A PRACTICAL TREATISE

ON

THE CULTURE

OF

SUGAR CANE,

AND

DISTILLATION OF RUM;

POINTING OUT

The most simple Process to be observed in their Manufacture,

AS SUCCESSFULLY PRACTISED IN

THE WEST INDIES.

WITH

SOME REMARKS ON THE CULTIVATION OF COTTON, &c.

Illustrated by Lithographic Plates.

BY

JOHN BELL.

Calcutta:

SOLD BY THE AUTHOR; AND BY MESSRS. THACKER AND CO.

1831.

To

JAMES YOUNG, Esq.

Sir,

In looking around, it puzzles me to find a Name, more intimately or dearly associated with the true basis of Commercial Prosperity, than that I now choose for my frontispiece.

That talent and perseverance may be rewarded, by the general advancement in India of every thing which tends to the greatness of a nation, is the sincere wish of

Sir,

Your most Obdt. Humble Servt.

JOHN BELL.

Calcutta, 30*th Sept*. 1[illegible]31.

DIRECTIONS FOR BINDING THE PLATES.

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Plate III.

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Plate IV.

Front view of the horizontal and vertical cattle mills, adapted to two yoke of oxen or mules.

N. B. Any inaccuracy of delineation in these plates must be charged on the ignorance of the Author, who has been tempted to give them, solely with a view to explain what probably would not be so easily understood by written *description.*

ADVERTISEMENT.

In presenting these pages to the Public, the practical experience of the Author is liable to question, when he presumes to treat upon a subject so different in its nature, from that which his present calling affords him opportunities of investigating. Suffice it, that the vicissitudes of life have their course; and that eleven years have now passed by since the effects of climate obliged him to quit the West Indies*, whence he dates his observations, confining them at present to what appears likely to attract the attention of agriculturalists in this country, viz. the *General Improvement of that grand Staple "Sugar;"* when the legislature shall think fit, to annul the unwholesome distinction in regard to duties, which has hitherto

* Tobago—
Permission is given Mr. John Bell, to depart the Island, he having complied with the act in such case made and provided.
Given under my hand, the Twenty-eighth day of April, 1820.
SAMUEL HALL,
Deputy Secretary.

kept in check all disposition towards equitable competition.

The original notes, made on the different plantations, where the Author served in the various grades, were unfortunately left with a relative in Cheltenham; and the want of such data has been felt, to render this essay perfect on many minute points, which memory fails to bring into view, and may be attributed by the reader to wilful neglect: but he prefers any defects to rest on this plea, rather than take a leaf from another book,—not a difficult task, considering the many publications that have issued from the press, bearing upon the same subject. But the Author's view at present is to offer, in a condensed shape, such practical information, as can only be found imbedded in voluminous and expensive works; and in which, the various notices are for the most part transcripts, dressed up in figurative language, to attract the ear, and mislead the understanding.

Many relations handed down in this manner, and received with unhesitating confidence from the respectability of their source, may, in the end, if efficiently analyzed, set forth a beautifully *finished* picture, covering the defects of inaccurate delineation. When we read of the test of a goldsmith, setting at naught, in the 15th century, the doctrines of such learned men as Hortius, Rullandus, Ingosterus, and Libavius, who had severally written a history on the supposed "golden tooth," which was said to have sprung from the gums of a child in Silesia, through divine instrumentality; and which, after the digestion of their elaborate disquisitions, proved to be but a bit of leaf gold, ingeniously applied to the natural tooth; we ought to guard against too solid a reliance on precepts, which are all liable to misconstruction, either from the manner in which they are delivered, or from a misconceived judgment of the writer, however well grounded his observations and inquiries.

The lapse of time which has gone by, since the Author left the scene of active operation, may tend to depreciate his essay; but it must be conceded, that notwithstanding, since that period, several scientific improvements have been proposed, in the method of boiling and curing Sugar, none of these patent inventions, appear to have been generally adopted in the West India Colonies, nor does it appear that the planter has deviated a tittle from the simple process which is laid down in this work.

It is therefore consigned to the public in nearly the same words, as the mind of the author dictated about eight years ago, when for amusement he compiled a copious MS. volume, treating upon all the products common to the West.

PREFACE.

The following short treatise is offered, not with a view to introduce prematurely the method of cultivation and manufacture adopted in the West Indies, but to contrast the practical parts of Agriculture which, in every country, are influenced, more or less, by prejudice and circumstances, and in no part of the world, perhaps, is the strength of hereditary opiniative ignorance to be found more permanently fixed than India.

The greatest advantages pointed out by the introduction of any new system, will scarcely be sufficient to plead for a native agriculturalist, any partial dereliction from the footsteps of his ancestors; and it is only through the united efforts of a Society, formed for the purpose of collecting information upon the practical results of different modes, pursued in different countries, and by a judicious dissemination of these, that we can ever hope to change, or be enabled to correct errors, which have obtained, in *this* country, for a long series of years, an almost unchangeable position, although powerfully counteracted of late by the efforts of the present Institution. This has already done much towards that end, and its unremitting exertions, it is confidently hoped, will eventually be crowned with complete success, by promoting a zest for individual skill, enterprize, and industry; since the period is fast approaching which may open a wider field for the free and unshackled range of private competition in *all* branches of Indian produce.

The present moment appears suitable to the introduction of a work, tending to promote inquiry into the most approved plans of culture and manufacture of an article, which has hitherto been *neglected* to an extent, in this country, palliated only by the difficulties thrown in the way towards a successful competition with England's more favored slave colonies in the West; but such unjust partiality, the offspring of legislative influence, cannot be expected to last for ever. Had the numerous petitions of our home Anti-slavery Societies, been anticipated by the legislature to their full extent, Great Britain, as most part of Europe would, ere this, have been compelled to draw on India for that grand staple, which a blind policy has attempted to crush.

Hampered by galling restrictions, it cannot be a matter of surprise, that British capital, skill, and industry, have been directed and confined to the *only* article—*Indigo;* which has been brought to the greatest pitch of excellence, and it is not going too far to hazard an opinion, that many other exportable products might have been long ago improved in an equal ratio.

The hope is at least worth cherishing. There is not a single production (Indigo excepted) which may not be improved by the aid of skill and industry, to a degree of excellence proportionate to the lamentable condition in which they have been nursed by ignorance and apathy.

It requires but little labour to shew, that a spur is all that is required to reverse the present state of things. With reference to the minor vegetable world, we have witnessed an almost incredible change in a very short space of time; and a climate long thought inimical to the productions of other countries, has been brought to yield vegetables, that would vie with the choicest of Covent Garden. And how, it may be asked, has this been brought about? Not by leaving things as they *were*, neither by coercion; but by example and encouragement.

If, therefore, in the more humble, although not less useful, walks of Horticulture, such an improvement has taken place, are we not fully warranted in the conviction, that similar happy results will arise, in every other branch, to which the stimulus of inciting beneficence may be extended?

Where is the country, on the face of the earth, whose fruits are left to nature, as in India? We cannot even tax those who are under the galling yoke of slavery with such indifference, as here prevails. If we turn our eyes towards the grounds allotted to negroes, in the West, for cultivation during their *leisure hours*, we behold, not indeed a regular nursery or garden, (each spot being cultivated according to the taste of its master,) but where every root and fruit which the soil is capable of nourishing, is seen in its greatest perfection, brought, as it were, into one focus, and by the aid alone of 12 hours labour out of 96; how much more then ought we not to expect from a people, whose hours are *wholly* their own, and whose livelihood is dependent on their agricultural exertions? But I must pause to recollect, that I am speaking of a nation proverbially indolent, and whose innate laziness is the offspring of the very soil, whose richness yields too bountiful a return, to the sparing hand of improvement.

That the present infantine and rude state of Indian agriculture, is wholly attributable to neglect, no one will attempt to deny; and it therefore only rests with those, who have it in their power to promote, to the utmost of their exertions, both individually and collectively, such objects as will conduce to that general improvement, which considering the natural capabilities of soil, and requisition for extension of exportable resources, is so urgently demanded.

To induce the natives to forsake the paths of ignorance, in which they have trodden for ages, requires a skilful direction. Premiums, indeed, are baits which elicit a certain degree of emulative competition; but when we regard the vast extent of country, with its thick set population, even in the Bengal presidency alone, the application of these means must be confined to the few who, by local and other advantages over their distant neig[illegible]ours, stand a double chance of success. It [illegible], that the promise of money is productive of [illegible] research, where a natural impulse is [illegible] wanting.

[illegible] this, we have a melancholy illustration in the avarice of the Spaniards; who, unable to withstand the temptation of a golden harvest, brought within view by the discovery of the New World, felt no compunction to leave their homes, expose themselves to the buffeting of a perilous ocean, and wade through cruelty and blood, in search of gold from the bowels of Mexico and Peru; exterminating, in their course, by deeds of the blackest perfidy, an unsuspecting people, who had received them with every demonstration of friendship. Such was the effect produced in the eyes of the Spaniards, by the glitter of artificial wealth; that, rather than lead on an unenlightened people by conciliatory address, and the aid of skilful art, to cultivate the more substantial resources under which the face of the country groaned, and which required the hand of industry alone to open living mines of more productive value, than all the hidden treasures that the mountains were supposed to possess, they turned their whole attention to conquest and plunder.

Touching the effect which money premiums held out in this country, by the Agricultural Society, may have, it remains at present conjectural, and any opinion advanced on the policy of such a step, would be premature, until the examination of parcels sent in by candidates in the course of next year, shall have taken place. There can, however, be but one mind as to its tendency to excite emulation, and there is hardly any thing which cannot be effected for the sake of possessing gold. On a recent occasion, in the midst of an assembly, I heard the Revd. Dr. Carey state in illustration, that a late respected member of the service had always a ripe mango at table on Christmas day, at the price of a gold mohur.

With respect, then, to the success of manufacturing strong-grained Muscovado sugar in Bengal, the idea which pervades the minds of sugar refiners and others, in England, that the country is incapable of producing such, is altogether erroneous. They imagine, that the soft clammy substance of the sugar is owing to the nature of the soil and climate, without reflecting, that prohibitory duties have hitherto shut out European skill and capital from producing sugar equal to any mad[illegible] in the West Indies. I have seen very recently a sample of Muscovado, sent up from Barripore, as the manufacture of Mr. Henley, which was, in my opinion, equal to any I had seen or made in the West; and sufficiently negatives the crude impression entertained at home of our inability to compe[illegible]ty.

Another local objection is offered, that trials have been made, and have been attended with loss. This fact is to be lamented, in as much that it may tend to repress more general application; but we must consider that the int[illegible]tion of new undertakings is not always accompanied by profit to those public-spirited individuals who first embark their capital and skill; yet that it is ultimately to the honor of their example, and unhappy failure, that others, upon their ruins, are enabled to erect the future prosperity of the grand design.

In this light, such individuals may be ranked with the undaunted volunteer, who, for his country's weal, steps first towards the scaling breach; content, that whatever the result, his name will be for ever associated with his country.

I do not mean to opine, that the same momentary enthusiasm seizes those who stand forward as practical advocates for improvement in commercial and agricultural pursuits: for few have the means to indulge in new chimeras, of what their imaginations conceive, would be successful inventions or improvements; and when their ideal speculations are laid before others for approbation and support, they are not unfrequently treated with contumely; and their only reward is in living to see others reaping the honors of what was due to them. Of this we have no mean example in the history of the great Genoese navigator, whose notions of the existence of another continent were scoffed at by kings; and the honor of whose subsequent discoveries was basely usurped by another, who did no more than follow his track.

Again, the few who possess the means to bring their ideas to maturity in practice, are *supposed* to be more scrupulous in the outlay; and that their ideas have been so completely argued in every possible bearing, that their plan of operations *cannot* fail to realize their most sanguine expectations; and here the fine distinction between theory and practice must obtrude, but seldom exhibits its deformity, until remedy is beyond reach, and the luckless originator is engulphed in difficulty, and falls an easy prey to the more crafty men of metal.

We have abundance of proof touching this melancholy fact; by adverting to the many who have, without due caution, embarked in planting in the West Indies, and where the issue of their calculations might be supposed less speculative, by being framed on a generally understood and well digested scale of expenditure and profit; in the face of all which they have been deceived and ruined. The *chief* cause of this has been an insufficient fund to embark upon. Thus the man, who is possessed of a little personal property, with a few favorable instances of affluent retirement before him, feels a propensity to engage in similar pursuits; and without weighing thoroughly the difficulties to be encountered, is tempted to make the purchase. He then finds, that to be enabled to carry on his operations on the grand scale proposed, he must have recourse to borrow, and in which he finds little difficulty; but the hand that is extending such encouragement is employed behind the curtain to undermine the unfortunate adventurer. It is well known, that the returns from a sugar plantation are slow, and insufficient in the offset to keep down the interest of the principal expended in its establishment.

Another advance is required, but disappointment at the issue, inability to meet further calls for support, or some other insurmountable pleas are set forth; and the golden prospects of the planter are betrayed, by these manœuvres, into the possession of his creditor, and the debtor falls a victim to his theoretical imprudence.

I would not be understood to uphold this fact as a *general* feature of the supporters of West Indian estates; for there are many instances on record, of agents being compelled to hamper themselves with unproductive concerns, and carry them on at their own risque, in hopes of retrieving the loss sustained, rather than sink the whole by abandonment.

I have thought proper to mention these circumstances, not with a view, uselessly to expose the measures of others; but to guard those in this country, who may be led away by too sanguine ideas of success, against the consequences, which must inevitably attend an immoderate scale of outlay. We must remember that by *economy* alone in manufacture, the natives of Bengal have been able hitherto to supply us with that description of sugar, whose depreciated qualities (owing to ignorance in treatment) have been translated at home into virtual incapacity; therefore, by the aid of better means and superior skill, our view is not only to improve *quality*, but to endeavour to make it even *cheaper* than at present.

This position may possibly be startling to some who have deemed such impracticable, and have contented themselves with the belief, that the superiority of their improved manufacturé, will amply make amends for large disbursements.

There is, however, no plausible reason, why under superior skill, and properly regulated economy, we should not be enabled to combine cheapness and improvement: for it is but natural to expect, that under the efficacy of equalized duties, cultivation in Bengal will keep pace with demand for the most profitable exportable products; and that the present cheapness of agricultural labour, will yield to its more general application, and universal distribution. Moreover, the great loss caused by the present rude method of partially, instead of wholly, inspissating the juice immediately after expression, will be removed, and the excess in *quantity* gained by the new method, would, with the preservation of feculencies, soon repay the expense of mills and buildings.

Lastly, we may conclude these general surmises with a firm hope, that (under an amelioration at least, if not total absence of all injudicious and oppressive restraints, which have tended most materially to discourage agricultural pursuits in India, especially as regards the article to which attention is now chiefly directed), we shall, in common with every country enjoying similar favour, successfully combat the ridiculous notions entertained, regarding our inability to compete with the productions of the West Indies and America. The idea is too absurd to receive a shadow of countenance, except from those who would gainsay their conviction for the purpose of effecting particular political objects, which might, after all, be grounded on questionable principles, and thereby retard, instead of encourage, the progress of commerce and agriculture. These would undoubtedly flourish, under the congenial influence of a wise administration, aided by the natural advantages which this country possesses, and the impulse given through the exigency of the times, and state of trade, consequent on a want of reciprocal resources, to improve those advantages which European skill and enterprize can alone bring to perfection: but it is evident, that unless every possible liberty be conceded to individual action, no such action can take place. In measuring the wisdom of such concession, there must be always a variety of jarring interests and opinions; but it is to be hoped, that the several petitions which have been transmitted to Parliament on this subject, supported by the opinions of such highly respectable and intelligent natives as Dwarkanauth Tagore and Rammohun Roy, in favor of a measure, which must bring with it an extension of agricultural labour, commensurate with the prosperity of British India, will not be addressed in vain.

SUGAR.

GENERAL MANAGEMENT

OF A WEST INDIA PLANTATION.

Before entering upon the detail of cultivating the cane, and manufacturing it into sugar, a few remarks on the general management of an estate, may not be out of place.

Proprietors themselves, for the most part, reside in England, entrusting their property to the care and controul of an *Attorney*, who is a person of tried repute, raised to that situation by regular gradation. This Attorney is not limited to one, but has frequently authority over several plantations, upon each of which is a *Manager*, at the disposal of whom again are placed two or more *Overseers*. An operative mechanic is also entertained, and a *Book-keeper*, but this last mentioned is not wholly employed by one proprietor; he divides his labours to the utmost of his ability; residing a few days, from time to time, upon each estate, from which he derives a stated salary*. In situations which command a short and easy communication between different estates, a Medical man has sufficient scope for the exercise of talent in his daily round to each; and there are few who do not possess a very handsome competency by these means.

The services of overseers are generally secured for a term of three or four years, by indentures, before leaving Britain, on very low salaries, seldom exceed-

* Or receives a stipulated sum for each Negro.

ing £40 sterling, and frequently not amounting to more than £25 per annum*. Next in gradation to the overseers, stand the "*drivers,*" *coopers*, *carpenters*, and *boilers*; who are the more intelligent and trust-worthy of the negroes; whose good services, aided by practical experience in their respective vocations, entitle them to this pre-eminence over their fellows.

Upon every well-regulated plantation, a register is kept, of the complement of slaves and free people of colour; with their names, age, country, and capacity. Another register is kept of dead-stock appertaining to the works; also the number of mules, horned cattle, sheep and swine; with their increase and decrease. A third journal is kept in the works, which sets forth the occupation of coopers, carpenters, &c. the quantity of sugar manufactured, the process and progress of charging the vats for distillation; the returns made in low wines, and proof spirit, &c.

A fourth diary is distinctly kept, called the "Field Journal," in which is noted every occurrence relating to field labour, and the various occupations of the different negro gangs, the number of cattle at work, &c.

The hospital, or sick house journal, attaches to the doctor, who enters the various diseases with which the patients are afflicted; when received and discharged; the births and mortality which take place, and so forth.

Duty of Manager.—The manager is required to frame the plan of operations, to direct generally the distribution of lands, the quantity to be tilled, what

* They live upon the estate, and have food, 'tis true, but the amount of salary is *barely* sufficient to find them in clothing. It must be remembered that they are exposed to *all* weathers; that articles of every description are exorbitant; and that they are paid in *produce*, which they are left to dispose of as they best can.

portion to be left in reserve, the time to cut the plant, what fields require weeding, to apportion the negro gangs according to their strength and ability, and finally, to prepare a full and just statement, (with attested copies of the several journals,) of work done, crop realized, disbursements made in produce to European assistants, outlay of shingles, staves, and other necessaries consumed throughout the season, and to indent for such as are required, together with stores of salt fish, beef and pork, wine, negro clothing, &c. These documents are made up annually, and sent to the attorney, who examines, and if approved, transmits them to the proprietor in England.

Duties of Field Overseer.—This person must be in the field by gun-fire, (sun-rise,) to call over the names of the negroes, which are written on the margin of a large board, with a line of holes opposite each, and as many pins as names. Absentees are thus noted, and if found frequently trespassing, without good cause, are punished at the end of a week, according to the extent of their offence, either by allotting extra work, while the others rest, or as the manager may direct*.

Work goes on until 9 A. M. when the labourers are allowed an hour for breakfast, and they either retire to their huts, or, being at a great distance, have it brought in clean calabashes†, by women or boys left for the purpose of cooking.

* I must here, in justice to those under whom I served my ordeal of overseership, observe, that the whip, (about which so much has been said at home,) was never used, except in a few instances of severe necessity; and from what I know, from actual observation, of the character of the negroes in their *present state*, I feel satisfied, that to take the power of using the whip entirely from the whites, would be to seal their death warrant.

† A species of Gourd.

At 12 o'clock, they are all again summoned, by the blowing of a shell, to leave off work, and have a respite for dinner until half past one. Work is then resumed until 6 P. M. and each is expected to bring home a bundle of guinea grass.

At 7 o'clock, the overseer again calls over the names of field negroes, who stand in front of their respective grass bundles. Those who are too lazy to cut their portion, or plead no good excuse, are required to bring two the following day*.

The grass is then distributed throughout the various mule and cattle pens, and all retire to their cabins to spend the night as they think fit; and none but an eye-witness would credit the gay, and I might add contentedly happy scenes, which prevail throughout their clean though humble habitations, after this hour; could we only divest our feelings of the odium accompanying the term " slave," which however disconsonant to the ear of every Christian, is nevertheless so distorted and exaggerated, as to leave the mind in doubt, when we apply it visibly. Nor would any man, who had ever crossed the Atlantic, and viewed the comparatively happy state in which these unfortunate creatures move, wish to see emancipation take place, but under the most cautious and timely measures; nor until their minds, by education, have been prepared to undergo so severe a trial of change; for until this new man is created, it would be as easy to change the leopard's spots as expect an enfranchised negro, in his present state, to work for hire. It would be to turn loose a wild beast, that had been caged, and fostered for a time, into a wilderness, beside his keeper, without food—but this digression is uncalled for, and might lead to irrelevant argument.

* Some managers deprive them of their daily allowance of rum, or if women, their allowance of sugar; but I adopted the above method, and found it have the most salutary effect.

Overseer of the Works.—It is necessary that an overseer be placed in charge of the works, whose duty is, to see them kept in proper order, and repair; and as the success of good yielding depends much upon cleanliness, too much attention cannot be bestowed. Thus the mill rollers, through which the canes pass, the bed, the wooden ducts which convey the juice to the receiver, that vessel itself, and every other used in manufacture, should be daily scoured with ashes, or lime water, during crop, in order to correct the acidity too apt to be imbibed. Out of crop it is enough to give them a layer of lime.

The coopers and carpenters are placed at the disposal of their overseer, and employed daily in the construction of hogsheads and puncheons, in repairing vats, mill, &c.

CLIMATE.

We can arrive at no just conclusion by contrasting the modes of conducting agriculture in different parts of the globe, without at the same time a general reference to climate, which, in the West Indies, may be said to constitute four seasons, though of very unequal proportions.

1st. The spring is ushered in during the month of May, by almost daily refreshing showers, which bring out a bright coat of the most luxuriant verdure; these first partial rains seldom last beyond a fortnight, when the atmosphere becomes tranquil, and hails the approach of summer, which without a cloud intervening to obstruct the beautiful serenity, remains in this fixed state, (the heat* only fanned by the prevailing south-east wind, which regularly sets in about 10 in the morning, and dies with the setting

* The Thermometer then ranging from 75° to 80°, sometimes rising to 85°.

sun,) until the middle of August, when the sea breeze becomes irregular; the heat during the day oppressive; the nights sultry, and rendered irksome by the constant buzz of myriads of insects, and harsh monotony of the crapaud tribe; the thermometer at intervals rising to 90°.

3d. The autumnal rains commence about the 1st of October, and in their continued and disastrous fall, sweep mould, cane pieces, and trees, from the vast heights, blocking up every vestige of road and pathway round their base. Streams which in the morning might be stepped over, are in the space of one day converted into unfordable torrents.

