultivated here, the ears being nearly cylindrical; but our author met with the true ſpecies in North Wiltſhire. Beans in this country are the common predeceſſors of wheat, and ſometimes peaſe; but here the farmers cultivate wheat upon every ſpecies of ſoil. The time of ſowing is in November and December, and the ſeed is thought to be ſown in ſufficient time if it is done before Chriſtmas. In this country it is thought that late ſown crops always produce better than thoſe which are ſown early; but Mr Marſhal accounts for this by the vaſt quantity of weeds the latter have to encounter, and which the late ſown crops eſcape by reaſon of the weakneſs of vegetation at

In the Vale of Glouceſter.

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that time of the year. The produce, however, throughout the Vale of Gloucester, is but very indifferent.—Setting of wheat is not practised, but hoeing universally.—In harvesting, Mr Marshal observes, that the grain is allowed to stand until it be unreasonably ripe, and that it is bound up into very small sheaves. The practice of making double bands is unknown in this district; so that the sheaves are no bigger than can be contained in the length of single straw. The inconveniences of this method are, that the crop requires more time to stook, load and unload, and stack: the advantages are, that the trouble of making bands is avoided; and that if rainy weather happens to intervene, the small sheaves dry much sooner than the large ones. Here the crop is cut very high, the stubble and weeds being mown off in swaths for litter soon after the crop is cut; and sometimes sold as high as 5s. per acre.—Mr Marshal is at a loss to account for the little quantity produced in this country: it being hardly possible to derive it from the nature of the soil, almost all of it being proper for the cultivation of the grain.

Remarkably small sheaves.

In the Cotswold hills.

Among the Cotswold hills of Gloucester the lammas and cone wheats are sown; and a new variety of the latter was raised not long ago by picking out a single grain of seed from among a parcel. The body is very long and large, but not sightly.—The Cotswold hills are almost proverbial for early sowing of wheat. The general rule is to begin ploughing in July, and sowing the first wet weather in August; so that here the seed-time and harvest of wheat coincide. If, in consequence of this early sowing the blade becomes rank in autumn, it is supposed to be proper to eat it down by putting a large flock of sheep upon it at once. Eating it in spring

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is considered as pernicious. It is usually weeded with spud-hooks; not hoed, as in the Vale. One instance, however, is mentioned by our author, in which a very thin crop full of seed-weeds hoed in autumn with uncommon success, occurred in the practice of a superior manager in this district; as well as others in which wheat has been weeded in autumn with great advantage. He also here met with a well authenticated instance of the good effect of cutting mildewed wheat while very green. "A fine piece of wheat being lodged by heavy rains, and being soon after perceived to be infected with the mildew, was cut, though still in a perfectly green state; namely, about three weeks before the usual time of cutting. It lay spread abroad upon the stubble until it became dry enough to prevent its caking in the sheaf; when it was bound and set up in shocks. The result of this treatment was, that the grain, though small, was of a fine colour, and the heaviest wheat which grew upon the same farm that season; owing, no doubt, to the thinness of its skin. What appears much more remarkable, the straw was perfectly bright, not a speck upon it.—In this part of the country, the produce of wheat is superior to that in the Vale; but Mr Marshal is of opinion, that the soil is much more fit for barley than wheat.

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Instance of the good effects of hoeing wheat.

Of cutting mildewed wheat very green.

In Yorkshire, though generally a grass land country, and where of consequence corn is only a secondary concern, yet several kinds of wheat are cultivated, particularly *Zealand, Downy, Kent, Common White, Hertfordshire Brown, Yellow Kent, Common Red*. All these are varieties of winter wheat; besides which they cultivate also the *spring* or *summer wheat*. Here our author makes several curious observations concerning the raising of *va-*

Cultivation of wheat in Yorkshire.

Culture of particular Plants.

Obſervations on raiſing varieties of plants.

rieties of plants. "It is probable, ſays he, that time has the ſame effect upon the varieties of wheat and other grains as it has on thoſe of cultivated fruits, potatoes, and other vegetable productions. Thus to produce an early pea, the gardener marks the plants which open firſt into bloſſom among the moſt early kind he has in cultivation. Next year he ſows the produce of thoſe plants, and goes over the coming crop in the manner he had done the preceding year, marking the earlier of this early kind. In a ſimilar manner new varieties of apples are raiſed, by chooſing the broadeſt leaved plants among a bed of ſeedlings riſing promiſcuouſly from pippins. Huſbandmen, it is probable, have heretofore been equally induſtrious in producing freſh varieties of corn; or whence the endleſs variety of winter wheats? If they be naturally of one ſpecies, as Linnæus has deemed them, they muſt have been produced by climate, ſoil, or induſtry; for although nature ſports with individuals, the induſtry of man is requiſite to raiſe, eſtabliſh, and continue a permanent variety. The only inſtance in which I have had an opportunity of tracing the *variety* down to the *parent individual*, has occurred to me in this diſtrict. A man of acute obſervation, having, in a piece of wheat, perceived a plant of uncommon ſtrength and luxuriance, diffuſing its branches on every ſide, and ſetting its cloſely-ſurrounding neighbours at defiance; marked it; and at harveſt removed it ſeparately. The produce was 15 ears, yielding 604 grains of a ſtrong-bodied liver-coloured wheat, different, in general appearance, from every other variety he had ſeen. The chaff was ſmooth, without awns, and of the colour of the grain; the ſtraw ſtout and reedy. Theſe 604 grains were planted ſingly, nine inches aſunder,

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der, filling about 40 ſquare yards of ground, on a clover ſtubble, the remainder of the ground being ſown with wheat in the ordinary way; by which means extraordinary trouble and deſtruction by birds were avoided. The produce was two gallons and a half, weighing 20$\frac{1}{5}$lb. of prime grain for ſeed, beſides ſome pounds of ſeconds. One grain produced 35 ears, yielding 1235 grains; ſo that the ſecond year's produce was ſufficient to plant an acre of ground. What deters farmers from improvements of this nature is probably the miſchievouſneſs of birds: from which at harveſt it is ſcarcely poſſible to preſerve a ſmall patch of corn, eſpecially in a garden or other ground ſituated near a habitation; but by carrying on the improvement in a field of corn of the ſame nature, that inconvenience is got rid of. In this ſituation, however, the botaniſt will be apprehenſive of danger from the floral farina of the ſurrounding crop. But from what obſervations I have made, I am of opinion his fears will be groundleſs. No evil of this kind occurred, though the cultivation of the above variety was carried on among *white* wheat. But this need not be brought as an evidence: it is not uncommon here to ſow a mixture of red and white wheats together; and this, it is confidently aſſerted, without impairing even the colour of either of them. The ſame mode of culture is applicable to the improvement of varieties, which perhaps would be more profitable to the huſbandman than raiſing new ones, and more expeditious."

Preparation of wheat with arſenic.

In Yorkſhire the very ſingular preparation of ſeed wheat prevails which we formerly mentioned, viz. the ſteeping it in a ſolution of *arſenic*, as a preventive of ſmut. Marſhal was informed by one farmer, that he

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had made ufe of this preparation for 20 years with fuccefs, having never during that long fpace of time fuffered any fenfible injury from fmut. Our author feems inclined to believe the efficacy of this preparation; but thinks there may be fome reafon to apprehend danger in the ufe of fuch a pernicious mineral, either through the carelefsnefs of fervants, or handling of the feed by the perfon who fows it. The farmer above mentioned, however, during all the time he ufed it, never experienced any inconvenience either to himfelf, the feedfman, or even to the poultry; though thefe laft, we fhould have thought, would have been peculiarly liable to accidents from arfenicated feed. The preparation is made by pounding the arfenic extremely fine, boiling it in water, and drenching the feed with the decoction. "In ftrictnefs, fays Mr Marfhal, the arfenic fhould be levigated fufficiently fine, to be taken up and wafhed over with water, reducing the fediment until it be fine enough to be carried over in the fame manner. The ufual method of preparing the liquor is to boil one ounce of white arfenic, finely powdered, in a gallon of water, from one to two hours; and to add to the decoction as much water or ftale urine as will increafe the liquor to two gallons. In this liquor the feed is, or ought to be, immerged, ftirring it about in fuch a manner as to faturate effectually the downy end of each grain. This done, and the liquor drawn off, the feed is confidered as fit for the feed bafket, without being candied with lime, or any other preparation. A bufhel of wheat has been obferved to take up about a gallon of liquor. The price of arfenic is about 6d. per pound; which, on this calculation, will cure four quarters of feed. If no more than three quarters

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be prepared with it, the coſt will be only a farthing per buſhel; but to this muſt be added the labour of pounding and boiling. Nevertheleſs, it is by much the cheapeſt, and perhaps, upon the whole, adds Mr Marſhal, the beſt preparation we are at preſent acquainted with. In this county it is believed, that a mixture of wheat and rye, formerly a very common crop in theſe parts, is never affected with mildew; but our author does not vouch for the truth of this aſſertion.

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We muſt not here omit to take notice of a new mode of cultivating wheat contrived by Mr E. Walker of Harply, Norfolk; which mode of culture we ſhall alſo afterwards have occaſion to notice when we come to treat of the culture of turnips. Mr Walker thus explains his mode of procedure in a letter addreſſed to the publiſher of the Annals of Agriculture *. "I ſow in broad-caſt, after the turnips have been once hoed, two buſhels of wheat or two buſhels of rye per acre; and then hoe the ſame in with the ſecond hoeing: if it be hoed by the day it may be beſt, as it will be better done by the ſhort ſtrokes or cuts with the hoes than otherwiſe. It is recommended to be done ſoon after the firſt hoeing, for many reaſons: It becomes a fine herbage, and keeps the land very clean, without any injury to the turnips, or to the wheat or rye. I began to feed in laſt September, the turnips, &c. the firſt of the month, and ſhall continue till all are done. I have fed off with all ſorts of ſtock mixed, and have drawn out the turnips in lines to ſet the hurdles, as is uſual, and fed off the turnips

Wheat and turnips ſown together.

* Vol. ix.

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turnips and growing corn in wet and dry weather; but find that dry weather, and ſheep, is the propereſt time and ſtock; and that ſheep and light beaſts are the beſt for light lands, which, on the whole, this method will greatly improve.

"All my experiments have been made without mucking, or any manure; for the turnip and wheat crop; and on thoſe parts where I have fed off at the time it has been dry weather, though with all ſorts of ſtock mixed and drawing as above, I have grown at the rate of five coomb of wheat per acre, and at the rate of eight coomb of rye per acre; and ſome was almoſt totally deſtroyed by feeding off in wet weather, as I was determined not to deſiſt, that I might know the bad or good effects from feeding off the turnips with the corn in different weather, as well as the different months; all which I ſhall be able to give information of next year, to thoſe who wiſh to know. I find the feed nearly worth the coſt of the ſeed corn, which is a material conſideration in caſe you plough the land for barley or other ſummer corn; but if the wheat or rye ſtands a crop to your mind, it will do better to harrow it in the ſpring, at which time you may ſow your graſs ſeeds, which I find anſwer very well; or plough the ſtubble early in the autumn, and ſow with clover or other ſeeds."

The well-known author of the Annals of Agriculture has given a farther account of this method of cultivation. The idea which led to Mr Walker's experiments was this: Wheat requires a certain degree of ſtiffneſs and compactneſs in the ſoil upon which it is reared. Of this compactneſs, ſandy ſoils are apt to be deficient in proportion to the degree of tillage they receive.

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ceive. Hence it occurred to Mr Walker, that if wheat could be ſown without any ploughing at all, there would be a better chance of a crop upon certain ſoils, than after the moſt expenſive ſyſtem of tillage. Accordingly, in 1784, he executed his ſcheme on ſix acres of turnips, which were fed during the ſucceeding winter by bullocks and ſheep, like the reſt of his turnip fields, without making the leaſt diſtinction on account of the wheat that had been ſown and was growing among them. It is known, that turnip land, when fed off, is left highly manured and much trodden; and the queſtion was, whether the firſt of theſe circumſtances would not counterbalance the laſt? and, whether even the treading itſelf might not prove advantageous? The ſucceſs juſtified the project, and, in 1785, Mr Walker extended it to 35 acres, a part of which was ſown with rye. The management was the ſame as before; the wheat did better than the rye, and the beſt crop was where the turnips were eaten in the drieſt weather. In 1786, the ſame culture was extended to 70, and in 1797, to 100 acres, with complete ſucceſs; but the crop was not better than that raiſed in the common way, though in general as good. The effect of this mode of culture, or the profit ariſing from it, conſiſted chiefly in this, that upon a farm of 600 acres, the labour of five horſes was ſaved, and at the time of the barley-ſowing, when all his neighbours were in the greateſt hurry, he was at his eaſe quietly ſtirring his turnip fallows. The chief difficulty attending this mode of cultivating wheat aroſe from the wetneſs of the ſeaſon at the time of feeding, as the ground was apt to be too much trodden and poached, particularly when the crop of turnips was very large ſo as to keep the cattle

long

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long upon them. On the contrary, in dry or frosty weather nothing of this kind happened. The greater the crop of turnips, and the more treading that occurred, the crop of wheat seemed afterwards to prosper the better. In a wet season, however, the evil arising from the treading was diminished when sheep alone without bullocks were introduced to consume the turnips. Under this husbandry, the following rotation was used: Two years grass put in among the wheat-stubble, ploughed once, and harrowed both in autumn and spring with the whole dung of the farm; Third year, oats; Fourth turnips; Fifth, wheat.

2. Oats.

Effect of frost upon tilled land.

As winter-ploughing enters into the culture of oats, we must remind the reader of the effect of frost upon tilled land. Providence has neglected no region intended for the habitation of man. If in warm climates the soil be meliorated by the sun, it is no less meliorated by frost in cold climates. Frost acts upon water, by expanding it into a larger space. Frost has no effect upon dry earth; witness sand, upon which it makes no impression. But upon wet earth it acts most vigorously; it expands the moisture, which requiring more space puts every particle of the earth out of its place, and separates them from each other. In that view, frost may be considered as a plough superior to any that is made, or can be made, by the hand of man: its action reaches the minutest particles; and, by dividing and separating them, it renders the soil loose and friable. This operation is the most remarkable in tilled land, which gives free access to frost. With respect to clay soil in particular, there is no rule in husbandry

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bandry more essential than to open it before winter in hopes of frost. It is even advisable in a clay soil to leave the stubble rank; which, when ploughed in before winter, keeps the clay loose, and admits the frost into every cranny.

To apply this doctrine, it is dangerous to plough clay soil when wet; because water is a cement for clay, and binds it so as to render it unfit for vegetation. It is, however, less dangerous to plough wet clay before winter than after. A succeeding frost corrects the bad effects of such ploughing; a succeeding drought increases them.

Culture of oats.

The common method is, to sow oats on new-ploughed land in the month of March, as soon as the ground is tolerably dry. If it continues wet all the month of March, it is too late to venture them after. It is much better to summer-fallow, and to sow wheat in the autumn. But the preferable method, especially in clay soil, is to turn over the field after harvest, and to lay it open to the influences of frost and air, which lessen the tenacity of clay, and reduce it to a free mould. The surface-soil by this means is finely mellowed for the reception of the seed; and it would be a pity to bury it by a second ploughing before sowing. In general, the bulk of clay soils are rich; and skilful ploughing without dung, will probably give a better crop, than unskilful ploughing with dung.

Hitherto of natural clays. We must add a word of carse clays which are artificial, whether left by the sea, or sweeped down from higher grounds by rain. The method commonly used of dressing carse clay for oats, is, not to stir it till the ground be dry in the spring, which seldom happens before the 1st of March, and

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and the feed is fown as foon after as the ground is fufficiently dry for its reception. Froft has a ftronger effect on fuch clays than on natural clay. And if the field be laid open before winter, it is rendered fo loofe by froft as to be foon drenched in water. The particles at the fame time are fo fmall, as that the firft drought in fpring makes the furface cake or cruft. The difficulty of reducing this cruft into mould for covering the oat-feed, has led farmers to delay ploughing till the month of March. But we are taught by experience, that this foil ploughed before winter, is fooner dry than when the ploughing is delayed till fpring; and as early fowing is a great advantage, the objection of the fuperficial crufting is eafily removed by the firft harrow above defcribed, which will produce abundance of mould for covering the feed. The ploughing before winter not only procures early fowing, but has another advantage: the furface-foil that had been mellowed during winter by the fun, froft, and wind, is kept above.

The dreffing a loamy foil for oats differs little from dreffing a clay foil, except in the following particular, that, being lefs hurt by rain, it requires not high ridges, and therefore ought to be ploughed crown and furrow alternately.

Where there is both clay and loam in a farm, it is obvious, from what is faid above, that the ploughing of the clay after harveft ought firft to be defpatched. If both cannot be overtaken that feafon, the loam may be delayed till the fpring with lefs hurt.

Next of a gravelly foil; which is the reverfe of clay, as it never fuffers but from want of moifture. Such a foil ought to have no ridges; but to be ploughed circularly from the centre to the circumference, or from the

circumference

circumference to the centre. It ought to be tilled after harvest: and the first dry weather in spring ought to be laid hold of to sow, harrow, and roll; which will preserve it in sap. Culture of particular Plants.

The culture of oats is the simplest of all. That grain is probably a native of Britain: it will grow on the worst soil with very little preparation. For that reason, as already noticed, before turnip was introduced, it was always the first crop upon land broken up from the state of nature.

Upon such land, may it not be a good method, to build upon the crown of every ridge, in the form of a wall, all the surface-earth, one sod above another, as in a fold for sheep? After standing in this form all the summer and winter, let the walls be thrown down, and the ground prepared for oats. This will secure one or two good crops; after which the land may be dunged for a crop of barley and grass-seeds. This method may answer in a farm where manure is scarce.

In Norfolk this kind of grain is much less cultivated than barley; and the only species observed by Mr Marshal is a kind of white oat, which grows quickly, and seems to be of Dutch extraction. Oats are cultivated occasionally on all kinds of soils, but more especially on cold heavy land, or on very light, unproductive, heathy soils. They most frequently succeed wheat, or ley ground barley: "but (says our author) there are no established rules respecting any part of the culture of this time-serving crop." The culture of the ground is usually the same with that of barley; the ground generally undergoing a winter fallow of three or four ploughings, though sometimes they are sown after one ploughing. They are more commonly sown Norfolk cultivation of oats.

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above furrow than barley. The feed-time is made subfervient to that of barley, being fometimes fooner and fometimes later than barley feed-time: and Mr Marfhal obferves, that he has fometimes feen them fown in June; it being obfervable, that oats fown late ripen earlier than barley fown at the fame time. The quantity of feed in Norfolk is from four to five bufhels per acre; but he does not acquaint us with the produce. He mentions a very fingular method of culture fometimes practifed in this county, viz. ploughing down the oats after they begin to vegetate, but before they have got above ground: which is attended with great fuccefs, even though the ground is turned over with a full furrow. By this method weeds of every kind are deftroyed, or at leaft checked in fuch a manner as to give the crop an opportunity of getting above them. As the porofity communicated to the foil is excellently well adapted to the infant plants of barley; that grain probably might frequently receive benefit from this operation.

Method of ploughing down oats.

Wild oats a weed in the Vale of Gloucefter.

In the Vale of Gloucefter, Mr Marfhal obferves, that the wild oat is a very troublefome weed, as well as in Yorkfhire; and he is of opinion, that it is as truly a native of Great Britain as any other arable weed, and is perhaps the moft difficult to be extirpated. It will lie a century in the foil without lofing its vegetative quality. Ground which has lain in a ftate of grafs time immemorial, both in Gloucefter and Yorkfhire, has produced it in abundance on being broken up. It is alfo endowed with the fame feemingly inftinctive choice of feafons and ftate of the foil as other feeds of weeds appear to have. Hence it is exceffively difficult to be overcome; for as it ripens

 before

before any crop of grain, it ſheds its ſeeds on the ſoil, where the roughneſs of its coat probably ſecures it from birds. The only methods of extirpating this plant are fallowing, hoeing, and handweeding, where the laſt is practicable, after it has ſhot its panicle. Culture of particular Plants.

No oats are cultivated in the Vale of Glouceſter; though the wild oat grows everywhere, as already ſaid. Mr Marſhal is of opinion that the ſoil is better adapted to oats than to barley. The reaſon he aſſigns for the preference given to the latter is, that in this part of the country the monks were formerly very numerous, who probably preferred *ale* to oaten cake.—He now, however, recommends a trial of the grain on the ſtronger cold lands in the area of the Vale, as they ſeldom can be got ſufficiently fine for barley. The fodder from oats he accounts much more valuable than that from barley to a dairy country; and the grain would more than balance in quantity the comparative difference in price. Oats not cultivated in the Vale of Glouceſter.

In the midland diſtrict the *Poland oat*, which was formerly in vogue, has now given place to the *Dutch* or *Frieſland* kind. It is conſtantly ſown after turf; one ploughing being given in February, March, or April. The ſeed-time is the latter end of March and beginning of April, from four to ſeven buſhels an acre; the produce is in proportion to the ſeed, the medium being about ſix quarters. Cultivation in the Midland diſtrict.

In Yorkſhire the Frieſland oats are likewiſe preferred to the Poland, as affording more ſtraw, and being thinner ſkinned than the latter. The *Siberian*, or *Tartarian* oat, a ſpecies unnoticed by Linnæus, is likewiſe cultivated in this country: the *reed* oat is known, but has not yet come into any great eſtimation. The In Yorkſhire.

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grain is light, and the ſtraw too ready to be affected by cattle.

Oats are particularly cultivated in the weſtern diviſion of the Vale of Yorkſhire; where the ſoil is chiefly a rich ſandy loam, unproductive of wheat. Five or ſix buſhels, or even a quarter of oats, are ſometimes ſown upon an acre; the produce from ſeven to ten quarters. In this country they are thraſhed in the open air, and frequently even upon the bare ground, without even the ceremony of interpoſing a cloth. The reaſons aſſigned for this ſeemingly ſtrange practice are, that if pigs and poultry be employed to eat up the grain which eſcapes the broom, there will be little or no waſte. Here the market is always very great for new oats, the manufacturing parts of Weſt Yorkſhire uſing principally oat-bread. The only objection to this practice is the chance of bad weather; but there is always plenty of ſtraw to cover up the thraſhed corn, and it is found that a little rain upon the ſtraw does not make it leſs agreeable to cattle.

Singular method of thraſhing.

In an experiment made by Mr Bartley* near Briſtol, upon black oats, we are informed that he had the prodigious increaſe of 98¼ Wincheſter buſhels from four on the acre: the land was a deep, mellow, ſandy loam. It had carried potatoes the former year, and received one ploughing for a winter fallow. Another ploughing was given it in February, and the ſeed was ſown on the 27th and 28th of the month. The ſucceſs of the experiment was ſuppoſed to be owing partly to the early ſowing and partly to a good deep tillage.

Experiment on black oats.

3. Barley.

* *Bath Papers*, vol. iv. p. 281.

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3. Barley.