Towards the middle of November, the force of the current is broken, and the improvement which takes place in December, admits of preparation to take off the sugar crop, and may be termed the 4th season, which is cool, and delightful until May. This is the most joyful season in the West Indies. Nothing is to be seen but industry in its fullest developement, harmoniously maintained by the cheerful songs of the negroes.

SOIL.

The soil of the West Indies is, in general, extremely fertile; and although during the season of drought, the sun's influence is severely felt, yet by the dense fogs that overhang and envelope the heights at nightfall, added to the thick foliage of trees, underwood, and fields of sugarcane, a constant and grateful moisture is retained*.

* In proof of this, it is only necessary to notice, that the "Land Crab" may be traced, (notwithstanding its annual visit to the seaside, for the purpose of spawning,) from the shore to the summits of the most central mountains, at all seasons; and it is well known that this animal cannot exist without water.

Although the nature of the soil varies considerably throughout these islands, it may be very properly classed under four denominations:—1st. That which predominates, is termed *brick-mould*, composed of sand and clay, of a nutbrown colour; and notwithstanding it exhibits a dry superficies, at an earlier period than others, the substratum is always moist, and it has the advantage of being more easily worked.—2d. The deep "black mould" is also well adapted to the growth of sugarcane; but being, for the most part, the basis of low plains, is found too retentive of water to produce a rich, although more luxuriant plant: nor is the sugar from such lands capable of being thoroughly cured; for as the cane is watery, and never attains the same degree of ripeness, the juice requires more than usual ebullition, the tempering virtue becomes weakened, or by a superabundant addition of alkali, the molasses never separate freely from the saccharine particles.—3d. In many parts, a red or bright brown soil exists, which, in the rainy season, imparts to every object in contact, a deep yellow colour, resembling paint.—4th. Another description is found of limestone, upon a stratum of white marle, which throws out a lively vegetation, but not so rich a cane as No. 3.

LANDS.

Of the best Method of Distribution and Tillage.

A systematic planter will have his estate always under a division of four equal parts, as nearly as possible.

1st. In woodland and bush.

2nd. In fallow, reserved for a second ploughing or holeing, with 60 acres guinea grass.

3rd. In plants.

4th. In rattoons;—

and no inducement will lead him to break in upon this order, save an actual failure in his crop, from blast, or other unforeseen calamity.

Some young managers, zealous of outstripping their neighbours, and to evince their desire to make a good appearance, promote an excessive and irregular cultivation, without reflecting that the same negroes and cattle are limited to take it off, the same mill or mills to grind it, the same number of coppers to evaporate the liquor, and the same number of coopers to make up hogsheads for its reception, as for a well apportioned crop. The effects of this system are, the destruction of valuable cattle, a double number of disabled negroes returned to the sick-house, the probable loss of cane, which frequently cannot be cut in time, or being cut, cannot be conveyed from the field, owing to these and other causes. These facts point out the necessity of applying the end to the means, and of limiting cultivation to the natural capability of an estate.

Lands intended for the reception of cane, ought to be chosen new; and those woodlands most free from the growth of large timber, are preferable, as the labour required in cutting and stunting such, is great. New woodlands are better adapted to sugar cultivation, in consequence of the rich and grateful vegetable deposit, left by fallen leaves, and decay of perennial underwood. The land is then thoroughly cleared of bush, leaving it conveniently laid out in rows for a few days to dry, when it is easily consumed by setting fire to it in different places, about sunset; after which, any of the larger roots may be taken up, by running a plough through it, if on plain; but if on high or uneven ground, extraction by the hoe must be resorted to.

On plains, the plough is sometimes introduced, but only as a preliminary measure to loosen the mould, and as a relief to the Negroes, preparatory to holing; and it is on such plains alone that *draining* is requisite, as in ridge holing on hilly ground the water finds its way spontaneously without detriment to the plant.

OF LAYING OUT, AND HOLING LANDS.

In bringing high lands (hills) under cultivation, it is usual to commence at the top, and as there are few of any great circumference possessing unexceptionable soil throughout, that of least worth is reserved for the growth of hard timbers, which come into use in the erection and repairs of works. Leaving therefore the summit in its original state, as a protection to the land below, from the force of the rains, line off that portion intended for planting, so as to run parallel with the base, intersecting it by angular paths in a zig-zag direction, for the convenience of travelling, and taking off crop.

On either high or level lands, the method of holing is the same, but ridge planting is preferable, unless upon very rich lands, where the plant requires scope on all sides to throw out its lateral shoots.

I have already stated, that lands intended for cultivation, ought to be cleared of all underwood and weeds, and that the plough run through it once or twice, affords very great relief to after-labour. This should be done in May, and the ground, thus partially pulverized, allowed to remain in fallow against autumn, when the negroes will hole almost double the quantity than if stiff and unbroken. That portion intended for immediate planting, is divided into plots of twenty-five acres by pathways, for the convenience of bringing off the cane when cut, as also to preserve regularity in holing, which is done by subdividing these plots into squares: thus, with a line knotted at intervals, mark off with pegs a straight line, distant four feet from the margin; again from the line given, draw another equidistant parallel, and so on, until you arrive at the opposite margin. Then by intersecting these lines, your plot will be ready for the hoe, which is best done by arranging the negroes along the first marginal line, and allotting one square to each. The females ought to be ranged along the opposite margin, or on a distinct plot, as they cannot keep up with the males, and it is only by a well-equalized distribution of labour that any degree of emulative regularity in holing can be maintained.

The first range of holes being completed, the negroes retreat, and dig out the second line of holes, and so on. The dimensions of these vary according to the soil, and ideas of planters; but they, in general, average eight inches in depth, three feet in width, at top, diminishing by slope to 14 inches at bottom*.

Ridge holing is performed precisely on the same plan, with this difference, that it does not require such niceness in the formation of banks, and is, upon the whole, more easy, requiring no subdivision, and that the ridge in *single* stem planting may be three inches narrower.

OF PLANTING.

First, with respect to square-hole planting, much depends upon the description of cuttings; and on this point, I have heard various opinions advanced by different planters. Some contend, that the stem nearest the root, is best suited to become a plant, while others prefer the top cuttings. As far, however, as my judgment has led to any practical inference, I feel satisfied,

* By this mode of holing, labour may be computed at one acre per day, to 40 *able* negroes, provided the land has had the advantage of previous ploughing; if not, new clay soil will occupy from 60 to 70 negroes, to complete the same number of holes.

Plate 1.

fig 1

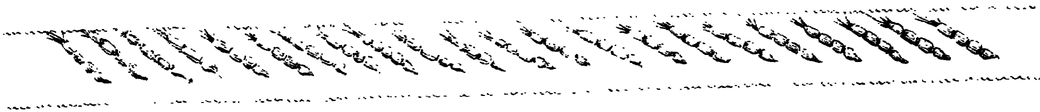
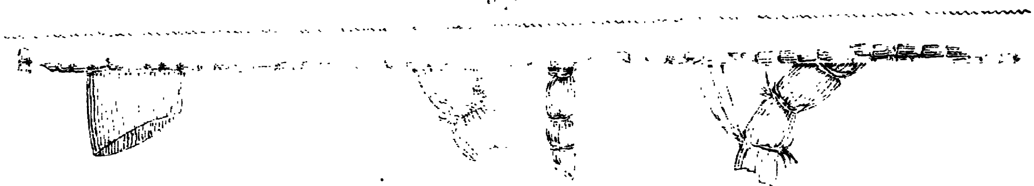


fig 2.



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that the preference of either depends greatly on the *soil* and *time* of planting. Thus, in heavy, moist, and very rich land, the under stem will be found more certain and productive, being less replete with *unripe* juice, and consequently less liable to rot, which is frequently the case with top plants, especially if much rain falls before the young shoots appear above ground. If the weather is favorable, and the soil not overcharged with moisture, top cuttings are unquestionably the best. Though of little use in manufacture by means of their watery consistence, they are applicable to the former purpose; and even under the disadvantage of bad weather and moisture, may be successfully used by taking the precaution of placing them in such a position in the ridge, that the upper extremity be not covered.

The same reasoning must determine the number of stems required for each hole, and their proximity to each other in the ridge or furrow; therefore, on very rich soil, with the advantage of *plant* cuttings, I consider two stems in length, proportionate to the width, sufficient, placed longitudinally; but if very old rattoons, or cuttings too near the top, from which few germs are likely to come, *four*, placed at equal distances from the sides, will not prove too many. The same caution is necessary in ridge-planting. If good healthy stems, they ought to be laid along the center of the furrow, in a direct line barely touching each other; if weak, or old rattoon plants, they must be laid against each other in a semi-double position, for it is more easy to thin a cane piece by lopping off all lateral shoots, after the parent stem begins to shew its joints, than to fill up gaps, the result of too thin planting, which cannot be done without disturbing the adjoining stocks, at all times detrimental. But this latter mode ought not to be pursued, excepting in light or impoverished soil, as thick planting on rich ground defeats the purpose, by the destruction of young shoots, which are either wholly choked, or run up into weak *suckers*.

The holes and ridges being planted according to the above directions, mould from the banks is drawn over them lightly with the hoe*. They generally break ground in twelve days, and the young shoots will shew a fine even line in three days more, if the stems have been carefully put in; but the reverse ought not to cause anxiety, as many plants will not stock before the end of the third, and often the fourth week; so that the first weeding may be gone through, after the shoots have attained the height of a few inches, bringing down with the hand a little mould about their roots, leaving unmolested the spaces caused by the non-appearance of shoots, when new plants must be brought to supply the place of the old stock, which will be found either rotten, or destroyed by grubs.

Time for Planting.—The proper season to put in slips, is from the first of August to the latter end of September, so that they may be ready for the mill about the middle of the second January †. Many planters, either from inefficiency, or not having their lands holed in time, postpone planting until October and November; but this plan can only be permitted by necessity, as they are thereby compelled to commence crop with unripe canes, or wait to begin at a period when they should be finishing.

A considerate manager, who has but a small complement of able labourers, will study to err on the right side, by getting as much land as he can well cultivate, under the hoe, immediately after crop; and if he cannot plant the *whole* before the 1st of October, allow the

* In dry weather, and on soil of the consistence of brick-mould, the stems ought to have full 2½ inches of mould; 1½ inches, if moist, and resting on manure.

† We are now speaking of plant canes.

remainder to fallow until January, when an early spring plant will answer well, and come in sufficiently ripe to close his crop in the following year. Again, rattoons from such canes as are planted in August or September, and cut in January or February, will be fit to cut in twelve months after*, and with which it is proper to commence the second year's crop, allowing the plant canes to follow up in succession.

The advantages which attend *regularity* in planting, are too evident to escape the attention of the least unthinking; and it has been proved by experience, that the best maxim, which can be deduced, is to begin *too soon*, rather than *too late*.

By attention to early planting too, it is in the power of the planter to controul his crop time. If he has a large portion of his cultivation in rattoons, he may retard, without injury, the young cane shoots, planted in August, by cutting them close over, in January following, so that they come in fully soon, to enable him to *finish* crop before the first rains set in.

On the other hand, late planting, either in autumn or spring, is the forerunner of many evils. It throws the crops out of place, and opens a door to all the disadvantages which I have already pointed out in treating of lands.

WEEDING AND HOEING.

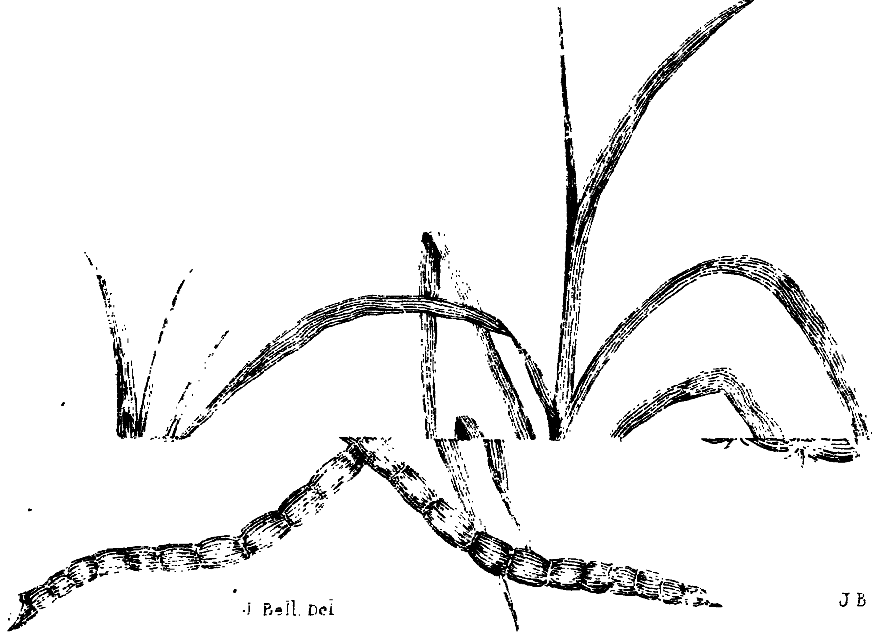
It has been already noticed, that the first weeding should take place as soon as the plant is a few inches above ground, and some mould from the bank carefully brought down about the roots. It is unnecessary

* Rattoons are the produce of the old stoles, after first cutting, which are termed 1st Rattoons; the 2nd year's growth 2nd Rattoons, and so on: and these, it is proper to observe, ripen sooner than plant canes,—few lands ought to yield longer than five years, when the land should be permitted to fallow in bush, keeping the old stocks or Rattoons for plants.

to state how often this ought to be repeated. Upon an estate of any magnitude, there are always hands unfit for other work, and they cannot be more judiciously employed than in constant weeding and moulding, until the cane shews its joint, and the field, by this work, has become level: hoeing must then be resorted to, and the *trash*, or falling leaves, as they decay from the cane, upwards, taken off and laid along the roots, which becoming soon incorporated with the mould, tend more effectually to nourish the plant; or if the land be sufficiently rich, such trash may be carried to the cattle pens.

This system of *trashing* the cane, has been deprecated by many well-informed planters, as the means of depriving it of due protection from the sun, and exposing the naked stem to the inclemency of season: but I am confirmed in opinion, that these are mistaken apprehensions; and even admitting them to be well grounded, must give way before the many mischievous effects, which neglect in trashing would produce; nay, further, that it is as essentially requisite to successful manufacture, and the prosperity of the cane itself, as all the weeding and hoeing, which I have described as imperative. It may be set forth in argument, that nature has provided the cane with this covering for its safeguard and nourishment, and on general principles such reasoning is applicable: but there are many instances, in which nature's functions must be assisted by art; and in no subject of Natural History, perhaps, more than the sugarcane. The first appearance of the plant is described by two small blades, like grass, from between which spring two more, and so on in regular succession, until the parent stem becomes independent of support towards the root, and shews its first joint, by throwing off the blades which gave it birth; thus the cane seeks its enlargement from a covering which has done its office, and now

Pl. II.



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becomes not only a burthen, but receptacle for water and animalculæ; thereby engendering a black viscid coat over the rind of the cane, which deteriorates the quality of the juice by admixture, to a great degree, in passing through the mill.

Secondly. An untrashed cane never attains the same degree of ripeness as when deprived of its superficial leaves, neither in this state can a cane-piece reap the desirable advantage of free circulation; and lastly, it is the only prospective means of keeping the cane free from its most destructive enemies, the borer, ant, and jumper.

It is needless here to enlarge upon this part of West Indian husbandry, as it can best be determined by experimental practice. What I have advanced in support of *trashing*, is the result of careful observation, during my services on a plantation, where I had an opportunity of seeing both methods in full operation, and where the advocate for the cane being left to nature as regarded the stem, could not, under the most favoured circumstances of superior works, bring his sugar to compete, either in colour or quality, although produced from the same soil.

From what I have said on this subject, however, I wish it to be clearly understood, that I do not recommend a free use of the pruning knife, nor that a leaf should be taken away before it is quite decayed. To do so, would be to injure the plant, by exposing the young germs prematurely to the action of the air, and throw back or destroy the circulation of the fluid; but a gradual trashing I consider indispensable.

If the influence of the sun be supposed too powerful for the top leaves, to shade and protect the stem naturally, let their extremities, at intervals, be tied or twisted together, so as to admit a person *stooping* to walk between the ridges, which will effectually shade, and at the same time support such as are top-heavy.

OF SUITABLE MANURE.

The vast difference in returns produced from lands of unequal quality, renders attention to their improvement a subject of importance. It is, however, a fact worthy of note, that in the West Indies, now-a-days, very little taste exists for experiment, and that too much reliance is placed on the natural fertility of the soil. This callous indifference can only be attributed to the absence of proprietors, who feel a real interest in the estate, and whose servants are paid to perform a certain routine of duty, without any advantage held out for furtherance of enterprize or skill. There are, doubtless, exceptions to this general imputation; but comparatively speaking, they are "few and far between." I do not speak from hearsay, having witnessed the superiority of a resident proprietor's plantation over others deprived of their watchful guardian; neither do I wish to infer, that the well-being of every estate is dependant upon such a measure: their presence can only be advantageous when accompanied by practical experience, and thus fitted to guide the reins.

I have known instances of educated and talented men, jumping into the possession of a plantation, by will or purchase, whose residence on the spot was productive of the most mischievous effects. Their constant anxiety about the negroes, and meddling interference in all matters connected with management, (about which they knew nothing,) destroyed all other authority, introducing discontent, with its distorting concomitants. Every petty pretext was an admission to the sick-house; the slightest deviation from theoretical direction was considered a breach of orders; the punishment of a negro was followed up by his immediate appeal to the grand master, and an eloquent reprimand was the manager's desert. Such a system reversed the order of things ; the manager became the slave, and the slave the manager.

I have deviated thus far from the present subject of enquiry, to shew, that the produce of an estate depends much upon the interest taken to improve its resources, and that a little attention to the best methods of manuring lands will, under the most reasonable expectation, reward the planter. He ought, therefore, to spare no pains in the collection of all refuse ingredients derivable from the boiling and still houses, carefully preserving, separately, the ashes of the cane trash, which are of great utility in helping to absorb superfluous moisture. The usual, and certainly most easy method of enriching soil, is performed by erecting temporary bamboo *pens*, on such sites as are intended for cultivation, into which the horned cattle are driven every evening. This mode of supplying dung is recommendable, so far as it saves carriage and fatigue at a time, when negroes and stock are, or ought to be, more usefully employed ; but the benefits afforded by satturation must be partial, and confined to spots where the *pens* have been placed.

There are some descriptions of soil which, although possessing all the properties of richness, are nevertheless charged with substances, which require counteraction, before they are in a fit state to receive the cane. Quick lime, or marle* will be found to destroy any acids or metallic salts that may abound.

In order to keep up a sufficient quantity of manure, weeds, field *trash*, and all substances convertible into mucilage, ought to be brought into heaps. And these, with such as I have already enumerated, added to the gleaning of mule *pens*, will be at all times acceptable, as available resources to the planter.

* Both quick lime and marle abound in almost every island.

METHOD OF MANURING LANDS.

The operations of *Manuring* and *Planting* ought to be conducted at the same time: thus a plot of ground being holed, let the manure be brought, (this work is suited to children,) as much as can be conveniently carried between the hands, to each hole, and the plants put in as I have before described, and covered with mould, thereby preventing the exhalation which would otherwise take place.

Crop Season.—The commencement of crop is regulated by the weather; if favorable, it is advisable to make a partial attempt about the 20th of December, in order to ascertain the efficiency of the mill, and all necessaries, towards the general crop. This precaution is highly proper, as in many instances, some parts of the machinery being found, after a long relay, defective, an opportunity is afforded for repair, without interrupting the variously regulated employment of men, women, and children, when once fairly begun. Secondly, a deficiency or total want of *Dunder**, (if none has been preserved from the former year's distillation,) being severely felt, a good day's work will remedy this evil, by yielding sufficient sweets, which, being mixed with water, and allowed to ferment, may be distilled, and thus supply the exigency of first charging the vats for the main purpose. Thirdly, a treat of sugar and rum is secured to the negroes against Christmas, when they are indulged with holidays, spent in banqueting and merriment.

A manager who consults the health and ease of his slaves and stock, will chuse for first cutting that portion of ripe cultivation nearest to his works; the prevailing moisture, and incessant tread of mules, bringing off the cane, soon rendering the paths al-

* *Dunder*, or lees, are the dregs of distillation.

most impassable. *Timing* the work of stock is also a desideratum.

As the cutting advances to distant lands, the soil acquires tenacity by the action of the air, and exposed exhalation, thereby lightening the difficulty to man as well as beast.

The cane is cut within an inch of the root, by a gang of able negroes. An after-gang bringing up the rear, who cut the fallen canes into convenient lengths, strip them of leaves, and pack them into bundles. With the tops are reserved a few joints, being too replete with watery juice to be available in manufacture; but serve every purpose for planting. Those not in requisition at an early stage of crop, are tied up and carried by the creole children to the mule pens, where they are laid along the mangers with a copious seasoning of salt*. The field is then cleared of trash, which I have before observed, serves as bedding to the cattle; if properly dried, it may be rendered a cheap and lasting thatch. The canes are then conveyed to the mill on mule back, where they are loosened, and carefully recleansed from all trash and impurities which may have been left. This is a point of no small importance, as the introduction of these into the mill causes the liquor immediately to ferment, and nine times out of ten spoils a whole skip of sugar, which is erroneously attributed to other causes.

Having now, to the best of my judgment and ability, gone through the various stages of field labour, it only remains to dispose of the roots† which

* Cattle and sheep exhibit, in a striking manner, their preference to sugarcane, or its leaves, by rejecting grass given at the same time. The salt, whilst acting medicinally in the correction of acidity in the cane, which, without it, is very apt to produce the "dry gripes," creates an appetite, and is extremely fattening.

† The root, or stump left in the soil, is called in the West Indies, "stole," or "stool."

have been left in the ground. The sap being at this stage thrown entirely into the root, young suckers are soon visible; therefore immediately after the canes have been cut, *mould* and *trash*, or dung should be brought up about the stools, to strengthen and nourish this *forced* vegetation. A second cleansing and effectual hoeing is all that is required to produce a good rattoon crop, which ought to be encouraged as far as consistent with the strength of soil; for although the rattoon does not yield the same *quantity* of juice as the plant cane, yet the *returns* fall very little short, requiring less boiling, because it is found to contain a less proportion of water and gum. I have seen the most flourishing rattoon pieces in some situations on the island of Tobago, which have been described to me as of *twenty year's standing* and upward; and from the respectability of my authority, I have no reason to doubt the fact.

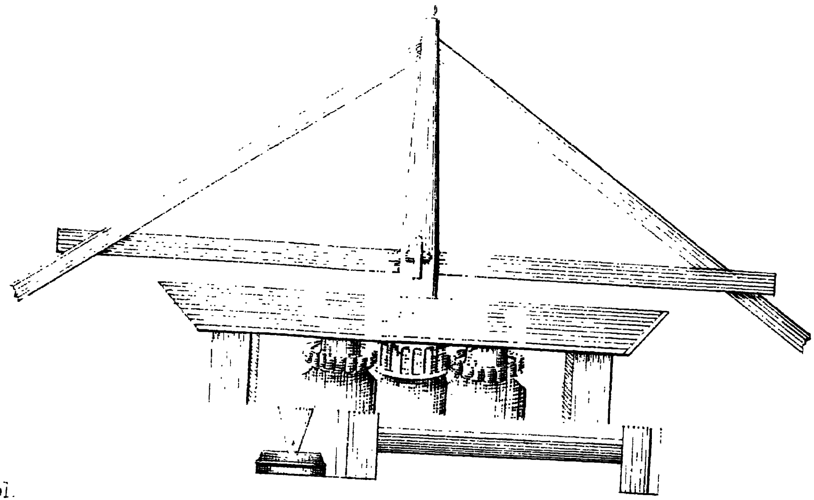
But I must here take leave of the field, and enter upon details of manufacture; without a knowledge of which the culture of the cane can be of little utility.

MANUFACTURE OF SUGAR.

The construction of a mill for grinding the cane, whether impelled by cattle, wind, or water, is in itself extremely simple, consisting of three vertical iron grooved cylinders. The power of motion is applied to the center roller, (in general from 3 to 4 inches less in diameter than the side ones,) and against which these latter revolve by cogs.

The cylinders are supported by pivots, working on steel steps. The main or center shaft, into which are introduced, (by means of a cross frame work,) the wooden cattle arms, should be of sufficient height to admit of the feeder, standing by the rollers.

Pl. IV.



J Bell del.

Horizontal Cattle Mill

J.B Tassin Lith.

The mill bed for the reception of the juice, as well as support of the rollers, is of cast iron, or the hardest wood procurable, lined with lead. The mill frame ought to consist of best seasoned timber, in the absence of cast iron, which is, of course, preferable. If a natural eminence can be conveniently chosen for the mill site, it ought to be embraced, as the duct for conveying the liquor thence to the boiling house will have the advantage of declivity; and in such case, the *receiver* should be *in* the boiling house, where the juice has time to settle, and may be let off by means of a small duct at once into the clarifier. On most estates, the receiver is close to the mill bed; but where the mill is hard by the boiling house, the former method is to be preferred.

Two oxen or mules being applied to each arm, the mill is set in motion, the feeder constantly putting in canes which are brought to him by the less bodily and creole negroes. The canes thus drawn in at the right of the center roller, are thrown back between it and the left, by a circular frame, expressing the whole of the juice contained in the cane; of which, by means of the first operation only, there would be a considerable quantity left.

The macerated remains are taken from the mill, by the persons employed to supply the feeder, and thrown into a heap, whence they are again lifted and laid in the sun to dry, and afterwards built into stacks, if not required for immediate fuel*.

As the juice of the cane, ought not to remain in the receiver longer than 15 minutes, owing to its tendency to ferment, the dimensions of that vessel, (which is of wood, lined with lead,) ought to be pro-

* Upon a well regulated plantation, this "*cane trash*," as it is termed, or "*megass*," is not only sufficient wholly to boil the sugar; but a considerable quantity built up in stacks like "hay," may be preserved to begin the succeeding year's manufacture.

portioned to the capacity of the clarifier, which is again proportioned to the capability of the mill or mills. Thus a cattle mill cannot be expected to express *more* than 500 gallons of juice in an hour, and on a general average, certainly not more than 400; therefore two mills being at work, the proceeds will authorize the clarifier to receive from 800 to 1000 gallons as the maximum. Under this arrangement, three more coppers, exclusive of the *teache*, will suffice: diminishing in size, from the first, or grand copper, down to the teache. I am now speaking of a moderately proportioned estate. There are many whose abilities considerably exceed this computation, and have a double range of coppers or boilers; in which case, there are *three* clarifiers in the center, with boilers on each side: but I proceed on the former scale.

The juice being drawn off by a cock, from the receiver into the clarifier, is heated to within a few degrees of ebullition, and tempered with quick lime*. In this interlude, a scum is thrown up, more or less impure, according to the quality of juice. It is not, however, taken off, but the damper being applied to the fire†, the liquor is allowed to remain until all feculencies are attracted to the surface, when it is let into the grand copper by means of a cock and duct, until within two inches of the bottom, which being composed of sunken scum, is thrown out into the reservoir.

The clarified liquor is allowed to boil in the largest copper, during which the scummer must be constantly at work. The brick stage upon which the coppers are hung, must be laid wholly with sheet lead, merging

* One-half pint of lime is ample to 100 gallons of liquor.

† The damper is an iron plate, sliding in a groove, which being pushed forward when required, extinguishes the fire.

to declivity between each, forming a sort of bason for the convenience of scumming.

These basons widen from a point, until the extreme sides represent the interior edge of a straight duct, which running along the whole length of the stage, carries the scummings into a large cistern.

When the liquor has been sufficiently reduced in quantity and consistence by evaporation in the first or grand boiler, so as conveniently to be contained in the second, it is laded into it, and undergoes the same process. If, however, the syrup at this stage of manufacture be not of a clear amber hue, it must have a small addition of *lime water*; which tends to retard the thickening, and admits of all remaining impurities being disengaged and thrown up. When sufficiently clear and condensed, it is laded from the 2nd to the 3d copper, and treated in the same manner, with this reservation, that no more alkali can be added without injurious tendency.

From the 3d copper to the last, (commonly called the *teache,)* the syrup is again laded; and this, it may be observed, is the crisis which demands the undivided attention of the planter.

The Overseer, who ought *never* to be out of the boiling house, whilst liquor is under evaporation, and when it arrives at this last stage, should be at the *teache*, to aid the boiler in determining the proper moment to apply the damper *. The syrup is then immediately struck into the coolers † by means of a movable duct thrown across from the *teache*, that the sugar may granulate in an even mass.

* The proper consistence of syrup is determined variously, but practice alone will make perfect. The negro judges by holding up his empty ladle, from which if the remains drop short and quick, it is time to skip.

† Of these, there are commonly from 4 to 6 wooden vessels, about 7 feet by 5, and 10 inches deep.

It is here suffered to cool, and with shovels is thrown in buckets, and carried to the *curing* house, where hogsheads are in readiness, placed upon a tier of beam work, under which is a deep wooden trough, merging into a small gutter at bottom, into which the molasses run from the hogshead, by means of holes pierced in the bottom, and into each of which is thrust the spongy stem of a plantain leaf. This gutter communicates its dripping contents to a deep cistern, which I shall hereafter have occasion to mention. The sugar thus *potted*, is allowed to remain curing for three weeks, or until the ships are ready to receive it, when the contents of each hogshead, are well beaten down with a wooden mallet, and the deficiency at top filled up from another barrel. The hogsheads are then headed for exportation.

Having now pointed out the most simple, usual, and economical method of manufacturing *muscovado* sugar, the work would be incomplete, without going into the details of disposing of all the feculencies, which form the basis of that highly esteemed spirit, usually sold in Great Britain, under the title of "*Jamaica Rum*;" more especially being called for in this place, to shew, that an individual entering upon such a field of agricultural speculation in other parts, will not only find the addition of a distillery to his sugar works an acquisition, but an indispensable and lucrative appendage; and that, if properly managed, the returns therefrom will nearly, if not wholly, meet the outlay of his annual cultivation.

It is worthy too of being kept in mind, that by having a distillery on the spot, not one *iota* of the cane is thrown away from the time of appearing above ground, until its ashes are taken to promote the growth of succeeding crops; but it would be labour lost to endeavour by written precept, to point out the many advantages possessed by a happy combination of the two great processes. Trial will best determine whether they can be separated without that shameful waste, *which* would *for* ever fix an *indelible* stigma on the most successful candidate in the list of rural economists.

DISTILLATION OF RUM.

Considering the simple means by which this wholesome spirit is obtained, every individual, who embarks in the cultivation of the cane, will find it to his advantage to possess some knowledge of absorbing the *dregs* of his sugar house.

· The magnitude of the stills must be in proportion to the ability of the estate; therefore I shall leave this computation, until the process of distilling has been explained. A tank should be built at the furthest end, *adjoining* the still house, for the immersion of the worms; and as the success of condensing the spirit depends upon the coolness of water, it is recommended to have a well at a convenient distance, sufficiently deep, to insure a constant supply, and by means of a covered brick duct communicating with the worm tank, to draw it up as required. In this case there must be a plug at the opposite side of the tank to let off the water; and a platform of wood thrown over the tank, more effectually to keep it cool.

The fermenting vats or cisterns, are placed in a double range, from one end of the still house to the other, divided by a wooden duct, for conveying the contents of each, as pumped off to the still; and their capacity must be proportioned to the contents of the largest still. Cisterns are preferred to vats, inasmuch that they are not so apt to leak, and do not require such frequent repairs; but in a climate, where the existence of white ants is found detrimental to the preservation of all work which is not exposed to daily examination, I would not hesitate to pronounce the vats preferable. Of these, the number varies ; from ten to fifteen may be considered a sufficient complement on a moderate plantation.

In addition to these, there ought to be at that end of the still house, which adjoins the sugar house, a large cistern, equal in size to the contents of four fermenting vats ; to receive the lees, or Dunder. All these vessels ought to be carefully scoured, against manufacture; and as the progress of fermentation at the first offset, is very slow, some megass ought to be burnt in each, which will season and bring them into proper working order.

As *lees* are indispensable in the distillation of Rum, and the want of them is severely felt at the beginning, I have, in a former page, suggested a remedy, by advising a trial of manufacture, before Christmas ; discouraging the method adopted by some planters, of reserving part of the former year's Dunder, which is apt, and in most instances does materially injure the flavour of the spirit.

As the use of lees is to promote fermentation, the quantity ought to be proportioned to the *nature* of the sweets, with which they are combined, and destined to act as a dissolvent. A careful Overseer will consult the *weather* also in charging his vats.

At the commencement of crop, when molasses are not to be had, the proportion of lees should be small. Thus, I would charge the vats with scummings 40 per cent.*, water 40 per cent. lees 20 per cent.

* Scummings, at first, are not so rich as in the middle of crop, when the cane has attained its full ripeness. Therefore, at this stage, *seven* gallons of scumming are not equal to more than *one* gallon of molasses.

2d. When molasses are procurable, let the charge be proportioned thus: scummings, lees, and water, of each *one-third*, adding 5 per cent. molasses; mix these well, and let the liquor stand until the following day, when from 2 to 5 per cent. more sweets may be thrown in.

3d. After crop, or when all the sugar has been boiled off, and a scarcity, or total want of scummings is felt, the distiller must have recourse solely to his molasses, and the proportion of lees must be increased with regard to the increased tenacity of the sweets. Therefore I would give; of *lees* and water, each an equal part, (or 40 per cent.) with 20 per cent. molasses.

At the commencement of this process, fermentation will not rise before full 40 hours, by means of the coolness of the still house, and unfriendly state of the vats; but when these impediments have been lessened, it will shew a head in half that time. As the liquor attains a greater degree of acidity, the thick dirty crust thrown up to the surface is seen disuniting, when it ought to be assisted by an open skimmer*. In accordance with the degree of fermentation first produced, will the contents be fit for distillation; thus, in the first instance, it will not have perfectly subsided before the end of ten days; but when the fermentation works rapidly, in half that period, which may be known by the general body becoming finer, throwing up only clear air bells. When this change takes place, let it rest undisturbed for four hours, before it is pumped into the still†. The lees must then be drawn off, and thrown into a cistern, and

* There is a natural species of sea weed, which, on being dried, answers this purpose. It resembles a large leaf, with the *fibres* only remaining.

† It is much the colour of unsettled beer at this stage, and has an agreeable flavour, acting as a wholesome and cooling alterative.

the empty vat well cleansed with warm and lime water, before it receives a second charge.

The fermented liquor being conveyed to the still, which is filled to *within eight inches* of the top*, when the head is well *luted*, and a steady slow fire kept up until it boils. The fire is then partially drawn, in order to allow the vapour gradually to condense, when it will be found shortly to force its way through the worm in a drippling rill, into the receiving *can*, augmenting to a crystal stream.

The two essential points to be kept in view, during the process of distilling are, 1st. strict attention to *luting* the head. This being done with *clay*, unless very carefully attended to, will admit of transpiration; to prevent which, is absolutely necessary both for safety and returns: for if the spirit be allowed to transpire through any interstice, however small, the consequences are frequently fatal to the person in attendance. In like manner as clay is tenacious of moisture, and cracks as heat augments; it requires *constant* watching, and frequent assistance to prevent these consequences.

2nd. The regulation of *heat*, which can only be determined by experience. The Overseer ought never to leave the still, unless relieved by an equally competent assistant; and as the fuel works upon the contents of the still, by listening attentively the degree of ebullition may be determined, and prompt means taken to draw or smother the heat, if too powerful; for unless this be adopted, the bottom of the still will get red hot, and by promoting too rapid a separation of the vapour from the ingredients at the bottom of the still, which become burnt, dispenses a disagreeable flavour to the spirit.

* This precaution is necessary to prevent the frequent mishap of the top flying.

The spirit obtained in this way, is called "low wines;" although some planters preserve the first runnings from the worm, separately, leaving only the last drawings under that denomination; but I conceive this to be an erroneous mode of proceeding; for although it is an easy operation to reduce all spirits above proof, to the proper standard, the *quality* must suffer by this partial method: and as these low wines are again thrown into a smaller still to undergo a second process, the spirit must be purer, and divested of that oily flavor, with which the first abounds.

In order, therefore, more effectually to produce rum of equal flavor, the whole of the runnings from the first still, without reference to strength, ought to be put into the second still; and the quantity of spirit which remains in the still, after the *high wines* have been drawn through the worm, should be reserved in a separate vessel till the end, and then rectified; or whilst the process of fermentation goes on in the vats, two gallons of this weak spirit, added to each, will improve and strengthen it for distillation.

The spirit is proved by the bubble, or in its absence, by olive oil, which will sink to the bottom, if "London proof."

Having now given a general idea of the manner in which Rum is distilled in the West Indies, it may be expected that I should lay down a scale, shewing the probable returns of a sugar plantation. This cannot, however, be done with any positive accuracy, for as the richness of the cane juice depends much upon the soil, and the quantity of sugar upon the richness of juice, so may the returns of 100 acres, upon choice soil, be to the returns of 200 acres, on inferior land. Again, as regards the quantity of labour, similar difficulties oppose the possibility of laying down any fixed rule; so much depends on the state of the weather, and nature of soil. But I conceive that if the soil has been previously loosened by the aid of ploughs, an able ñegro will, with great ease, dig 50 holes in a day, 4 feet by 4, thereby requiring the labour of 55 negroes to hole an acre. But the more accurately to determine the number of labourers required, having fixed upon the extent of land for cultivation, divide the number of feet contained in a square acre by the area of the cane hole, and the quotient shews the number of holes. Again, to ascertain what plants are required, multiply the number of holes in an acre, by the stems to be put into each.

An acre of good plant cane ought to produce two thousand gallons of juice. A single cattle mill, (on the most approved construction,) will not, on an average, express *more* than 450 gallons per hour; and this, reckoning the mill to be at work 9 clear hours, will give 4050 gallons of juice, which ought to yield 3580lbs. of muscovado sugar, equal to about two hogsheads of 16 cwt. each per day. This calculation pre-supposes the hogshead to absorb 2000 gallons of raw juice.

There are canes capable of yielding the same quantity of sugar, from a much less proportion of juice; and others again, so watery, as to require much more. That which is laid down, I consider a tolerably equitable medium.

The quantity of rum obtainable, is dependant on the ratio of sweets thrown off. Thus, on some estates, where the soil is heavy, and productive of watery plants, a greater quantity of sweets ensue by means of the longer process of clarifying and ebullition, which throws off a greater portion of scummings; frequently averaging 10 per cent. of the whole charge: and sugar from such liquor being difficult to cure, yields a greater quantity of molasses.

Should the manufacture of sugar conduce most to the advantage of a plantation, in the event of proportionately remunerating prices not being obtainable for rum, the scummings, instead of going towards the distillation, ought to be returned to the clarifier, as even by the most careful boilers, a large quantity of available sweets are thrown out with them, and will add considerably to sugar returns.

In the course of the preceding pages, I have confined my views of planting, manufacture, and distillation, to the long matured and simple methods pursued successfully in the colonies. It is natural however, to expect, that, as the progress of competition advances, the depreciation in price of an article, hitherto maintained solely by protecting duties, must take effect; and it requires the aid of inventive genius, to bring into action such resources, as will by economizing labour and improving quality, allow the manufacturer to uphold his station.

A question presents itself, as to the expediency of introducing prematurely into *this* country, the most recent improvements in the art of boiling and concentrating the juice; or, by following the track which has been successfully beaten in the West, gradually initiate the natives in that course, preparatory to a more scientific and complex method.

From the peculiar position of the colonists, and the advantage of long experience, it must be admitted, that they are better fitted to judge of the efficacy of new inventions; and that on trial, if found to offer encouragement, they would be as generally introduced, as the Otaheite cane was, when its superiority over the creole had been fully determined; and more especially since within the last ten years, they have been threatened, by an increase of stock in the home market, from the East Indies, to guard against which all their most powerful interests have been brought to bear. But, although such incentives, would have tempted the application of superior skill, independent [illegible] produce to the [illegible], we do not find, that the [illegible] patent inventions or improvements, which have been devised within that period, have discarded the use of older and less complicated machinery; and unless it can be satisfactorily shown, that, very great advantage is to accrue, a *practical* planter will hesitate to encumber his estate with what is foreign to his own, and the understanding of his negroes.

We are not only therefore to look at the outward construction, and its superior use when applied; we must consider whether we are so happily situated, as to command mechanical aid, at the moment required: for without that, the introduction of what cannot be immediately repaired or remedied, cannot be recommended. In Europe, where so many patents have been conferred, many scientific improvements have been effected in the art of refining sugar; and their benefits, if applied in the primary process of manufacture on the spot, would doubtless be conducive to general economy and good quality: but the absence of safety, not omitting expense attending most of these novel inventions, when consigned to the management of inexperienced overseers and negroes, must render their use partial, and their success questionable.

Under these circumstances, I would deem it advisable to follow the ordinary and simple process in this country, which has marked the rise of the West Indian colonies; refraining from all propensity to indulge in such experiments as will entail excessive cost, whilst their practical efficacy on an extensive scale still remains problematical*.

* The cultivation of Sugar in Bourbon has of late been greatly augmented; but the *newly improved* methods are understood to be too expensive, to overbalance the difference in quality.

We must first equal, and *then* endeavour to excel; as yet we have no real basis upon which to found improvement. The few isolated examples before us that the same quality of sugar can be manufactured from the growth of this climate, as the Muscovado of the West, are sufficient to encourage perseverance on a more extended scale; but by no means warrant a costly and speculative outlay, which has been the bane of individual enterprize hitherto. Both the cultivation of the cane, and its manufacture, in India, may be said to be unborn, or at most in their primitive infancy; for as the objections applicable to native manufacture must be removed, that system is to be rendered obsolete, to make room for a more skilful and effective process.

Again, as we know from recent experiments that the soil and climate are favorable to the *growth* of the Otaheitan cane; it remains to be determined by analysis, whether its saccharine qualities are proportioned to its bulk, and superior to the most favoured indigenous species.

With reference to the estimation in which it is held in the West Indies, we are led to hope that it will be equally so in the East.

The peculiar advantages which the Otaheitan cane possesses over every other description, are too manifest to be passed unnoticed by the most superficial observer. The graceful bend of the leaves, contrasted with the uniform straightness of the Creole and other sorts, distinguish, in an eminent degree, the difference of origin. The stem offers a pale inclining to straw colour, in opposition to the deep green and purple offspring of other parts, and retains this essential difference to the eye, in the juice, when expressed. Its produce may be calculated with safety to *double* that of any description of canes common to *this* country, in their *present* state.

It is found in the West Indies to withstand the effects of drought and vermin, whilst the less favoured kinds have been wholly destroyed.

On loose soil, exposed to solar influence, it comes to maturity in a much shorter space of time.

With these perfections in favor of the South Sea cane, its introduction here, ought to be hailed as a most valuable acquisition, if found to yield in proportion to promise.

As in every pursuit to which general attention is attracted, there is a diversity of opinion, respecting the best method of treating the subject, we shall proceed to make a few remarks on improvements that have been suggested in the art of manufacturing the best raw sugar, from the juice of the cane; leaving aside the branch of *refining*, which does not come within the limits of our present enquiry.

The construction of the mill is now nearly the same as when first used in the West Indies. The frame work, which formerly consisted of wood, has given place to cast iron: so also the cylinders, which were blocks of yellow heart, or other hard timber, cased with sheet iron, are now wholly cast; and some considerable improvements have been introduced, which have added to its general capability*.

The most simple and economical mill applicable *to this country*, is that worked by cattle.

The efficacy of steam, would at once condemn our recommendation of less powerful agency, could its introduction be effected on a proportionately moderate scale of expenditure; and where there is a command of cheap fuel.

Wind mills are at all times precarious, and cannot be available in India. We are therefore confined to

* The cast iron frame work is not generally introduced, nor is it likely to be in these times, when a proprietor has his own timber, some descriptions of which are nearly as durable as iron.

steam or cattle mills, the choice of which must rest with those who embark in the pursuit.

The cattle mill may be worked either by two or four arms, according to size. The rollers may be placed either horizontally or vertically ; and a preference has been shewn in favor of the former, since by having a sloping dumb feeder fastened along the whole length of the cylinder, the canes can be introduced more regularly, and without the same liability to derange the position of the rollers, as in feeding them when placed vertically. In addition to this is a stated superiority, the horizontal rollers being placed in a triangular manner. The canes introduced, as above, between the upper and near low cylinder, are impelled on between the upper and opposite one, carried off by another inclined shelf in a completely expressed state.

Excepting the danger to which human life is exposed in the act of carelessly feeding the vertical rollers, I cannot admit, by practical inference, any great advantage which the one is said to possess over the other ; on the contrary, the high estimation in which the vertical mill continues to be held in the colonies is evidence of its capability.

Moreover, the dumb returner, already mentioned in a former page, has not only economized labour, but lessened the greatest evil formerly complained of.

Again, as the disadvantage of more action being applied to one part of the vertical rollers than another, by which the surface is irregularly destroyed, is said to be entirely removed by the general disposition of the cane along the dumb receiver affixed to the horizontal cylinder, it may be questioned whether this theoretical remedy has been confirmed by practical testimony. The attendance of more than one feeder at the mill, is at all times to be deprecated ; and those who have superintended a sugar plantation, can answer whether a board of five feet in length can be regularly supplied with cane, so that the whole length of interstice be filled at once. Recommending, therefore, the adoption of vertical mills, especially where steam cannot be brought to act, in this country, we shall proceed to investigate the defects accompanying the usual method of boiling and curing the syrup, as practised in the colonies.

The first visible disadvantage, which appears to have had its origin in a view to economize fuel, is the unequal distribution of heat applied to the clarifiers, as well as the evaporating and concentrating coppers.