This is a culmiferous plant that requires a mellow foil. Upon that account, extraordinary care is requi-fite where it is to be fown upon clay. The land ought to be ftirred immediately after the foregoing crop is removed, which lays it open to be mellowed by the froft and air. In that view, a peculiar fort of ploughing has been introduced, termed *ribbing*; by which the greateft quantity of furface poffible is expofed to the air and froft. The obvious objection to this method is, that half of the ridge is left unmoved. And to obviate that objection, the following method is offered, which moves the whole foil, and at the fame time expofes the fame quantity of furface to the froft and air. As foon as the former crop is off the field, let the ridges be gathered with as deep a furrow as the foil will admit, beginning at the crown and ending at the furrows. This ploughing loofens the whole foil, giving free accefs to the air and froft. Soon after, begin a fecond ploughing in the following manner: Let the field be divided by parallel lines crofs the ridges, with intervals of thirty feet or fo. Plough once round an interval, beginning at the edges, and turning the earth toward the middle of the interval; which covers a foot or fo of the ground formerly ploughed. Within that foot plough another round fimilar to the former; and, after that, other rounds, till the whole interval be finifhed, ending at the middle. Inftead of beginning at the edges, and ploughing toward the middle, it will have the fame effect to begin at the middle, and to plough toward the edges. Plough the other intervals in the fame manner. As by this operation the furrows

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Ribbing.

A better method.

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of the ridges will be pretty much filled up, let them be cleared and water-furrowed without delay. By this method, the field will be left waving like a plot in a kitchen garden, ridged up for winter. In this form, the field is kept perfectly dry; for befides the capital furrows that feparate the ridges, every ridge has a number of crofs furrows that carry the rain inftantly to the capital furrows. In hanging grounds retentive of moifture, the parallel lines above mentioned ought not to be perpendicular to the furrows of the ridges, but to be directed a little downward, in order to carry rain water the more haftily to thefe furrows. If the ground be clean, it may lie in that ftate winter and fpring, till the time of feed-furrowing. If weeds happen to rife, they muft be deftroyed by ploughing, or braking, or both; for there cannot be worfe hufbandry, than to put the feed into dirty ground.

Advantages of this method.

This method refembles common ribbing in appearance, but is very different in reality. As the common ribbing is not preceded by a gathering furrow, the half of the field is left untilled, compact as when the former crop was removed, impervious in a great meafure to air or froft. The common ribbing at the fame time lodges the rain-water on every ridge, preventing it from defcending to the furrows; which is hurtful in all foils, and poifonous in a clay foil. The *ftitching* here defcribed, or *ribbing*, if you pleafe to call it fo, prevents thefe noxious effects. By the two ploughings the whole foil is opened, admitting freely air and froft; and the multitude of furrows lays the furface perfectly dry, giving an early opportunity for the barley-feed.—But further, as to the advantage of this method: When it is proper to fow the feed, all is laid flat with the

the brake, which is an eafy operation upon foil that is dry and pulverized; and the feed-furrow which fucceeds is fo fhallow as to bury little or none of the furface earth: whereas the ftirring for barley is commonly done with the deepeft furrow; and confequently buries all the furface foil that was mellowed by the froft and air. Nor is this method more expenfive; becaufe the common ribbing muft always be followed with a ftirring furrow, which is faved in the method recommended. Nay, it is lefs expenfive; for after common ribbing, which keeps in the rain-water, the ground is commonly fo foured, as to make the ftirring a laborious work.

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It is well known that barley is lefs valuable when it does not ripen equally; and that barley which comes up fpeedily in a dufky foil, muft gain a great advantage over feed-weeds. Therefore, firft take out about one-third of the contents of the facks of feed-barley or bear, to allow for the fwelling of the grain. Lay the facks with the grain to fteep in clean water; let it lie covered with it for at leaft 24 hours. When the ground is extremely dry, and no likelihood of rain for 10 days, it is better to lie 36 hours; fow the grain wet from fteeping, without any addition of powdered quicklime, which, though often recommended in print, can only poifon the feed, fuck up part of its ufeful moifture, and burn the hand of the fower. The feed will fcatter well, as clean water has no tenacity; only the fower muft put in a fourth or a third more feed in bulk than is ufual of dry grain, as the grain is fwelled in that proportion: harrow it in as quickly as poffible after it is fown; and though not neceffary, give

Management of feed in a dry feafon.

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it the benefit of a fresh furrow, if convenient.' You may expect it up in a fortnight at farthest.

It ought to be understood as a general principle, that of all preparations for barley, the best is a crop of turnips properly cultivated during the preceding year. Upon a clayey soil, however, it is absolutely necessary that these should not be consumed upon the field, on account of the additional tenacity which such a soil would acquire from being poached by the feet of cattle during wet weather. The dung in this case ought to be restored to the land. On lighter soils the turnip crop may be consumed in the field; though this is a practice by no means to be recommended where a contrary mode can conveniently be adopted.

The following experiment by a correspondent of the Bath Society being considered as a very interesting one, is here subjoined.

Important experiments on seed-barley

"The last spring (1783) being remarkably dry, I soaked my seed-barley in the black water taken from a reservoir which constantly receives the draining of my dung heap and stables. As the light corn floated on the top, I skimmed it off, and let the rest stand 24 hours. On taking it from the water, I mixed the seed grain with a sufficient quantity of sifted wood-ashes, to make it spread regularly, and sowed three fields with it. I began sowing the 16th, and finished the 23d of April. The produce was 60 bushels per acre, of good clean barley, without any *small* or *green* corn, or weeds, at harvest. No person in this country had better grain.

I sowed also several other fields with the same seed dry, and without any preparation; but the crop, like those of my neighbours, was very poor; not more than

twenty

twenty bushels per acre, and much mixed with green corn and weeds when harvested, I also sowed some of the seed dry on one ridge in each of my former fields, but the produce was very poor in comparison of the other parts of the field."

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Time of sowing.

Where the land is in good order, and free of weeds, April is the month for sowing barley. Every day is proper, from the first to the last.

The dressing loamy soil and light soil for barley, is the same with that described; only that to plough dry is not altogether so essential as in dressing clay soil. Loam or sand may be stirred a little moist: better, however, delay a week or two, than to stir a loam when wet. Clay must never be ploughed moist, even though the season should escape altogether. But this will seldom be necessary; for not in one year of 20 will it happen, but that clay is dry enough for ploughing some time in May. Frost may correct clay ploughed wet after harvest; but when ploughed wet in the spring, it unites into a hard mass, not to be dissolved but by very hard labour.

Miscellaneous observations concerning the cultivation of barley.

On the cultivation of this grain we have the following observations by a Norfolk farmer.

The best soil, he observes, is that which is dry and healthy, rather light than stiff, but yet of sufficient tenacity and strength to retain the moisture. On this kind of land the grain is always the best bodied and coloured, the nimblest in the hand, and has the thinnest rind. These are qualities which recommend it most to the maltster. If the land is poor, it should be dry and warm; and when so, it will often bear better corn than richer land in a cold and wet situation.

In the choice of your seed, it is needful to observe,

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that the beſt is of a pale lively colour, and brightiſh caſt, without any deep redneſs or black tinge at the tail. If the rind be a little ſhrivelled, it is the better; for that ſlight ſhrivelling proves it to have a thin ſkin, and to have ſweated in the mow. The neceſſity of a change of ſeed by not ſowing two years together what grew on the ſame ſoil, is not in any part of huſbandry more evident than in the culture of this grain, which, if not frequently changed, will grow coarſer and coarſer every ſucceeding year.

It has generally been thought, that ſeed-barley would be benefited by ſteeping; but liming it has, in many inſtances, been found prejudicial. Sprinkling a little ſoot with the water in which it is ſteeped has been of great ſervice, as it will ſecure the ſeed from inſects. In a very dry ſeed-time, barley that has been wetted for malting, and begins to ſprout, will come up ſooner, and produce as good a crop as any other.

If you ſow after a fallow, plough three times at leaſt. At the firſt ploughing, lay your land up in ſmall ridges, and let it remain ſo during the winter, for the froſt to mellow it; the ſecond ploughing ſhould be the beginning of February. In March ſplit the ridges, and lay the land as flat as poſſible, at the ſame time harrowing it fine. But in ſtrong wet lands (if you have no other for barley) lay it round, and make deep furrows to receive the water.

"I have often (continues he), taken the following method with ſucceſs: On lands tolerably manured, I ſowed clover with my barley, which I reaped at harveſt; and fed the clover all the following winter, and from ſpring to July, when I fallowed it till the following ſpring, and then ſowed it with barley and clover

as

as before. Repeating this method every year, I had very large crops, but would not recommend this practice on poor light land. Culture of particular Plants.

"We ſow on our lighteſt lands in April, on our moiſt lands in May; finding that thoſe lands which are the moſt ſubject to weeds produce the beſt crops when ſown late.

"The common method is to ſow the barley-ſeed broad-caſt at two ſowings; the firſt harrowed in once, the ſecond twice; the uſual allowance from three to four buſhels per acre. But if farmers could be prevailed on to alter this practice, they would ſoon find their account in it. Were only half the quantity ſown equally, the produce would be greater, and the corn leſs liable to lodge: For when corn ſtands very cloſe, the ſtalks are drawn up weak; and on that account are leſs capable of reſiſting the force of winds, or ſupporting themſelves under heavy rains.

"From our great ſucceſs in ſetting and drilling wheat, ſome of our farmers tried theſe methods with barley; but did not find it anſwer their expectations, except on very rich land.

"I have myſelf had 80 ſtalks on one root of barley, which all produced good and long ears, and the grain was better than any other; but the method is too expenſive for general practice. In poor land, ſow thin, or your crop will be worth little. Farmers who do not reaſon on the matter will be of a different opinion; but the fact is indiſputable."

When the barley is ſowed and harrowed in, he adviſes that the land be rolled after the firſt ſhower of rain, to break the clods. This will cloſe the earth about

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about the roots, which will be a great advantage to it in dry weather.

When the barley has been up three weeks or a month, it is a very good way to roll it again with a heavy roller, which will prevent the ſun and air from penetrating the ground to the injury of the roots. This rolling, before it branches out, will alſo cauſe it to tiller into a greater number of ſtalks; ſo that if the plants be thin, the ground will be thereby ſilled, and the ſtalks ſtrengthened.

If the blade grows too rank, as it ſometimes will in a warm wet ſpring, mowing is a much better method than feeding it down with ſheep; becauſe the ſcythe takes off only the rank tops, but the ſheep being fond of the ſweet end of the ſtalk next the root, will often bite ſo cloſe as to injure its future growth.

Cultivation of barley in Norfolk.

The county of Norfolk, according to Mr Marſhal, is peculiarly adapted to the cultivation of this grain, the ſtrongeſt ſoil not being too heavy, and the lighteſt being able to bear it; and ſo well verſed are the Norfolk farmers in the cultivation of it, that the barley of this county is deſired for ſeed throughout the whole kingdom. It is here ſown after wheat or turnips, and in ſome very light lands it is ſown after the ſecond year's ley. After wheat, the ſeed-time of the latter being finiſhed, and the ſtubble trampled down with bullocks, the land is ploughed with a ſhallow furrow for a winter fallow for barley. In the beginning of March the land is harrowed and croſs-ploughed; or if it be wet, the ridges are reverſed. In April it receives another ploughing lengthwiſe; and at ſeed-time it is harrowed, rolled, ſowed, and the ſurface rendered as ſmooth and level as poſſible. After turnips the ſoil is broken

broken up as fast as the turnips are taken off; if early in winter by *rice-balking*, a practice already explained; but if late, by a plain ploughing. It is common, if time will permit, to plough three times; the first shallow, the second full, and the third a mean depth; with which last the seed is ploughed in. Sometimes, however, the ground is ploughed only once, and the seed sown above; but more frequently by three ploughings, though, perhaps, the farmer has not above a week to to perform them in. After ley, the turf is generally broken by a winter fallow, and the soil treated as after wheat.

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This grain is seldom manured for, except when sown after ley, when it is treated as wheat. No manure is requisite after turnips or wheat, if the latter has been manured for. If not, the turnip crop following immediately, the barley is left to take its chance, unless the opportunity be embraced for winter marling.

Little barley is sown by the Norfolk farmers before the middle of April, and the seed-time generally continues till the middle of May; though this must in some measure depend on the season; which, says Mr Marshal, is more attended to in Norfolk than perhaps in all the world besides." In the very backward spring of 1782, barley was sown in June with success. No preparation is used. It is all sown broadcast, and almost all under furrow; that is, the surface having been smoothed by the harrow and roller, the seed is sown and ploughed under with a shallow furrow; but if the season be wet, and the soil cold and heavy, it is sometimes sown above: but, if the spring be forward, and the last piece of turnips eaten off late, the ground is sometimes obliged

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ged to be ploughed only once, and to be sown above; though in this case Mr Marshal thinks it the most eligible management, instead of turning over the whole thickness of the soil, to *two-furrow* it, and sow between. This is done by only skimming the surface with the first plough, sowing the seed upon this, and then covering it with the bottom furrow brought up by the second plough. Three bushels are usually sufficient for an acre.

The barley, as well as the wheat, in Norfolk, is allowed to stand till very ripe. It is universally mown into swath, with a small bow fixed at the heel of the scythe. If it receive wet in the swath in this county, it is not turned, but *lifted*; that is, the heads or ears are raised from the ground, either with a fork or the teeth of a rake, thereby admitting the air underneath the swaths; which will not fall down again to the ground so close as before, so that the air has free access to the under side; and this method of lifting is supposed not to be inferior to that of turning, which requires more labour, besides breaking and ruffling the swaths.

In the Vale of Gloucester.

In the Vale of Gloucester the quantity of barley cultivated is very inconsiderable; the only species is the common long-eared barley, (*hordeum zeocriton*). In this county the grain we speak of is used, on the every year's lands, as a cleansing crop. It is sown very late, viz. in the middle or end of May; sometimes the beginning or even the middle of June The reason of this is, that the people of the Vale think, that if a week or ten days of fine weather can be had for the operation of harrowing out couch, and if after this a full crop of barley succeed, especially if it should fortunately ly take a reclining poſture, the buſineſs of fallowing is effectually done, inſomuch that the ſoil is cleaned to a ſufficient degree to laſt for a number of years. A great quantity of ſeed is made uſe of, viz. from three to four buſhels to an acre; under the idea, that a full crop of barley, eſpecially if it lodge, ſmothers all kinds of weeds, couch-graſs itſelf not excepted. Our author acknowledges this effect in ſome degree, but does not recommend the practice. "If the land, ſays he, be tolerably clean, and the ſeaſon favourable, a barley fallow may no doubt be of eſſential ſervice. But there is not one year in five in which even land which is tolerably clean can be ſown in ſeaſon, and at the ſame time be much benefited by it for future crops." The barley in this county is all hand-weeded. It is harveſted looſe, mown with the naked ſcythe, lies in ſwath till the day of carrying, and is cocked with common hay forks. The medium produce is three quarters per acre. Its quality is preferable to that of the hill barley.

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In Cotswold.

The common long-eared ſpecies is ſown among the Cotſwold hills. It is ſown in the latter end of March and beginning of April, in the quantity of three buſhels to an acre, producing from 20 buſhels to four quarters to an acre; "which, ſays our author, is a low produce. It muſt be obſerved, however, that this produce is from land deficient in tillage; and that barley delights in a fine pulverous tilth."

In the midland diſtrict.

In the midland diſtrict they cultivate two ſpecies of barley, viz. the *zeocriton* or common long-eared, and the *diſtichon*, or ſprat barley; the latter not being of more than 50 years ſtanding, but the former of much older date. The ſprat is the more hardy, and requires

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summer 1787.—After spring feedings, a crop of turnip-rooted cabbage, or vetches, there will be sufficient time to sow the land with buck-wheat. Probably, in hot dry summers, a crop of vetches might even be mown for hay early enough to introduce a crop of this grain after it.

In the year 1780, about seven acres of a sandy soil on Brislington common *, having been first tolerably well cleansed from brambles, furze, &c. received one ploughing. To reduce the irregularities of the surface, it was rolled; and on the 9th of June in that year, two bushels and a half of buck-wheat per acre sown, the ground rolled again without harrowing.

Advantages of this cropping.

The vegetation appeared in five or six days, as is constantly the case, be the weather wet or dry. The growth was so rapid, that the fern, with which this land greatly abounded, was completely kept under. About the middle of September the crop was mown; but by reason of a great deal of rain about that time it was not secured until the beginning of October; hence a loss of a great part of the grain by shedding, as well as some eaten by birds. However, there were saved about 24 Winchester bushels per acre; and, notwithstanding its long exposure to the weather, it received no sort of damage, only perhaps that the finest and most perfect grain was the first to fall from the plant. The ground after this had almost the appearance of a fallow, and was immediately ploughed.

When it had lain a moderate time to meliorate, and to receive the influences of the atmosphere, it was harrowed,

* A very rough piece of land, at that time just enclosed.

rowed, ſown with Lammas wheat, and ploughed in under furrow, in a contrary direction to the firſt ploughing. Thus a piece of land, which in the month of April was altogether in a ſtate of nature, in the following November was ſeen under a promiſing crop of what is well ſtyled the king of grain, and this without the aid of manure, or of any very great degree of tillage. Nor was the harveſt by any means deficient; for ſeveral perſons converſant in ſuch things eſtimated the produce from 26 to 30 buſhels per acre. As ſoon as the wheat crop was taken off, the ground had one ploughing, and on the firſt of September following was ſown with turnip ſeed. The turnips were not large, but of an herbage ſo abundant as in the following ſpring to ſupport 120 ewes with their lambs, which were fed on it by folding four weeks. After this it was manured with a compoſition of rotten dung and natural earth, about 20 putt loads per acre, and planted with potatoes. The crop ſold for 138l. beſides a conſiderable number uſed in the family, and a quantity reſerved with which ten acres were planted the following ſeaſon. The enſuing autumn it was again ſown with wheat, and produced an excellent crop. In the ſpring of 1784, it was manured and planted with potatoes, as in the preceding inſtance; the crop (though tolerably good) by no means equal to the former, producing about 100 ſacks per acre only. In ſpring 1785, the land was now for a third time under a crop of wheat, it being intended to try how far this mode of alternate cropping, one year with potatoes and another with wheat, may be carried.

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From the ſucceſs of the preceding and other experiments, by Nehemiah Bartley, Eſq. of Briſtol, as de-

tailed

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tailed in the Bath Society Papers, it would seem, that the culture of this plant ought in many cases to be adopted instead of a summer-fallowing: for the crop produced appears not only to be so much clear gain in respect to such practice, but also affords a considerable quantity of straw for fodder and manure; besides that a summer-fallowing is far from being so advantageous a preparation for a succeeding crop.

5. Pease.

Culture of Pease.

Pease are of two kinds; the white and the gray. The cultivation of the latter only belongs, in strictness, to this place.

There are two species of the gray kind, distinguished by their time of ripening. One ripens soon, and for that reason is termed *hot seed;* the other, which is slower in ripening, is termed *cold seed.*

Pease, a leguminous crop, is proper to intervene between two culmiferous crops; less for the profit of a pease crop than for meliorating the ground. Pease, however, in a dry season, will produce six or seven bolls each acre; but, in an ordinary season, they seldom reach above two, or two and a half. Hence, in a moist climate, which all the west of Britain is, red clover seems a more beneficial crop than pease; as it makes as good winter food as pease, and can be cut green thrice during summer.

A field intended for cold seed ought to be ploughed in October or November; and in February, as soon as the ground is dry, the seed ought to be sown on the winter furrow. A field intended for hot seed ought to be ploughed in March or April, immediately before sowing.

ing. But if infested with weeds, it ought to be also ploughed in October or November.

Culture particul Plants.

Peafe laid a foot below the furface will vegetate; but the moft approved depth is fix inches in light foil, and four inches in clay foil; for which reafon, they ought to be fown under furrow when the ploughing is delayed till fpring. Of all grains, beans excepted, they are the leaft in danger of being buried.

Horfe-hoeing of peaf

Peafe differ from beans, in loving a dry foil and a dry feafon. Horfe-hoeing would be a great benefit, could it be performed to any advantage; but peafe grow expeditioufly, and foon fall over and cover the ground, which bars ploughing. Horfe-hoeing has little effect when the plants are new fprung; and when they are advanced fo as to be benefited by that culture, their length prevents it. Faft growing at the fame time is the caufe of their carrying fo little feed: the feed is buried among the leaves; and the fun cannot penetrate to make it grow and ripen. The only practicable remedy to obtain grain, is thin fowing; but thick fowing produces more ftraw, and mellows the ground more. Half a boll for an Englifh acre may be reckoned thin fowing; three firlots thick fowing.

Notwithftanding what is faid above, the late Mr Hunter, a noted farmer in Berwickfhire, was accuftomed to fow all his peafe in drills; and never failed to have great crops of corn as well as of ftraw. He fowed double rows at a foot interval, and two feet and a half between the double rows, which admit horfe-hoeing. By that method, he had alfo good crops of beans on light land.

Peafe and beans mixed are often fown together, in order to catch different feafons. In a moift fea-

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ſon, the beans make a good crop; in a dry ſeaſon, the peaſe.

The growth of plants is commonly checked by drought in the month of July; but promoted by rain in Auguſt. In July, graſs is parched; in Auguſt, it recovers verdure. Where peaſe are ſo far advanced in the dry ſeaſon as that the ſeed begins to form, their growth is indeed checked, but the ſeed continues to fill. If only in the bloſſom at that ſeaſon, their growth is checked a little; but they become vigorous again in Auguſt, and continue growing without filling till ſtopped by froſt. Hence it is, that cold ſeed, which is early ſown, has the beſt chance to produce corn: hot ſeed, which is late ſown, has the beſt chance to produce ſtraw.

The following method is practiſed in Norfolk, for ſowing peaſe upon a dry light ſoil, immediately opened from paſture. The ground is pared with a plough extremely thin, and every ſod is laid exactly on its back. In every ſod a double row of holes is made. A pea dropt in every hole lodges in the flayed ground immediately below the ſod, thruſts its roots horizontally, and has ſufficient moiſture. This method enabled Norfolk farmers, in the barren year 1740, to furniſh white peaſe at 12s. per boll.

Experiments on ſetting peaſe in drills.

In the Bath Papers, vol. i. p. 148. we have an account of the ſucceſs of an experiment by Mr Pavier near Taunton, on ſowing peaſe in drills. The ſcale on which this experiment was made, however, being ſo ſmall, it would perhaps be raſh to infer from it what might be the event of planting a large piece of ground in the ſame manner. The ſpace was only 16 ſquare yards, but the produce ſo great, that by calculating

culating from it, a ſtatute acre would yield 600, or at the leaſt 500 pecks of green peaſe at the firſt gathering; which, at the high price they bore at that time in the country about Taunton, viz. 16d. per peck, would have amounted to 33l. 6s. 8d. On this the Society obſerved, that though they doubt not the truth of the calculation, they are of opinion, that ſuch a quantity as 500 or 600 pecks of green peaſe would immediately reduce the price in any country market. "If the above-mentioned crop (ſay they) were ſold only at nine pence per peck, the farmer would be well paid for his trouble." In a letter on the drill huſbandry by Mr Whitmore, for which the thanks of the Society were returned, he informs us, that drilled peaſe muſt not be ſown too thin, or they will always be foul: and in an experimet of this kind, notwithſtanding careful hoeing, they turned out ſo foul, that the produce was only eight buſhels to the acre.—From an experiment related in the 5th volume of the ſame work, it appears that peaſe, however meliorating they may be to the ground at firſt, will at the laſt totally exhauſt it, at leaſt with regard to themſelves. In this experiment they were ſown on the ſame ſpot for ten years running. After the firſt two years the crop became gradually leſs and leſs, until at laſt the ſeed would not vegetate, but became putrid. Strawberries were then planted without any manure, and yielded an excellent crop.

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Peaſe muſt not be ſown too often on the ſame ſpot.

On the Norfolk culture of peaſe, Mr Marſhal makes two obſervations. "Leys are ſeldom ploughed more than once for peaſe; and the ſeed is in general dibbled in upon the flag of this one ploughing. But ſtubbles are in general broken by a winter-fallow of

Mr Marſhal's obſervations.