On small estates, whose means do not admit a sufficient supply of wood, or in other words, where the number of negroes does not admit of their time being applied to cutting timber, such a plan may be reconciled; since the manager must be dependant upon his *Meguss*, and his utmost care is required to keep up an adequate supply for combustion. In such cases, the evaporators are all hung to one fire, and as the *teache* is nearest to its mouth, the action of heat is much greater upon that, than the other coppers, to which it is communicated by flues, constructed of fire bricks, and other materials, least impervious to its effects.

This system, which has been introduced to avoid expenditure in fuel, cannot be too severely censured; for although the degree of heat produced is fully commensurate, the result bears ample testimony of its mischievous tendency. The *teache* being the last copper into which the syrup is laded; concentration operates by far too rapidly, discolouration takes place, and the viscid juice, which ought to run off in molasses, becomes so incorporated with the pure saccharine liquor, that when struck into the cooler, it forms a liquid muculent mass incapable of crystallization.

This error in manufacture has been too often attributed to soil and season, where a little attention would have satisfactorily established the reigning evil.

Whilst upon this subject, it may be proper to mention, what occurred to the mind of the writer, on viewing the imperfection of the operation, "striking"—during his residence in the West Indies. To a commonplace observer, the plan of gradually striking from the *teache* (however expeditiously), offers at once remark. The syrup, as laded out, assumes a darker and thicker consistence, in proportion to the intense action of heat applied to the sides of the copper, as they become vacant and exposed, until at last it becomes so thick as to require a fresh supply of unconcentrated juice. Now since the disposition of the sugar to granulate becomes less after the moment it has attained the proper degree of concentration, and in many instances is destroyed for want of celerity in skipping; would it not be advisable to have the *teache* constructed, so that, by means of a small lever, its contents might at once be thrown into the cooler ?

I submitted my opinion on this point to a well-informed planter on the spot, who agreed in the practicability and great advantage such an improvement would effect ;—but before he had time to make the experiment, death closed his career, and I shortly after left the island.

It occurred to me that the *teache*, being of small capacity, might be hung on a frame of cast iron sunk in the masonry, and by joints, (being of the figure described in plate 3—fig. 4) admit of being raised to discharge the syrup into the cooler C, at the mouth A, along the channel B ; by which the tedious and injurious process of "lading out" would be avoided.

Within the last five years, several *patent* improvements have been suggested for the manufacture of sugar from cane juice, by the aid of high pressure steam; but the danger of this agency, united to its high cost, and liability to derangement, offers similar objections to what have been already advanced, and points out the necessity of beginning on the most simple and best-understood principle, which I shall endeavour to point out by a ground plan of the works.

BUILDINGS, &c.

With reference to the annexed Plate III. we shall determine an *actual cultivation* in cane, of two hundred acres, which would require the application of two cattle mills of 4 yoke each. The produce of such an estate may be estimated *(on a very moderate average)*, at 180 hogsheads of sugar, and 110 puncheons of Rum, per annum, and will require an extent of works as follows:—

FIG. I.—A BOILING HOUSE, 40 by 20 feet.

f—A platform of brick, overlaid with sheet lead, 5 feet broad, and 2½ feet high from the level of the *interior* of boiling house.

a—A clarifier, to contain 500 gallons.

b—The grand copper, of same capacity.

c c—Evaporators of 340 and 200 gallons.

d—The *teache* of 100 gallons.

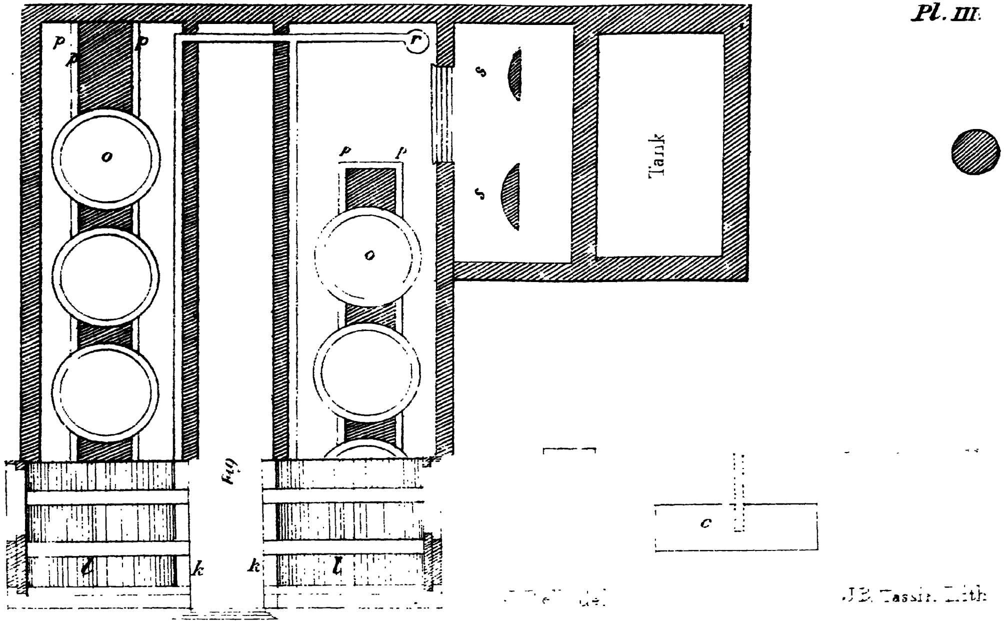
e e e e e—A duct to receive and carry off the scummings as taken from the coppers.

g g g g—Coolers.

h—A moveable wooden duct thrown across from the *teache* to the coolers, when the liquor is to be struck.

i—A wooden duct lined with lead, for conveying the juice from the receiver *at the mill, to the clarifier.*

Pl. III.



J.B. Tassin. Lith.

FIG. II.—THE CURING HOUSE.

k k k k—A double range of solid beams, thrown across two deep wooden troughs, merging into a small gutter.

l l l l—The gutters, with a descent to convey the molasses, (dropping from the hogsheads placed over the beams,) to two cisterns *m m*.

FIG. III.—THE STILL HOUSE, 65 by 25 feet.

To contain a double range of fermenting vats, *o o o o*, of 1,000 gallons each, placed on beam work, *p p p p*.

q q—Wooden ducts running along the house into which the fermented liquor is pumped, emptying in a small reservoir *r*, for the convenience of supplying the stills.

s s—Stills of 1,000 and 500 gallons.

t—A tank for the immersion of the worms.

u—A well to supply the tank.

It may be necessary to point out that all this compound building ought to be of solid masonry; as cleanliness and safety in sugar manufacture and distillation are indispensable. The tops of the buildings ought to be of shingle, or some other substitute, but by no means thatched. This needful expense is only confined to the principal buildings.

There are farther required to complete the works, a shed for the mills, which may be constructed of posts, with thatched top; a trash house to protect the dried cane trash from rain; 2 mule stables, a cart house, and cooper's shed.

Remarks on the evils attending injudicious Tempering and ignorant Management.

The mere routine of sugar-making is exceedingly simple; and may be said to be completely carried on by negroes who have learnt their respective duties, as the subordinate actors of a drama do their several parts. Some managers do not visit their works above twice in the space of one year, although residing within a few hundred yards.

They think it sufficient to convey their orders through an overseer, or driver; idling their own time in visiting distant estates, and in amusements foreign to the interest of their employer. The overseer left in charge, is perhaps either a raw inexperienced lad, or an uneducated person of 20 year's standing*, quite ignorant of the properties of the cane, or its produce. Certain rules are laid down and taught *by the negroes*, and the same is pursued, from year to year, without the shadow of improvement, or being aware that any defects were removable.

It is quite necessary that an individual, embarking in the planting line, or a person placed in charge, should not only be conversant with the mere process, but he ought to be acquainted with the nature of the cane in all its distinct stages, whereby the properties of its juices are most materially affected; and by a knowledge of which a due proportion of alkali is to be administered to promote successful concentration. He ought to know, that the first developement of the plant is occasioned by the action of the root, and sap, produced by the moisture which it absorbs; and that, according to the peculiar qualities of soil, will be the proportions of matter, which constitute the formation of its juices.

* I have seen overseers who had been 20 years on an estate, who had never risen beyond that rank, and were as ignorant of the principles of sugar-making, as the man newly arrived.

Thus we know, that the first leaves which indicate the appearance of the cane above ground, are destined to foster it to a certain degree, (plate II. fig. 2,) in preserving the joint, until sufficiently strong to render their agency no more necessary; but not until a vast number of successive joints have been created (from 35 to 60), expanding upwards, and at greater distances, until at length the last is lost in the numerous and close wrappings of the leaf, and the stem completely formed by these various revolutions, (vide plate II. fig. 6.)

It is not intended here to enter into all the details of the plant from its germination to its fullest developement: what has been said with a view of the plant in the rough sketches which I have introduced, is sufficient for present inquiry, and may, perhaps, create a spirit towards investigating more closely a subject of so much importance to be understood. I have endeavoured in plate II. fig. 5, to represent a plant cane arrived at maturity, and when it *ought to be* cut for the mill. After this period, although it does not actually decay, the flowing of the sap vessels being impeded by the dryness of the skin, and absence of leaves, which have done their office, is thrown back into the root, or lost in the further functions necessary to its entire growth of fructification.

At this epoch, too, the cane is remarkable for its bright lively yellow rind, easily snapped, and on being cut, shews a dry surface spotted like the grain of a Malacca cane, grateful to the smell, and sweet to the taste, which, if left uncut for two months, relapses into that unripe and watery consistence, void of flavour, as in its primitive stages towards maturity.

The chemical analysis of cane juice may, as relates to any particular spot or time, sufficiently guide the manufacturer, in the proportion of alkali applicable; but the quality of the cane varies so essentially on the same estate, and according to the season in which it is cut, that no positive rule can be laid down*.

The destructive effects produced by unskilful tempering, renders it an object of great moment, to be acquainted with its use. And in order to understand the principle of boiling thoroughly, we must, *First*, consider, of what the component parts of the raw juice consist. *Secondly*, what is required towards the absorption or removal of some, and the ultimate successful concretion of essential fluids. *Thirdly*, the most effectual means to be employed.

As regards the first question, the several coppers into which the juice must pass, before it attains the consistence necessary to crystallization, at once point out that something more than simple ebullition is required, and the name given to the first of these, signifies the existence of matter which must be disengaged. This solid matter is made up of the various particles of cane, its crust, earth, &c. which are swept into the receiver by the operation of grinding. Secondly, the use of alkali is to disunite these from the fluid, and assist, by the gradual application of heat, in throwing them to the surface. This first process leaves the liquor in a comparatively pure state, in which it is drawn off to undergo a second process; but before we proceed, it is proper to observe, that carelessness in tempering, without particular attention to the *quality* of juice, is attended with evils that adhere throughout the whole after-process, or which

* The juice from the mill ordinarily contains eight parts of pure water, one part of sugar, and one part made of gross oil and mucilaginous gum with a portion of essential oil. The proportions are taken at a medium; for some juice has been so rich as to make a hogshead of sugar from thirteen hundred gallons, and some so watery, as to require more than double that quantity. By a hogshead I mean sixteen hundred weight. The richer the juice is, the more free it is found from redundant oil and gum: so that an exact analysis of any one quantity of juice would convey very little knowledge of the contents of any other quantity.--Edward's West Indies.

cannot be counteracted but by means inimical to the sugar produced. Thirdly, thus the indiscriminate use of *temper*, destroys the very object which its application is intended to produce, by separating entirely the solid parts from the mucilage, which becoming incorporated with the juice, is carried withal into the grand copper.

The juice, now divested of solid impurities, requires the superabundant water to be evaporated, when at the same time, the remaining feculencies are forced to the surface, and constantly scummed. This is continued in the other coppers, until sufficiently reduced to be contained in the *teache;* but the heat must, in all these stages, be so regulated, that the liquor be not condensed, and so prevent any adhesion, until by the act of concentration it can no longer be prevented.

After the utmost care has been bestowed throughout the process of clarifying, evaporating, and concentrating; it will be found that a great residue of impurities still exists in the sugar manufactured, attaching to the saline particles, and which cannot be removed but by the operation of claying, when the water applied is found to carry off, in filtration, a portion of calcareous earth, and other substances, leaving it colourless, and free from any tartareous taste, which frequently abounds in its raw uncleansed state.

From what has been said on the subject of *tempering*, it stands to reason, that the culture and manufacture of the cane must be blended. We must know the different stages of advancement belonging to each cane piece; we ought to know the properties as correctly as an intimate acquaintance with the various soils will warrant; we must determine their fitness for the mill, by outward indication, which, to a practical observer, is more to be relied on, than the time they have been vegetating; for it is not the foreign aqueous substance, which on being expressed with the juice, depreciates its quality.

Whether this unnatural developement is the result of some peculiarity in climate, or caused by misplaced artificial assistance, requires investigation. It appears to the writer to be exclusively owing to the unfortunate system adopted in this part of India, of choking the natural growth of the plant, by bundling its decayed leaves about the stem; and he is the more confident on this point, from *trashing* a cane in his garden, which being now arrived at maturity, indicates by rows of pointed dots above each joint, the existence of roots in the matrix, as in the West, but without any disposition to shoot forth before their functions are called in requisition, towards the support of further propagation. It is evident, that had this cane been left, as the native *malee* thought indispensable, the same effect would have been produced as in the canes grown elsewhere; whereas it is not only free from such radical encumbrances, but is of much greater circumference than the largest he has been able to procure by offering any price.

From this example, it would appear, that the shooting forth of these extraneous roots, is consequent on the *wisping* of canes in India, done with a view to protect them from injury by drought*; but without considering that this false clothing, of which the cane no longer stands in need, when the leaves gradually decay, so far from retaining the moisture, intended to nourish *the stem*, actually robs it of what nature designed for its ultimate perfection; nay more.—The decayed leaves are thus converted into a receptacle for water, which together uniting, become a bed of

* How would a cucumber, pumpkin, or water-melon, ever arrive at the size and perfection which they attain in their natural state, if tied up with straw or leaves?

mucilage, and draw forth vegetation from these radical points, thereby exhausting the cane of substance, which would otherwise tend to its enlargement and excellence.

Further considerations on the mode of curing Muscovado Sugar.

What we have said on the subject of curing sugar, as practised in the West Indies, may require some suggestions, as to its application in this country. Throughout the British Colonies, (of which we alone profess to treat at present,) sugar after being sufficiently cooled, is potted into hogsheads, and nothing further is necessary than to allow the molasses freely to drain, as already pointed out.

Here the process is altogether different; being divested of its molasses, by arbitrary means, and exposure to the sun, it is incapable of retaining much matter, liable to exude, and is therefore packed in bags, the most convenient for inland as well as sea transportation.

As it is foreign to the purpose to enter upon the details of native manufacture, the imperfection of which we are required to remove by substituting a method, that will admit of bringing our produce into competition, with others of better quality: we are led to enquire, whether with reference to convenience, we can accommodate the *Muscovado* sugar, by transmitting it to the Europe market, in the same description of package as heretofore, without detriment; and if so, under what process it is curable.

If we are to follow the method adopted in the West Indies, the ship's hold, on arrival in Britain, will be one coagulated mass. Since even during the comparatively short voyage (not much above one-fourth), from the West, so great a separation takes place in the best cured sugars, how much more will not transpire through cloth or gunny bags?

The inefficiency of bags, therefore, must give way to chests, which, being better adapted than hogsheads to close stowage, is a desideratum. Moreover, the process of curing sugar, intended to be so packed, might be advantageously performed by perforating the bottom surface of the chests intended for exportation, and by introducing the stems of plantain, as with the hogsheads, and admit of the sugar being at once potted*.

A still more efficacious method might be introduced by having cases made for the purpose, of such dimensions and form as would most effectually carry off the molasses; and these cases being fixed along a wooden frame, would discharge through the several holes the molasses into a cistern, sunk at one end by an inclined duct.

On this plan, the sugar when perfectly cured, (which would be in about fifteen days,) should be stowed into the cases for shipment, and properly secured.

These considerations might lead us to a greater length than our limits will admit; we shall therefore consign those hints to such readers as may think them worthy of experiment, and close our pages with a few remarks on the article Cotton.

* 'The superior quality of the sugar of the Philippines is acknowledged, when compared to that produced in the island of Java, China, or Bengal; notwithstanding in the latter countries it may naturally be concluded, that greater pains and care are bestowed on its manufacture. The pressure of the cane in the Philippine Islands is performed by means of two coarse stone cylinders, placed on the ground, and moved in opposite directions by the slow and unequal pace of a *Carabao,* a species of oxen or buffalo, peculiar to this and other Asiatic countries.

'The juice is conveyed to an iron caldron, and in this the other operations of boiling, skimming, and cleansing, take place, till the crystallization of the sugar is completed.

'After being properly clayed, the sugars acquire such a state of consistency that, when shipped in *canvas bags,* they become almost *petrified* in the course of the voyage.'—*De Comyn's State of the Philippine Islands.*

COTTON.

ON THE CULTURE OF COTTON IN THE WEST INDIES.

The desultory manner of cultivating the cotton plant, in many of the islands, cannot be recommended as an example towards scientific improvement in other countries; but with a view to place within reach of enquiry the usual routine, I shall confine myself to facts, which have come under my own observation; with such suggestions, as appear worthy of attention.

The principal error to be noticed in the West Indian method of culture, is the choice given to *poor soil*. Modern practice has exposed the fallacy of an opinion, originally entertained, and which has been handed down by successive writers, to posterity; but in an article of so much commercial importance, it is to be expected, that in proportion to the attainment of perfection in manufacture, will improvement in the arts of husbandry keep pace; and in the developement of numerous experiments, we are more likely to ascertain the true medium for correction of inaccuracies.

The crude notions entertained some fifty years ago, in the West Indies, that any soil, *however barren*, was applicable to the growth of the cotton plant, is quite erroneous. This impression I conceive to have originated in some chance indigenous plants having been seen to flourish on rocky eminences; and a trial made on the *two extremes*, connected with circumstances that cannot be traced, had determined a preference to the one.

The second point to be deprecated in the West Indian plan of cotton planting, is the little attention bestowed on tillage. It is thought, by many, sufficient to clear the soil of weeds and incumbrances, and proceed to plant the seed, which is doubtless the result of the first mistake, that in its primary state it requires little, if any artificial assistance.

That a *moist soil*, and humid atmosphere, are both inimical to the prosperity of cotton, I am convinced from personal observation, and experiment in the West; but that a rich soil, *provided it be loose, and pulverized*, is conducive to its perfection.

The holes for the reception of seed, are dug out in straight lines, from six to eight feet apart, according to the soil, and full five feet from each other, nine inches square, and six inches deep; eight or twelve seeds are placed in each hole, and care is required in this operation, as if allowed to adhere to each other, they are less likely to vegetate, and tend to produce those effects, which a plurality was meant to counteract; the seed should not be covered with mould above $1\frac{1}{2}$ inches; being liable to rot at a greater depth. The plants shew themselves within a week, although they frequently require fourteen days, to be distinctly traced in equal rows. In ten days after their appearance, they must be thinned, leaving three only in each hole; and freely cleared of weeds. This operation must be repeated until only one plant remains; at the end of the 3d month, they are *topped;* that is, about two inches from each extremity taken off, which throws back the sap into the parent stem, and causes a new generation of lateral branches. Under a luxuriant foliage, this *topping* ought to commence sooner, and be repeated until the plant begins to shew its bloom about five months after the seeds are planted; when the mould is brought well up about the roots with the hoe. In the course of six weeks more, the pods, or bolls, are formed, and arrive at maturity, but very irregularly; frequently extending to the tenth month.

The uneven and dirty state in which a large portion of the cotton is transported to the British market, is owing to carelessness in the reaping process, and therefore demands the strictest attention. The system of leaving the *picking* season until the full maturity of crop, cannot be too severely deprecated. It is done with a view to save expense, but the returns from such bad policy ought to point out the misapplied economy.

As soon as the first pods burst, and the cotton can be drawn by the fingers from the husk, without any degree of force, the produce is picked into a bag, and it is very advisable to separate in the field at once, any inferior quality, by each picker having two bags; this business ought also to be postponed, until the sun's influence has inhaled all night dew: and the same course is observable after rain; as picking under such circumstances will injure, materially, its appearance and market. In fact, too much care cannot be bestowed in gleaning, for more depends on that than on its culture.

The best season for planting cotton in the West Indies, is in June and July; some commence in May, while others again plant so late as September. Those situations, naturally protected from the north wind, and as before noticed, free from moisture, are best adapted for a cotton plantation. In proof of this, it may be useful to refer to the success which attended the introduction of cotton on the northern part of St. Domingo, in the year 1776, by *Chevalier*, who took advantage of the drought which prevailed for four preceding years, and had caused a total failure of sugar and coffee. His example was followed by others, but a recurrence of the former periodical rains having destroyed all the cotton plants in 1777, the cane and coffee resumed their soil.

The different species of cotton cultivated in the West Indies, are not so nicely discirminated as in

North America. Thus we know, that the Sea Island cotton of Georgia ranks first in commerce; and next to it the upland cotton, of which there are two kinds, the superior known under the designation of New Orleans. The West Indian produce is, therefore, a link between the upland bowed and Sea Island, although on a general scale of average inferior to both. This inferiority is probably owing to the different plans observed in cultivation, and undue attention to the separation of different species of seed, more than to the influence of climate on the staple; since in Demerara and Berbice, where the produce is superior to that of the islands, a similar mode of culture is prosecuted by the hoe to that in Georgia and Carolina, where the ground is repeatedly ploughed and harrowed.

The practice of cutting down the plant (after harvest), within four inches of the ground, has been admitted to be injudicious, when the necessity of cultivating a perennial plant can be dispensed with, as the rattoon shoots are never so productive as the original.

The cotton, from the time of germinating, until it attains maturity, is peculiarly subject to destruction from grubs, and other insects.

The planter is frequently at a loss to account for the nocturnal ravages committed on his crop, when no traces beyond actual depredation are visible, after sun rise; but a little reflection will point out, that the numerous tribes of crickets, grasshoppers, locusts, &c. abounding in these latitudes, have all an appeal to the herbaceous bounties of Providence, on which they browse in the night season; and as a well governed cotton plantation is kept free from grass and weeds, from first to last, there is left no variety of choice, and hunger causes them to devour what comes within reach*. The most effectual method to deter the worms from destroying the seed, is by steeping it, for some hours before planting, in a compound of slacked lime, tobacco juice, and water; but this precaution does not always insure undisturbed vegetation †. When the plant arrives at the age of two months, powdered lime, scattered along the intervals, will be found a beneficial protection; that failing, a change of soil must be resorted to. Even under a successful repetition of crop, it is advisable, (as a general rule,) to give it the benefit of fresh land, or that which has sustained sugar cultivation, provided it has been allowed to fallow for a short time.

The cotton, after being picked from the plant, must be carefully and thoroughly dried in the sun. If stained and inferior sorts be not separated in the field, they must be before being separated from the seed by the *gin;* as reception of cotton in the British market depends much on cleanliness and colour, as well as staple.

With regard to the probable returns from a cotton plantation, no very exact estimate can be formed. An acre of good plant ought to yield from 12 to 1,500 lbs. of uncleaned cotton, and which, on being freed from the seed, will give 300 to 380 lbs. net. There are some soils which will produce more, but I fear I have even exceeded a general average, considering the many vicissitudes to which the plant is exposed, and that it ought not to be reckoned at above 250 lbs. an acre.

The experiments now making by the Agricultural Society in this country, aided by private enterprize

* Confine a rabbit or other animal, upon dry food, for a short time, and it will greedily devour leaves put before it, which in the enjoyment of choice it would not touch.

† If cotton could be raised from slips, the disappointment frequently experienced in its first stage of growth, would be at once removed: the experiment is worth a trial.

through these means, will soon determine, whether the great object in view of raising and cultivating *cotton from the American seed, is likely to succeed.* The result of partial trials already made, is said to be favorable to those hopes which, if realized, will raise our commercial resources to a scale of prosperity, proportionate to the benefits that will accrue. But we must not draw any definite conclusions from the transactions of one season: the cotton experiments must stand the test of two or three generations; both from original, and the *offspring* of original seed, planted every year, when a comparison of staple will establish its liability to stand undeteriorated by climate. This precaution has, no doubt, been anticipated by the Parent Society, as well as another of no less importance, viz. whether the plant requires annually a change of soil, or will flourish, in an equal ratio, during a series of crops on the same?

From the luxuriance and rapidity of vegetation in India, it appears probable that the first years' gleaning from the issue of imported seed, will be the best, and that succeeding crops, from Creole seed, will degenerate to a certain extent until the plant becomes acclimated; unless, indeed, the climate be found conducive to the staple as well as the leaf, as that of the West Indies has been to the successful introduction of the South Sea cane.

INDIAN CORN—(*Zea Maize*).

There is no plantation in the West Indies without a cultivation of this valuable resource,—and the indifference which it evinces to any particular season of planting, affords an opportunity for keeping up a constant supply. The Indian corn arrives at maturity within four months, and no labor (on a sugar plantation) beyond planting and reaping is requisite; being sown between the ridges of canes, immediately after planting; and which, so far from injuring, tends by its active vegetation to protect the young shoots. When the ears are ripe, the entire plant is at once removed from the cane-piece. In a ground state, it is a favorite meal of the negroes, and is very palatable, boiled up with milk: but it is chiefly reared by the planter for feeding stock; and in this light, is worthy of consideration, by those who propose to cultivate the cane in this country.

The maize grows abundantly in this climate; but whether from neglect or other cause, it is far from being equal to the descriptions reared in the West India Colonies.

A very fine specimen was recently presented to the Agricultural Society, by Mr. W. C. Hurry, the produce of N. S. Wales seed; and its decided superiority over the indigenous or naturalized exotic species, common in Bengal, will induce its general cultivation.

The method of planting between cane ridges, saves tillage, and the weeding of both is performed at the same time. The corn stalks are drawn, before the cane is sufficiently forward to be injured by want of free circulation. I shall finish this notice with an extract from Wood's residence in Illinois.

"The corn I took was on a new prairie-land, thin on the ground, had been badly cultured, and much injured by cattle and pigs getting into it; yet had very near 50 bushels per acre. I have heard of 132 bushels per acre, but from 60 to 80 is considered a good crop.

"The husks that cover the corn ears, and the flags or leaves are all good for fodder. Horses, cattle, and sheep, all seem as fond of it as of the best hay. Horses and cattle will eat part of the stalk after the corn is ripe; but in a green state, they, and pigs, will eat it all up. Horses and pigs will eat the corn, and leave the cob or inside of the ear; but cattle will eat inside and all.

"The time of planting is from April to the middle of June; the middle of May is considered the most proper season. It is planted in rows of about four feet in each direction; and after it is up, they plough between the rows, first one way, and in a week or two, in the other direction; a third ploughing is sometimes given to it. Between the corn they hoe up the weeds left near the corners that escape the plough; so that the land is made very clean. Generally two or three plants are left at each angle."

"There are several sorts of Indian Corn, and of different colours; viz. white, red, yellow, mixed, &c."

"A good ear of corn contains from 14 to 20 rows, and from 40 to 50 grains of corn in each row. One hundred ears of middling corn will yield a bushel of clear corn."

"I have now growing 12 acres of it."

"I planted some of it six feet between the rows, and the plants near three feet apart, as I wished to keep it particularly clean and in good order for wheat; and so ploughed it all one way, and ran a harrow between the rows. I do not see but it comes on as well as that I planted on the square.

"I have not seen any corn near us so large as mine; much of it is upwards of twelve feet high. It was planted between the 10th and 20th of May, but the weather being dry, it did not come up very soon."

GUINEA GRASS.

It certainly appears strange, that in a country proverbial for *bad pasturage*, and in which so maddening a propensity exists for *field sports*, so very little attention should be paid to the rearing of good grass. This supineness to the wants of the animal, cannot be supposed to emanate from any principle of economy; since those who have the means, pay any price for the best *obtainable* resources: we must therefore attribute it to that fixed determination predominant in India "not to go out of the beaten path," to look for others more wholesome, and consequently more nutritive.

Viewing things in this light, there is little reason to hope, that all we can write or say will have any effect; still, however, we live in hope, and although all the artillery that can be mustered, may not make a breach in the rampart, one stray shell sometimes causes deadly effect.

What ludicrous impression does not the appearance of the grass-cutting operation, about Calcutta, fix on the mind of the stranger? He reflects on the rich pasturage at home, and naturally enough comments on the disparity; but habit is a second nature; and he, in common with all before him, lapses into that happy opinion, that what *is*, must be best, without reference to the difference between an English horse and an Indian Tangan. The sight of so many natives squatting on the plains, and scraping up the roots of close-cropped grass, with which to feed our horses, and the wretched fodder imported from the interior, under the denomination of "Hay," are surely in themselves sufficient incitements to introduce exotics which will place us upon a more equitable footing with other countries.

Why Guinea grass has not been cultivated most abundantly, all over India, is a question difficult of solution.

Does it thrive in India? Yes! Do cattle in general prefer it to other wet food? Yes! Does it fatten? Yes, in the greatest degree.—How many crops may it yield in a season? Three.—What height does it attain? Six feet, the first cutting—four feet the second—and three feet the third. Is it curable for the state of Hay? Certainly; and a *fourth* cutting may be obtained, which will give *better* Hay than the first quality now brought to Calcutta.—And with so many advantages in favor of this grass, how does it happen that it has not long ere this been brought under cultivation? For the best reason in the world:—people will not trouble themselves who have the means, and those who have not cannot induce others.

The usual mode of planting Guinea grass, is in rows: it requires but little culture, it being sufficient to stock out any trees, and set fire to the whole—line off the ground, and dig out holes of three inches in diameter, six inches apart, four feet between the rows. In these, throw a few seeds, or a small root, placed in an inclined position, with the upper extremity above ground. In this state it is allowed to remain for the first cutting, until it has thrown its seed, which, dropping between the ridges, springs up in all directions. It ought then to be cut over within four inches of the ground, and the field again set fire to, when an even crop will appear, and continue an unceasing resource towards the support of all cattle, either fresh or cured for provender.

FINIS.

ERRATA.

In the Advertisement.

Page 1, line 11, *fon* 'Agriculturalists,' *read* 'Agriculturist.'

,, — ,, 14, *for* 'unwholesome,' *read* 'unwarrautable.'

In the Preface.

Page 1, line 12, *for* 'Agriculturalist,' *read* 'Agriculturist.'

,, — ,, — *for* 'dereliction,' *read* 'deviation'.

,, 14, ,, 24, *for* 'at the price,' *read* 'for the value.'

,, 15, ,, 13, *for* 'offered,' *read* 'urged.'

,, 19, ,, 19, *for* 'surmises,' *read* 'premises.'

In the body of the Work.

Page 7, line 32, *for* 'holeing,' *read* 'holing.'

,, 11, ,, 27, *for* 'center,' *read* 'centre.'

,, 14, ,, 29, *for* 'Natural History,' *read* 'Rural Economy.'

,, 16, ,, 29, *for* 'distorting,' *read* 'distressing.'

,, 17, ,, 21, *for* 'Satturation,' *read* 'Saturation.'

,, 22, ,, 21, *for* 'In this interlude,' *read* 'During this interval

,, 23, ,, 10, *for* 'laded,' *read* 'passed.'

,, — ,, 16, *for* 'laded,' *read* 'passed.'

,, 36, ,, 10, *for* 'in a view,' *read* 'with a view.'

,, — ,, 32, *for* 'laded,' *read* 'passed.'

,, 45, ,, 11, *for* 'tantamount,' *read* 'paramount.'

,, 51, (last line,) *for* 'disciriminated,' *read* 'discriminated.'

N. B.—The reader is requested to overlook all errors, and faults; as this pamphlet was written in great haste, and little attention paid to correct the letter press.

A TREATISE,

ON

THE CULTIVATION OF SUGARCANE,

AND

THE MANUFACTURE OF

SUGAR.

COMPREHENDING,

Instructions for Planting, and saving the Cane, expressing the Juice, Clarifying, Boiling, Potting, Claying, and Packing the Sugar; the Distillation of Rum, from the Cane, Peach, Pineapple, and other natural Productions.

SOME USEFUL INFORMATION ON THE CULTIVATION OF COFFEE, GINGER, GUINEA GRASS, &c. &c.

ACCORDING TO THE MOST APPROVED METHODS.

AND

A LETTER TO THE HON'BLE EAST INDIA COMPANY, ON THE SAME SUBJECTS.

By W. FITZMAURICE,

MANY YEARS A PLANTER IN THE ISLAND OF JAMAICA.

First let the Planter, with discretion meet,
The force and genius of his soil explore;
To what adapted, what it shuns averse;
Without this necessary care his hope are vain.

PHILLIPS

CALCUTTA:

RE-PRINTED AT THE HINDOOSTANEE PRESS.

1830.

TO SIR WILLIAM JONES, *Knt.*

SIR,

When I undertook the task of preparing the following sheets for the press, it was not from any ambition of mine to appear as an author, for I am sensible of deficiency in every qualification except such knowledge of my subject as a long residence in the West Indies may be supposed to afford a manufacturer who has not had the advantage of a classical education. With the liberal minded, the following motives will I trust prove a sufficient apology for my humble labors; the unhappy situation I am reduced to, has hitherto effectually prevented my pursuing the culture and manufacturing of Sugar, the object of my voyage to this country. I received some comfort however, in reflecting that I might be useful to the settlement by communicating the theory of what I am not at present able to practice, and it also appeared to be the only means I had of extracting myself from difficulties in which (as far as concerns my own actions) no error of mine has involved me.

Forgive me, Sir, if the knowledge of your disposition to alleviate the distresses of the unfortunate, your desire to promote the happiness of society, and your unwearied endeavors to diffuse the blessings of knowledge widely among mankind, have induced me to submit the work to the public under the protection of your name.

I am, Sir,

With the utmost respect,

Your most obedient

And devoted Servant,

W. *FITZMAURICE.*

Calcutta,
August 30*th*, 1793.

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SUGAR.

DISTILLATION.

INTRODUCTION.

TRADE, which derives its chief support from the productions of the earth, can never be more effectually promoted, than by affording protection and security in the fruits of his labor to the husbandman, and encouraging the improvement of every art dependant on agriculture.

THE decline of these arts, must ever prove injurious or fatal to commercial countries, and the failure of any considerable branch must, by their mutual and natural dependence, materially affect commerce; with a treatise, therefore, professedly instructive, and designed not alone to restore a lost art, but to lay down lessons of improvement on its recovery—it cannot be impertinent to offer some observations, which may elucidate the causes and effects of former failure, and to shew the necessity of adopting *now—particularly at this time*—a system which may *establish* the Sugar trade in this country, and secure it from danger of failure or decay hereafter.

By an eminent character, as illustrious for the importance and variety of his literary researches as for his virtues, it has been recently discovered, that from a very remote time, till within a period so recent as the last eighty years, the natives of this country possessed the art of making Sugar in the *first process*,—or in other words, the exact principles of manufacture pursued with so much success in the West Indies:—from a very able report, drawn up by order of the Court of Directors in the last year, and published at their expence, the causes which brought on the decline of the Sugar trade of this country, and the recent loss of an art so long known, may be traced with some degree of accuracy and use.

The facts worthy of principal consideration, the particular regards of the merchant, and the most serious attention of administration, are, *first*, that Sugar, even since the accession of the British to territorial jurisdiction in Bengal, was a capital staple commodity, and drew into these provinces specie to a very considerable amount annually, which was wholly expended here on the purchase of that commodity for exportation, principally to the ports of aliens, on both sides of India; *secondly*, that the trade has been lost at a late period, the current totally reversed, and immense treasures exported from hence for the purchase of the same article in foreign ports; and *thirdly*, that it is now capable of being restored with advantages which never did, nor ever could, and probably never may again offer, or arise should the present period be neglected.

In 1776 the Sugar trade had so alarmingly declined, that an address on the subject was presented to the Government of that period, by persons evidently conversant in the subject, and impressed with a warm regard for the public prosperity; the export appeared to have then ceased, and the trade was so far ruined internally, that the provinces scarcely afforded a sufficiency of Sugar for local consumption.*

* See the report of Committee of Warehouses, printed by Debrett, 1792——and extract from the Bengal Consultations, Revenue Department, 5th June, 1776.

THE loss of the export trade, may be well supposed to have occasioned the neglect of the perfect system of manufacture; and the consequent loss of that art, to have made way for the practice requiring little labor or ingenuity, which arose on its decline; the peasant, or ryot, had few wants and the raw cane or a vicious juice expressed from it, answered all his purposes for temporary aliment or indulgence; the juice boiled into syrup, and of a quality well enough adapted for making the coarse kind of sweetmeats in common request, was the only inducement to ingenuity or labor, and being a species of luxury, tho' simple and cheap, could not be supposed subject to a very general or extensive demand, as it was neither essentially useful nor more then slightly profitable; this syrup they called *Gour*, it is now known by the name of *Jaggery*, and from this the Sugar so plentifully exported to Europe for the last two years, has been, and continues to be, manufactured; in the course of these introductory remarks, and of the treatise occasionally, the judicious reader will have an opportunity of discerning with what success and probable future effect.

THE industry and ingenuity of the Chinese, and of the Dutch at Batavia, undoubtedly promoted the fall of the Bengal manufacture; by their sending in to these markets Sugars of a superior quality, and at length by suppling the deficiency on its total failure; the political loss to the Government, the abridgment of resources and occupation for the peasantry and manufacturers, who in many districts are one and the same, was not perhaps immediately felt; as the times and the government were then unsettled, and the British policy did not yet completely embrace the conservation of the revenues; thus until a late period it has been altogether forgotten or neglected; the manufactures of the Chinese have been imitated latterly, but neither they nor the Dutch are totally supplanted, because their Sugars are yet unequalled in quality: the flattering prospect of finally attaining the perfect practice of the art, the complete supply for internal consumption, and the trade of the greater part of India, and even any quantity that may be required for the European market, is now open to Government.

But the Sugar trade of this country has yet to struggle with a considerable share of very opposite prejudices, and it may not be entirely useless to meet them; some will exclaim against the West India method, as an infrigement on the sacred and long established customs of the natives, whose religious prejudices with difficulty admit of alteration in their mode of manufacture, or the usuages of their ancestors;—to those prejudiced or superficial assertions it need be only replied, that the mode of the present day, is not that of former times, but that the methods laid down in this treatise, are on the same principle with those followed in India in its former days of riches and prosperity.

A prejudice of an opposite kind will be urged by those who have already profited by the exportation of the Sugars of this country; a concurrence of unusual events in the West Indies and in Europe, threw open the British markets with considerable and unprecedented advantages to the East India speculator; the failure of the French Sugar Colonies, the abatement of produce in the British, together with the popular prejudices raised by the numerous advocates for the abolition of the slave trade, caused East India Sugar of a very inferior quality to meet a reception and sale, that, in their present state, can never be expected to occur again; moreover, as the improvement of the quality of the India Sugar, would by extending the channels of trade, lessen the advantage to the exporters of Sugar of the inferior sort, those who possess the present profit by the defective manufacture and limitted export, may be not unreasonably supposed inclined to discountenance the further augmentation of the produce, or the improvement; however it would tend to the general advantage of the merchant, the Ryot, trade at large, and the Public Revenue.

An erroneous opinion has been received, that the Sugars of Bengal are equal in quality to those of the West Indies; and the late occurrences in England, by causing the beforementioned fluctuation in that branch of trade, have in some degree helped to give it an air of plausibility; the India Sugars were brought up during that time, as scale Sugars for the common consumption, at an enhanced price by a considerable number on the humane principle that they were not manufactured by slaves; by many more, because, thro' a spirit of monopoly, among some capital Sugar dealers, which had not yet ceased, scarcely any other Sugar was to be then procured;—but, on analysing the East India Sugar, and even in the common experiment of applying it to household purposes, it has been found many degrees inferior in strength, deficient in the saccharine sweet, and in no respect equal to the produce of the West Indies, owing to the defective method of manufacture, which alone renders it unfit for the refiner.

THIS defect will appear a matter of the more important consideration, when sugar is viewed as a capital article of Trade, and of essential importance to the public Revenue; not merely for use in the state in which it is exported hence, but as a material for the great, opulent, and valuable body of Sugar refiners, in which point of view it should be here principally considered: by a comparative view of the quantities of Sugar imported into England for a series of years, it appears that nearly two hundred and seven millions of pounds weight pass thro' the hands of the British Sugar dealers yearly; it has been demonstrated, that on an average, one third of the whole of that quantity has been consumed within the British Islands, one half of the other two thirds, exported to Ireland, and other dependencies; and the other third after undergoing the expensive operations of refining wholly exported; so that supposing no more refined, than the complete one third, exported in that state, how necessary will it be for the administration here, and particularly the Merchant, to know, that the Sugar of this country will not answer the purposes of the refiner; that it is deficient of strength, thro' the defective state of the manufacture; and, that until the defect shall have been corrected, the trade must be precarious, and the British markets remain open for either the direct or circuitous introduction of the more rich and yielding Sugars of the French, should their colonies be restored, or to the Americans should their southern Sugar plantations prove successful; while these provinces which possess the best soil, and produce the best Sugar canes, capable of affording supplies which might for ever secure to England the Markets of the universe, both in quantity and excellence if properly manufactured, will be shut out by baleful prejudice or cold neglect.

CONSIDERABLE stress has been laid by the opponents to the improvement of the Sugar manufacture, on the little success that has attended a Sugar factory erected at a heavy expence at *Omeidpore*, called the " Chinese works," and it is to be lamented that where the mercantile spirit was so laudibly evident in the proprietor, the ignorance of the person confided in of the business undertook, should alone be the cause of the failure; a brick loam, which is the most prevailing soil of Bengal, is the best of all others, for the culture of the Sugar plant, unfortunately the person who chose Omeidpore for the scite of Sugar works, seems not to have known this important circumstance; The author of this treatise led by a spirit of curiosity, and anxious to account for the ill success of this praiseworthy undertaking, took a guide and visited the place; crossing the country beyond Kidderpore, he examined the soil on his way, which appeared such as the most sanguine planter could wish for the culture of Sugar, and continued uniformly the same till within a short distance of the works, where it changed to a black foggy clay, mixed with a bad marle, which will not produce even a kind grass, but throws up the rank foxtail plant commonly used for thatch by the natives; such land is termed a savannah in the West Indies, and common in England; it affords no sort of nourishment for useful vegetation, and renders the juices of a feeble Sugarcane that it may with difficulty be forced to produce, utterly unfit for mixing in the manufacture with Canes of a generous or good quality

ANOTHER cause of this ill success may be found to originate at a source which is generally complained of, and notoriously oppressive in every species of useful industry; the multiplied exactions of a constant series of useless idlers, Banyans, Sircars, Peons, &c. who in every district, are attached to every branch of business; these by various arts of cunning and exaction, derive the greater part of the husbandman's earnings, who must submit to their impositions or starve; the native landholders naturally expect to derive a profit, and the landholders below him in different degrees; expect their proportion; the Banyan receives a fee or commission, which is generally the reward of some species of peculation or collusion, and never for any service more than he is bound to by his duty, which principally consists in employing those below him, from each of whom he also has a profit; the Sircar who pays the laborers' hire for the Banyan, demands a deduction from every rupee, and the Shroff or Banker has an allowance for ascertaining that his master's money is good; the Peon who watches over the laborer that he may not slumber at his work, demands something for the trouble of watching him, but, as must be expected in such a consistent system, it is ingeniously converted by the Peons into a premium or compensation for conniving at indolence, neglect, and often total absence.

PRIOR to entering on the immediate course of this treatise, a few retrospective remarks, and some observations on the practical part of the subject may be useful, and tend to elucidate the different branches on perusal by being thus previously offered.

FROM the report before alluded to in this introductory essay, it appears, that the French, by an effort of industry and emulation, admirable for its design and execution in a commercial view, were enabled at a period when the British colonies were at the zenith of prosperity, to commence a rivalship, which by their perserverance deprived the British of the foreign market; it cannot be too strongly inculcated, that it was by superior activity in clearly perceiving and promptly employing favorable advantages, that the French succeeded to so vast an extent against the active spirit of commercial enterprize which so eminently characterises the British merchant: —and the same observations will equally apply to the successful competition of the Dutch and Chinese in the Indian market.

IT must therefore be ever kept in view, that the true value of the Sugar trade of India, must depend on the quality of its fabric, which is at present bad, but capable of improvement to the highest degree of perfection; that unless it shall be improved, tho' there may be a temporary demand for the crude Sugar now produced, even that demand must speedily fail, on the revival of the French colonies, or the improved cultivation or manufacture in the American states, none of which could cope with the Indian produce, if once well encouraged and established.

THE cultivation and manufacture requires considerable care and skill, the natives are utterly ignorant of the most important parts of the art of boiling, claying, potting and clarifying, fit for the European markets; but they are capable of receiving instruction; and it will not be denied, that it is the first duty of those who are actuated by public spirit, as well as attention to the interests of their employers, to promote that knowledge: the supposition of expensive and cumbrous buildings being indispensable for the West India method, ought no longer to be countenanced; for not only the erection of works and mills upon a vast scale, but even the expence of cattle may be spared; the man of enterprize whose activity will lead him to overcome casual or trivial difficulties, will procure a number of hand-mills, of the kind in use among the natives, he will set his laborers actively to work with these imperfect machines, he will be arduous in his undertaking, and with every possible expedition extract the juices and collect them into one reservoir; he will lime his utensils, keep them tenaciously clean and in general he will pursue the system laid down in the following pages as closely as possible; if he has not, nor can immediately provide copper pans, earthen pots, fire proof will answer his temporary purposes, and he will produce, with care, *sixty* per cent *more* from his juices than the most ingenious or experienced native can now effect.

THESE truths have been proved, the author of this treatise has demonstrated them by actual experiments made in the presence of natives, who looked on admiring without being able to account for the vast difference in the quality of the Sugar and the quantity produced—but they paid no attention to *cleanliness*, and the acidity which their juices acquired contaminated and diminished the produce; theirs was that coagulated material from which the molasses is not separated, which clods and hardens, and on breaking displays a dusky and soapy appearance; the other was equal to any Sugar ever produced, and of which kind *one hundred thousand* tons may be exported annually from this port without difficulty.