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three or four ploughings; the feed being fown broad-caft and ploughed in about three inches deep with the laft ploughing."—In the Vale of Gloucefter they are planted by women, and hoed by women and children, once, twice, and fometimes thrice; which gives the crop, when the foil is fufficiently free from root-weeds, the appearance of a garden in the fummer time, and produces a plentiful crop in harveft. The diftance between the rows varies from 10 to 14 inches, but 12 may be confidered as the medium; the diftance in the rows two inches. In the Cheltenham quarter of the diftrict, they fet the peafe not in continued lines, but in clumps; making the holes eight or ten inches diftant from one another, putting a number of peafe into each hole. Thus the hoe has undoubtedly greater freedom; all the difadvantage is, that in this cafe the foil is not fo evenly and fully occupied by the roots as when they are difpofed in continued lines.—In Yorkfhire it is common to fow beans and gray peafe together, under the name of *blendings*; and fometimes vetches (probably, fays Mr Marfhal, a gigantic variety of the *ervum lens*) are fown among beans. Such mixtures are found to augment the crop, and the different fpecies are eafily feparated by the fieve.

Suffolk culture of peafe.

A Suffolk farmer has given the following remarks upon the culture of peafe, fome of which are very worthy of attention. He enumerates eight kinds: "1. The common white. 2. The forty-day. 3. The Charlton. 4. The blue. 5. The large gray. 6. The fmall gray. 7. The fpeckled. 8. The large Dutch." Between the three

* *Annals of Agriculture*, vol. xxxiii.

three firſt of theſe he repreſents the diſtinction as not very clear. "The gray hog pea, he adds, whether large or ſmall, will bear being ſown in autumn; a common practice in Hertfordſhire, where they begin pea-ſowing as ſoon as the wheat ſeed is over. The farmers, however, have diſtinctions, and think that ſome ſorts will ſtand the winter, and that others will not; but I never could gain explicit information upon this head ſufficient to overthrow my own practice: for I have ſown them all in November more than once with ſucceſs. The blue and ſpeckled, I believe, are ſpring peaſe. All that I know of the Dutch is, that a perſon had them from Holland; they are as large as a horſe-bean, and ſucceeded well with him.

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"Of all other preparations for peaſe, that is beſt which admits the leaſt tillage, viz. ley ground, with only one ploughing, the peaſe to be pricked in with iron dibblers, a common method in Suffolk, and which ſucceeds greatly; but it ſhould be practiſed only on loams and good ſand; very poor ſand will not do for peaſe, and on clay beans anſwer far better. When this preparation is not followed, but the crop put in on a ſtubble, the land ſhould be ploughed in autumn, and, if the ſeaſon demands it, twice in the ſpring; but one ploughing, judiciouſly timed, may do better than two. The ſeed may be either ploughed or harrowed; if the former, it muſt not be above three inches deep; but harrowing in is ſafer, if the harrows let them in two inches. If harrowed in, they muſt be watched againſt rooks, &c.

"As no manuring ſhould be given for peaſe, I paſs on to the time of putting them into the ground; and here it is neceſſary to reject the autumnal ſowing, when

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the crop is to be harvefted time enough for turnips. In that cafe, I recommend it only for dry lands. The fort which are fown before Chriftmas are late peafe, which are not off foon enough for this purpofe. The forty-day, or the Charlton pea, fhould be fown early in March; and if turnips are intended, not later than that month. Late fown crops are fubject to the green fly. If they are not intended as a preparation for turnips then the time of fowing is before Chriftmas; but to choofe a dry time, for if they are fown foon after rain or fnow, the crop will fuffer.

" I would never fow broad-caft lefs than three bufhels an acre of peafe. One great object, perhaps the greateft in this crop, is to procure a thick cover over the foil; which, if thick enough, deftroys weeds very effectually, and breeds a moift putrid fermentation on the furface of the land; this is never effected with a thin crop. If you look only to the produce, and defign to have the hoes perpetually at work, two bufhels and even lefs are enough.

" Peafe when ripe are very apt to be devoured by rooks, wood-pigeons, and other birds; they fhould therefore be well watched. The beft way of cutting them is with the tool called a peafe-make, made with half an old fcythe; and, as cut, they are turned up into wads or bundles, which fhould lie out fome days to wither. Thefe wads fhould be fmall, for they do not dry well when large. Peafe are fometimes mown, but it is a very bad practice.

Early peafe are recommended by this writer as a preparation for turnips. " By fowing the charlton or forty-day pea early in March, they will be cleared from the field within the month of June, or the firft week of

July,

July, which is a very good feafon for turnips, and on all dry foils (the only ones proper for peafe) ought never to be neglected. If the harveft happens to be later, the wads fhould be laid in rows, and the ploughs fent in without waiting for their being cleared away; by which a week or perhaps ten days may be gained. The advantages of this practice muft be obvious, when it is confidered that a thick fmothering crop of peafe, not only kills weeds, but improves the foil, and particularly in leaving the furface loofe and friable from the putrefactive fermentation carried on under the peafe, which retain moifture but exclude the fun; and if the land is ploughed directly, which is a great point, though much neglected by farmers in general, proves a fine preparation for turnips. The peafe are not the only gain, but the faving in tillage; for by this means the latter crop is put in upon only one ploughing, which can be effected no other way."

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6. Beans.

The propereft foil for beans is a moift and deep clay, but they may alfo be raifed upon all heavy foils. They are cultivated in two ways; either in the old way by broad-caft, or, according to the more recent practice, they are drilled in diftinct rows. Of each of thefe we fhall give a very fhort account.

When the mode of cultivating beans by broad-caft is adopted, it is to be obferved, that as this grain is early fown, the ground intended for it fhould be ploughed before winter, to give accefs to the froft and air; beneficial in all foils, and neceffary in a clay foil. Take the firft opportunity after January, when the ground is dry, to loofen the foil with the harrow firft defcribed,

Culture of beans by broad-caft.

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till a mould be brought upon it. Sow the feed, and cover it with the fecond harrow. The third will fmooth the furface, and cover the feed equally. Thefe harrows make the very beft figure in fowing beans: which ought to be laid deep in the ground, not lefs than fix inches. In clay foil, the common harrows are altogether infufficient. The foil, which has refted long after ploughing, is rendered compact and folid: the common harrows fkim the furface: the feed is not covered; and the firft hearty fhower of rain lays it above the ground. Where the farmer overtakes not the ploughing after harveft, and is reduced to plough immediately before fowing, the plough anfwers the purpofe of the firft harrow; and the other two will complete the work. But the labour of the firft harrow is ill faved; as the ploughing before winter is a fine preparation, not only for beans, but for grain of every kind. If the ground ploughed before winter happen by fuperfluity of moifture to cake, the firft harrow going along the ridges, and croffing them, will loofen the furface, and give accefs to the air for drying. As foon as the ground is dry, fow without delaying a moment. If rain happen in the interim, there is no remedy but patience till a dry day or two come.

Carfe clay, ploughed before winter, feldom fails to cake. Upon that account, a fecond ploughing is neceffary before fowing: which ought to be performed with an ebb furrow, in order to keep the froft-mould as near the furface as poffible. To cover the feed with the plough is, with regard to this as well as other grain, expreffed by the phrafe *to fow under furrow.* The clods raifed in this ploughing are a fort of fhelter to the young plants in the chilly fpring months.

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The foregoing method will anſwer for loam. And as for a ſandy or gravelly ſoil, it is altogether improper for beans. Culture of particular Plants.

Culture of beans in drills.

Previous to the year 1770, beans were ſeldom ſown in Scotland, unleſs upon the very rich clays; but ſince that time, by adopting the plan of raiſing them in drills, or diſtinct rows, they have been ſucceſsfully cultivated upon all the heavy loams, and in many farms they now conſtitute a regular branch of rotation. With very few exceptions, beans are conſtantly drilled at intervals of from 20 to 27 inches. Of theſe modes, the laſt is the moſt prevalent, becauſe it admits the ground to be ploughed with a horſe, in the moſt ſufficient manner. Very little hand-hoing is given; nor is it required, as the kind of land which is beſt adapted for their growth, and upon which they are commonly ſown, has not naturally a tendency to the production of annual weeds; and fine crops of wheat generally follow, provided due attention has been given to working the bean crop. The neceſſity of ſummer fallow, which the preſent high price of labour, and the loſs of a year's crop, render an expenſive affair to the farmer, is conſequently much leſſened: for if land is once thoroughly cleaned, and afterwards kept in an alternate courſe of leguminous and culmiferous crops, it will remain in good order for a conſiderable number of years.

As beans delight in a moiſt ſoil, and have no end of growing in a moiſt ſeaſon, they cover the ground totally when ſown broad-caſt, keep in the dew, and exclude the ſun and air: the plants grow to a great height; but carry little ſeed, and that little not well ripened. This diſplays the advantage of drilling; which

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which gives free accefs to the fun and air, dries the ground, and affords plenty of ripe feed.

The following remarks upon the fubject made by Mr Vancouver * are alfo worthy of attention. "The land upon which peafe or tares may be cultivated to advantage, does not require to poffefs fo deep a ftaple as that appropriated to the culture of beans; the feed of which, in moft foils, be their texture what it may, fhould never be depofited at a lefs depth than five or fix inches below the fettled furface of the ground. The neceffity for placing the bean thus deep, will appear very obvious to any one who will take the trouble to infpect the root of the bean, when the plant has attained to its full growth, and its feed to its complete maturity; it will then appear evident, that from the point where the feed was depofited in the ground it fends downwards a long flender tap root, and upwards a thick ftrong one; along this upper divifion of the root, lateral fibres are detached from the feed to the furface of the ground, and are evidently deftined to collect and convey nourifhment to the plant. The long tap-root which defcends perpendicularly, and to a great depth from the point where the feed was placed in the ground, being perfectly clear of laterals, will not be fuppofed to contribute but in a fmall degree to the growth and fubfiftence of the plant. Hence the neceffity of placing the bean to a proper depth in the ground, that the plant may not be deprived of its proper organs for receiving and conveying from the earth that portion of nourifhment which the bean requires; but which, as well as in the cafe of peafe

* *Annals of Agriculture*, vol. xxv.

peafe or tares, will not be found equal to that conftantly demanded and drawn from the land by turnips, cabbages, and the white ftraw crops.

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II. *Plants Cultivated for Roots.*

1. POTATOES.

THESE, next to the different kinds of grain, may be looked upon as the crop moft generally ufeful for the hufbandman; affording not only a moft excellent food for cattle, but for the human fpecies alfo.

Are not prejudicial to mankind.

In this laft refpect, indeed, they are extremely valuable. They are the only fubftitute for bread formed of grain which has hitherto been introduced with any tolerable degree of fuccefs. They affume by the affiftance of cookery fuch a variety of forms as renders them at all times extremely acceptable; and they are now juftly regarded by the public as the fureft refource in all times of fcarcity, chiefly for this reafon, that in the Britifh iflands, furrounded as they are by the waters of the ocean, the crop of grain is chiefly found to fail in confequence of wet feafons, which do by no means affect the potato in the fame degree.

Kinds of potatoes to be preferred.

Various kinds of potatoes have at different periods been fafhionable, and the varieties which the fpecies is capable of exhibiting feems unbounded, as every perfon who takes the trouble to raife them from the feed difcovers new forts. In felecting the kind which he is to rear, the hufbandman ought to confider the ufe that he is to make of them. If his lands are fituated at a diftance from any town, which may prevent his crop from being fold for human ufe, and confine it to the confumption of cattle, he will probably derive moft be-

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nefit from planting the coarfe dark red kind of potatoes called *yams*, which afford a very great produce. They are extremely valuable for milch cows, increafing the produce without affecting the quality or tafte of the milk; they grow on poor foils even more abundantly than on rich, (where they are apt to run too much to ftem, and to be lefs productive at the root) and from the conftant verdure which they retain to the lateft period of the feafon, they are highly valuable in improving the ftate of the foil.

In the choice of potatoes intended to be confumed by man, the hufbandman ought to attend to this quality of the potato, that the kinds which afford the moft valuable and abundant crop at the root are apt to fend forth the leaft luxuriant ftems, while thofe whofe ftems are very large and branchy are lefs productive at the root. Thus the kidney potato, which is much valued on account of its quality, and which on on a rich foil is extremely prolific, is apt to fend out a very feeble ftem, which affords little or no covering to the foil, on which account fome of the moft judicious hufbandmen have laid it afide.

General culture.

The choice of foil is not of greater importance in any other plant than in a potato. This plant in clay foil, or in rank black loam lying low without ventilation, never makes palatable food. In a gravelly or fandy foil, expofed to the fun and free air, it thrives to perfection, and has a good relifh. But a rank black loam, though improper to raife potatoes for the table, produces them in great plenty; and the product is, as already obferved, a palatable food for horned cattle, hogs, and poultry.

The fpade is a proper inftrument for raifing a fmall quantity, or for preparing corners or other places inacceſſible to the plough; but for raiſing potatoes in quantities, the plough is the only inſtrument. Culture particu Plant

As two great advantages of a drilled crop are, to deſtroy weeds, and to have a fallow at the ſame time with the crop, no judicious farmer will think of raiſing potatoes in any other way. In September or October, as ſoon as that year's crop is removed, let the field have a rouſing furrow, a croſs-braking next, and then be cleared of weeds by the cleaning harrow. Form it into three-feet ridges, in that ſtate to lie till April, which is the proper time for planting potatoes. Croſs-brake it, to raiſe the furrows a little. Then lay well digeſted horſe-dung along the furrows, upon which lay the roots at eight inches diſtance. Cover up theſe roots with the plough, going once round every row. This makes a warm bed for the potatoes; hot dung below, and a looſe covering above, that admits every ray of the ſun. As ſoon as the plants appear above ground, go round every row a ſecond time with the plough, which will lay upon the plants an additional inch or two of mould, and at the ſame time bury all the annuals; and this will complete the ploughing of the ridges. When the potatoes are ſix inches high, the plough, with the deepeſt furrow, muſt go twice along the middle of each interval in oppoſite directions, laying earth firſt to one row, and next to the other. And to perform this work a plough with a double mouldboard will be more expeditious. But as the earth cannot be laid cloſe to the roots by the plough, the ſpade muſt ſucceed, with which four inches of the plants muſt be covered, leaving little more but the tops above ground; and this operation will at the ſame time bury all the weeds that

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have ſprung ſince the former ploughing. What weeds ariſe after muſt be pulled up with the hand. A hoe is never to be uſed here: it cannot go ſo deep as to deſtroy the weeds without cutting the fibres of the plants; and if it ſkim the ſurface, it only cuts off the heads of the weeds, and does not prevent their puſhing again.

Particular methods.

In the Bath Society Papers, we have the following practical obſervations on the culture and uſe of potatoes, given as the reſult of various experiments made for five years ſucceſſively on that valuable root, the growth of which cannot be too much encouraged.

When the potato crop has been the only object in view, the following method is the moſt eligible.

The land being well pulverized by two or three good harrowings and ploughings, is then manured with 15 or 20 cart loads of dung per acre, before it receives its laſt earth. Then it is thrown into what the Suffolk farmers call the *trench balk*, which is narrow and deep ridge-work, about 15 inches from the centre of one ridge to the centre of the other. Women and children drop the ſets in the bottom of every furrow 15 inches apart; men follow and cover them with large hoes, a foot in width, pulling the mould down ſo as to bury the ſets five inches deep; they muſt receive two or three hand-hoeings, and be kept free from weeds; always obſerving to draw the earth as much as poſſible to the ſtems of the young plants. By repeated trials, the firſt or ſecond week in April is found the moſt advantageous time for planting.

In the end of September or the beginning of October, when the haulm becomes withered, they ſhould be ploughed up with a ſtrong double-breaſted plough.

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The workman muſt be cautioned to ſet his plough very deep, that he may ſtrike below all the potatoes, to avoid damaging the crop. The women who pick them up, if not carefully attended to, will leave many in the ground, which will prove detrimental to any ſucceeding corn, whether wheat or barley. To avoid which inconvenience, let the land be harrowed, and turn the ſwine in to glean the few that may be left by their negligence.

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By this method, the ſets will be 15 ſquare inches from each other; it will take 18 buſhels to plant an acre; and the produce, if on a good mixed loamy ſoil, will amount to 300 buſhels.

If the potatoes are grown as a preparation for wheat, it is preferable to have the rows two feet two inches from each other, hand-hoeing only the ſpace from plant to plant in each row; then turning a ſmall furrow from the inſide of each row by a common light plough, and afterwards, with a double-breaſted plough with one horſe, ſplit the ridge formed by the firſt ploughing thoroughly to clean the intervals. This work ſhould not be done too deep the firſt time, to avoid burying the tender plants; but the laſt earth ſhould be ploughed as deep as poſſible; and the cloſer the mould is thrown to the ſtems of the plants, the more advantageous it will prove. Thus 15 buſhels will plant an acre, and the produce will be about 300 buſhels; but the land, by the ſummer ploughings, will be prepared to receive ſeed-wheat immediately, and almoſt enſure a plentiful crop.

The potato ſets ſhould be cut a week before planting, with one or two eyes to each, and the pieces not very ſmall; two buſhels of freſh-ſlaked lime ſhould be

To prevent the grub.

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fown over the furface of the land as foon as planted, which will effectually prevent the attacks of the grub.

The expence attending an acre of potatoes well cultivated in the firft method, fuppofing the rent 20 fhillings, tithe and town charges rather high (as in Suffolk), taking up, and every thing included, will be about 6l. In the laft method, it would be fomewhat reduced.

A premium having been offered by the above-mentioned fociety for the cultivation of potatoes by farmers, &c. whofe rent does not exceed 40l. per annum, the following methods were communicated, by which thofe who have only a fmall fpot of ground may obtain a plentiful crop.

Methods of cultivating potatoes on fmall fpots.

Firft, then, the earth fhould be dug 12 inches deep, if the foil will allow of it; after this, a hole fhould be opened about fix inches deep; horfe dung or long litter fhould be put therein about three inches thick: this hole fhould not be more than 12 inches in diameter. Upon this dung or litter a potato fhould be planted whole, upon which a little more dung fhould be caft, and then earth muft be put thereon. In like manner the whole plot of ground muft be planted, taking care that each potato be at leaft 16 inches apart; and when the young fhoots make their appearance, they fhould have frefh mould drawn round them with a hoe; and if the tender fhoots are covered, it will prevent the froft from injuring them: they fhould again be earthed when the fhoots make a fecond appearance, but not be covered, as in all probability the feafon will then be lefs fevere. A plentiful fupply of mould fhould be given them, and the perfon who performs this bufinefs fhould never tread upon the plant, or the hillock that is raiſed round it; as the lighter the earth is, the more room the potato will have to expand. From a ſingle root thus planted, very near 40 pounds weight of large potatoes were obtained, and from almoſt every other root upon the ſame plot of ground from 15 to 20 pounds weight; and except the ſoil be ſtony or gravelly, 10 pounds or half a peck of potatoes may almoſt always be obtained from each root, by purſuing the foregoing method. But note, cuttings or ſmall ſets will not do for this purpoſe.

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The ſecond method will ſuit the indolent, or thoſe who have not time to dig their ground; and that is, where weeds much abound and have not been cleared in the winter, a trench may be opened in a ſtraight line the whole length of the ground, and about ſix inches deep; in this trench the potatoes ſhould be planted about ten inches apart; cuttings or ſmall potatoes will do for this method. When they are laid in the trench, the weeds that are on the ſurface may be pared off on each ſide about ten inches from it, and be turned upon the plants; another trench ſhould then be dug, and the mould that comes out of it turned carefully on the weeds. It muſt not be forgot, that each trench ſhould be regularly dug, that the potatoes may be throughout the plot 10 or 12 inches from each other. This ſlovenly method will in general raiſe more potatoes than can be produced by digging the ground twice, and dibbling in the plants; and the reaſon is, that the weeds lighten the ſoil, and give the roots room to expand. They ſhould be twice hoed, and earthed up in rows. And here note, that if cut potatoes are to be planted, every cutting ſhould have two eyes, for though fewer ſets will be obtained, there will be a greater cer-

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planted with potatoes, and a good crop might be expected, as the leaves of trees, thorns, &c. are a good manure, and will furprifingly encourage their growth, and gratify the wifhes of the planter; who by cultivating fuch places, will then make the moft of his ground, and it will be in fine order to receive a crop of corn the the following year.

Beft method of taking them up.

The fhorteft and moft certain method of taking up potatoes, is to plough once round every row at the diftance of four inches, removing the earth from the plants, and gathering up with the hand all the potatoes that appear. The diftance is made four inches, to prevent cutting the roots, which are feldom found above that diftance from the row on each fide. When the ground is thus cleared by the plough, raife the potatoes with a fork having three broad toes or claws; which is better than a fpade, as it does not cut the potatoes. The potatoes thus laid above ground muft be gathered with the hand. By this method fcarce a potato will be left.

Of preferving them.

As potatoes are a comfortable food for the common people, it is of importance to have them all the year round. For a long time, potatoes in Scotland were confined to the kitchen garden; and after they were planted in the field, it was not imagined at firft that they could be ufed after the month of December. Of late years, they have been found to anfwer even till the fucceeding crop has arrived at maturity, which has proved a great fupport to many a poor family, as they are eafily cooked, and proverbially require neither kiln nor mill. When taken out of the ground, lay in the corner of a barn a quantity that may ferve till April, covered from froft with dry ftraw preffed down:

down: bury the remainder in a hole dug in dry ground, mixed with the husks of dried oats, sand, or the dry leaves of trees, over which build a stack of hay or corn. When the pit is opened for taking out the potatoes, the eyes of what have a tendency to push must be cut out; and this cargo will serve all the month of June. To be still more certain of making the old crop meet the new, the setting of a small quantity may be delayed till June, to be taken up at the ordinary time before frost. This cargo having not arrived to full growth, will not be so ready to push as what are set in April.

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If the old crop happen to be exhausted before the new crop is ready, the interval may be supplied by the potatoes of the new crop that lie next the surface, to be picked up with the hand; which, far from hurting the crop, will rather improve it.

Mr Young's experiments on the clustered potato.

In the Transactions of the Society for the encouragement of Arts, a number of experiments are related by Mr Young on that kind called the *clustered* or *hog potato*, which he strongly recommends as food for the poor, in preference to the kidney or other more expensive kinds. The following is the result of the most remarkable of his experiments.

In the first week of March 1780, two acres and a quarter of barley stubble were sown with the cluster potato, which appeared on the 23d of May. A sharp frost on the 7th of June turned them as black as they usually are by the frosts of November and December. In time, however, they recovered; and by the end of October produced 876 bushels from the 2¼ acres; which, when cleaned, were reduced to 780, or 350 bushels per acre; thus affording, when valued only at

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6d. per bushel, a clear profit of 7l. 14s. 4d. per acre. The experiment, however, in his opinion, would have been still more profitable, had it not been for the following circumstances: 1. The soil was not altogether proper. 2. The crop was grievously injured by the frost already mentioned, which, in our author's opinion, retarded the growth for about six weeks. 3. The dung was not of his own raising, but purchased; which cannot but be supposed to make a great difference, not only on account of the price, but likewise of the quality, as happened to be the case at present. He is of opinion, however, that potatoes, at least this kind of them, are an exhausting crop. Having sown the field after this large crop of potatoes with wheat, his neighbours were of opinion that it would be too rank; but so far was this from being the case, that the wheat showed not the least sign of luxuriance, nor the least superiority over the parts adjacent which were sown without dung. He was willing to account for this by the poverty of the dung, and the severe cropping which the ground had undergone while in the possession of the former tenant. In another experiment, however, in which the ground had been likewise exhausted by severe cropping, the succeeding crop of wheat showed no luxuriance; so that the former suspicion of the exhausting quality of the cluster potato was rather confirmed. The ground was a fine turnip loam; but though the produce was even greater than in the former case, viz. 356 bushels from an acre, the profit was much less, viz. only 4l. 15s. 6d. An acre of ley ground was sown at the same time with the turnip loam, but the produce from it was only 200 bushels. Mr Young supposes that the produce would have been greater if the potatoes had

been

been planted with an iron dibble, as the turf, in ploughing, lay too heavy upon the feed. A few rows of other potatoes, planted along with the cluftered kind, did not vegetate at all; which fhows that the latter have a more powerful vegetative faculty. Culture of particular Plants.