MAY it not then be earnestly hoped, that this treatise will prove of that public utility of which it is capable, that neither the Dutch system pursued in the spice trade, nor the vicious customs of the idle class of natives, will any longer stand in the way of an object which can so eminently benefit the government, the merchant, and the people at large; and that those blessings which providence has thrown into the lap of Britain, in giving her the most prolific soil in the universe, a docile, ingenious, and numerous people, will not be neglected, but on the contrary cherished restored, and supported, by her genius and power.

A

PRACTICAL TREATISE,

ON

SUGAR.

OF LAYING OUT GROUND.

GROUND intended for the cultivation of Sugar cane, must be first cleared of all shrubbery and grass, the roots carefully stocked up with hand-hoes, ploughed over once or twice, and levelled for laying out the whole into pieces of thirty, fifty, or seventy biggahs; along these pieces it will be requisite, for the purpose of draining, to form a strait commodious trench on each side, at least four feet wide at top, four feet deep, and proportionably narrow at bottom, that the banks may be sloped so as to prevent injury to the sides of the trenches in the heavy rains, which would, if the sides were dug perpendicular, occasion the banks to fall in, thereby obstruct the passage of the water, and require continual labor in repairing them.

THE mold dug from the trenches will help to raise the internals, and make paths which should be formed, for ease, convenience, and dispatch, in carrying the cane to the works.

THE main trenches must be eight hundred yards from each other, and thro' the centre of the plantation, according to its extent, there should be cross trenches of the same dimensions as those on the sides of the pieces, into which the latter should lead; and as the water will find its own level, its direction should govern the line of the main trenches, to which the inclination would be easily found or made by the same means.

WHEN the grounds is thus prepared, it should be laid out in beds of twenty feet wide: or if it is high ground, thirty feet beds will be preferable; form a trench of two feet in width and depth between each bed, the mold of the trenches will raise the cane beds in the middle, and the rubbish collected in them taken out from time to time in hoeing and weeding the cane, will contribute to manure and raise the beds, so that they will be found sufficient to convey all the superabundant water to the main trenches, as will be requred when the rainy seasons are severe.

THE soil of Bengal being low, it is very requisite that the ground should be carefully drained, some time before it is planted; for that purpose, therefore, a gang of sixty laborers ought to be hired to do this; they may in a fortnight dig, and lay out all the trenches and intervals of a plantation of five hundred biggahs; but this should be completed some considerable time before the heavy rains set in, or the commencement of the regular planting season, in order that the trenches may be strengthened, hardened, and durable; if this is done in time, the drains will afterwards continue in good repair, by cleaning out as often as the plantations are weeded; and at the same time the manure acquired in the drains will raise the beds in the centre, nourish the cane roots, and render the soil productive to a degree that cannot be without experience easily conceived or credited.

WHEN the plantation is thus far prepared, have it ploughed, the trenches cleaned, and the pieces marked off, from one end to the other in the following manner; prepare a line of a sufficient length, and affix thereto, at every seven or eight feet distance, a piece of colored cloth, like a surveyor's line; stretch this across the beds as strait as possible, so as to square with the sides, and ends of the beds; be prepared with a number of pegs of about two feet long, place one in the earth at each of the cloth marks on the line; this work may be performed by boys, and girls; when the first row is lined out, let the *liners* retreat about three and half feet, and line and mark another row, like the first; still retiring three and half feet, till they have lined the whole piece; when the liners have marked off the first-row, the laborers may commence the digging of that row; four smart boys or girls may line, without fatigue, three biggahs per day; with two or three more to collect the pegs, as fast as the holes and banks are formed by the laborers.

MUCH care and some pains are required, on the first laying out the ground for trenching and holeing; it ought to be carefully drained, the beds shaped, and planted in such a manner, as that the superabundant rain water may drain from the cane beds, into the trenches, so that the canes may not be chilled, or injured by stagnant water, or too great a quantity of it, as it will contribute to the excellence and quantity of the crop, if the ground retains only an equal share of moisture throughout, to promote the spreading of the plants in vegetation; each stock planted in this manner properly managed, will give twenty or more canes; a single cane alone is produced from the root planted after the careless and improvident method of culture in Bengal.

SHOULD the land be high, let the liners begin at the top, and line it in an oblique, or winding direction, gradually to the base; the farmer who feels the spirit of cultivation, who will see his ground carefully prepared and planted, in his yielding, will find himself amply compensated for his trouble; three Biggahs will contain about three thousand five hundred holes, three feet and half wide, the canes from which will yield on a fair average properly manufactured a ton and half of Sugar; but it cannot be too much attended to in this branch, that the ground must be well ploughed, the earth pulverised, and carefully planted; fifty coolies can with ease, even in their mode of working, turn up three Biggahs per day, and half that number will prepare an equal quantity, when familiarized to the use of a mold plough, wherewith they can form the cane furrows and afterwards it will require only a few hands to shape the banks, clean out the furrows, and preserve the whole in an orderly condition.

WHEN forming the banks, and furrows for planting, the earth must be dug in rows about six or eight inches deep, until they each shew an even pretty bank from one end to the other, then let the laborers fall back to the second row of pegs, and so on till the whole piece is dug into narrow ridges, and strait and even trenches, which will appear if properly attended to square, parallel, and regular.

IT is recommended with the foregoing method to have the laborers, employed by daily task-work ; the employer, or a steady well tempered servant as overseer, or steward, to visit them often, and the owner as frequently as he can, to see that the work in every department is well, neatly, and exactly performed.

THE soil if newly turned up for cultivation will require no manure, but if in any degree impoverished by repeated tillage, it will be found more productive if slightly manured for the growth of the Sugar cane; this part of the planting business in Bengal will be found very easy, on account of cheapness of stock, and of labor,—and as that best and most productive method of enriching a soil, will be so easily effected here, the construction and use of moveable penns are worthy of adoption ;—with bamboo posts and rails form a number of light frames which may be bound to each other as a fence, sufficient to enclose about two Biggahs of ground at a time ; by removing the penns at the end of one week, one side of the penn to stand, and the two sides and the other end to be carried forward, and forming the penn on the outer or opposite ground of the standing part of the fence : thus the planter can go gradually thro' his whole estate feeding, manuring, exercising his cattle, and following all up with turning up his soil for tillage.

THE stock should be fed every night with grass, or vines, and in crop time with cane tops, which are then plentiful, an hundred head of cattle will amply manure with their dung and urine, be the soil ever so impoverished, an estate of five hundred Biggahs.

THE plantation should be divided into three separate parts, the first to be in manure and preparing for the *fall plant;* by ploughing up the penns as they are so manured, the earth will be duly pulverised and in proper order, against the rainy season in time for planting; the second division should be under cane to cut for the succeeding crop; and the third division under *rattoons*, or roots of canes, which if moulded up, and hoe-ploughed between the roots when young, will produce nearly as much Sugar as the plants; but should the soil be too poor to support rattoons, let one third lay over as fallow, and the other two thirds under fall and spring plants for the ensuing crop; if the rattoons are moulded up, and manured with rich earth from tanks and ditches, as they spring up after cutting, they certainly will be found deserving the attention and care of the cultivator; the juices of rattoons are much richer than the juices of luxuriant plants, and on that account, both are mixed in crop in order to improve the Sugar.

MOVABLE cattle penns afford the most easy, and certain mode of enriching, and nourishing the soil for the growth and culture of Sugar; repeated experience in Jamaica has proved it; and the farmers of Wiltshire who manure their fields by forming sheep-walks before ploughing in that manner, which they call flying penns, improve their crops very considerably; but whether the soil is poor or not, it is recommended to the Bengal farmer to collect all the cleaning of his tanks, as well as all the manure about his yard, and heap it up at or near the centre of the plantation, so that it may be convenient whenever it is required; the manure heaped up should be covered from the sun with rich mold, to prevent the exhalation of its richness, and to keep the salts with which it is charged alive, the ricks or heaps should be at times mixed and chopped up with hoes.

AS the seasons are usually regular in Bengal, the ryots may begin to put the canes in the ground a week or ten days before the time the rains usually fall, and they will experience and derive from this practice considerable advantage, as the young plants will immediately shoot up with the first showers.

The part of the canes that ought to be preserved for plants, and indeed the only part fit to plant, is the green watery cane top, with a few joints, which is unfit for manufacturing; if the ground is in want of manure, which the farmer will be the most competent judge of, from the appearance and stunted growth of his canes, or if his land is exhausted from frequent cultivation, recourse must be had to his heaps of manure; laying it slightly in small quantities in the holes as he plants the cane, or round the cane roots as they come up: about twenty weight or about two Bengal bullock loads dung to every hundred feet of rich mold taken out of ditches or tanks will be found a salutary and nourishing manure.

Should any white ants be observed in the ground under preparation for planting, or should they make their appearance after the canes have began to vegetate, the most effectual mode of destroying them will be by poison,—in this manner, take a small quantity of arsenic, and mix it up with a few ounces of burned and pulverized ship bread, oatmeal, flour, or ripe plaintain, let this be mellowed with a little molasses, avoiding cautiously while handling it the noxious effects by breathing too near it when mixing; or lest the wind should blow it into the eyes; place the size of a turkey egg of this composition upon a flat board, covered with a wooden bowl, and place several of those bowls with the mixture in different parts of the plantation; the ants will soon take possession of the wooden vessels, and the poison will have a general effect, for those ants that die, being always eaten by the others, the whole estate will be effectually cleared of white ants; this mode never failed of destroying white ants, during sixteen years in the West Indies; rats will likewise be destroyed by similar means, mixing a little arsenic with ripe plantain or parched corn, ground and tied up in plantain leaves will be effectual; rats are very destructive to a field of cane, but when the poison is once taken, it is as effectual as if the animals were destroyed, for vermin of every kind will afterward shun the plantation.

CHUNAM, where white ants are few, will help to destroy them, a small quantity of it thrown over or under the canes, when planting, will preserve them from these insects.

OF PLANTING.

THE plants should be laid flat in the centre of the hole, two or three close to each other, or within an inch, one after the other, in a right line so that they may come up regular and even; cover them slightly with part of the bank, and if seasonable rains occur, they will sprout up in a few days, from every joint; in about a month after planting, the laborers must be employed to hand-weed them carefully and tenderly, boys or girls may do this light work.

THREE weeks after the first, the weeding must be repeated, and the plants slightly molded; and again from time to time until all the banks are level with the roots; but this they will not bear until the canes are pretty forward, so as to cover the field; after the canes have had all the earth of the banks, they will require frequent hoeings, piece after piece, till the canes shew their joints, after which vegetation will be rapid, and the withered leaves become burthensome; according as the canes come to perfection this encumbrance must be taken off once or twice during the rainy season, to give the canes a free circulation of air, but when the dry weather sets in, they should be suffered to remain, as the canes coming to maturity, with the dry weather, these leaves help to preserve the juices by repelling the intense heat of the sun, or forming a shade for the cane.

THE season for planting in Bengal is in the months of April, May, June, and July; allowing twelve months for the growth and maturity; they are cut for Jaggery in rotation as they are planted; planting in the spring, and cutting the following spring, is in the West Indies called spring planting, which can only be effected with the richest soil, the land is always divided in this mode, one part or division under plants for the after crop, another part under rattoons, which could not fail in Bengal of being highly productive if molded up when young with rich earth; and the other part under plants for the first crop; vegetation is so very quick, the soil so fertile, and the seasons so regular in Bengal, that it would be adviseable to appropriate one part of the plantation for spring plants solely, and another under what is called fall-plants; and to encourage the growth of rattoons by hoe-ploughing between the roots, so that the whole estate should be thus judiciously divided, under caltivation at once, and crops rendered certain by the cane roots being molded up and preserved with rich mold of ditches, or tanks; the yielding would be thus constant, considerably augmented, and vast labor saved.

RATTOONS, it may be proper to observe is a name given to the roots of canes which yield a second produce, or a third, and frequently many more; they have been found thirty years old in some parts of the West Indies, and answer better than plants, as the juices are better in quality, and ploughing is entirely saved, for they require only molding and hoeing, that kind of labor best adapted for the temper and habits of the natives of Bengal.

OF NURSERIES.

NURSERIES are of such importance to the planter, that the establishing and securing a good nursery should be a primary object of attention, for it will be found that good plants will at all times be wanting to supply young canes, when the old are either casually stunted, or roots rotted, or in danger of rotting by stagnated water; it would prove of real advantage to the planter, to have from twenty to thirty Biggahs of the best ground taken up, and planted as a nursery; *an old or-*

chard or a cattle pen is best—the more rich and more spontaneously the cane vegetates, the more plants it will produce on transplanting; this nursery must be hoed often in order to keep it up.

OF RIPE CANE.

WHEN the cane is ripe, it may be ascertained by making an incision with a sharp knife across the cane, and observing the internal grain; if it prove soft and moist like a turnip, or such soft edible roots, it is not yet fit for cutting; but if it cuts dry, and white particles appear, the cane is ripe and fit to cut; a little experience will shew the planter when his canes are ripe, by the degree of yellowness, and the withered appearance of the cane tops, which at a distance look like a field of ripe wheat.

THE plantation should be constantly under the culture of a fall, a spring, and a rattoon growth, in this country; to be cut in rotation according to their age, and as the seasons vary but little, and the dry weather is so wonderfully favorable to vegetation, compared with other countries within the tropics, there is little doubt but this mode of cultivation would be found eminently advantageous; the mills might on this system of planting be set to work the first of December as the fall plant would then be ripe, and the spring and rattoons follow in succession, so that the sugar might be ready for lading yearly on the Company's Ships of each season, in the proper time, and in prime condition for the Europe markets.

OF FEEDING STOCK.

As it often happens, unless guarded against, that a crop of Sugar suffers considerably, and is liable to particular injury from the meagre condition of the live stock, to be worked in the mills for extracting the juices from the cane, and that they must consequently be inadequate to that labor at a time when the canes may be spoiling, eitheir from drought or heavy rains; to obviate this, the farmer should keep them in good condition, which he may safely effect by feeding them twice a day, with chopped cane-tops; salt, and molasses, sprinkled over this provender, will be found to fatten equal to bran if not better, as it effectually cleanses all impurities in their blood ;* by regular care paid to his cattle the farmer manures his land, and prevents any obstruction in taking off the crop in proper seasons, upon which greatly depends both the quantity and quality of his produce, hence it will behove him to have all his utensils before the commencement of crop, in perfect repair; well cleansed and a commodious shed covered with long grass for the purpose of receiving the expressed cane trash, and the waste cane leaves gathered up and carried from the field, which trash makes the best fuel for boiling sugar; the use of this article will be considered valuable, in proportion to the price, and access to wood for fuel, with these carefully heaped up in the sheds, at the beginning of crop the prudent farmer will be enabled to provide for his occasions and avoid the great expence of firewood; except for the two first weeks a sufficient quantity of fuel will be afforded from the mills, and the supply will amply keep pace with the boilers, he will build the trash-shed at a safe distance from the sugar houses, to guard against accidents by fire, withered cane tops after the cane is cut, gathered up in the fields make also good fuel for boiling sugar, and ought to be tied up in bundles and brought home for that purpose; where fire-wood is scarce attention is particularly required in guarding against the imposition which the laborers may practise; the farmer or a steady trusty servant, should often walk into his cane pieces, to see that the canes are cut close to the ground, for the part near the root contains the best juices, and also particularly that too much of the top of the cane is not thrown in for Sugar, for as it is replete with a watery substance, it would impoverish the juices, and, on that account require a greater quantity of fuel than rich juices to bring them into sugar; carelessness and inatten-

* Let a horse be ever so low, if he is fed with cane tops, and salt, skimmings or molasses mixed, in five weeks he will be fat.

tion in any manufacture is pernicious, but particularly in that of sugar, it tends to injure and curtail the returns, and ultimately ruin the employer, particularly when it may not be convenient to him to be present, or if he be not a competent judge, so as to detect impositions; the employer should for his own interest learn the business, and often walk among the young canes, to see that they are properly moided and weeded, and often among the forward canes, to see that they are not stolen or destroyed by rats, or any other animals; in short he must be a guardian to the whole plantation, his stock and his daily laborers, so as to encourage them, and if it is expected to make any progress in reforming the habitual vices of the natives, particular care should be taken, that they duly receive that which they are entitled to, their just hire, which is the best mode of making and keeping them honest, and the most powerful motive for their industry and attention.

OF MANUFACTURE.

Economy should be the rule in building, the sugar manufacture requires a boiling house, of about eighty feet by forty, to make one hundred and fifty tons of Sugar, a back wall of brick, to contain the coppers and the chimneys; one clarifier of three hundred and fifty gallons to one fire, and three more to another; the first to contain one hundred, the second two hundred, and the third two hundred and fifty, which as evaporators, with the clarifiers will be sufficient to make ten ton per week.

Exclusive of the above walls, &c. for the coppers, but little brick work is necessary in this country, as every building, the boiling house excepted, may be constructed of those light and cheap materials, bamboos, matts, and long grass, which abound in all parts of Bengal, provided they can be kept sufficiently clean, but without perfect cleanliness no permanent good can be effected, so that when these light buildings are used, care should be taken that a cloth be placed under the roof of them, as Gentlemen have them in their Bungalows, to prevent dirt, or bits of straw, or grass, as they may be thrown down by birds or the wind, from falling upon the Sugar in its various operations.

THE mill for griding the canes and expressing the juices should be of a similar construction with those of the West Indies, the roof built of a conical form, supported either by brick pillars or sufficient timbers, a brick platform of fifty feet diameter to be firmly fitted up to an height sufficient to afford a gradual and competent fall for channels or gutters, to convey with expedition the expressed juices to the boiling house in a pure and unaltered state.

WHEN the roof is erected, the mill must be placed exactly in the centre, the timber for rollers, and the mill frame to be of the hardest and best timber and a bed for the mill likewise of the best and largest timbers that can be got, constructed of two heavy timbers to be joined, at least eight feet long, and six feet broad, and five feet thick, the mill bed supports the main and two side rollers, the mill when erected, and at work must be attended often by a carpenter, to see whether the rollers are too much or too little braced; extending out from the main rollers to the angles of the roof, should be four arms, fixed with care to answer the tread of the cattle, so as that they might find the mill light and easy, eight oxen, or two horses yoked to each arm and the set to be changed every two hours, or when they express five hundred gallons of juice; the mill bed must be leaded, and the spout or channel from the mill to the boiling house should be so likewise, and covered from the sun, the juices being in a disposition to ferment and to acquire such a degree of acidity as cannot afterwards be easily corrected, and which would prove ruinous to the process by destroying the good quality and lessening the quantity, the manufacturer should be careful; that his mill is kept constantly braced up, so as to express all the juices, if this is not attended to, a considerable quantity will be left in the ground cane, which ought to be pressed between the rollers once or twice before he sends it to the *trash house*, it will require two men to feed up the mill regularly without choking it with too much cane at a time, and one man on the opposite side to return the cane back to the feeders, till all the juice is expressed from it.

CAUTIONS AGAINST ACIDITY

CLEANLINESS, is so indispensably necessary for the manufacture of good Sugar, and good yielding, that the success of a crop depends upon an invariable attention to it, in the most minute degree; receivers, coppers, and in short every vessel, thro' which the cane liquors pass, and every utensil, used in it, should be washed at least every morning and evening, with boiling water, and ashes, and afterwards cleansed with cold water; and when the works at any time are stopped, they should be washed clean in like manner, and finally sprinkled over lightly with chunam.

THE mill-bed, rollers, and gutters, should be particularly limed over, whenever stopt, for if the glutinous parts of the liquor lodge within the joints, or crevices, they speedily acquire a degree of putrescence which cannot fail of infecting the whole body of liquor, and destroy to a certainty all the pure juices that approach it.

OF CLARIFICATION.

THE cane liquor must be clarified within twenty minutes after its expression; unless that be done fermentation commences, to the injury of the Sugar in quality, and quantity; hence the necessity of expedition in the operations of both the *mills and coppers, so as to boil the juices in a pure, and unaltered state, and to prevent their acquiring acidity in the process of clarification and boiling,* this process requires the most skilful nicety of any in the whole manufacture; on it depends the superior, or inferior quality of the Sugar; indeed the manufacturer has many gradations to observe in making Sugar, such as sufficient boiling, too much boiling; sufficient temper, too much temper, too little temper, rich canes, poor canes replete with watery juices, and burnt canes; when the juices get too much boiling, or too much temper, it hardens the molasses in the Sugar, and will appear black in the coolers, and pots, nor will it cure properly, *i. e.* the molasses will not drain from it; when liquor has got sufficient temper it is known by holding up the ladle (when the liquor is boiled into the consistence of syrup in the *teach*) if it drops short from the edge of the ladle, or skimmer, it has got enough, but if long, like tar, too little; if the juices are not sufficiently tempered, Sugar will waste more into molasses in the curing than it ought to do, and will not shew a strong grain; and to this part of the process, as the most important, the artist's attention is constantly required. The true, and correct mode of ascertaining the due proportion of alkali to any quantity of cane juice will be as follows:

FIRST, ascertain the weight of the alkali with precision; scales, and weights ought to be kept in the boiling house for that purpose; fill a quart decanter with cane juice, take about half a grain at first of alkali, and continue adding a grain at a time, until you perceive the impurities of the cane begin to separate from the liquor, and continue adding till every particle is disengaged, and precipitates to the bottom of the decanter, the liquor then will appear as clear as Madeira Wine, if properly tempered; it will take three quarters of an hour to ascertain, and the proportion of temper for the clarifying copper, and the whole crop will them be, as grains of alkali are to one quart in this trial, so many ounces will be the standard for every hundred gallons; if this is well attended to, the Sugar will be of a strong white quality, containing all the essential salts of the cane, and consequently, possess all its laxative virtue, which the Jaggery made Sugar is deficient of.

When the liquor is tempered *in the clarifying copper*, set fire to it; when it begins to simmer, the fire must be damped till all the dirt and trash which gathers to the top, is skimed off, then the liquor must be shifted, and the evaporators to each clarifier filled, and tempered again; if the liquor is properly tempered, it throws up all the glutinous and impure particles in bubbles on the surface, which must be skimmed off, as fast as possible, occasionally throwing in a cup of lye water to promote it.

OF BOILING IN THE FIRST PROCESS.