Having fucceeded fo well with his experiments on this kind of potato hitherto, Mr Young determined to try the culture of them upon a larger fcale: and therefore, in the year 1782, fowed 11 acres: but being obliged to commit the care of fowing them to an ignorant labourer, his unfkilfulnefs, together with the exceffive cold and moifture of that feafon, fo diminifhed the produce, that he had only a fingle acre out of the whole. This produced 180 bufhels, which yielded of clear profit 4l. 2s. 6d. From this experiment he draws the following conclufions: 1. "That the poor loam, on which thefe potatoes were fown, will yield a crop of clufter-potatoes, though not of any other kind. 2. That the manure for potatoes ought to be carted and fpread upon all foils inclinable to wet before the planting feafon, either in autumn preceding, or elfe during a hard froft." In 1783 he fucceeded ftill worfe; for having that year fown three acres and a half, the profit did not exceed 11s. 4d. per acre. The produce was about 224 bufhels per acre. He gives two reafons for the failure of this crop: 1. The cluftered potato thrives beft in wet years; but the fummer of 1783 was dry and hot. 2. The fpring froft, by interrupting the hoeing, not only greatly raifed the expences, but very much injured the crop by encouraging the growth of weeds. Barley was fown after the laft crop, and produced well; fo that our author thinks the potatoes feem to be a better preparation for fpring corn than Experiments on a larger fcale.

wheat,

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wheat. His experiment in 1784 produced a clear profit of 2l. 0s. 4d.; the produce being 250 buſhels per acre. Still, however, an error was committed, by employing an old man and woman to cut the ſets, by whoſe unſkilfulneſs there were many great gaps among the potatoes as they came up; ſo that, on the whole he reckons that he thus loſt from 500 to 800 buſhels.

Concluſion favourable to the cultivation of this kind.

On the whole, however, his opinion is favourable to the cluſter potato. "With ſmall crops (ſays he), and at the low rate of value which is produced by conſuming them at home, they are clearly proved to be a crop which will pay the expence of manuring, and very ample tillage and hoeing. This is, after all, the chief object of modern huſbandry; for if a man can rely upon this potato for the winter conſumption of his yard in fattening or keeping hogs, in feeding his horſes, and fattening his bullocks, he has made one of the greateſt acquiſitions that can be deſired; ſince he can do all this on land much too ſtiff and wet for turnips; houſes his crops before the winter rains come on; and conſequently without doing any of that injury to his land which the turnip culture is known to entail, and from which even cabbages are not free. Thoſe who know the importance of winter food on a turnip farm, cannot but admit the magnitude of this object on wet ſoils."

Board of Agriculture's rules of culture.

In conſequence of the threatened ſcarcity in 1795, the Board of Agriculture circulated ſome hints reſpecting the culture of potatoes, which deſerve attention. Concerning the ſorts which ought to be planted, it was obſerved, "1ſt, That the ſorts ſhould not be liable to the *curl*; and, 2d, That they ſhould be mealy. The kind known under the name of the *champion* has thoſe qualities,

qualities, and is alſo very early and próductive. The ox-noble is hardy, keeps well, and in the ſpring boils mealy. The kidney is of an excellent quality; and though the crop is leſs productive, and in ſome ſoils liable to curl, the price at market is proportionably great. The Surinam, cluſter, or yam, ſo well calculated for ſtock, never curls, and is extremely productive. Thoſe who cultivate potatoes on a great ſcale ought to have different ſorts—for early uſe—for keeping—for ſtock." Culture of particular Plants.

"The modes of planting are, 1ſt, Drilling on land already in tillage. 2d, Dibbling upon graſs or leys. 3d, Lazy bed on bogs, wet peat moor, and lands too rough to plough.

"*Drilling.*—Soils liable to be wet during the winter ſhould be ploughed in autumn ſo as to lie dry. In the ſpring plough and harrow flat. In April and May the ſets may be planted. Draw furrows three feet aſunder; in thoſe furrows lay the dung, not leſs than twenty loads or tons per acre. Drop the ſets on the manure nine inches aſunder. If the land be at all ſtiff, cover the dung and ſets, by drawing earth over them with hand-hoes; adding more, afterwards, with the plough: if it be light and friable, it may be covered with the plough. Keep the intervals clean by ploughing or horſe-hoeing for ſix or eight weeks after the potatoes appear; afterwards by hand-hoeing. Hand-hoe the rows when young, and afterwards weed them. Take up the crop by opening the rows with a plough, and harrow and pick them more than once. Drilling.

"Lands prepared and dunged for wheat, that could not be ſown on where the plant has been deſtroyed by

Culture of particular Plants.

the froſt, are ready, without further manuring to receive potatoes in this mode of culture.

Dibbling.

" *Dibbling.*—If the ſoil of the graſs be very rich, it will want no manure: if moderately good, only ten or twelve tons per acre. If no manure be ſpread, plough late in autumn, and ſcuffle or ſkim the ſurface ſhallow; or, for want of thoſe tools, if weeds or graſs ariſe, hand-hoe it in March. If manure be uſed, ſpread it on the ley in ſpring, and plough it in: in either caſe dibble in the ſets ſtraight on the centre of every other furrow, nine inches from plant to plant. Keep clean by hand-hoeing; but a narrow ſkim may be paſſed twice along the intervals. Weed the rows, if neceſſary. When the crop is taken up, plough acroſs the former furrows.

" This method is applicable alſo to dry moors and waſtes capable of being ploughed; and by paring and burning the ſurface during the drying and north-eaſt winds of March dung may be ſaved. To add lime in ſuch caſes, to the aſhes, is beneficial.

" After an early crop of graſs for hay, or after the firſt crop of clover, the land may be ploughed, and potatoes dibbled in, if proper ſets have been preſerved for that purpoſe; and in the more ſouthern parts of the iſland a good crop may be obtained.

Culture by lazy beds.

" *Lazy beds.*—Upon bogs, partially or wholly drained, and upon ſuch rough ſoils as are difficult to plough, this method may be adopted. Pare and burn the ſurface; add lime to the aſhes. Strike the lands into ſtraight beds, ſix feet wide, with intervals of two feet or two and a half. Lay the ſets twelve inches ſquare on the beds, and cover them two or three inches deep, with ſpades from the intervals: when the plants appear,

cover

cover them again in the ſame manner one and a half or two inches more. Keep them clean by one hand-hoeing and ſucceſſive weeding. They may be taken up with the plough, by ſplitting the beds, and filling the former intervals, converting the open furrows left of the centre of the former beds, into drains deep enough to leave the land dry in winter.

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" *Produce.*—In any of theſe methods the farmer may expect from 200 to 300 buſhels an acre, of 75lb. per buſhel; ſome ſoils will yield more, and ſome may afford leſs. The drill method is by much the cheapeſt. If the whole ſhould not be ſaleable, the reſt may be given to fatten oxen, to horſes, and to any other live-ſtock, with advantage; particularly if, when boiled or ſteamed, a handful of ſalt be added to two buſhels of potatoes.

Produce.

" *Double crops.*—In Cornwall, in Cheſhire, in Lancaſhire, and in the neighbourhood of London, two crops have been obtained from the ſame ground in one year: the mode of raiſing which will be found in the Agricultural Reports from the counties of Cheſhire and Lancaſhire. Thoſe who raiſe early potatoes may certainly have a ſecond crop on the ſame ground.

Double crops.

" *The following crop.*—Wheat has been ſown with ſucceſs after potatoes; but barley or oats are more to be recommended. On dry moory ſoils, treated as above, turnips may follow, fed off by ſheep, and theſe by ſpring corn and graſs.

The ſucceeding crop.

" *Preſervation.*—The moſt approved method is that of digging in a very dry ſpot, trenches ſix feet wide, and eighteen inches deep; ſpread ſtraw; pile the potatoes into the ſhape of the roof of a houſe; cover tight and cloſe with ſtraw ſix inches thick; and then with earth

Mode of preſervation.

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fifteen to eighteen inches more; flatted regularly and firmly, and ſharp at top; raiſed from three feet to five feet above ground. If there ſhall be any apprehenſion of moiſture, dig a trench a few yards off deeper than that in which the roots are laid. The drier they are, when thus packed up, the ſafer they will be."

Mr Marſhal's remarks on the cu[illegible]

Mr Marſhal in his Rural Economy of Yorkſhire, has ſeveral very intereſting remarks on the potato. Its varieties, he ſays, are endleſs and tranſitory. The rough-ſkinned Ruſſia potato, which was long a favourite of the Yorkſhire farmers, he is of opinion, has now no longer an exiſtence, more than many others which flouriſhed for a time. "There is ſome reaſon to believe (ſays he) that the diſeaſe which has of late years been fatal to the potato crop in this and in other diſtricts under the name of CURLED TOPS, has ariſen from too long a continuance of declining varieties. Be this as it may, it appears to be an eſtabliſhed opinion here, that *freſh varieties*, raiſed from ſeed, are not liable to that diſeaſe." Our author, however, does not look upon this to be a fact abſolutely eſtabliſhed: though one inſtance fell under his obſervation, in which its removal was in all probability owing to the introduction of new varieties. It made its appearance between 40 and 50 years ago, and ſpread in ſome degree over the whole kingdom. In ſome places it continued but a ſhort time, ſo that its effects are almoſt forgotten. It is ſeldom obvious at the firſt coming up of the plants, but attacks them as they increaſe in ſize; the entire top becoming dwarfiſh and ſhrivelled, as if affected by drought or loaded with inſects: they nevertheleſs live and increaſe, though ſlowly, in ſize; but the roots are unproductive. Some crops have been almoſt wholly

deſtroyed

destroyed by this disease. In Yorkshire the Morelands are in a manner free from it, but the Vale is in some measure infected. Plants procured from the Morelands remain free from it in the Vale the first year; but, being continued, become liable to the disease. Where the attack has been partial, weeding out the diseased plants, as they failed, is said to have had a good effect; and it is said that the Morelanders got rid of the disease by this means.

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In Yorkshire some intelligent husbandmen are acquainted with the method of raising potatoes from seed; which is as follows: "In autumn, when the apples are beginning to fall spontaneously, they are gathered by hand, and preserved among sand until the spring, when they are mashed among sand or among fresh mould; separating the seeds and mixing them evenly with the mould. As soon as the spring frosts are judged to be over, they are sown in fine garden mould; and as fast as the plants get into rough leaf, and are strong enough to be handled without injury, they are transplanted into another bed of rich mould in rows, which are kept clean during summer. In autumn, bunches of small potatoes are found at the roots of these plants, varying in size, the first year, from a hazel nut to that of a crab. These being planted next spring, produce potatoes of the middle size; but they do not arrive at their fullest bulk until the third or fourth year. Where the use of the stove or the garden frame can be had, this process may be shortened. The seeds being sown within either of these early in the spring, the plants will be fit to be planted out as soon as the frosts are gone; by which means the size of the

Method of raising varieties from seed.

roots

Culture of particular Plants.

roots will be much increafed the firft year, and will in the fecond rife early to perfection."

Another account of the mode of raifing potatoes from feed is given by Mr Henry Doby of Woodfide Chapel, Allerton, near Leeds *. "Take the largeft potato apples, of the kind you wifh to renew, and ftring them on a very ftrong coarfe thread, and hang them in a dry warm place till the latter end of February; when breaking them very fmall and wafhing them in feveral waters, the feed is to be feparated from the flefhy part and fkins; this done, it fhould be fpread on brown paper; and when dry, fow it in the beginning of March, or fooner, on a hot-bed, in lines about nine inches afunder, and one-third of an inch deep, and very thin: water between the lines frequently, and when the plants are rifen a little height, introduce fine rich earth between the lines to ftrengthen them. They fhould have air admitted frequently, the better to enable them to bear being removed into the open air as foon as the weather fhall be fufficiently temperate. Before they are tranfplanted they fhould be plentifully watered to make them rife with a large ball at their roots; old rotten horfe-dung and yellow mofs are the beft manures; plant them in trenches, as celery was formerly, with a fpace of four feet between the trenches, and 12 or 14 inches between each plant; as they grow up, draw the earth between the trenches to the ftalks, but do not cover their tops. The ground, when brought to a level, fhould be dug, and the plants earthed until there are pretty deep trenches formed between the lines. With

* *Annals of Agriculture*, vol. xix.

With this treatment they will produce the first season from a pound weight to five pounds a plant; and many of the plants considerably more than a hundred potatoes a-piece; the produce of which for ten or twelve years after will be prodigious." Culture of particular Plants

In the 4th volume of the Bath Papers, Dr Anderson relates some experiments made on potatoes raised from seed. The first year they were of different sizes, from a pigeon's egg to that of a small pea. On planting these next year, it was invariably found, that the largest potatoes yielded the largest crop; and the same happened the third, when a few showed blossom; but not even these had bulbs equal to what would have been produced by very large potatoes. Whence he concludes, that it is impossible to assign any time in which these seedling potatoes will arrive at what is called *perfection*; but that it must depend very much on the nature of the soil and the culture bestowed on them. From the practice of the Yorkshire farmers, however, and even from the experiments of the Doctor himself, it is evident, that potatoes raised in this way will at last grow to the usual size, as during the three years in which his experiments were continued they constantly increased in bulk. Dr Anderson likewise contends, that there is no reason for supposing that potatoes raised from bulbs in the ordinary way degenerate, or require to be renewed by seminal varieties; and he instances the universal practice of Britain and Ireland for a great number of years past. But this may be accounted for from an observation of Mr Marshal's, that varieties of potatoes, like those of corn, are partial to particular soils and situations. Hence, by transplanting all the different varieties of potatoes into all possible soils and Dr Anderson's experiments. Whether potatoes degenerate.

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situations, as has been done within this last century in the islands of Britain and Ireland, these varieties have continued for a much longer time than they would otherwise have done. In Yorkshire, Mr Marshal tells us, that "the old favourite sorts were driven until some of the individual plants barely produced their seed again." It is evident, therefore, that there is a necessity from time to time of renewing them from seed; though it deserves well to be considered whether it would not be more eligible to choose the seed from a plant in full vigour than from that which is so far degenerated that it can scarce produce its seed. "Potatoes raised from seed (says Mr Marshal) are a miscellany of endless varieties. Sometimes these varieties are planted miscellaneously; sometimes particular varieties are selected. In selecting varieties from seedling potatoes, two things are to be attended to; the intrinsic quality of the potato, and its productiveness. If these two desirable properties can be found in one plant, the choice is determined. To this species of attention and industry we are indebted for the many valuable kinds which have been and now are distributed throughout the island. It is observable, however, that varieties of potatoes, like those of corn, are partial to particular soils and situations. Hence the propriety of husbandmen raising potatoes from seed; as by this means they obtain, with a degree of moral certainty, a sort adapted to their own particular soils and situations. Whoever has attended closely to the work of taking up potatoes must have observed the great inequality in the productiveness of individual plants. The difference in the produce of adjoining roots, where no disparity of soil can influence, will sometimes be three or four fold.

Hen

Hence it is evident, that each variety has its *ſub-varieties*; through whoſe means it can hardly be doubted the parent variety may be improved, and its continuance be prolonged. Thus the farmer has another mean in his power of improving the quality and productiveneſs of his potato crop, by improving varieties; or in other words, ſelecting ſub-varieties, ſuperiorly adapted to his ſoil and ſituation."

How to obtain an early crop.

Sir Archibald Grant, Bart. of Monymuſk, in a letter * to the conductors of the Farmer's Magazine, has recently made known a mode practiſed by him with a view to the ſaving of ſeed, and the obtaining an early crop of potatoes. "In ſpring 1800, (ſays that gentleman), from a ſcarcity of ſeed, I followed a method ſometimes uſed by gardeners, for forcing early potatoes, peaſe and beans, viz. that of planting them out upon a ſmall dunghill, in order to make them come ſooner forward, and afterwards tranſplanting them into the ground. This I did, after they had upon the dunghill riſen to be good plants, and the leaves about an inch long. The dunghill was about three feet broad and 18 inches high, with from 2 to 3 inches of earth upon the top of it, and as long as held about a peck and three quarters of a peck of Aberdeenſhire meaſure (or 32lb. Dutch to the peck) of ſmall potatoes, cut into ſets, ſtuck as cloſe to each other as poſſible in the rows, and each row about two inches aſunder. On the 17th of April, they were put upon the dunghill; on the 2d of May they were in leaf; and on the 14th and 15th of May were planted out into the field; each plant 3 feet aſunder each way. On the 12th June, they were earth-

* *Farmer's Magazine*, June 1802.

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ed up with the plough, and were afterwards dressed in the ordinary method. On the 1st Monday of October, being taken up, they produced from 14 to 16 bolls Aberdeen measure. In June I observed, that potatoes which had been planted in the ordinary way in other parts of the parish in the middle of April were scarcely appearing above ground when these were so high as to require being earthed up with the plough; so that six weeks were gained in growth by this method."

Potatoes planted by scooping out the eyes.

During the late great dearth of all kinds of provisions, a plan was adopted with a view to save for food a part of the potatoes used as seed, which consisted of not cutting them into pieces with one or more eyes in each piece, as usual, but of slightly scooping out the eyes, which in that state were planted while the greater part of the potato was preserved for the use of man or cattle. This mode of planting potatoes was successful with a great number of persons; but in some instances, where the ground was not in an excellent state of preparation, the crop is understood to have been more defective than when the usual mode was adopted of cutting off large pieces of the potato along with the eye. The point, however, about the utility of this mode of practice must still be considered as doubtful or worthy of farther investigation. We are rather disposed to think that the practice of slightly scooping out the eye will not ultimately prove beneficial, because in ordinary cases the plant will be left destitute of due nourishment from the parent root at too early a period of its growth, and before it is completely capable of deriving its subsistence from the soil around it; in the same manner, and for the same reason, that light seed is apt to produce a light crop of grain. This objection may not indeed

indeed hold good with regard to potatoes planted on a very fine ſoil, or upon a hot-bed, for tranſplanting after the manner adopted by Sir Archibald Grant above mentioned. But on poor lands, where the ſtrength of the young plants is more ſeverely tried, any defect in the ſize of the root planted will probably always be productive of bad effects.

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2. Turnip.

Culture of turnip.

Turnip delights in a gravelly ſoil; and there it can be raiſed to the greateſt perfection, and with the leaſt hazard of miſcarrying. At the ſame time, there is no ſoil but will bear turnip when well prepared.

No perſon ever deſerved better of a country, than he who firſt cultivated turnip in the field. No plant is better fitted for the climate of Britain, no plant proſpers better in the coldeſt part of it, and no plant contributes more to fertility. In a word, there has not for two centuries been introduced into Britain a more valuable improvement.

Of all roots, turnip requires the fineſt mould; and to that end, of all harrows froſt is the beſt. In order to give acceſs to froſt, the land ought to be prepared by ribbing after harveſt, as above directed in preparing land for barley. If the field be not ſubject to annuals, it may lie in that ſtate till the end of May; otherwiſe, the weeds muſt be deſtroyed by a braking about the middle of April, and again in May, if weeds ariſe. The firſt week of June, plough the field with a ſhallow furrow. Lime it if requiſite, and harrow the lime into the ſoil. Draw ſingle furrows with intervals of three feet, and lay dung in the furrows. Cover the dung ſufficiently, by going round it with the plough, and forming the three-feet ſpaces into ridges. The dung comes thus to lie below the crown of every ridge.

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Seaſon and method of ſowing.

The ſeaſon of ſowing muſt be regulated by the time intended for feeding. Where intended for feeding in November, December, January, and February, the ſeed ought to be ſown from the firſt to the 20th of June. Where the feeding is intended to be carried on to March, April, and May, the ſeed muſt not be ſown till the end of July. Turnip ſown earlier than above directed, flowers that very ſummer, and runs faſt to ſeed; which renders it in a great meaſure unfit for food. I ſown much latter, it does not apple, and there is n food but from the leaves.

Though by a drill plough the ſeed may be ſown o any thickneſs; the ſafeſt way is to ſow thick. Thi ſowing is liable to many accidents, which are far fron being counterbalanced by the expence that is ſaved i thinning. Thick ſowing can bear the ravage of th black fly, and leave a ſufficient crop behind. It is a pro tection againſt drought, gives the plants a rapid pro greſs, and eſtabliſhes them in the ground before it i neceſſary to thin them.

The ſowing turnip broad-caſt is almoſt univerſal i England, and common in Scotland, though improper i ſome reſpects. The eminent advantage of turnip is, tha beſides a profitable crop, it makes a moſt complete fallow and the latter cannot be obtained but by horſe-hoeing Upon that account, the ſowing turnip in rows at thre feet diſtance is recommended. Wider rows anſwer n profitable end, ſtraiter rows afford not room for a hor to walk in. When the turnip is about four inches hig annual weeds will appear. Go round every interv with the ſlighteſt furrow poſſible, at the diſtance o two inches from each row, moving the earth from th rows towards the middle of the interval. A thin plat

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of iron muſt be fixed on the left ſide of the plough, to prevent the earth from falling back and burying the turnip. Next, let women be employed to weed the rows with their fingers; which is better, and cheaper done, than with the hand-hoe. The hand-hoe, beſide, is apt to diſturb the roots of the turnip that are to ſtand, and to leave them open to drought, by removing the earth from them. The ſtanding turnip are to be at the diſtance of twelve inches from each other: a greater diſtance makes them ſwell too much; a leſs diſtance affords them not ſufficient room. A woman ſoon comes to be expert in finger-weeding. The following hint may be neceſſary to a learner. To ſecure the turnip that is to ſtand, let her cover it with the left hand; and with the right pull up the turnip on both ſides. After thus freeing the ſtanding turnip, ſhe may ſafely uſe both hands. Let the field remain in this ſtate till the appearance of new annuals make a ſecond ploughing neceſſary; which muſt be in the ſame furrow with the former, but a little deeper. As in this ploughing the earth-plate is to be removed, part of the looſe earth will fall back on the roots of the plants; the reſt will fill the middle of the interval, and bury every weed. When weeds begin again to appear, then is the time for a third ploughing in an oppoſite direction, which lays the earth to the roots of the plants. This ploughing may be about the middle of Auguſt; after which, weeds riſe very faintly. If they do riſe, another ploughing will clear the ground of them. Weeds that at this time riſe in the row, may be cleared with a hand-hoe, which can do little miſchief among plants diſtant twelve inches from each other. It is certain, however, that it may be done cheaper with the hand.

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hand *. And after the leaves of turnips in a row meet together, the hand is the only inſtrument that can be applied for weeding.

In ſwampy ground, the ſurface of which is beſt reduced by paring and burning, the ſeed may be ſown in rows with intervals of a foot. To ſave time, a drill-plough may be uſed that ſows three or four rows at once. Hand-hoeing is proper for ſuch ground; becauſe the ſoil under the burnt *ſtratum* is commonly full of roots, which digeſt and rot better under ground than when brought to the ſurface by the plough. In the mean time, while theſe are digeſting, the aſhes will ſecure a good crop.