The cane juice drops from the mill bed thro' blankets or hair cloths into the receiver, which should be erected close to the mill, and the juice, when the receiver is full, let run into the gutter, to convey it to the boiling house; the receiver in size should be in proportion to the clarifier, where there must be another strainer, and in like manner from the clarifier to the evaporators; when the liquor begins to acquire the consistence of syrup, let it be tried with the ladle to ascertain if properly tempered; if not, a little more must be added between the three evaporators; supply the *teach* slowly with a laddle full from the second copper, as it boils down in the *teach* until it is boiled into Sugar; the most accurate way for trying when the syrup is nearly reduced to Sugar, is by turning up the bottom of the ladle, if the Sugar is observed granulating on the back of the ladle, it is nearly fit to *skip*, or remove, but the moment the grain appears white and large the fire must be damped, and the Sugar skipped off immediately into the cooler, throwing into the *teach* when the Sugar is almost out, a ladle full or two of syrup from the next copper, in case the Sugar should be over boiled, which it will shew by a frothy scum raised on the surface of the Sugar, as it begins to spread in the cooler. Another mode of boiling Sugar has been found accurate and advantageous; take up constantly in the ladle about three pints of the syrup, as it begins to granulate, the syrup always disengages itself from the granulated particles which rise to the top, and the ungranulated, or saponaceous parts, run off like molasses; attend to this quantity, constantly rising up as the granulation increases, and *drop it very lightly back into the teach until no appearance of scum remains, then damp the fire and skip it immediately*; this requires great attention, and it is a very nice and important art, which nothing but experience by practice will shew how to execute with propriety, and nicety; the boiling of Sugar effectually, tho' not with equal satisfaction and exactness, may be done by turning up the back of the ladle repeatedly until the syrup in the teach suddenly granulates, and small crystals appear on all parts of the ladle;—at the moment of that appearance the fire should be damped and the Sugar skipped into the coolers with all possible expedition; on touching the back of the ladle likewise with his fore finger, and closing it with his thumb, if the Sugar forms into crystals without shewing a ropy or tarlike appearance, the workman may skip off the Sugar with all dispatch; this is the method the Sugar refiners observe in boiling, and is termed *boiling by the touch*: the method is not accurate, and in boiling from the juices in the first process, where there is an equally simple and more certain method, it is unnecessary to say it is the preferable one.

THERE ought to be large coolers fixed close to the teach for receiving the Sugar, which must be skipped with great quickness into them successively by the means of small gutters; if the Sugar be taken up with ladles out of one into the other, to cool, the grain becomes broken and weakened, the Sugar consequently ought to be potted from each cooler when it is so hot as that the workman may just bear his finger in it; if the Sugar is properly limed and boiled, the molasses will run off as free from it as blood from a vein; the curing house for potting in the first instance, should be at one end, of the boiling house; the other at an hundred yards distance, to avoid danger by fire, and for the purpose of claying and stowing up the Sugars; at the end of every five or six days the pots should be removed from the boiling house, to the curing house for claying.

OF CLAYING.

Two or three laborers should be constantly employed in procuring, and preparing clay; for this operation pipe-clay well beaten, and reduced by water to the consistence of a paste, so that a stick may stand up in it, is what is requisite; dig an inch or two in the Sugar and press down the top of each pot, then lay on an inch and half of the clay; at the end of twelve or fourteen days when the clay is sufficiently dryed and cracks, put on another layer of new clay, and in about ten days the Sugar must be taken out upon a platform, built within the curing house with a stove to keep the house dry in damp weather; the bottom part of the clayed Sugar in the pots, which is not sufficiently white, should be broke up and thrown into the hot Sugars to be potted and clayed over again;—break up with great care the clayed Sugar, which will be very white, for stowing in the boxes, or casks for exportation, it must be pressed down with large rammers; Sugars thus manufactured in Bengal will be much sought after in the European markets, by the Sugar refiners; they will average at least equal with the St. Kitts clay'd Sugars, or about seventy shillings per hundred, which will be a very good price, when the freight is regulated and the duty upon India Sugars are equalized.

OF THE MANUFACTURE IN GENERAL.

The French methods differ a little in the process of boiling and claying from those now practised in the British West India Islands; but in general the practice of both being upon similar principles, tho' differing in a few particulars, a comparative summary of both may be productive of utility.

THERE are three descriptions of Sugar in St. Domingo, the first is called the *Brute*, or common kind, made from the juice of the cane in the first process of boiling, but tempered by a method different from the English. In the boiling houses of St. Domingo there is generally a large vat for preparing the lime-water used in the clarification; when the juices have been expressed from the canes, it is directly conveyed into large coppers, in which the liquor undergoes the operations of fining, or clarifying, as we term it, which is done by taking a quantity of bullocks blood and wood-ashes, well mixed with the lime-water, which becomes a very strong lye, and perfectly clear, to this is added the juice of the cane; just as they commence the progress of boiling, the composition or solution is used, and in the boiling its grossest impurities are thrown up in a molasses, which is skimmed off as it rises, in the same manner as practised by the English manufacturer, until by frequent skimmings, a thin white scum appears on the surface in its room; then another lye is prepared, composed of eggs, and lime-water, which the English do not think requisite; this is used in the same manner as the first, and when the juices begin to granulate, this separates the saccharine from the saponaceous parts, which latter are skimmed off as forced up in the operation of boiling; a general estimate of the quality of the cane, and the juices in different stages, are the only rules of the manufacturer, in St. Domingo, as to the quantity they use in preparing these lyes;—but there they often err, because rich juices will be found to require less temper than the poor, and the use of strong lime-water is found very essential in the first, and second mixtures, because should either the blood or eggs be blended with weak lime-water, the instant they are thrown into the boiling coppers they form into concretions, or large clots, and thereby become utterly unfit, and useless for the purposes intended.

AFTER clarification, the French process accords with the English; the syrup is transported from copper to copper, until it reaches the teaches, there to finish the boiling just to that certain degree, which brings it into Sugar; when the Sugar is cool, it is potted to undergo the operation of claying in the molds, or pots, and then is taken from them without breaking and in a compact form; it must here be observed that altho' the French are not *equally judicious in boiling* with the English, they are far superior in the art of claying and bleaching their Sugar, nevertheless there is good reason to suppose that the Sugars of St. Domingo, could not produce an equal quantity of double refined Sugar as the clayed Muscovado of the British islands, because the English manufacturer avoids every means *which can in the smallest degree weaken or injure its genuine richness, hence it is such sugar* yields the best and most in refining and renders it so much more valuable as an article of trade.

THE fire used in boiling must be capable of being speedily exhausted, or extinguished, by iron dampers fixed in the chimneys, lest the Sugar should burn or take too strong a tinge of the fire in the boiling, which happens very suddenly if caution and haste are not used in slackening the heat.

THE Sugar in this state is transported to a third copper, or caldron under which there is no fire, and is called the cooler because the Sugar is left there, till by stirring it from time to time it is sufficiently cooled; as, if the Sugar were to be carried too hot to the moulds it would run thro' them; with the Sugar from the cooler the moulds or pots are filled, and it is again stirred in the Pots from the top to the bottom (which the English as already observed avoid to preserve the grain) and all round equally with sticks made for the purpose; the manner of stirring is by plunging the stick vertically into the pots, and in every part of it blending completely the whole contents of the moulds or pots; some hours after it has been thus stirred, it gradually acquires a consistence, or body, a kind of thin crust forms on the top, and in twenty four hours it becomes so hard that it can be taken entire out of the mould; this is not done, but on the third or fourth day, the *forms* are carried into other rooms where they are placed vertically over pans with the apex, or sharp part of the canes, or loaves, downwards, that the syrup may drain from them; eight or ten days afterwards the loaves which in that space acquire a considerable hardness, are taken from the moulds and rounded, and the Sugar thus becomes what is called the *Brute* or coarse Sugar.

THE process in potting and claying brown or brute Sugar, must be precisely the same, till put into the moulds:—immediately after the potting, the moulds are removed, and placed over pans with the points of the loaves downward, then clayed and left to drain ten or fifteen days, more or less, as is required; when the Sugar having sunk, three or four inches, by the first claying, the fallen space is filled up again, and the second layer of clay put on; the earth which is rendered into a paste, by its humidity penetrates the Sugar, and operates to whiten it to a certain degree; after having filled the vacancy in the moulds with the clay, they are left for ten or twelve days according to the state of the weather, and when the clay is entirely drained, it is moved, and the Sugar which by this operation becomes of a yellowish white color, is called the *clayed Sugar.*

WHEN the Sugar goes through this first and second operation of claying, it becomes as white as our common loaf Sugar in Europe and a third trial is never necessary to be made.

THIS Sugar is ordinarily put into large rooms to dry, and in them are stoves to quicken the drying to a proper degree; the moulds remain in these rooms a month, more or less, they are then transported into another, where they are taken out of the forms, placed upright upon shelves, stoved as before; they are finished by drying them to a proper hardness, and cutting off the points or heads, which never whiten; the fragments are boiled over again with the raw cane juice, and become clayed Sugar in due time. After breaking the loaves of clayed Sugar, it is pounded, and this kind sent to France, is what is there called *cassonade,* or powdered Sugar.

THE PREPARATION OF CLAY.

THERE is a kind of marle, which if too rich it is necessary to reduce or weaken, by mixing with it a very fine fresh-water sand, it is put into a reservoir built for the purpose, weak lime-water is added to it, and thus left to soak for some days, it is then mixed until it is reduced to a proper consistence, observing that it is not too thin, for its too great fluidity would be very prejudical, because the humidity would precipitate too quickly thro' the forms, and communicate too much dampness to the Sugar, and of course too much increase the quantity of Syrup, or molasses; beside by passing thro' too promptly, the Sugar would not have, sufficient time to bleach; while on the other hand, when the humidity of the clay passes gently, the result is less syrup, whiter Sugar, and consequently more Sugar, therefore the preparation of the clay and the alkaline mixtures in exact proportions or quanties, are essential points: in these, as well as in the art of manufacturing Indigo, the preparations, mixtures, indications, &c. &c. must greatly depend upon the experience, and discernment of the manufacturer, and cannot be precisely told in any form of words without practice to illustrate it.

THE French method of preparing the lime-water differs from the English; the cisterns for it are generally larger than those for the clay, some in St. Domingo are from eighteen to twenty feet square, and from fifteen to twenty eight feet deep, very carefully built with stone, and bricks, and plaistered with a very strong cement—containing upwards of one hundred hogsheads of lime, leaving sufficient space for the water which must be added to it.—This quantity in a large manufactory, by frequently replenishing the water, will serve at least a crop; the lime after crop, in St. Domingo, is usually sold out of those cisterns for about a third less than its prime cost, for the purposes of building.

THE French, whose example let it be understood is here meant to be constantly kept in sight, as it is generally received in the British Islands, have their stoves in the drying rooms, which are very large, and called Grenieres, at one of the angles of the building, or at both ends, of a large size in proportion to the rooms, from twelve to fifteen feet square within, and from thirty five to forty feet high, the walls are very thick, to preserve the heat communicated to them by fire, which is kept up in them day and night for a week together.

THE drying rooms are surrounded from top to bottom by shelves, formed by thick laths, at a proper distance from each other, to give vent; and at a convenient height one over the other in the drying rooms, the loaves and laths are so placed upon stancheons as to admit the circulation of an equal heat throughout the whole, and when all are placed, the trap door of the stove is shut to preserve its heat; in the placing of the loaves, the largest are laid on the lower shelves, as requiring the greatest heat, and by the same rule continue to the uppermost shelves. They have small windows one above the other at about the distance of eight or ten feet, to observe from the outside when the Sugar is sufficiently dry, but these are closely shut until it is time to take out the Sugar, when they are all opened, the fires of the stoves extinguished, and the whole left a few days to cool, so that the workmen can enter the room without inconvenience and remove the Sugar, which is then broken up and packed for exportation.

THE fire is kept in iron furnaces, each of which has a chimney to convey out the smoke, and with proper precautions against excessive heat; this again is a point in the art of Sugar claying, which requires practical experience and the nice discernment of the manufacturer.

THE order required in every species of work, is too well understood to be much enlarged upon, it will be seen in the preceding observations how necessary it is that there should be no part of the Sagar manufacture without constant and precise attendance, and that every servant should know his particular duty; in the field and at the mills, it will be as useful as at the fires, the pans, and in the drying houses; the canes are tied up in bundles or faggots as they are cut in the field and collected into heaps or stacks, which are covered from the heat of the sun, with the *field-trash*, or the juices would ferment in the canes by the intense heat; on their removal to the neighborhood of the mills, they are piled and covered in like manner, and all the rat-eaten or decayed parts perceptible in the canes carefully cut away upon tying the bundles in the field, as well as at the mill.

Two persons are attached to the duty of *feeding the mill* with the canes, the bundles are made up promiscuously in the field, without regard to the smaller or larger end, and tied with a twisted cane top; close to the mill, bundles of cane are laid conveniently on a long table, for the man who feeds the mill to hand them with ease and dispatch, he is prepared with a good sharp knife, with which he cuts the bandage of the bundle, so as that the canes by spreading may be all equally pressed, and the mill work the more freely, with greater celerity, and ease to the cattle; on the opposite side of the mill another person is constantly placed, who from his duty is called the *trash-turner*, his business is to return the canes which have once passed thro' the rollers, to the *mill feeder*, that they may be repassed, and thereby the juices completely expressed from the whole of the cane.

If the cattle which work the mills are strong and in good condition, there may be two persons on each side of the mill to feed and return the canes with adequate advantage.

Two persons are constantly employed in carrying away to the *trash-house*, the expressed cane, according as it is dropped from the mill, after its second pressure; this trash is the best fuel for boiling, and is found after a few days work of the mills to be competent to the boiling of the crop.

Beside an expert carpenter who is always at hand to superintend the mills, an experienced man, called in the West Indies the *Boatswain*, but whom here they would perhaps call the *Sardar*, or head workman, superintends and lends a hand in all the different branches of the work; his business also is to see after the mills, that they are not neglected, over-fed with canes, nor the cattle over-worked, that they are properly fed, and duly relieved, to see that the mills are properly scoured and cleansed, and the gutter, mill bed, &c. limed three times a day.

In all the Islands, the laborers in the mills and boiling houses, are divided into two or three parties, or as they are termed *spells*, where there are but two *spells*, one goes to work at a particular hour, as at high twelve, and are relieved by the other spell at midnight; so that the work is equally divided among them for a week or month, or for the whole crop, as is found most expedient; the working cattle are set to work and relieved in like manner; so sensible are those animals found in the West Indies, that when they have finished their common period of work, and are neglected to be relieved, they stand still till taken out, this duty being the principal workman or Boatswain's business to see to, this sagacity of the cattle is in general a spur to his vigilance.

It is not unworthy of observation that the cultivation and manufacture is carried on in St. Domingo in a manner which renders the work very easy to the laborers, who tho' all Negro slaves, have the comfortable appearance of citizens, and unless that they cannot totally throw off the obligation of labor, very much resemble the natives of this country in their manner of work, with this difference, that they are more robust and willing, because more capable of toil, and more certain of obtaining the indulgence and kindness that they are entitled to; their attention to religion must doubtless add to their happiness, for a slave of St. Domingo will go to mass in the morning, and afterward take his hoe on his shoulder, and walk into the field, and on his return employ himself in little household arts for his family or personal use.

Previous to entering on the important branch of *distillation*, so intimately connected with the Sugar manufacture it may be useful to offer a few observations on the report of the Committee of Ware houses, and on the experiments and other information communicated in the same report, particularly Mr. Lambert's letter to the Supreme Board, on this important subject.

Mr. Anthony Lambert, whose mercantile knowledge is sufficiently known in this settlement, affords the most exact and just information on the present manufacture of Bengal, of any that has yet fallen under the observation of the author of these sheets; on presenting to Government with his address, certain samples of Sugar, he has given the following valuable remarks " The sample No. 1" says Mr. Lambert, " is the " produce of Jaggery after one boiling, and is produced in the

" proportion of four to ten; that is *one hundred* maunds of " *Jaggery* will yield *forty* maunds of this Sugar, and *forty* " *seven* maunds molasses, losing *one-eighth* or twelve and a " half maunds of the original material in the process." On this decisive experiment, it is proper further to remark, the *forty-seven* maunds of molasses are of such small value, that they may be also computed as a deduction from the quantity of the original material; for if it is considered that *Muscovado* or *clayed Sugar* as described in the preceding pages requires like the Sugar in this experiment, only *one boiling*, and that consequently the *hundred* maunds of Jaggery, which thus produced only *forty* maunds of Sugar, with the addition of a *small portion of* unslaked lime, and a few additional minutes fire, would produce Sugar instead of Jaggery, the disparity will be clear; beside in the experiment the proportion of molasses was too much by upwards of thirty maunds, without computing upon the twelve and half maunds lost of the original material by the second boiling:—the disadvantage of the present Sugar system cannot be better exemplified.

SUGAR would not be worth making, if separating the molasses and claying diminished nearly one half, and required a second process of boiling to reduce it twelve and half per cent more; but certain it is, that in Bengal the first manufacture experiences this loss: if the Sugar is properly boiled and tempered in the first process the proportion of molasses will be very small indeed.

" NO. 2" says Mr. L. " is loaf Sugar made of the same " material *twice* boiled; which yielded of this Sugar a pro- " portion of one and half to ten; or 100 maunds of Jaggery " produced fifteen maunds of loaf Sugar and sixty-five maunds " of molasses, losing in the process of refining, one fifth or " twenty maunds," a brief return indeed!—fifteen maunds of refined Sugar in Bengal is worth at the utmost £. 35 produced from one hundred maunds of *Muscovado* Sugar, worth £. 90.

" THE sample No. 3, is *Sugar-candy*, made also from " Jaggery, after *three* boilings; one hundred maunds of Jag- " gery gave ten maunds of Sugar-candy, and seventy maunds "of molasses, losing twenty maunds in the refining"—ten maunds of Sugar-candy, thus stands the manufacturer in 90 £. and is worth £. 22 only, at the rate of 20 Rs. the maund, for which it sells in Bengal.

Mr. Travers, an eminent Sugar refiner of London, in giving his opinion on the quality of Bengal Sugar to the Court of Directors, remarked, "that it proved extremely different "in its nature from any Sugar that had ever passed his pans; "it had no disposition to granulate like West India Sugar, "though tempered with strong lime-water; and now that it "has undergone the operation of claying; it is become very "soft, and of the nature of soap, when it has lain a long "time *in water*."

Another eminent refiner who must have examined the Bengal Sugar chemically observes as follows:

"The appearance of the East India Sugar sold at your "last sale gave me little hopes of its answering the purposes "of refining, on account of its being clammy, yellow, and "soft, with small grains; yet from the large crystals of the "candy from the East (much larger and stronger than British "West India Sugar will produce) I was induced to think "that its natural qualities were concealed by improper treat-"ment of the cane juice, and that by a new solution it might "in a great degree be restored.

"I have not been much disappointed in my expectations "for the process of refining, its natural qualities are good, "and, I conceive, had it been properly tempered or limed in "the first boiling, it would have carried off all its impurities, "would have given a larger grain, which is the genuine es-"sential Salt of the cane; the particles of Sugar would have "disengaged themselves from the clammy substance, (its only "defect) and thereby would have been equal in strength to "the most favoured of our West India Sugars."—This Sugar the author of this work saw, and was at first led to believe that those defects were to be attributed to a too great luxuriancy in the cane, and that the appearance of grease which it exhibited, was owing to excesses in the original process of boiling, which cane juice of this description cannot bear, but on boiling the juices here, the error was removed and the canes proved to be of the best quality and the produce rich and grateful.

CLAMMINESS and the soapy quality of the Bengal Sugar clearly appear to be owing to the great quantity of earth or other impurities peculiar to the cane itself and added as an adulteration by dealers in Jaggery, a combination of vicious matter very naturally produces putrifaction, and destroys the fabric, either in whole or in part, and give an unproductive as well as an unwholesome, in the place of a salutary and useful article of consumption.

SUGAR properly tempered and boiled, will not sink nor lose by the separation of the molasses, more than from one inch and half to two and a half inches, in a cask of any size; but the Sugar to be thus perfect must not be potted too hot.

IF the cane juices are clarified and boiled with accuracy the quantity of molasses will be so trifling as to separate itself in the cooler, and the operation of what in the manufacture is called the *first potting*, will be thereby rendered unnecessary; the advantage of which in every respect, but particularly where casks and moulds are scarce, will be obvious.

WHEN the Sugar begins to harden in the cooler, a hole about the size of the crown of a man's hat, or larger, should be made in the Sugar at one end of the cooler, which will answer the end of a receiver, as the molasses will run into it with facility, which as fast as the hole fills should be removed to the distillery; after the separation of the molasses thus from the Sugar, it may be dug up in large flakes, and will present a strong grained Sugar, intermixed with large crystals, the number of which will afford a proof proportioned to the degree of excellence of the manufacture.

THIS is the state of the Sugar called *Muscovado,* in which it is broken and committed to the pots for claying, and there will not arise thenceforward, a diminution of the quantity to the amount of more than from fifteen to twenty-five per cent.

WHY this species of Sugar, which is the most sought by the English refiners, has not been successfully manufactured by the natives, is sufficiently explained in different parts of the preceding pages; and the causes of failure of European undertakings also accounted for, and corroborated by the preceding most respectable authorities; and perhaps it is to these repeated failures, owing to want of due skill in the natives and Europeans of enterprize, we may attribute the custom of the ryots in some districts, who, like the cultivators of Indigo, on cultivating the canes, very judiciously leave the manufacture, its expences, and its disappointments to Europeans, from whom they take advances, and enter into engagements, to deliver, any number of biggahs, in proper condition, at the commencement of crop; a system well enough calculated to promote industry, and very promising to that constant supply which is necessary to the establishment of Bengal Sugar at the Europe markets.

DISTILLATION.

PRELIMINARY RULES.

THE distil house should be either annexed or contiguous to the boiling house, where the cistern or vats are fixed, for fermenting the molasses, and receiving the skimmings from the boiling and curing houses; the contents of the fermenting vessels should be proportioned to the size of the stills, so that one still may contain a whole cistern, or one cistern fill two stills, for when the liquor is down, and broke, whatever part is left, the immediate evaporation of its spirits renders it useless, or pernicious.

AT the commencement of the crop great care should be taken to have the cisterns carefully scrubbed, and washed with lime and hot water, and afterward dryed by burning in them a small quantity of the waste fuel, to heat them, which will tend to promote the fermentation; the skimmings from the boiling house must be conveyed in a small gutter kept carefully clean, to a large cooler, from thence into the cistern or vats, the dross thrown away, and the cooler well scalded and washed out; afterward it must be cleansed of the fuel burnt in it; if skimmings remain ten or twelve hours unset, they will turn ropy and become infectious by their rich and glutinous quality; hence if cleanliness, and attention in setting the ingredients in a pure and unaltered state, when set for actual fermentation, is not minutely and rigidly attended to, the whole set of cisterns or vats will be contaminated, and the quality, and quantity of the manufacture injured or distroyed; therefore, should a charge of liquor become thro' any neglect ropy, the lees should be thrown away, and the cistern washed with ashes and water, and fuel burnt in it more than once; for the lees of any bad charge, as already repeatedly observed, will, tho' set ever so cool, contaminate any other mixture they are put to; this will be found by experience, and it should be carefully guarded against, for if one round of the house only is contaminated, that crop of rum is diminished, or destroyed; five gallons of skimmings in Bengal will be found to contain sweets equal to one gallon of pure molasses; and it is recommended to use fourteen gallons of sweets, to every hundred gallons of the lees and water, which from experience yields the best proportion of rum.