Properties of different ſorts of turnip.

In cultivating turnips to advantage, great care ſhould be taken to procure a good, bright, nimble, and well-dried ſeed, and of the beſt kinds.

The Norfolk farmers generally raiſe the oval white, the large green-topped, and the red or purple-topped kinds, which from long experience they have found to be the moſt profitable.

The roots of the green-topped will grow to a large ſize, and continue good much longer than others. The red or purple-topped will alſo grow large, and continue good to the beginning of February; but the roots become hard and ſtringy ſooner than the former.

The

* Children under thirteen may be employed to weed turnips with the fingers. We have ſeen them go on in that work with alacrity; and a ſmall premium will have a good effect. For boys and girls above thirteen, a hand-hoe adapted to their ſize is an excellent inſtrument: it ſtrengthens the arms amazingly. In driving the plough, the legs only are exerciſed; but as the arms are chiefly employed in huſbandry, they ought to be prepared beforehand by gentle exerciſe.

The green-topped growing more above ground, is in more danger of fuftaining injury from fevere frofts than the red or purple, which are more than half covered by the foil; but it is the fofteft and fweeteft, when grown large, of any kind. We have feen them brought to table a foot in diameter, and equally good as garden turnips. Culture of particular Plants.

Turnips delight in a light foil, confifting of fand and loam mixed; for when the foil is rich and heavy, although the crop may be as great in weight, they will be rank, and run to flower earlier in fpring.

From a ftatement given by the Agricultural Society of Penzance in Cornwall, it appears, that falt is there ufed with great fuccefs as a manure for turnips. "The extenfive pilchard fifhery (fay thefe gentlemen) *, eftablifhed on our coafts fortunately enables us to make fome ufe of this valuable manure. Salt is frequently imported for curing fifh at 9d. or 9½d. per bufhel of 84 pounds; and what remains after it has been once or fometimes twice ufed in preferving the pilchards, is ufually fold at [illegible] the fame price to the neighbouring farmers. Unqueftionably, fome animal-oil is united to the falt; but in the general opinion this is at leaft compenfated by the admixture of fifh fcales, as that falt which has been leaft ufed is univerfally preferred, and found to be moft effectual.

"At Michaelmas 1790, Mr Sickler entered on an eftate fo much impoverifhed by the former tenant as fcarcely to return the feed.

"1791.—In the fpring of this year Mr Sickler prepared

* *Annals of Agriculture*, vol. xxvii.

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pared two acres for turnips which had borne feven crops of oats in fucceffion. The laft crop did not produce nine bufhels on an acre.

" In the firft week of April, the earth from two ditches was carried into the fields and laid in four piles; each pile received three cart-loads of fea-fhell fand, and five bufhels of falt. The earth from another ditch chiefly confifting of the decayed foil which had been taken off the ground in former tillage, was placed in three more piles; and each of thefe received alfo three cart-loads of fand, but no falt, on account of the apparent richnefs of the earth. Half the field was manured with the four firft piles; but the three laft not being fufficient for the other half, what remained was fown with falt at the rate of ten bufhels to an acre.

" The part of the field where falt had been ufed, either mixed with earth or alone, produced about half a crop of turnips: but the crop totally failed where there was no falt. In the fpring following, white oats were fown, and produced a crop of [illegible] bufhels to an acre.

" 1792.—Three acres, which in 1791 had borne a crop of wheat, not exceeding 12 bufhels on an acre, were ploughed before Chriftmas, and brought into fine tilth by midfummer following. On each acre were fown 20 bufhels of falt, excepting that two ridges towards the middle of the field were purpofely left without any manure: on thefe two ridges the turnips totally failed, but the remainder of the field produced a plentiful crop.

" 1793.—Four acres of land, completely worn out by fucceffive tillages, were ploughed before Chriftmas; three

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three acres were ſown with ſalt at the rate of 25 buſhels, and the remaining acre with 18 buſhels, without any other manure. The crop was in general a good one, but viſibly beſt where the greateſt quantity of ſalt had been uſed.

"Crops of turnips have been raiſed with equal ſucceſs by the uſe of ſalt ſince that time, and in the ſevere winter of 1794-95, it was obſerved, that theſe turnips were much leſs injured by the froſt than others ſimilarly ſituated, and cultivated in the common way.

"When ſalt is uſed in the quantity of 20 or 25 buſhels to an acre, the turnips ſhould not be ſown till at leaſt three weeks after the ſalt. Clover ſown with barley, after turnips raiſed by the uſe of ſalt, has never failed to produce an abundant crop of hay the year following."

Obſervations with regard to ſeed.

Turnip-ſeed, like that of grain, will not do well without frequent changing. The Norfolk ſeed is ſent to moſt parts of the kingdom, and even to Ireland: but after two years it degenerates; ſo that thoſe who wiſh to have turnips in perfection ſhould procure it freſh every year from Norwich, and they will find their account in ſo doing. For from its known reputation, many of the London ſeedſmen ſell, under that character, ſeed raiſed in the vicinity of the metropolis, which is much inferior in quality.

When the plants have got five leaves, they ſhould be hoed, and ſet out at leaſt ſix inches apart. A month afterward, or earlier if it be a wet ſeaſon, a ſecond hoeing ſhould take place, and the plants be left at leaſt 14 inches diſtant from each other, eſpecially if intended for feeding cattle; for where the plants are left thicker, they

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they will be proportionally ſmaller, unleſs the land is very rich indeed.

Method of culture in Norfolk.

Some of the beſt Norfolk farmers ſow turnips in drills three feet aſunder, and at a ſecond hoeing leave them a foot apart in the rows. By this means the trouble and expence of hoeing is much leſſened, and the crop is of equal weight as when ſown in the common method. The intervals may eaſily be cleared of weeds by the horſe-hoe.

Culture of turnip by drill and broad-caſt compared.

There has been laid before the Board of Agriculture*, the reſult of ſome intereſting experiments, which we ſhall here ſtate, that were made by Mr W. Jobſon of Turvelaws, with a view to aſcertain the comparative merits of the two modes of rearing turnips by drill or broad-caſt. The trial was made upon a part of a field of 15 acres ſown in the month of June 1797. "The whole field, ſays Mr Jobſon, was in equal tilth, was manured as equally as poſſible immediately before ſowing with rotted fold-yard dung, at the rate of 17 cart loads per acre, each load containing about 28 Wincheſter buſhels; and in order to make the experiment perfectly fair, there were breadths of land of 20 yards each, ſown in broad-caſt and drills alternately, throughout the whole field. Part of the drills on one-bout ridges of 27 inches each, with the dung laid immediately underneath, where the row of ſeed was depoſited; the reſt of the drills upon a level ſurface, were ſown by Mr Bailey's machine at 21 inches diſtance. The produce per acre is calculated from the weight of four ſquare perches, or the fortieth part of a

* *Communications to the Board of Agriculture*, vol. ii.

a ſtatute acre of each, having firſt cut off the tails, or fibrous part of the root, and thrown them aſide as unfit for food, and then taken the weight of the tops and roots ſeparately.

" It is neceſſary to obſerve, that this field of turnip was but a middling crop, having been much hurt immediately after the firſt hoeing, by the *grub* (a ſmall worm which deſtroys the root), particularly the drilled part of the field, which, having had the plants ſet out, at the diſtances at which they were intended to remain before the grub ſeized them, was on that account rendered too thin and otherwiſe much injured; notwithſtanding which, it was found that thoſe on the one-bout ridges exceeded the others in weight; alſo, that theſe parcels of turnips were taken from an inferior (though not the worſt) part of the field, and may therefore be deemed to be a pretty fair average of the whole: there were alſo three other portions weighed, which were taken from a part of the field where the roots were larger, and a fuller crop, with a view to aſcertain what might have been expected, had not the grub ſeized them in the manner deſcribed; but unfortunately the paper containing their weight has been loſt or miſlaid, which puts it out of my power to furniſh you with it. There was alſo an account taken of the number (but not the weight) of loads which were produced upon a few acres of the worſt part of the field which was in favour of the broad-caſt, in the proportion of ten of broad-caſt to nine of thoſe drills on one-bout ridges, and eight of Mr Bayley's drills.

" From this experiment (though defective from the reaſons aſſigned) we have reaſon to conjecture, though not to form a concluſion, that a heavier crop may be

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raifed by fowing in drills at 27 inches diftance with the dung immediately beneath the plants, than in broadcaft or in drills at 21 inches on a level furface: but whether the advantage arifes from the fituation in which the dung is depofited, or from their having a freer circulation of air, or from both thefe united, it remains for future and repeated experiments to decide. Notwithftanding this, it will be found, that each of thefe methods poffeffes peculiar advantages and difadvantages, according to fituations and circumftances; the reafons for which I deduce from the obfervations I have made refpecting this as well as former crops. In the firft place, the one-bout ridges I think preferable for early fowing, and eating off, through the winter months, even fo late as the month of February, as they are more eafily procured for food for cattle in deep fnows; alfo in fituations where it is difficult to procure a fufficient number of experienced hoers, thofe under the drill fyftem can be more eafily managed and at lefs expence, as boys and girls may be readily taught to fet out the plants with great regularity in very little time; but turnips under this fyftem are liable to the inconvenience of being more apt to be injured by fevere frofts from their high expofure. Another inconvenience I have alfo obferved on wet and heavy lands, more efpecially with little declivity, that although there fhould, and poffibly may, be a larger crop produced thereby, yet the land will unavoidably be fo much poached by carrying them off, that the fucceeding crop of corn will be leffened more than the extra value of the turnips will compenfate. When it is attempted to raife turnips upon land of this defcription, it will be found more advantageous to form it into ridges of fufficient

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height to carry off the water with eafe into the water furrows, and of fufficient breadth (fuppofe fifteen feet) to allow a cart to pafs along them freely, without forcing the earth in to choke up thefe furrows. The turnips may be fown either in broad-caft or in drills, upon the furface of thefe ridges. If the land is addicted to annual weeds, they will be beft in drills, which will expedite the hoeing; but if not, or if they be late in fowing, or if the land be fubject to the grub, broad-caft will generally be found to produce a more certain crop, as they can be left fo near to each other at the firft hoeing as to admit of being thinned, and thereby give the opportunity of taking out unhealthy plants at the fubfequent hoeings, and alfo that they grow more vigoroufly between the firft and fecond hoeings."

The refult of the experiment here alluded to, is ftated in the following manner:

COMPARATIVE

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COMPARATIVE WEIGHT x portions of ps, which were part of a Field of fifteen Acres: the whole of which was S in the Mont une 1797, as an experiment between the Drill and Broad-caſt ſyſtems.

	me ighı		Weight on four ſquare perches, or the 40th part of an acre.						Weight per ſtatute acre.				Average weight of each turnip.		Average diſtance of each turnip.
			ROOTS.			TOPS.									
			Cwt.	qr.	lb.	Cwt.	qr.	lb.	Tons	cwt.	qr.	lb.	lb.	oz.	
Nᶜ Drilled on one-bout ridges, at 27 inches diſtance.		354	8	1	1	1	1	3	19	1	0	20	3	0¼	16½ in. by 27 in.
Drilled with Mr Bayley's machine, on a level ſurface, at 21 inches diſtance.	dit	428	7	1	15¼	1	1	5¼	17	7	1	8	2	4¼	17 in. by 21 in.
Broad-caſt.	do.	568	7	2	12½	1	0	11¼	17	8	1	26	1	11½	16¼ each way.
Drilled on one-bout ridges, at 27 inches diſtance.	M	334	8	3	0	1	1	22	20	7	3	12	3	6½	17 by 27 in.
Broad-caſt. Theſe and the preceding were round white turnips.	do.	628	8	2	22	1	1	8	20	0	2	24	1	12½	16 each way.
Broad-caſt (Red).	do.	561	6	3	26½	2	3	5	19	11	1	0	1	15¾	16½ each way.

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"By noting the average diſtance of each turnip, as is done in the laſt column, is intended to ſhow, at one view, how many plants there were wanting in the drills to have made them a full crop; for, if 550 be ſtated as a medium number in a full crop, upon the 40th part of an acre, they will be found to occupy a ſpace of 17 inches each way in broad-caſt, $10\frac{1}{2}$ by 27 inches on the one-bout ridges, and $13\frac{1}{2}$ by 21 inches of thoſe drilled on the level ſurface; from whence may be eaſily ſeen, how much thoſe were wider in the rows than they ought to have been."

Dr Campbell of Lancaſter, in his eſſay addreſſed to the Board of Agriculture, gives the preference in very decided terms to the cultivation of turnips in drills rather than broad-caſt *. "On comparing the drill with the broad-caſt ſyſtem of cultivating turnips, I feel no heſitation in giving the drill ſyſtem the preference; which opinion is gaining ground faſt among my neighbours, who have had no opportunity of comparing the two methods. To ſay nothing of the ſuperior, neat, and workman-like appearance which a field of drilled turnips exhibits in all its ſtages, there are many circumſtances which contribute to give it a decided ſuperiority over the broad-caſt.

"The firſt is the ſecurity of the crop from the ravages of the fly. When dung is ſpread at random over a field, a part will receive a greater proportion of it than is neceſſary, and another a ſmaller. Should dry and hot weather come on immediately after the ſowing, that dung, which is expoſed to the influence of the ſun,

* *Communications to the Board of Agriculture*, vol. iii.

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will be dried up, and a great part of its juices and the volatile alkali which it contains will be exhaled and loſt. The ſeeds that fall in the intervals betwixt the dung, or where there is a deficiency of it, will languiſh, and perhaps be cut off by the fly or ſnail, and at any rate will never attain a full ſize. In the caſe of the drill method the dung, being buried in the bottom of the furrows, is excluded from all evaporation, and the ſeed being depoſited directly above the dung, is by the warmth which proceeds from it brought into immediate vegetation; and the young roots, as ſoon as the ſeed germinates, ſtriking into the dung, occaſion ſo rapid a growth, that in a few days the plants paſs into the rough leaf, and get beyond the riſk of injury from the fly, ſlug, or whatever vermin have a tendency to prey upon them in their weak ſtate. It would appear, that the weak and ſickly plants are particularly the objects of theſe deſtroyers, rather than the luxuriant and healthy. Vegetables, in a certain ſtate of decay and of a yellow hue, are moſt ſought after, and preyed upon by ſlugs in a garden; and I have taken notice, that ſome turnips from ſeeds accidentally dropt in the intervals of the drills, when there was no manure, have exhibited a ſickly hue, and been preyed upon by ſome inſects, whilſt the vigorous plants in the drills eſcaped. In the courſe of the laſt three years that I have cultivated turnips in ſeaſons where we have experienced the extremes of wet and drought on their coming out of the ground, I have not loſt a ſingle plant by the fly; which I am inclined to attribute to the rapid growth of the plants from the cauſes above enumerated.

" Another advantage ariſes from their being able to ſtir and horſe-hoe the land in the intervals of the drills; by by which means the weeds are more early and completely deſtroyed, at the ſame time that the ground is more effectually opened. Culture of particular Plants.

"In land abounding with ſtones to the degree of ſome of ours, it appears, that it would be almoſt impracticable to hoe it properly, when ſown in the broadcaſt way: in ſome ſituations it appears almoſt entirely a bed of ſtones, which would render the plants inacceſſible to the hoe; whereas, by the drill method, it is eaſily effected.

"It appears, that in proportion to the deficiency of manure (either in quantity or quality) the drills ſhould be brought cloſer together, and a ſmaller diſtance alſo be left betwixt the plants in hoeing them. It is quite abſurd to leave the ſame ſpace for a turnip, which we know will not attain the bulk of more than a few inches in circumference, as for another that will be two or three feet with the top in the ſame difference of proportion."

Great quantities of turnips are raiſed in Norfolk every year for feeding black cattle, which turn to great advantage.

It is well known, that an acre of land contains 4840 ſquare yards, or 43,560 ſquare feet. Suppoſe then, that every ſquare foot contains one turnip, and that they weigh only two pounds each on an average; here will be a maſs of food, excellent in kind, of 46 tons per acre, often worth from four to five guineas, and ſometimes more. Value as food for cattle.

Extraordinary crops of barley frequently ſucceed turnips, eſpecially when fed off the land. In feeding them off, the cattle ſhould not be ſuffered to run over too much of the ground at once, for in that caſe they

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will tread down and ſpoil twice as many as they eat. In Norfolk, they are confined by hurdles to as much as is ſufficient for them for one day. By this mode the crop is eaten clean, the ſoil is equally trodden, which, if light, is of much ſervice, and equally manured by the cattle.

A notion prevails in many places, that mutton fattened with turnips is thereby rendered rank and ill taſted; but this is a vulgar error. The beſt mutton in Norfolk (and few counties have better) is all fed with turnips. It is by rank paſtures and marſhy lands, that rank mutton is produced.

If the land be wet and ſpringy, the beſt method is to draw and carry off your turnips to ſome dry paſture; for the treading of the cattle will not only injure the crop, but render the land ſo ſtiff, that you muſt be at an additional expence in ploughing.

Method of preſerving turnips.

To preſerve turnips for late ſpring feed, the beſt method, and which has been tried with ſucceſs by ſome of the beſt Engliſh farmers, is, To ſtack them up in dry ſtraw; a load of which is ſufficient to preſerve 40 tons of turnips. The method is eaſy, and is as follows:

After drawing your turnips in February, cut off the tops and tap roots (which may be given to ſheep), and let them lie a few days in the field, as no weather will then hurt them.

Then, on a layer of ſtraw next the ground, place a layer of turnips two feet thick; and then another layer of ſtraw, and ſo on alternately, till you have brought the heap to a point. Care muſt be taken to turn up the edges of the layers of ſtraw, to prevent the turnips from rolling out; cover the top well with long ſtraw, and it will ſerve as a thatch for the whole.

In

In this method, as the ftraw imbibes the moifture exhaled from the roots, all vegetation will be prevented, and the turnips will be nearly as good in May as when firft drawn from the field. If ftraw be fcarce, old haulm or ftubble will anfwer the fame purpofe. Culture of particular Plants.

But to prevent this trouble and expence, perhaps farmers in all counties would find it moft to their intereft to adopt the method ufed by our neighbours the Norfolk farmers, which is, to continue fowing turnips to the latter end of Auguft; by which means their late crops remain good in the field till the latter end of April, and often till the middle of May.

The advantages of having turnips good till the fpring feed is generally ready, are fo obvious, and fo great, that many of the moft intelligent farmers (although at firft prejudiced againft the practice) are now come into it, and find their account in fo doing.

Their culture faid to be generally attended with no profit.

Turnips have long been in fuch general ufe as food for cattle, that the profit on raifing them might be reafonably thought to be altogether certain; neverthelefs, Mr Young, in the paper already quoted, informs us, that " turnips dunged for are univerfally a lofing crop; for if they are ftated from 30s. to 40s. an acre, their value does not amount to the dung alone which is fpread for potatoes; yet the latter pays that dung, all other expences, and leaves a profit fometimes confiderable. I admit that turnips fed upon the land will prepare better for corn; but that is by no means the queftion. Would not the dung raifed in the farm-yard by the confumption of the potatoes, fuppofing it fpread on the potato acre, make that produce more than the turnip one? I have no doubt but it would give a fuperiority. But turnips are liable to great failures, and

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and cannot be relied on late in the ſpring: potatoes may; and are applicable to uſes to which the other root cannot be applied."—In the ſecond volume of the Bath Papers, p. 101. we have a comparative account of the value of turnips, turnip-rooted cabbage, and lucerne, as food for cattle. The reſult of this writer's obſervations is, that "when ſheep are allowed as many turnips as they can eat (which ſhould always be the caſe when they are fattening), they will, on an average, eat near 20 pounds each in 24 hours. An acre of turnips twice hoed, will, if the land be good, produce about 50 tons; which will, on the above calculation, maintain 100 ſheep 52 days. The ſheep mentioned weigh 20 pounds per quarter. An acre of turnip-rooted cabbage will maintain 100 ſheep for a month, and ſometimes five weeks; but an acre of Scots cabbages will maintain 200 ſheep a full month." The number fed by lucerne is not determined.

Compared with other vegetables as food for cattle.

The fly occaſions the great inconvenience in turnip culture.

The greateſt diſadvantage which attends a crop of turnips, is their being ſo ready to be damaged by the fly, which ſometimes deſtroys them ſo completely, that they muſt be ſown over again two or three times the ſame ſeaſon, and even this without any certainty of ſucceſs. Innumerable methods of avoiding this evil have been projected, ſeveral of which were formerly noticed; and we ſhall here introduce ſome additional remarks upon the ſubject. We have already ſtated Dr Campbell of Lancaſter's propoſal to drill with dung under the rows. The remaining remedies may all be reduced to the following claſſes: 1. Steeping the ſeed in certain liquids. 2. Fumigation of the fields with the ſmoke of certain herbs. 3. Rolling. 4. Strewing ſoot, lime aſhes, &c. on the ſurface of the ground. It is very difficult, however,

however, to determine, with any degree of certainty, whether remedies of this kind are effectual or not; because sometimes the turnips are not injured though no precaution has been made use of: and when this happens to be the case, after the use of any supposed preventive, the preservation of the crop is ascribed to the use of that preventive, whether it be really efficacious or not. The virtues of steeps seem to have been fully ascertained by Mr Winter Charlton near Bristol, of whose experiments an account is given in the Transactions of the Society for Encouraging Arts, vol. v. The seeds were of the Dutch kind, sowed on beds in the kitchen garden in drills, about twelve inches distant, an inch and a half deep, on the 11th of May 1786. The beds had been prepared with rotten dung in May 1785, and afterwards sown with cabbages. The quality of the turnips is exhibited in the following table; the best being marked 1; and those of inferior quality, 2, 3, &c. The observations were taken on the 26th of June.

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Whether steeps for turnip seed be of any use.

Seed without any preparation, - -	1
steeped in train oil, flourished extremely.	
steeped in linseed oil, somewhat inferior,	1
Seed mixed with soot and water, - -	2
with drainings of a dunghill, -	2
with elder and barton draining, -	2
with soot, - - -	3
with elder-leaf juice, - -	3
with elder and barton draining, soot being sowed over the covered drills,	3
with ditto, and lime sowed over the drills, - - -	3
sowed with soot scattered over, and then covered, - - -	3

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Seed sowed with barton draining, - - 4
an elder bush drawn over when the plants appeared, - - 4
with stale human urine, very few plants appeared.
with slaked lime scattered over, and then covered, very few plants appeared,
with elder, barton-draining, and slaked lime, very few plants appeared,
with lime and barton-draining did not vegetate.

Another set of experiments was made with the green Norfolk turnip, drilled an inch and a half deep, the rows one foot distant, on beds eight feet three inches long, and two feet wide; half a drachm of seed allowed for each bed, steeped and mixed with various substances like the former. The seeds were drilled upon unmanured ground on the 20th of June 1786, and the observation made on the 17th of July. None of the beds were found free from the ravages of the fly; but the seeds which had been steeped in train oil and linseed oil were much more free from this injury than the others. The linseed oil, as in the former experiment, was found inferior to the train oil, which was supposed to have been owing to its being kept in a bottle that had formerly held oil of turpentine. The leaves of the steeped seeds were of a much darker green than the others, appeared twice as thick in bulk and luxuriancy, and the plants were considerably larger than those of the other kinds. The substances mixed with the rest were soapers ashes, wood ashes, pounded gunpowder, brimstone, slaked lime, soot, barton-drain-

ing,

ing; fometimes mixed together in various proportions, and fometimes with the addition of a portion of fifted mould.

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Thefe experiments fhow, that no dependence can be had on fteeps or mixtures of any kind with the turnip-feed; though the train oil and linfeed oil feem greatly to have forwarded the vegetation of the plant. It does not appear that fumigation has ever been tried; nor indeed does it feem eafy to be tried in fuch a manner as might enfure fuccefs.—In the fourth volume of the Bath Papers, Mr Gullet of Devonfhire gives fuch directions for performing the operation as he thinks would be productive of fuccefs.—In a preceding paper he had explained the good effects of fumigating orchards; but the cafe with thefe muft be very confiderably different from a field of turnips. The trees in an orchard are elevated above the ground, and the fmoke naturally afcends, and is blown along their tops: but in fumigating a large field of turnips, it muft creep along the ground in fuch a manner as is by no means agreeable to its nature; and without any exceffive degree of labour, as well as a vaft quantity of burning materials, there cannot be the leaft hope of fuccefs. Mr Gullet's directions are as follow: "If the turnip-ground be fpaded and burnt, or the weeds, &c. burnt without fpading, the fumigation thereby may fuffice to chafe fuch of the winged tribe from thence as are then there; but in all cafes, when the field is ploughed and ready for fowing, let heaps be made at different places and intervals round by the hedges and boundaries of the turnip-ground, and fome few fcattered through the field; then, as foon as the feed is fown, let the heaps on the windward fide and the fcattered ones be lighted and kept fmothering during

Mr Gullet's directions for fumigation.

Culture of particular Plants. ring the continuance of the wind in that quarter; the lefs the fire, and the more the fmoke, the better. Should the wind happen to fhift, thofe heaps on the quarter it fhifts to muft then be lighted and kept fmothering in like manner; fo that during the growth of the tender turnip leaf, and until it becomes rough and out of all danger, this fumigation and fmoke, over and acrofs the field, muft be continued from one quarter to the other; which I venture to affert, will effectually deter and prevent any winged infect tribe from approaching the turnip-ground: nay more, if there already, it would moft completely drive them from thence, as fuch delicately formed infects (which can only feed on the moft tender leaf) would be ill able to continue long in fuch a fmother of fire and fmoke. The confequence is obvious and certain, that if the fly be kept from approaching the field, the turnip-crop is fafe; and few, I believe, will difagree with me, that *prevention is better than remedy.*"

Our author does not fay that he has ever tried this method with turnips; but lays great ftrefs upon his fuccefs in a fimilar experiment with cabbages, in order to preferve them from the caterpillar. To make the matter more fure, however, he recommends the trailing of a bufh of elder over the turnip field at the time of harrowing or brufhing in the feed: but this remedy has by numberlefs experiments been found infignificant, and by thofe above related feems even to be pernicious: fo that whatever good effects we can expect from this method, muft depend on the fumigation alone; and even this is attended with very great uncertainties, as has already been obferved.

Of rolling. Rolling promifes to be of fervice when the young turnips

turnips are attacked by snails, which frequently destroy them; but it cannot be supposed to have much effect in destroying flies, these being too numerous and too minute to be effectually crushed by the roller: and indeed, though this has been frequently recommended, we have no decisive proofs of its having ever been attended with any good effect.

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The strewing of soot, lime, ashes, &c. upon the ground, have been determined ineffectual by the experiments already related, at least when applied before the turnips come up; and there seems to be little hope of their proving more effectual even when applied after the crop has appeared above ground. We may argue indeed *à priori* about the taste or smell of soot, lime, &c. being disagreeable to insects; but of this, after all, we have no sufficient proof; and even though this were the case, the leaf soon emerges from under this covering, or the insects will feed on the under part of the leaves, where these substances cannot lie. It is evident, therefore, that very little can be expected from any of the methods hitherto proposed either by way of cure or prevention. The more probable methods are,

1. To sow the turnips at such a season of the year that they may be well grown before the fly makes its appearance. In the Bath Papers, vol. iv. p. 132. Mr Wimpey observes, that in order to procure food for their cattle in the spring before the grass is grown, farmers are obliged to postpone the sowing of turnips beyond the natural time of vegetation: but were turnips to be sown in April, as soon as the season would permit, it is very probable that there would be as great a crop of them as of other vegetables usually sown in these months. On account of the delay in sowing, however,

Early sowing recommended.

for

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for the reaſon already mentioned, the ſucceſs of the farmer becomes exceedingly precarious, unleſs he is ſo fortunate as to have a few rainy days, or cloudy weather and frequent ſhowers, ſoon after the ſeed is ſown: and this our author ſuppoſes to be the true reaſon why the turnip is a more uncertain article than any other. But though ſpeculations of this kind have a great ſhow of probability, there is not any experiment hitherto publiſhed, even by our author himſelf, by which the truth of the above conjecture can be abſolutely aſcertained. Our author, however, is of opinion, that none of the common methods propoſed can anſwer any good purpoſe, farther than as by means of them the vegetation of the plant may be invigorated. Mr Wimpey recommends aſhes, ſoot, or a rich compoſt of lime and dung, uſed in ſufficient quantities; but the method of uſing them is, either to ſow them with the ſeed, or rather by themſelves immediately before, and to harrow them well in, that they may be completely incorporated with the ſoil. This for the moſt part would ſo invigorate and encourage the growth of the plants, as to be an overmatch for the moſt vigorous attacks of the fly.

Sowing a great quantity of ſeed.

2. Another method propoſed for ſecuring turnips from the fly, is by ſowing ſuch a quantity of ſeed as will be more than ſufficient for the conſumpt of the inſects. This we find recommended in a letter to the Bath Society, by a gentleman-farmer in Eſſex, vol. ii. p. 238. His method is to make the land clean and fine as ſoon as the ſeaſon will permit, and to ſow four pints per acre. It may be objected, that if the fly does not take them, the plants will ſtand ſo thick, that they cannot eaſily be hoed; but this may be obviated by harrowing them firſt, which will make them fit for the

hoe,

hoe. There can be no expectation of a crop if the fly takes them when only a pint of feed is fown per acre; but this gentleman remarks, that he has not in any one inftance miffed of a crop when he fowed four pints; becaufe, though the fly has fometimes deftroyed more than one half, and much damaged the othe , ftill there was a fufficient number left behind. He alfo agrees with others of the Society's correfpondents, that the ground fhould be well dunged and manured previous to the fowing of turnips, as this makes them grow vigoroufly, fo that they quickly get into the rough leaf, in which ftate the fly will not touch them.

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In the fame volume, a gentleman of Norfolk remarks, that manuring the ground in autumn for turnips is preferable to the doing fo in fpring. This difcovery he made in confequence of the following accident.—" A neighbouring farmer, not having a fufficient quantity of manure for all his turnip land, was under the neceffity of fowing four acres unmanured. The effect was, that the turnips on the manured part of the land were moftly eaten off by the fly, while four acres unmanured efcaped without injury." In confequence of having obferved this, the gentleman made a fimilar experiment, by manuring five acres well for turnips, and tilling three acres and a half in the ufual way without any manure. The manured crops were almoft all deftroyed by the fly, fo that he was obliged to fow moft of the land over again. The three acres and a half which had no manure were entirely free from injury, though the plants were much fmaller than thofe of the manured ground which came up. Not content with this trial, however, he repeated the experiment, by manuring fix acres of wheat ftubble in autumn, ploughing it in

Manuring in autumn preferable to fpring manure

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in immediately, and leaving it to incorporate with the earth during the winter: the turnips which grew upon this were as large as if the ground had been manured in the spring. This experiment was repeated with surprising success in two succeeding years; whence he infers, that the fly is either engendered in the new dung or enticed by it. But when the manure is laid on in autumn it loses its noxious qualities, though it still retains its nutritive ones.—This conclusion, however, does not appear to be well founded; for it is certain from undoubted experience, that turnips which have been well manured in the common way, have sometimes escaped any injury; while others, which have got no manure at all, have been almost totally destroyed. Another material advantage, however, which this correspondent observes is to be derived from manuring in autumn is, that all the seeds contained in the manure, and which are of course carried to the land with it, vegetate almost immediately, and are mostly killed by the cold of the succeeding winter, while the few that remain can scarce escape destruction from the ploughshare.

Mr Wimpey's opinion of sowing a great quantity of seed.

Mr Wimpey is also of opinion, that it is proper to sow a large quantity of seed; but thinks two pounds will be sufficient for an acre. A few ounces indeed would be sufficient to stock the land; but as the article is so precarious, he thinks it by far the safest way to allow seed in plenty, and reduce the plants afterwards by harrowing. He observes also, that it is of great consequence to have seed both good in quality and of the best species. He prefers the large and green topped, as being the most sweet and juicy; others give the preference to the red or purple-topped, as being hardier:

hardier: but at any rate, the ſeed from the largeſt and fineſt tranſplanted turnips, of whatever ſort, is greatly to be preferred, even though it ſhould coſt double or treble the price. Such as is ſold by the ſeedſmen in London he found generally of a mixed kind, and often in great part not worth cultivating. "Whether plants from new or old ſeed are moſt ſecure from the depredations of the fly (ſays he), is perhaps a queſtion which cannot be eaſily determined even by experiments; for concomitant circumſtances are frequently ſo much more operative and powerful, as to render the difference between them, if there be any, imperceptible. It is, however, known to every practical man, that new ſeed ſprouts or vegetates ſeveral days before old; and I think more vigorouſly: and it is equally well known, that the healthy and vigorous plants eſcape the fly, when the ſtinted and ſickly ſeldom or never eſcape it. Hence it would ſeem, that new ſeed, *cæteris paribus*, is more ſecure from the fly than old; and for my own uſe I would always prefer it."

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Of the quality of the ſeed.

3. The ſowing of turnips along with grain.—This, of all others, ſeems to be the moſt eligible and efficacious. In the ſecond volume of Bath Papers, p. 210. a Hertfordſhire correſpondent gives an account of the ſucceſs of an experiment of drilling turnips with wheat. A ſmall field of ſpring-wheat was drilled in rows two feet apart; and in the month of May turnips were ſown by hand in the intervals. They came up very well, and were thinned once by the hoe. The crop of wheat turned out better than another field of the ſame ſoil ſown broad-caſt in autumn, though it ripened ſomewhat later. The turnips were no other way injured by cutting it, than having ſome

Of ſowing turnips with grain.

With wheat.

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of the large leaves trodden down by the reapers. After harvest the weeds were cut up round the turnips with a hand-hoe, and they grew very large and vigorous. They were of the purple and white long kind, and the crop proved nearly as good as the same land produced in common. An excellent crop of barley and clover was got from the same field afterwards.

Mr Anderdon's experiments of sowing them with beans.

In the third volume of the same work we find an account of several successful experiments in sowing turnips between rows of beans. The advantages of this method are strongly set forth by R. P. Anderdon, Esq; who made some of the experiments, and are as follow: "1. You may have a crop of beans and turnips on the same field the same year. 2. The bean crop being well horse-hoed, no ploughing is wanted for turnips. for which the best Norfolk farmers give five ploughings. 3. It is hoed cheaper, more effectually, and consequently more profitably, than in any other way. 4. The ground is kept clean from weeds. 5. It is in order for a Lent crop the succeeding year with one earth. 6. The ground is kept in heart, if not improved, by fallowing your alleys. 7. It brings the plant to perfection in poor ground, where it would not become so otherwise. 8. It doubles the crop in any ground which Mr Anderdon has had experience of. 9. You have the crops more within your own power in this than in any other method, let the seasons turn out as they will. 10. You may have on the same ground a bean and turnip crop annually, if the land be suitable, and you think proper. 11. The clay farmer, by this mode, renders land which is naturally unfit for turnips, so free and open by seasonable horse-hoeings, that it will bring this useful plant to great perfection."

On this paper the Society made some remarks, and stated the following objections: 1. The same soil cannot be proper for both crops. Scotch cabbages are more adapted for a bean soil; and they wished him to repeat the experiment with cabbages instead of turnips betwixt his beans. 2. The Norfolk farmers rarely use more than three ploughings for turnips, instead of five, as Mr Anderdon represents, unless the ground be full of couch-grass. 3. They think him too sanguine in his expectations of having double crops on the same field. 4. Nothing renders a clay soil so free and open as to have it exposed to frosts and snow by being laid up in high ridges in January and February; but, on Mr Anderdon's plan, this cannot be done, unless the turnips are lessened in value by being fed off in autumn. Culture of particular Plants. Objections by the Bath Society.

These strictures were sent to Mr Anderdon before the papers were printed, but did not make any alteration in his opinion; and he replied to the following purpose:

1. *The same soil cannot be proper for beans and turnips*, &c.—Granted.—But had Mr Anderdon adhered rigorously to this rule, he would have sowed no turnips at all, not having on his farm any soil altogether proper for that crop; "but (says he) while I can get in single rows, four feet asunder or more, from half a dozen to half a score tons of turnips per acre, after, or rather between, a crop of beans in my heavy lands, I shall feel that product here more beneficial than to drop the mode." Mr Anderdon's reply.

Mr Anderdon then proceeds to acquaint the committee, that he had tried the experiment as they wished with Scotch cabbages instead of turnips betwixt the

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the rows of beans; but the crop of the turnips was so much preferable, that he found himself inclined to suppose the cabbage would not get to so great perfection there as to be profitably introduced on a large scale, for want of the great quantity of dung necessary for that crop, and which could not be procured in that part of the country. He further remarks, in favour of turnips, that they have an abundance of very small lateral fibrous roots, which run as far in search of food, and feed as ravenously where they can penetrate, as those of almost any other vegetable; and the plant certainly derives more nourishment from those than from its tap-root*.

2. *The Committee doubt of the possibility of doubling the crop.* Mr Anderdon gives the following explanation: "I have made many comparative trials on turnips between this mode and broad-cast sowing, and always found on *my ground* the horse-hoed crops the best. But here, in denoting the benefits of the horse-hoe by its *doubling* a crop, I wish to be understood, that if, *in soils like mine*, a crop be drilled, leaving proper intervals for horse-hoeing, and one part be horse-hoed, the other not, the horse-hoed part will double the other in product."

Mr Pavier's opinion.

This subject is further considered in the same volume by Mr Pavier, who viewed Mr Anderdon's turnips, and gave in a report of them to the committee. He supposes a crop of beans drilled in single rows at four feet distance, and the turnips drilled in the intervals,

* Here the Society remarks, that this is not the case with those kinds of turnips which grow chiefly above ground, and which are generally the best crops, and most capable of resisting the frosts.

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vals, according to Mr Anderdon's method, there will then be four rows of 17 feet in length to make a ſquare perch; whereas Mr Anderdon's rows were only 15 feet 8 inches in length; and this diſparity in length will make a difference of weight on a perch from 230 to 249 pounds, and on an acre from 16 tons 8 cwt. 2 qrs. 8lb. Mr Anderdon's produce, to 17 tons 15 cwt. 2qrs. 24lb.—Each turnip at this diſtance (viz. four feet from row to row, and nine inches in the rows) muſt occupy a ſpace of three ſquare feet; conſequently the greateſt number produced on an acre muſt be 14,520; but if ſown in broad-caſt, twice hoed, and the diſtance on an average 15 inches, each turnip will then occupy little more than one foot and an half, and the number produced on an acre may be about 27,920; an exceſs which may reaſonably be ſuppoſed to overbalance the value of the beans, let us ſuppoſe the crop as great as we can reaſonably do. Thus far the argument ſeems to lie againſt this method of cultivating beans and turnips together: but, on the other hand, Mr Pavier conſiders it probable that the expence of drilling and horſe-hoeing the beans, together with drilling the turnips in the manner Mr Anderdon did, muſt be conſiderably leſs than that of fallowing and preparing the ground, and ſowing the turnips in broad-caſt; to which we muſt likewiſe add the facility of hoeing the drills in compariſon of the broad-caſt. But beſides theſe, the great advantage ariſing from this method, and which, if certain, gives it a decided ſuperiority, is, "the great chance, if not an almoſt certainty, of preſerving the turnips from the depredations of the fly." Mr Pavier was inclined to think that this muſt be the caſe, as Mr Anderdon had ſuch crops repeatedly with-

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out any damage of that kind: but the committee differ from him, and think that this may have proceeded from some other cause; though they do not assign any reason for this opinion. "The principal point (says Mr Pavier), in determining this question, seems to me to be this: if the crop of beans drilled as above after deducting the seed, and some additional expence in taking the crop off the ground without injuring the turnips, can be, one year with another, supposed to be as valuable as the quantity of turnips that might be reasonably expected in the broad-cast method more than in the other, I should not hesitate to declare in favour of drilling between the beans."

Thus far the argument seems to be carried on *a priori*. Mr Wimpey, in the letter already quoted inclines to the practice of sowing turnips between beans planted in rows. "It exactly corresponds (says he) with all my observations on the successful vegetation of that root. A considerable degree of moisture is necessary to the rapid vegetation of that very juicy root, and nothing retains moisture equal to shade: and shade can be obtained and secured by no means so effectually on a large scale as in the intervals of tall growing plants, as beans or wheat planted in drills." The success of Mr Bult of Kingston, near Taunton, leaves little room to doubt of the propriety of the method, and its success in preventing the fly. The beans were planted in drills not quite two feet asunder, on two ploughings, horse-hoed three times, and the turnips sown in the intervals at the last hoeing. The field measured six acres and a quarter, and was a very good clayey soil, but had not been manured, nor had any dressing laid upon it, for six years before. It produced

produced this year three quarters of beans per acre, and 37 tons 5 cwt. of turnips. This field was alfo viewed by Mr Pavier, who makes the following obfervations upon it. 1. The turnips were fown promifcuoufly among the beans at the laft hoeing, which was given about midfummer; from which time nothing was done but drawing off the beans and carrying them off the land. 2. The crop of beans was believed to be confiderably above 20 bufhels per acre, which is much more than was produced by any other method that feafon in the neighbouring part of the country; and as Mr Pavier had this account before he faw the turnip crop, he did not expect any thing confiderable from the latter; but as it turned out, the produce muft be accounted highly profitable, when we confider that there was no crop loft, no preparation, dreffing, nor any expence whatever, excepting the price of the feed and fowing it. 3. This he confiders as one of the ftrongeft recommendations of the drill hufbandry he ever knew or heard of; but he is of opinion that it never can anfwer except where the ground is perfectly clean and free from weeds, by the crops having been horfe-hoed for a few years before. 4. He thinks the beans ought to have been planted at wider intervals, by which the fun and air would be freely admitted, and the plants would alfo be lefs damaged by the operation of the hoe.

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Mr Pavier likewife informs the Society of two other experiments on a fimilar plan; but with this difference, that the turnips were fown among the beans at the fecond horfe-hoeing. The turnip crops were very good, and the beans more than *double* the value of thofe raifed in the ufual mode of hufbandry. "I think it is

Other experiments on fowing turnips among beans.

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very evident (says he), that the beans preserve the turnips from the fly; and as no expence or trouble attends the practice, I apprehend it will soon become more general." The Society own, that the common success of Mr Bult's experiment *seems to militate* at least against what they said on Mr Anderdon's letter; but they insist that the cases are by no means similar. "Though the land (say they), in both instances, is called a *heavy clay*, they are very different. Mr Anderdon's is poor, wet, and cold: the other a good rich clay; and we apprehend naturally mixed with a kind of marl, which is called clay by persons not thoroughly acquainted with the nice distinction of soils apparently alike, but very different in their nature. Our principle therefore, that cold wet clay lands are unsuitable for turnips, remains unaffected by this experiment; and general practice confirms the truth of the theory."

In another letter, Mr Pavier gives a more particular account of the two other crops of beans and turnips raised upon Mr Bult's plan. The beans were drilled in rows about 22 inches distance, twice horse-hoed, and the produce from about 25 to 30 bushels the computed acre, or from 30 to 36 bushels the statute acre. The preceding summer had been very unfavourable to beans, and the produce per acre in the common husbandry did not, on an average, equal a third part of this quantity. One of these crops was superior to that of Mr Bult: they were sown upon a field of nine computed acres on the 10th of June, after the second horse-hoeing; but whether the second hoeing was performed too soon, the ground not clean, or whatever might be the cause, the beans were weeded twice by hand afterwards; and he is of opinion, that the turnips

were

were somewhat benefited by it. Mr Pavier was assured by a very intelligent farmer, that this was the best crop of turnips he had ever seen. The turnip-seed in the o[illegible] put in between the rows of beans by a hand drill; but the work was badly performed, the plants coming up in some places vastly too thick, and in others as much too thin; but wherever they happened to be of a proper thickness, the farmer told him it was one of the most profitable crops he ever had. The soil was wet, heavy, and not very favourable for turnips. Hence Mr Pavier deduces the following conclusions: 1. That with respect to beans in particular, the drilling and horse-hoeing is vastly superior to the common mode of husbandry. 2. That the beans are undoubtedly a good preservative of the turnips from the depredations of the fly. 3. That as by this method no crop is lost, and consequently no rent, but a mere trifle of expence (if any) chargeable to the turnip crop, it must be one of the most profitable as well as the most certain methods of propagating that useful root ever yet practised.—He still insists, however, that if he had an opportunity of trying this method, he would drill the beans in rows at a greater distance, that the turnips might be hand-hoed easily; and that he should prefer the London tick-bean to any other, by reason of their shortness and being such bearers; that he should also take off their tops as soon as the under blossoms began to decay; which, he supposes, would be of great service.

Culture of particular Plants.

In this dissertation on the culture of turnips, we cannot avoid taking notice of an instrument used in Norfolk for transplanting them, and thus filling up the gaps which frequently happen in fields from the failure

Instrument for transplanting turnips.

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of the plants in particular ſpots *. It is repreſented in Plate XIII. fig. 4. and the conſtruction and mode of uſing are obvious from the figure.—When the turnips are to be tranſplanted, the workman holds the long handle with the left hand, and the ſhort one with the right hand drawn up. Put the inſtrument then over the plant that is to be taken up, and with your foot force it into the ground; then give it a twiſt round, and by drawing it gently up, the earth will adhere to the roots of the plant in a ſolid body; then with another inſtrument of the ſame ſize take the earth out where the plant is to be put, and bringing the inſtrument with the plant in it, put it into the hole which has been made by the other; then keep your right hand ſteady, and draw up your left, and the earth and plant will be left in the hole with the roots undiſturbed. In this operation two men muſt be employed, each of them having an inſtrument of the form repreſented in the plate. One man takes up a plant, while the other fills his inſtrument with earth only, thereby making room for the depoſition of the plant; ſo that the hole which is made by taking up the plant is filled with the earth taken out where the plant is to be put; which being depoſited, he takes up a plant, and returns to the place he firſt ſet out from, the former man at the ſame time returning with the earth only; ſo that each man is alternately the planter, and each being employed both ways, the work goes on briſkly.—This inſtrument was the invention of Mr Cubitt Gray of Southrepps, Norfolk.

Turnips

* *Bath Papers*, vol. iv. p. 126.

Turnips being the grand basis of the Norfolk husbandry, Mr Marshal gives a very particular account of their culture in that county.—The species cultivated are, 1. The common *white-stock*, called in many places the Norfolk turnip. 2. The *purple-stock* is similar to the former, but its rind is of a dark red or purple colour; its size in general smaller and its texture closer and firmer than that of the common white-stock; it also stands the winter better, and is more succulent in the spring, but it is not so well relished by cattle as the former; whence it is less generally cultivated. 3. The *pudding-stock*, the *tankard-turnip* of the midland counties is in shape so perfectly different from the common sort, that it might be ranked as a distinct species. It rises in a cylindrical form, eight, ten, or twelve inches high, standing in a manner wholly above ground; generally taking a rough irregular outline, and a somewhat reclining posture. It very much resembles the common turnip, and is by much its most formidable rival. In many respects it seems to be superior, particularly in being readily drawn, and eaten off by sheep with much less waste than the common turnip.—The disadvantage is, that they are liable to the attacks of frost, by reason of their standing so high above the surface of the ground; so that on the whole, Mr Marshal concludes, that the common white turnip is to be preferred to every other.

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Norfolk cultivation of turnips.

In Norfolk, turnips are sown upon every species of arable land. Marl is found to be highly beneficial; and by means of this manure, a soil naturally unfit for turnips may be rendered proper for it. They succeed barley better than any other crop; some few are sown on wheat or pea stubble after harvest; but this is

Advantage of using marl.

not

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Manures of different kinds.

not a general practice. The manures in greateſt reputation for turnips are dung, with a greater or ſmaller admixture of mould; *malt-coombs* are alſo in good repute, and oil-cake is uſed by a few individuals; "but it may be ſaid that nine acres of ten of the turnips grown in eaſt Norfolk are manured with muck."—The quantity of dung ſet on for a crop of turnips generally depends on the quantity on hand, and the quantity of turnip ground to be manured. From 10 to 15 cart loads of muck are conſidered as a good dreſſing; and about a ton of oil-cake to three acres; 50 or 60 buſhels of malt-coombs, and 40 or 50 buſhels of ſoot, to an acre.

Cultivation of turnips for early conſumption.

When turnips are intended for early conſumption, the ſooner they can be got into the ground the better; but when they are intended to ſtand the winter, the beginning of July is thought ſoon enough. The moſt general rule is to begin ſowing about a week before midſummer, and continue till about a fortnight after, viz. from the 17th or 18th of June to the 7th or 8th of July.—Broad-caſt ſowing is univerſal, in the quantity of two pints to an acre. The ſeed is covered by two lines of a pair of light harrows drawn backward, in order to prevent the tines, which uſually point ſomething forward, from tearing up the clods, and burying the ſeed too deep. The horſes are univerſally *walked* one way, and *trotted* back again in the ſame place. This is an excellent cuſtom; the quick zigzag motion of the harrows at once aſſiſting to level the ſurface, and to diſtribute the ſeeds more evenly.—They are univerſally hoed; and unleſs they be ſown very late, are generally hoed twice. The diſtance of time between the ſowing and the firſt hoeing depends upon the ſoil

Method of ſowing, and culture.

and

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and ſeaſon; the ſize of the plants being the only guide. When turnips are ſuffered to grow too large before they are hoed, the plants are difficult to be ſet out ſingly, and are liable to be drawn up by weeds, thereby acquiring a ſlender upright tendency; whereas their natural growth, in their infant ſtate, is procumbent, ſpreading their firſt leaves on the ground, and taking the form of a roſe.—If the hoe be put in too ſoon, the plants which are ſet out are liable to be buried, and their tender roots diſturbed in the act of ſetting out the neighbouring plants. The time for hoeing, as directed by the moſt judicious huſbandmen, is when the plants, as they lie ſpread upon the ground, are about the ſize of the palm of the hand: if, however, ſeed-weeds be numerous and luxuriant, they ought to be checked before the turnips arrive at that ſize, leſt being drawn up tall and ſlender they ſhould acquire a weak and ſickly habit. The proper diſtance depends upon the nature of the ſoil and the time of ſowing; ſuch as are ſown early, in a rich productive ſoil, require to be ſet out wider than thoſe ſown late on a ſoil of a contrary nature. If the ſoil be at par, the diſtance ought to be regulated by the time of ſowing: if this be at par, the nature or ſtate of the ſoil ſhould be the regulator.—Mr Marſhal complains of the conduct of the Norfolk farmers in general in this reſpect, who "hack out their turnips 14, 15, or perhaps 18 inches aſunder, without any regard to the ſtate of the ſoil, or time of ſowing. This practice was eſtabliſhed while the Norfolk ſoil was full of marl, and new to turnips; and when, it is probable, 11 or 12 inches in diameter was no uncommon ſize, with tops proportionally large and ſpreading; and 14 or 15 inches might then be a proper diſtance.

But

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But now, when the efficacy of marl is lessened, and the soil no longer the favourite of turnips, which seldom reach more than seven or eight inches in diameter, it is ruinous and absurd to continue the practice."

Turnips are cultivated either for seed, for sale, or for consumption. When cultivated for seed, it is supposed in most parts of the kingdom that it ought always to be taken from transplanted roots; but in Norfolk they are frequently raised from such as are untransplanted. "It is a fact (says Mr Marshal) well understood by every husbandman in Norfolk, that if the seed be gathered repeatedly from untransplanted roots, the plants from this seed will become coarse-necked and foul-rooted; and the flesh of the root itself will become rigid and unpalatable. On the contrary, if it be gathered year after year from transplanted roots, the necks will become too fine, and the fibres too few; the entire plant acquiring a week delicate habit, and the produce, though sweet, will be small. For the neck, or onset of the leaves, being reduced to the size of the finger (for instance), the number and size of the leaves will be reduced in proportion; and in a similar proportion will the number and size of the fibrils be reduced. From a parity of reasoning, it may perhaps be inferred; that when the neck acquires a thickness equal to that of the wrist, the size of the root will be in proportion.

Cultivation of turnips for seed.

With respect to the fibres or rootlings, this is a just inference; but with respect to the bulb, it is in a great measure erroneous. For a few generations the size of the bulb will keep pace with the increase of leaves and fibres; but after having once reached the limits

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limits which nature has ſet to its magnitude, it begins to revert to its original ſtate of wildneſs, from which to its preſent ſtate it has undoubtedly been raiſed by tranſplantation. The farmer has therefore two extremes to avoid. The one is diſcoverable by the thickneſs and coarſeneſs of the neck, the ſcaly roughneſs of the bulb, the thickneſs of the rind in general, the foulneſs of its bottom, and the forkedneſs of its main or tap root: the other by the ſlenderneſs of the neck, the fineneſs of the leaf, and the delicacy of the root. The former are unpalatable to cattle, and are therefore creative of waſte: The latter are unproductive, are difficult to be drawn, and do not throw out ſuch ample tops in the ſpring, as do thoſe which are, by conſtitution or habit, in a middle ſtate between theſe two extremes. There is not, however, any general rule reſpecting how many years turnips ought to be tranſplanted ſucceſſively, and how often they ought to be ſuffered to run up from the ſeed-bed: the ſoil and ſituation have, and other circumſtances may have, influence on the habit and conſtitution of vegetables as of animals; and the farmer muſt attend to the ſtate of the turnips themſelves. Whenever he judges, that, by repeated tranſplantation, they have paſſed the acme of perfection, then it is his duty and intereſt to let them run up to ſeed without tranſplantation. In Norfolk it has been found, by long experience, that tranſplanting two, three, or four years, and letting the plants run up the third, fourth, or fifth, will keep the ſtock in the deſired ſtate. The time of tranſplanting is from Old Chriſtmas to Old Candlemas. In the choice of plants, the farmer is not guided by ſize, but picks the cleaneſt plants without regard to ſize; or, more

Culture of particular Plants.

more accurately fpeaking, he makes choice of fuch as are near, but not at or above, the ftate of perfection. In almoft every turnip-field there are plants in various ftates: much judgment, therefore, is requifite in the choice of plants. A piece of good ground near a habitation is generally chofen for this purpofe; but the method of planting is various: the plants are generally fet in rows, at uncertain diftances from one another." Thefe diftances the fame author has obferved to be 16 or 18 inches, and the diftance of the plants in them nine or ten inches; but the practice of a man who, he tells us, is indifputably near the head of his profeffion, is to plant them in rows two feet afunder, the plants in the rows being contiguous. The only culture required, is to keep the intervals clean hoed; but when the feed begins to ripen, much care is requifite to keep it from birds. If the plot be large, it is neceffary to employ a boy to fcare them; but if it be fmall, and near the houfe, Mr Marfhal has known the following expedient ufed with fuccefs. "On a flender poft, rifing in the midft of the patch of feed, was fixed a bell; from which a line paffed into the kitchen: in the moft frequented part of this hung the pull. Whoever paffed the pull rung the bell; fo that in a farm-houfe kitchen, where a miftrefs and two or three maids were fome of them almoft always on the foot, an inceffant peal was kept up; and the birds, having no refpite from alarm, forfook their prey."

Method of planting.

Method of fearing away birds.

Of drawing the turnips.

The time of drawing commences about Michaelmas, and continues until the plants be in blow. The procefs of drawing, he fays, "in fevere weather is an employment which nothing but cuftom could reconcile to thofe whofe lot it is to go through it, namely, ftout

lads

lads and youths; whose hands are frequently swelled until the joints are discernible only by the dimples they form;" nevertheless he never heard of any instance of bad effects from this circumstance. When the tops will bear it, their method of pulling is very expeditious: they pull with both hands at once; and having filled each hand, they bring the two together with a smart blow to disengage the soil from the roots, and with the same motion throw them into the cart. If the tops be cut off by the frost, or if this be in the ground, the turnips are raised with two-tined forks named *crooms*. If the roots are buried under deep snow, it is removed by means of an implement called the *snow-sledge*. This consists of three deal-boards from one to two inches thick, 10 or 12 inches deep, and from seven to nine feet long, set upon their edges in the form of an equilateral triangle, and strongly united with nails or straps of iron at the angles; at one of which is fastened, by means of a double strap, a hook or an eye, to fasten the horses to. This being drawn over a piece of turnips covered with snow, forces up the latter into a ridge on each side, while between the ridges a stripe of turnips is left bare, without having received any material injury from the operation. Though it is customary, in drawing, to clear the ground entirely, our author met with one instance in which the small ones were left by a very good husbandman on the ground, both to increase in size, and to throw out tops in the spring; it being observable, that a small turnip sends up a top nearly equal to one whose bulb is larger. There is one inconvenience, however, arising from this practice: the plough is prevented from entering upon the soil until late in the spring; which

upon

Culture of particular Plants.

Snow-sledge described.

Culture of particular Plants.

upon ſome ſoils is an unſurmountable objection; though it may be very proper upon land which will bring good barley with one ploughing after turnips.

Mr Marſhal relates the following ſimple method, by which a Norfolk farmer preſerved turnips through a conſiderable part of the winter ſeaſon. Having cut off their tops with a ſpade, he gave them to his cows, and carried the bulbs to a new-made ditch, into which he threw them, and then covered them up with ſtraw, laying over it a quantity of bramble kids. Here they lay until wanted in a froſt. They were then again carted by means of a fork, and given to the cattle, who ate them as well, or rather better than freſh drawn turnips; and in general they came out as freſh as they went in. Our author is of opinion, that this method might be extended to the preſervation of turnips till the ſpring.

END OF VOLUME FIRST.

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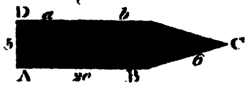
Plate I.

Fig. 1.



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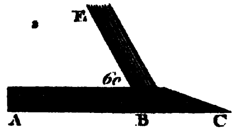
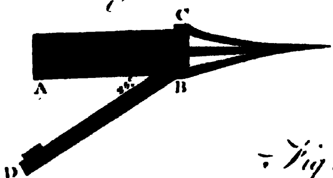


Fig. 3.

Fig. 4.



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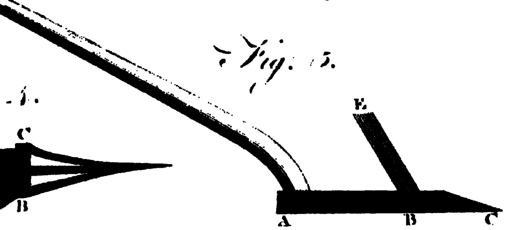

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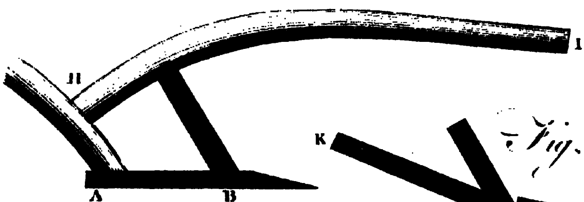

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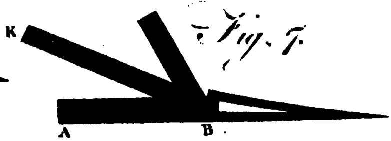

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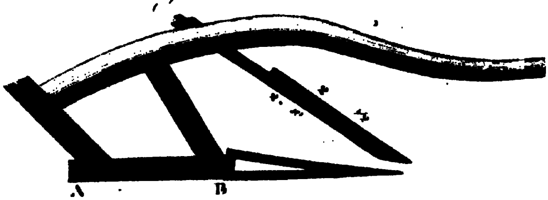

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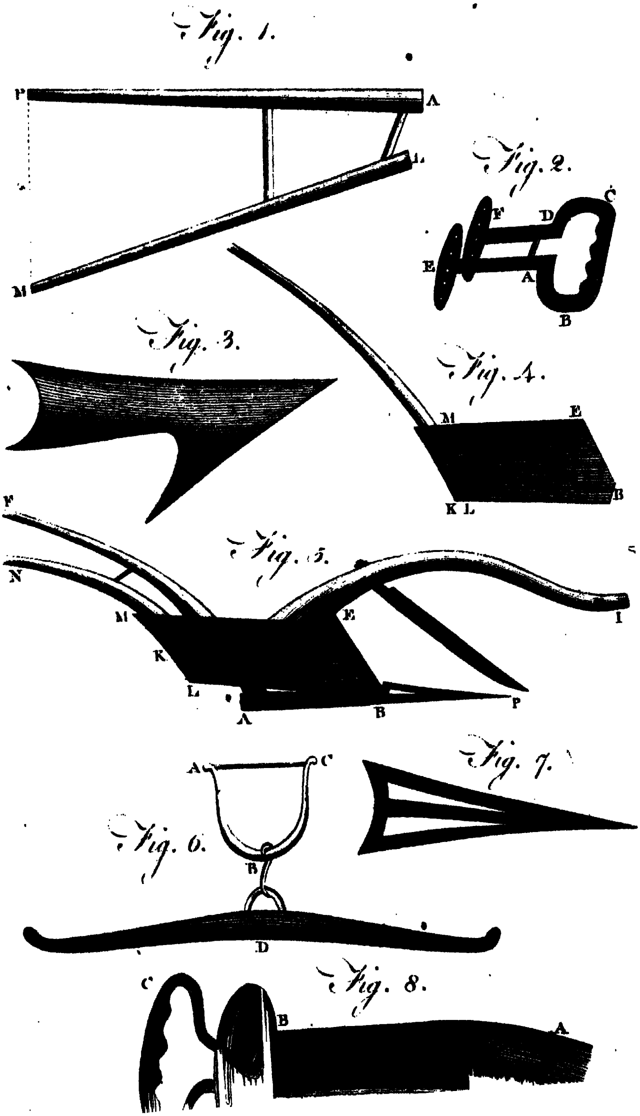
Fig. 1.
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Fig. 6.
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Fig. 7.
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Fig. 8.
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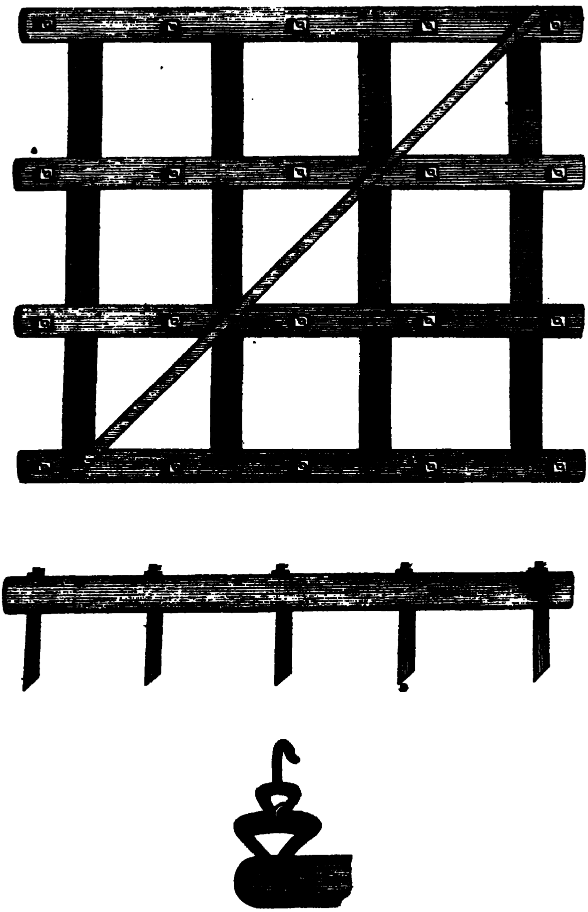
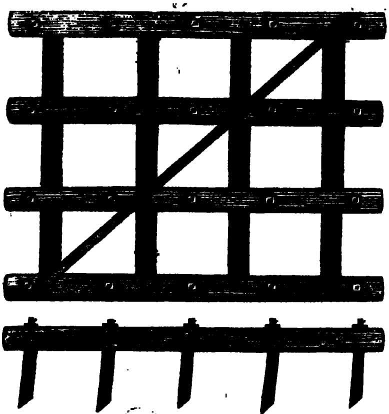
Fig. 1.

Fig. 2.





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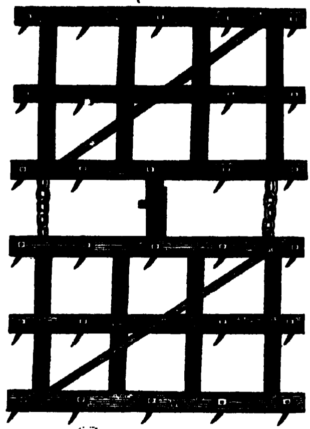

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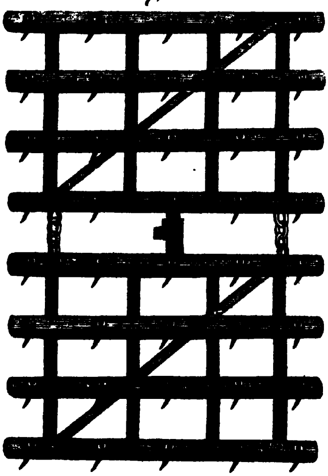

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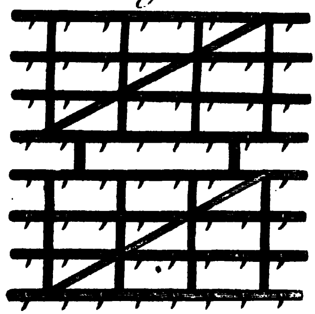

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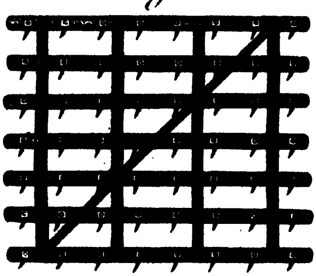

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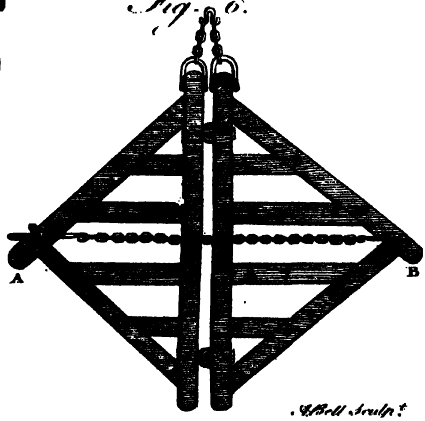

A. Bell Sculp.t

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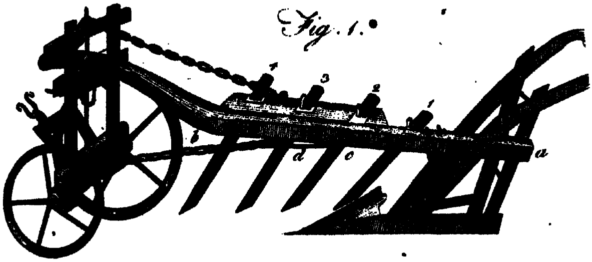

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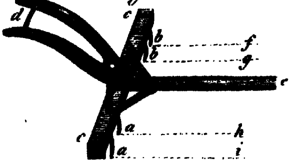

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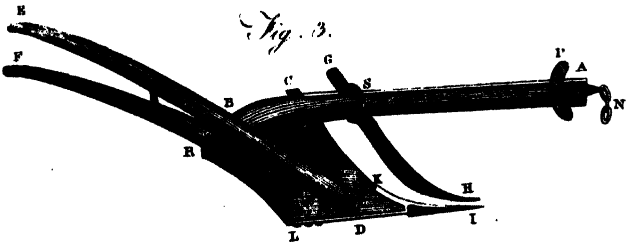

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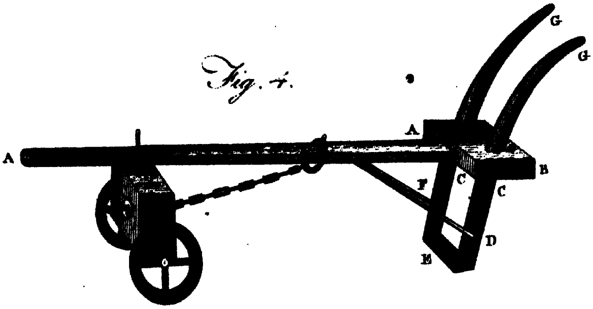

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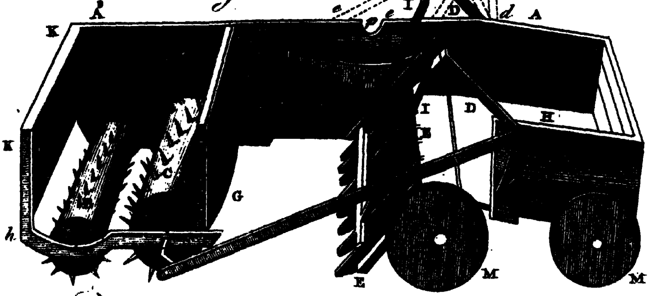

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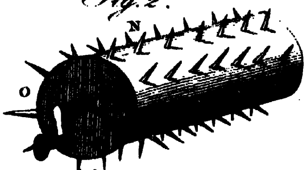

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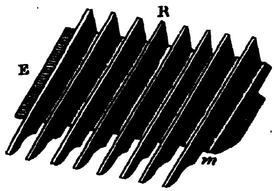

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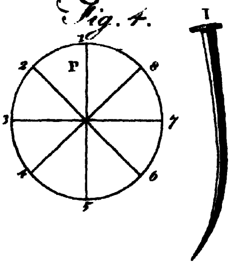

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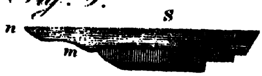

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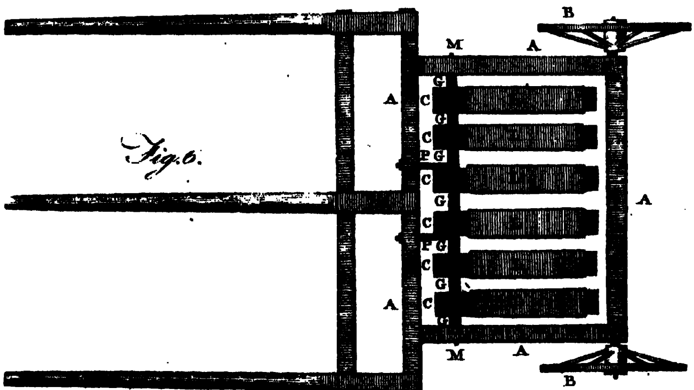

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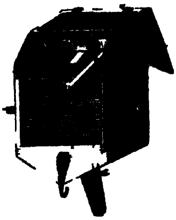

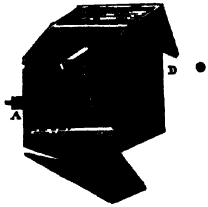

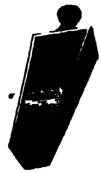

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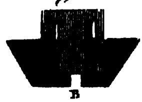

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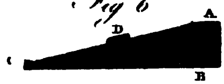

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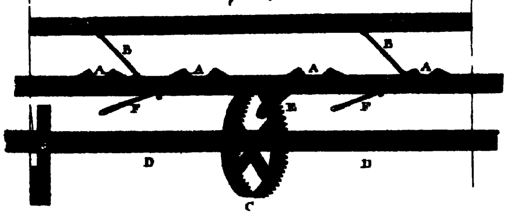

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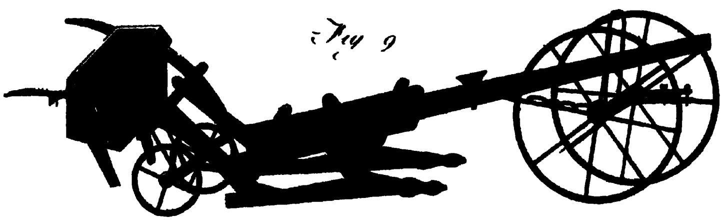

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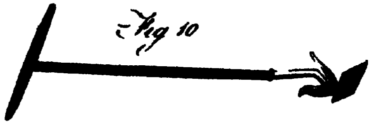

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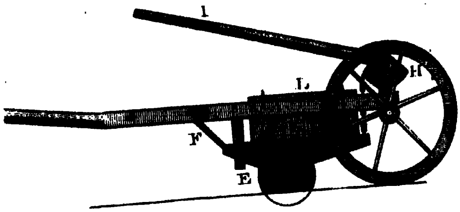

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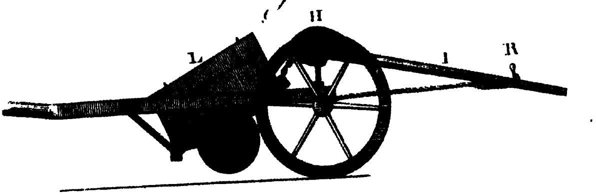

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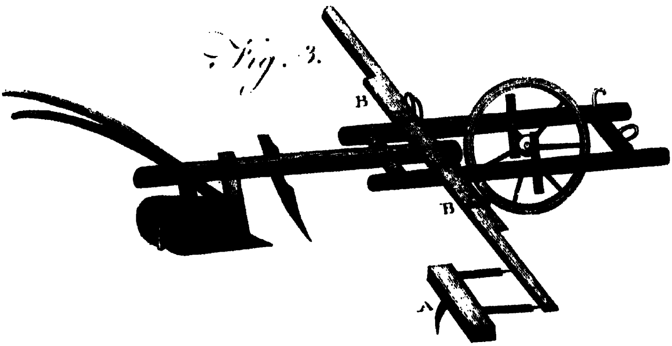

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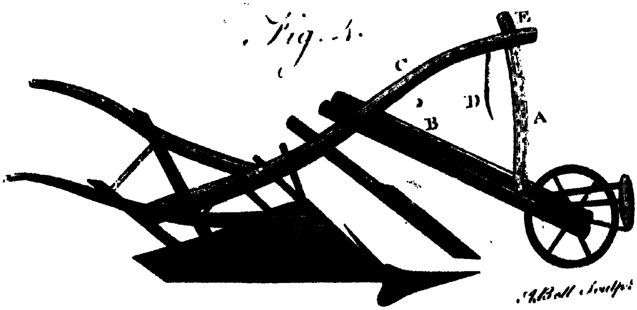
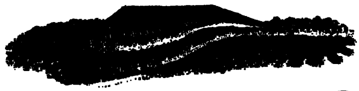


A. Bell Sculpt.

Fig. 1.

Fig. 2.



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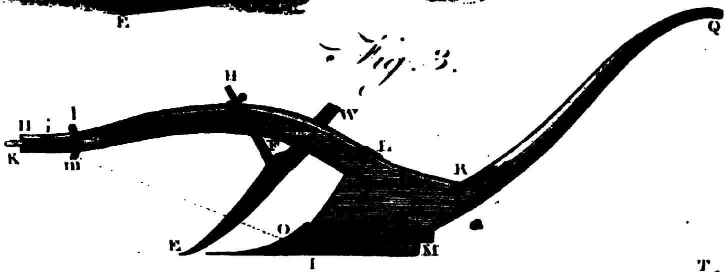
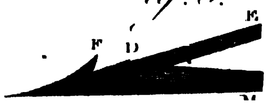


Fig. 4.

Scale of Feet.

Fig. 5.

Fig. 6.



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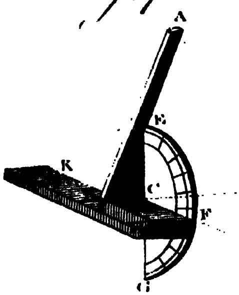

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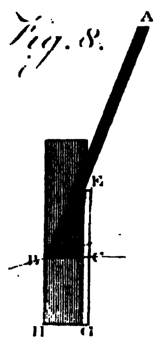

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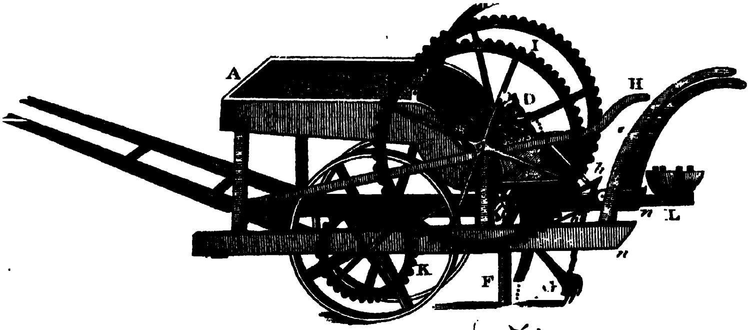

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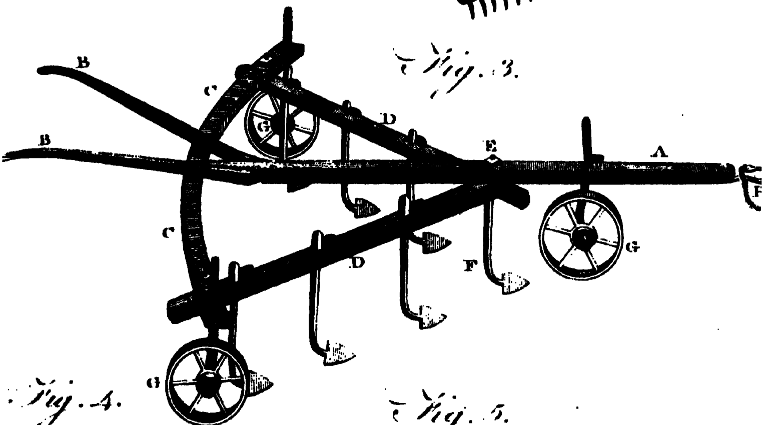

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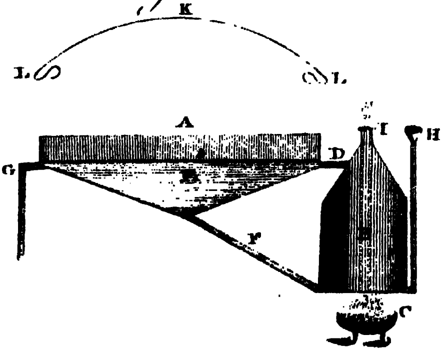

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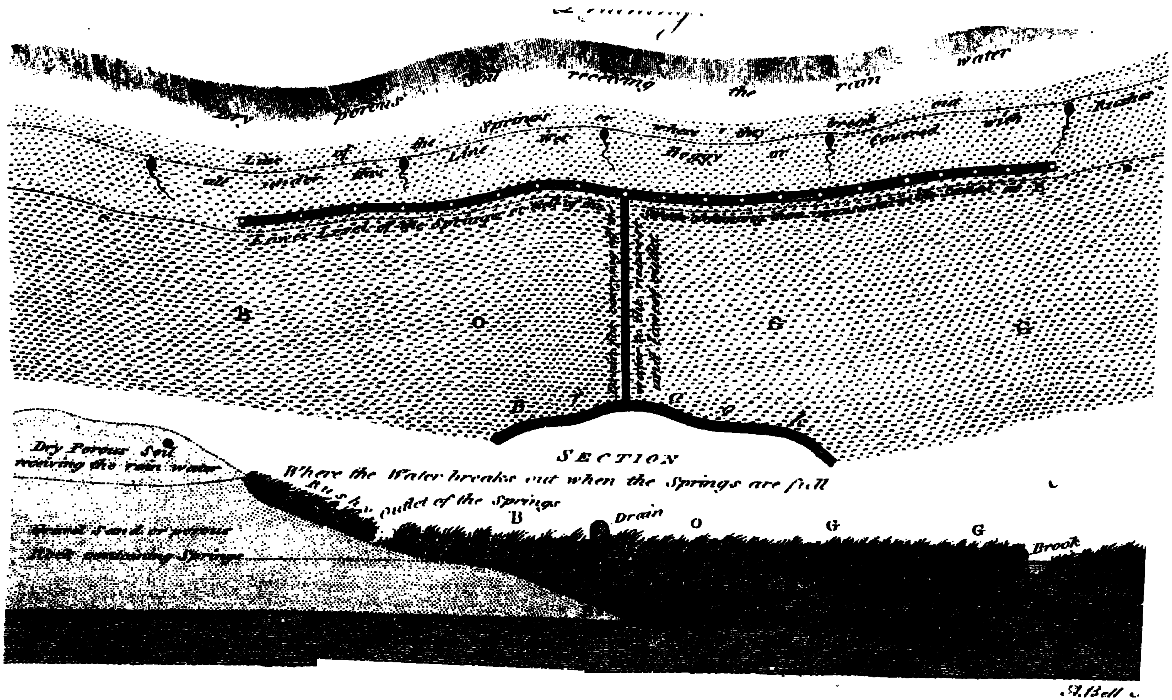
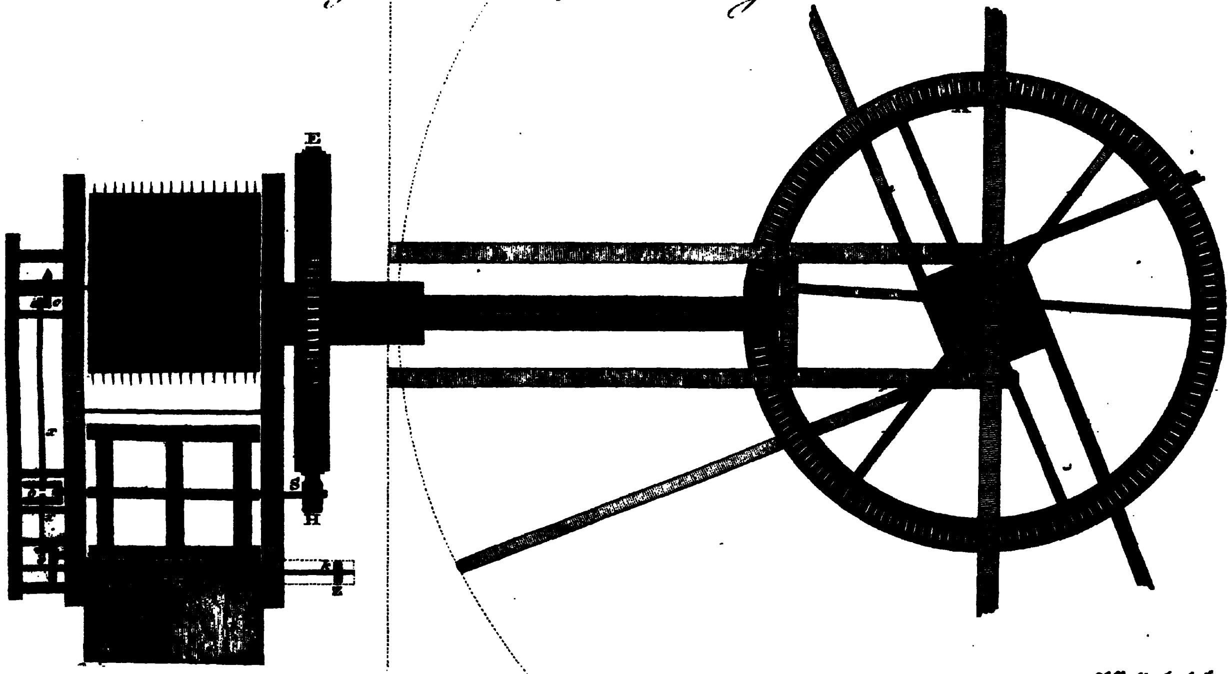

Dry porous Soil receiving the rain water
Line of the Springs or where they break out with Rushes
all under this Line Wet Boggy or Covered
Lower Level of the Springs
SECTION
Where the Water breaks out when the Springs are full
Rushy outlet of the Springs
Dry Porous Soil receiving the rain water
Drain
Brook
S. Bell

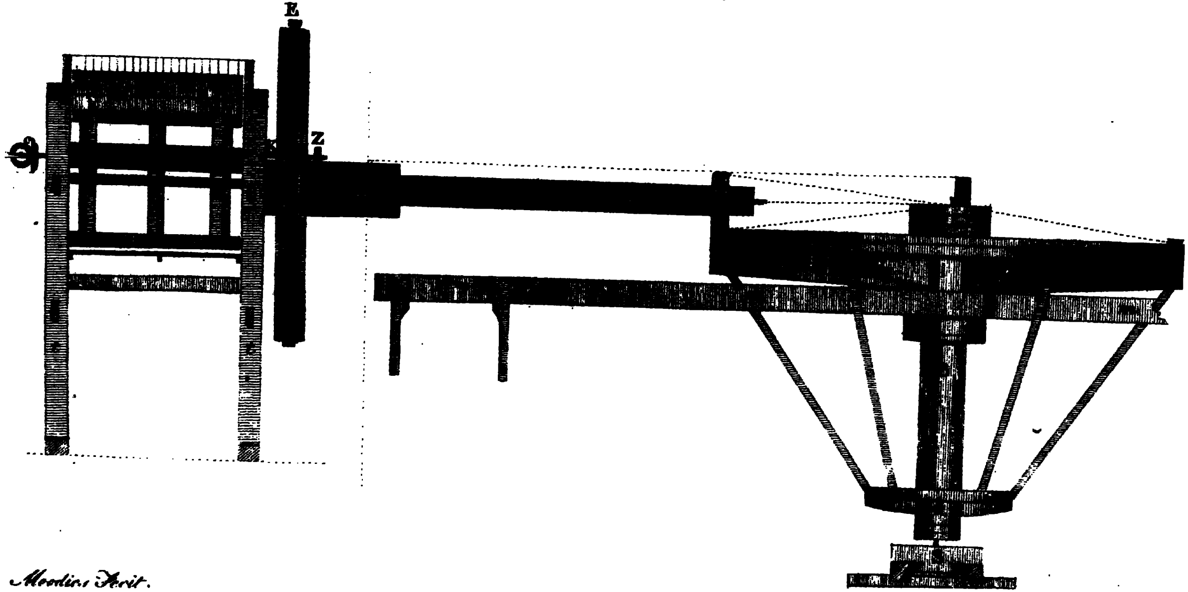
No. 1 Ground Plan of the Threshing Machine. Plate XVI.



A. Bell Sculpt.

Elavation of the Threshing Machine

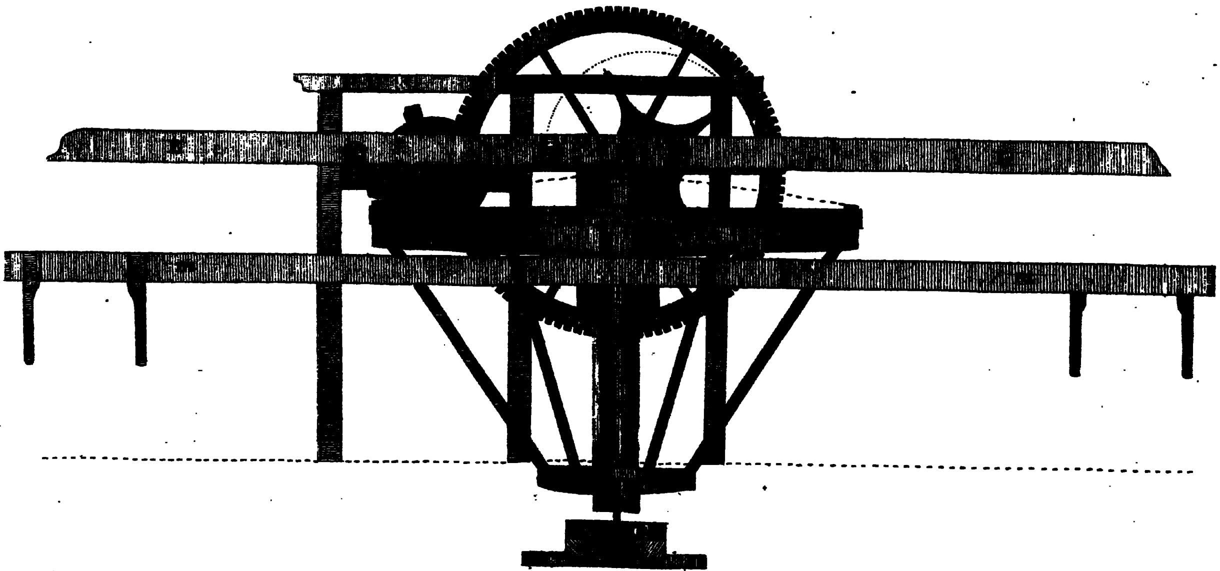
Plate XVII.



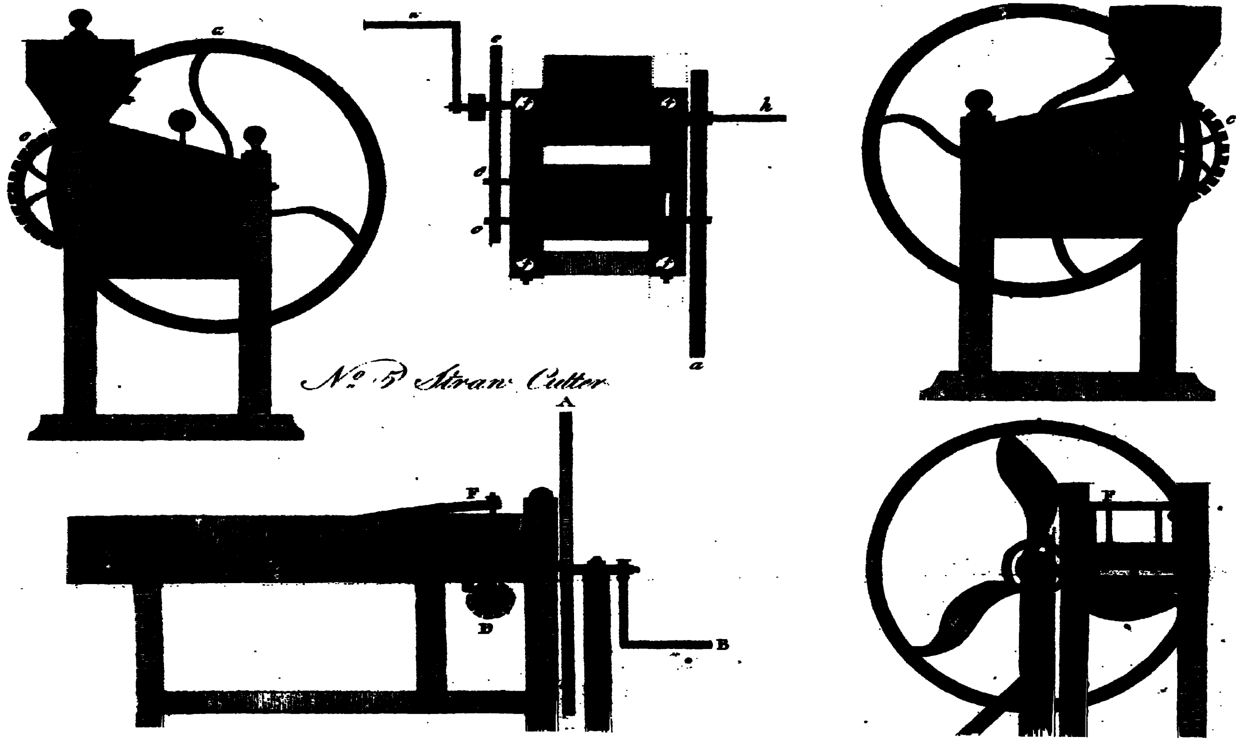
Moodie Fecit.

A Bell Sculp.t

No. 3) *End View of the Threshing Machine* **Plate XV**



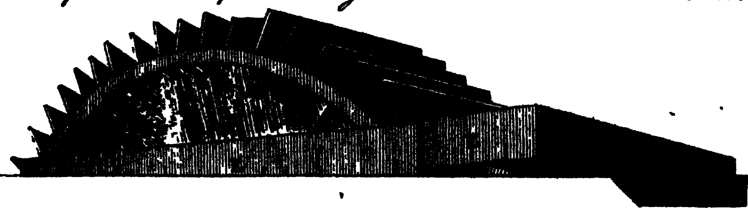
Mandins Fecit.   A Bell Sculp



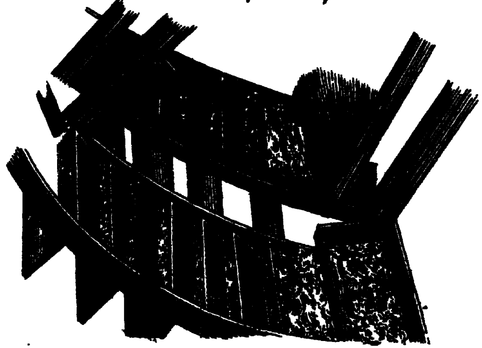
No. 5 Straw Cutter

Plate XXI.

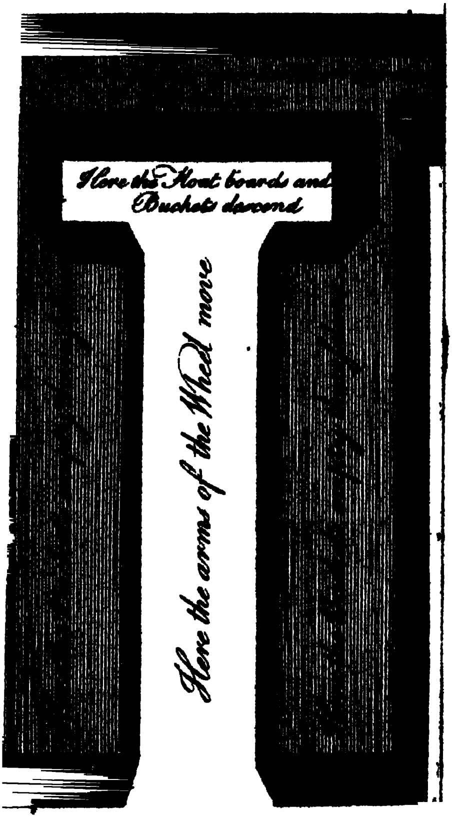
Sketch of the Wheel for raising Water at Blair Drummond



Sketch of the manner in which the Water is filled from the Troughs into the Buckets



A. Bell Sculp.


Here the Float boards and
Buckets descend
Here the arms of the Wheel move