As the manufacturer begins his crop, probably there may not be good lees remaining from the prior year, in that case there must be a greater quantity of skimmings than usual set, if there are no molasses saved on the outset sufficient for setting the first cistern, or vat, it should have seventy parts out of an hundred of pure skimmings, and thirty of water; but if there are no molasses saved on the commencement sufficient for setting the first cistern, or vat, it should have seventy parts of an hundred of pure skimmings, and thirty of water; but if there are molasses, fifty per cent of skimmings, four per cent of molasses, and forty-six per cent of water will answer very well.

THE mixture should be no more than luke-warm when set.

As soon as the first charge has run off, the lees must be conveyed into a cistern, prepared for that purpose; from which they should be pumped with a handy copper pump into a large cooler, where they cool, and settle; they are then mixed with the sweets, and serve as yeast or barm, in hastening the fermentation; eight per cent of molasses, thirty per cent of lees, and thirty-two per cent of water, will, if set pure and cool, as before mentioned, ferment in a few hours, and be ready to distil in five or six days, and will yield a good proportion of rum: too much care cannot be taken to have the skimmings and lees pure and cool when set, the liquor should be skimmed three or four times, the vats or cisterns, every time when emptied should be washed well; the mixture when set too hot will ferment strongly for about twenty-four hours, fall flat suddenly, and not yield a due proportion of rum; observe that when a charge of liquor has been set too hot, or when any charge does not yield a proper quantity of low wines, to throw the lees out.

Cisterns sunk in the floor, rammed well round with tough clay about five feet square, and five feet deep, have been found to answer better than vats;—they should be fixed in rows with covers to them, and built some distance asunder, so that a man may walk between them, when they are in apparently a boiling fermentation, to separate the froth; a good handy pump will pour the contents of such a cistern into a gutter and convey it to the still, in about twenty minutes; good liquor when properly fermented will blaze like low wines, on the head of the still.

OF THE PROPORTIONS OF MATERIALS.

Having shewn the different proportions for mixing of liquors, it will be of some importance to afford an easy, and exact method of calculating them without the tedious process of measuring the liquors; if the vats, or cisterns are eqally round or square at bottom and top, let the exact depth be taken on a rod, and that divided into an hundred equal parts; and marked so on the rod; then let the molasses be thrown into a cistern till it is eight of those parts deep, consequently let it be ever so large, that is eight per cent; again, if skimmings be put in until it is thirty-eight parts deep, that is thirty per cent of skimmings; and if lees are put in till it is sixty-eight parts deep, there will be thirty per cent of lees, and the remainder of water will be thirty-two per cent.

SOME distillers throw in the sweets at different times, and make such mixtures as keep working on slowly for sixteen or twenty days, but such a mode of proceeding is contrary to experience, and the best practice in distillation.

THE first degree in fermentation is an intense action, thro' all parts of the liquor; it then begins to separate from the thinner, or more rare parts, and is thrown to the top where it forms a thick spungey crust, which covers the liquor, and repels its more active parts, so that they cannot easily evaporate before they have performed their proper office, the crust must not be broke till it separates itself; the third is, when the crust in part or in the whole becomes heavier (as it often does) and less rare, on account of the spirits, and is dissipated or sunk to the bottom; when the fermentation ceases, a clear thin liquor swims at top, and the former subsides to the bottom. As soon as fermentation is completed (if time will permit) it is proper to shut close the vessel, and let the fermented liquor rest a few hours on its lees, for it will still consume much of them, and assimilate to them of itself with advantage, render them more spirituous, and much fitter for distillation; the molasses cistern should be covered very carefully, for if any water is conveyed to the cistern, a new fermentation will be excited to the destruction of the general fermentation, yielding, and qualities, when set for the regular fermentation.

THE heads of the stills should be well luted, and in this country where the natives are proverbially careless and negligent, great care should be taken in this particular, lest the best part of the spirits evaporate; the worms too should be kept as cool as possible; slow fires are best, for if the spirit is hurried, and runs hot, it will not only waste, but acquire a disagreeable flavor, somethiug like low wines, which is a constant defect in most of the liquors distilled in this country;* never fill the stills above two thirds of their height, let the fire at first be very moderate, and by degrees increased, damp or draw the fire when it is found, by feeling the goose-neck, that the wines begin to turn down towards the worm, which should be done very briskly, otherwise the violent heat will bring over foul wines, which is dangerous, (in sometime blowing off the still-heads) and at any rate should be carefully prevented, by keeping the fire in such a temperate state as to prevent it, and cause the wines to run down in a cool, steady, even stream, which, from a still of four hundred gallons, may be about the size of the little finger; till the whole comes over the helm, never drawing off more than will burn on the still-head; the same rule will hold good in rectification, except that you may then draw off a few jars lower than the burning proof, and throw it into any set liquor, as it will help the fermentation, and in some measure encrease the strength of the fermenting liquor; when rectifying, throw into the low wines about a pint of finely pulverised salt, and a gallon of pure molasses, for every hundred gallons of low wines; the salt will occasion the spirits to cleanse themselves from their phlegmatic parts, and render their passage over the helm much more free, pure, and fine, and the molasses will give the spirit an agreeable flavor, and take off a great part of the empyreumatical, or burnt taste, which all spirits are liable to contract in the distillation. Whenever the first runnings come down, take a small phial full from each can of rum, as they fill from the still, put the whole into a quart bottle; when the rum is almost drawn off, shake the bottle, if a hydrometer or bubbles are not to be had it may be proved with new sweet oil, which will be found a very accurate mode of proving rum, if the oil goes down very slow, and rises again, it is under the London proof; if it goes down boldly and remains down, it is good proof, and will sink a bubble of twenty-two the London proof; by this simple method, the proof standard may

* At Mr. Lambert's distillery, as likewise that at Omiedpore, the author has seen rum equal in quality to the best Jamaica, but it partook of the essential Oil of the cane; being distilled from cane liquor and pure molasses; the natives make a spirit which they sell very cheap, and consequently if quantity without regard to quality is the only requisite, it will command the sale; a man must have some knowledge of science to make rum or liquor of a good quality.

be infalliably ascertained for the crop, by trying the bottle when the still is nearly run off.

BUT if the first running is only drawn off and lowered with fine fresh water to oil proof, the quality of the rum will be good, as it then partakes of no part of the low wines, which are often too much connected with the lees, from running off too close; avoid this, and the rum will contain only its purest and genuine parts.

THE rectification of rum, as well as all other spirits, is but the repetition of distillation, until it is perfectly divested of all its phlegmatic parts, that is separating the more volatile from the lesser; to a certain degree or speaking technically, so as to avoid blending the smallest particle of what is called the feints with the pure spirit.

THE best state in which to keep rum is certainly that of alcohol, or spirit highly rectified or dephlegmated; and according as it is wanted to have it reduced to a market proof by fine fresh water; in the state of alcohol it may be transported in a smaller bulk.

ALL ingredients set for rum should be in a pure unaltered state; for should they coagulate, or grow sour before they are set for actual fermentation, the spirits never can be effectually dephlegmated, or purified, and in that state will retain the sour and deleterious parts.

To the neglect of these indispensable precautions it is owing that Bengal Rum is of a nauseous taste, and to bad treatment of the materials, neglect of the purity of the distilling utensils, and the great proportion of fermentable and putrid matter acquired in transporting the Jaggery from one place to the other; for similar reasons it is also, that the molasses transported from the West Indies to Charlestown, in Corolina, produce Rum as sour and pernicious as that of Bengal and that it is in similiar disrepute.

DISTILLATION.

OF PEACH, PINE, AND MANGOE RUM.

In setting Liquor for Peach, or Pineapple rum, &c. instead of mixing the usual quantity of lees, add the same quantity of pure cane juice, with the usual proportion of molasses and water, that the cistern be first washed and trash burnt in it observing.

Take a few bundles of Peach leaves with a few dozen of fruit, and flowers dried, which should be fermented in the cisterns, also some of the fruit and leaves should be put into a copper of syrup, or molasses, and boiled to the consistence of strong treacle, giving each cistern (a few days after the fermentation has taken place) three or four gallons of this treacle, which contains all the virtue, and flavor of the fruit; avoid going too near the less when canning off the low wines; and when the low wines are thrown into the still for rum, add four gallons of treacle to every hundred gallons of low wines, with one quart of salt, when the rum begins to come down, avoid taking the two first cans, as well as the last two, the middle will be therefore divested of the smallest particle of the lees; reduce the high wines to the necessary strength with clear water; when the fruit is put to the syrup, it should be boiled with a slow fire to the due consistence of treacle.

Oranges likewise, will, if put in the cisterns promote the fermentation, and improve the quality of the rum; and it is recommended the rind of the Orange with some of its flowers to be added to the syrup and mixed up with the low wines as it is committed to the still for the second distillation.

The Pineapple, rind and all, should be cut into pieces when thrown into the cistern for fermentation, and into the syrup; the Cocoanut also, and its contents, both in the fermentation, and the treacle will be found very fine; the quality of the fruit dispels all the imperfections belonging to the spirit; *in every stage of the process all depends—on cleanliness.*

One hundred gallons of rum rectified with one hundred gallons of water, will make the spirit of a fine flavor and quality, equal to the best Brandy; it is recommended that the rum for use in this country be put into porter casks, the dregs and lees of Porter greatly improve it, as do Tea-leaves, and one pint of unslacked lime to fine two hundred gallons down.

INDIGO.

THE brick-mould soil, as well as for Sugar, is found also best suited to the cultivation of Indigo, the ground intended for the growth of this plant should be well worked up by repeated ploughing and a thorough pulverization, which is indeed a general axiom in husbandry.

THE land preparatory to planting, if situated low, or if a flat, should be judiciously trenched forming forty feet beds, the trenches in width about four feet and three feet in depth; the Indigo is planted in regular and straight rows at about the distance of eighteen inches every way, so that those spaces or intervals may be hoe-ploughed from time to time, by which means the earth will be kept in a constant pulverized state and imbibe moisture, to support and nourish the plant; in the heavy rains retain a proper quantity of water and part with the superfluity; excess would produce Indigo of a stunted, withered appearance; the usual effect of stagnate or corrupted water.

WHEN the Indigo is judiciously cultivated it will shew a fine vivid thick foliage, an even quality and disposition; in the important process of fermentation upon the accuracy of which depends the success of all the subsequent operations.

THE error which the munufacturers in Bengal seem most liable to, arises from their not attending to the ill effects of an admixture of plants of unequal or opposite qualities, of various ages, soils, growth, and cultivation, which are committed to the steeper or vat promiscuously as received from the ryots.

WHATEVER superiority the Guatimala Indigo may possess over that produced generally in Bengal, must entirely be owing to the cultivation, and guarding against the evil effects of mixing different species of plants; for the Guatimala Indigo is produced from exactly such a soil, and the seasons are much the same as in Bengal; but no other weed nor grass is permitted to grow among their Indigo, as weeds draw a proportion of the essential oils from and frequently impart their unkind qualities to the Indigo plant.

INDIGO manufacturers in the West Indies burn ashes in the bottom of the vat, and rub it all over every time it is empt[illegible] they likewise use a lixivium prepared from wood ashes and quick-lime in fermentation, as it possesses the proper[illegible] removing and bringing into contact those substances which are held (in a partial [illegible]mentation) at too great distances and consequently [illegible]ards a [illegible]gular dissolation and [illegible]ion of the Indigo [illegible] the quick-lime in solution prevents an excessive fermenta[illegible] and putridity which is fatal to the manufacture.

COFFEE.

TH[illegible] cultivation of Coffee to a [illegible]nsiderable extent in this country would not only become a valuable article of trade, to the commercial interest of Bengal, but would also promote industry and wealth among the poorer Inhabitants, who may be inclined to cultivate small patches of ground which would amply reward them for labor, and always command a sale in Europe.

ALL descriptions of soil almost answer for the culture of Coffee, as it is a shrub that takes a strong root in the ground and requires sun and heat more than moisture or richness.

SINCE 1771 the price of good Coffee has been on an average; from £. 5, to £. 6, ster. pr. cwt. and the Coffee Planters of Jamaica annually got more clear profit in proportion to their capital than the Sugar Estate proprietors.

THE ground intended for this species of culture should be cleared of all grass and shrubbery, by burning; straight rows should be formed at four feet distance, and if the ground be hilly, let the rows be up hill as the Coffee tree will, if regularly planted, come up neat and even, and the trees will present a fine thick foliage and bear Coffee accordingly.

AFTER a Coffee walk, as it is called in the West Indies, is once established, it will last for ages and produce an annual crop—the first year of planting, it should be kept clear of all weeds; and the roots of the shrubbery should be moulded round from time to time; in case any of the plants perish, their places should be supplied with young slips or suckers from a nursery, which should be kept for that purpose during the first year; after that time suckers are found under old trees.

IF the ground is to be planted from the seed, care must be taken that it be not too ripe nor too green, the holes should be dug very slightly in rows as already described, and the seed covered with the earth of each hole; when planting slips, crush the earth round them with the foot, and water frequently.

THE success of the Coffee Planter greatly depends on his attention to picking the fruit from the trees when exactly ripe, before it drops from the twigs, as also his care in the process of curing.

IT is certain that Coffee growing in the same country and in the same soil is frequently found different in its quality; and for which many causes may be adduced, such as a greater or lesser degree of sun; from experience and observation it is conclusive that the quality of soil under Coffee (provided it be in its native climate) may be held as of little consequence, provided the trees are exposed to the morning sun, and the necessary degree of heat throughout the field, sustained till the perfect maturity of the grain.

PICKING Coffee with expedition, before it begins to drop from the trees, must be attended to without deviation, but the most particular and indispensable precautions should be taken in drying the fruit, after it has been newly gathered; and with regard to the materials made use of in constructing the platforms for drying, which must have no scent nor smell in any of the materials; planks sufficiently elevated for the air to circulate freely under them, are the best platforms, the *exhalations* from the earth are liable to communicate some foreign smell to the Coffee, that may destroy its required qualities; the pores of new gathered grain, being more open and containing a superabundance of water, are always disposed to receive every sulphureous or putrid exhalation with which the surrounding air may be impregnated.

WHEN Coffee has been well dried it should be kept in granaries or magazines, disposed in such a manner, as that the air may freely circulate therein, and thereby afford space for adventitious moisture to evaporate, so that it may digest itself, and discharge the green color and raw taste with which the new gathered Coffee is always charged.

IT is beyond a doubt that the quality of Coffee greatly depends on a strict care in drying, many Coffee planters in Jamaica have lately adopted the Arabian method, of leaving the grain in the pods, until it acquires a degree of dryness, sufficient to facilitate the conjunction of the fragrant violatile salt, with the nutritive part which resides in the pods, which latter tho' they appear to be exhausted, so as to be incapable of furnishing nourishment to the grain they cover, nevertheless may be of great use to favor the concentration of the essential salts, which are in such a state the more susceptible of evaporation, the fragrant principle being continually agitated by the rays of the sun, to which the new grain is exposed; the principles which unite it to the characteristic qualities of the fruit, are of too weak, or lax a nature, to retain it in the body of the grain.

THE cause of that difference found in the productions of Java, the West Indies, and Arabia, arises chiefly, if not entirely, from the degree of attention bestowed on *drying*; the stands should be about three feet above the ground, and the platforms or rather plankings, should be constructed with hurdles adapted one to the other; a construction of this nature, would greatly accelerate the drying of the grain, the column of air which would circulate under the planking and pass thro' the intervals of the hurdles, would contribute successfully to force off the raw humidity, in proportion as the rays of the sun would have the faculty to take it off from the Coffee which was exposed to it, at any rate the coolness of the circulating air would contribute to close the pores of the grain, so as to retain the particles of essential salt, which might otherwise quit it at the same time with the humid particles exhaled by exposure to the sun.

THE servants of Coffee planters in Jamaica are the happiest in it, the process being easy they are not overstrained with work, their chearful appearance shews it, the Coffee planters being much among the slaves, there is visibly a reciprocal regard between the slave and the master, and upon the whole nothing but peace and plenty reigns upon a West India Coffee plantation.

GINGER.

THE Cultivation of Ginger might be made an article of considerable advantage, as it will always command a good price at home, on an average from £ 3, 10 to £ 4, 10 the hundred.

GINGER thrives best in a loose soil, and should be planted at the distance of four feet asunder in regular rows,

IT is a prolific plant, and spreads and propagates itself with great facility over a field, and vegetates so thick that it obstructs the growth of other plants or even weeds; it requires however weeding only once a year, and that when young, after it once takes root and begins to seed, there is no further trouble with it until it is fit to dig which is a little after the seed drops.

WHEN digging the Ginger, care should be taken to leave a slip in the ground for seed as the laborers go on, and by the time one end of the field is finished, the other end will then recommence vegetation; after crop, the labor attending this cultivation is very easy, for a man cannot easily over fatigue himself, care and attention being only necessary in digging and picking the whole of the Ginger out of the ground, and separating it from the earth.

THE Ginger heaped up in the fields from whence it is picked is always washed prefectly free from every particle of earth; it should not be left any considerable time in water, as it quickly imparts much of its virtue thereto—to the disadvantage of the Ginger.

WHEN it is well washed it should be dryed in the sun upon a platform or a hurdle, and removed in baskets; when the root is hard, difficult to break, and of a resinous white, it is fit to be packed up for sale; there are two species, the black and the white, there is about five shillings per hundred difference in the price, but it is difficult to discern any in the quality; the white is however, somewhat more prolific than the black.

WHEN dryed it should be sent to market in coarse bags; of strong canvas, containing about 300 lbs. averdupoise, this article if encouraged, would furnish a considerable export from Bengal, and many other parts of India.

GUINEA GRASS.

THE Cultivation of Guinea Grass in the western parts of our provinces, would unquestionably be productive of the greatest importance and advantage to the country; and even here, where the fodder for cattle is extremely bad, and often scarce, it might be worthy of regard.

THE want of good fat Oxen on the momentary emergency of a war, for which this country should never be unprepared, would be of no trivial utility, and would obviate many inconveniencies to which our troops are liable even on the yearly relief.

GUINEA GRASS, which grows on the most sandy desert or mountain, when it has once effectually taken root, puts it almost beyond possibility again to eradicate it, it is perhaps the best fodder, produced on earth, its properties in the conclusion.

PREPARATORY to planting, let the ground be cleared (by burning) of all other productions, set the people to dig shallow holes through the field in regular rows, at the distance of four or five feet asunder, or at the distance of ten feet in case of a scarcity of seed or plants.

WHEN the ground is thus prepared, at the commencement of the rains, plant four or six grains of the seed, or half the number of slips of old Guinea Grass in each hole, slightly covered with mould, with the ends of the slips open to the air, planted across the hole, they will in two or three days shoot forth young grass.

FOUR or five weeks after the grass is planted it should be well cleared of all other weeds and shrubs, the roots moulded up, and so on until it begins to seed, when it should again have a thorough cleaning, and let it remain till the seed is dropping off; at this time it will be five feet high, then the stock should be turned into it, the cattle feeding over the field of grass, helps to trample and plant the new seed in the ground; when the grass is sufficiently trampled in the earth and eat down, it should be cut close to the roots, and a fire set through it, but should be done as the rains begin to fall, the grass will then spring up as thick as clover, and is ever afterwards established, and fattens the most reduced Horses or Bullocks in a few weeks; stock has been recovered by Guinea Grass in America which were so low, that when put into this kind of pasture they lay down and fed on the grass on each side within their reach, till they gained strength and afterwards improved so fast that they appeared almost like wild cattle in less than two months, or by the time they were wanted to work in the mills.

GUINEA GRASS in Jamaica, previous to the American war, was cultivated only on those plantations which could afford a small piece merely for recovering lifting steers* after crop, and if a Sugar work had fifty acres under grass, it was considered a great deal; there were then no more cattle bred than were barely sufficient to supply Saint Jago de-la-vega and Kingstown, with beef at 20 pence per pound; the plantation never saw fresh beef, they were obliged to live upon salt beef from Ireland and, their poultry, the island of Cuba supplied Jamaica with oxen, Horses and Mules, to the number of 50,000 annually, for which the Spaniards drew an immense sum in specie from the Islands, and proved extremely distressing, to the British planters; this trade it is probable would have continued since, were it not for the American war, by which salt provision, in the first place rose to an extravagant price, and but very little was brought to the island; the trade being diverted by various casualties elsewhere; the Spanish war put an end to the Cuba trade (as it was called) and the army and navy's demands rose fresh provisions to a most grevious price; as necessity is well called the parent of industry, the small settlers turned their attention to the breeding of stock, great tracts of the interior wood-lands were cleared away, and formed into extensive Guinea Grass, pastures, and as expeditiously converted into breeding penns; on the fourth year after the distress occasioned by the non-importation of cattle from Cuba it was amply obviated, and the great inconvenience arising from the extravagant price of fresh meat, was remedied, as beef fell from 20 to 5 pence per lb. this successful effort gave birth to another, a charming breed of English Horses was introduced, and at length an English breed of oxen; the ready cash before annually drawn from the island

* The steers which work in the Waggons carrying the Sugar to be shipped, are often so reduced by the end of the crop, that when they lay down they cannot rise without assistance.

by the Spaniards, was now circulated on the Island to the advantage of the Guinea Grass planters.—Hence it was that the cattle in Cuba became so numerous, that the Spaniards now frequently kill them in the open field for the sake of the tallow and hides, leaving the flesh to the birds of the air; there was not an acre of Guinea Grass in the whole island of Cuba, it being all in valleys and plains of common pasture.

It was computed that between 1772, and 1792, 150,000 acres of Guinea grass were planted, and 30,000 head of stock annually raised in Jamaica; notwithstanding that increase, the price of working steers, horses, and mules, kept up on account of the annual demand for the Sugar estates, only breeding farms in the West Indies, take three years to establish them, but the capital required here would be so trifling in comparison, and the advantages of every other kind, so many, that it would require both less time, and trouble, to which we may add the great difference between the price of labor in the East and West Indies.

To the colony of South Wales, Guinea Grass farms to support a good breed of stock, would soon remedy all the disadvantages there complained of; and at the Andamans, it is worthy of consideration, how far it would prove useful there, the Island being situated centrically for the exportation of cattle on emergency, or victualling of merchantmen.

It would be only requisite to clear away the under-wood at the Andamans, for the Cultivation of Guinea Grass.—In Jamaica all the timber trees are spared in clearing, to be cut down for use when wanted.

In travelling through the Jamaica Guinea Grass-farms, the man who recollects the period prior to their establishment, feels inexpressible delight, the valleys, hills, and plains, divided and lined by handsome stone walls, far as the eye can reach, the plantations covered with herds of charming oxen and horses, and shaded by the magnificent cotton, mahogany, and cedars lofty as those of Lebannon, vocal with the music of a variety of birds, the nature of the climate altogether seems to have changed, and verdure taken place of a hot and parching soil.

TWELVE hundred biggahs of Guinea-Grass, fenced round and divided into parks or lots by substantial fences, judiciously stocked with a proper breed of horses, oxen, and sheep, would in this country (after the first three or four years) yield a clear annual profit of twenty thousand rupees at least; to keep up the fences, the Guinea-Grass clear of all weeds, and the different denominations of stock separate, this breeding farm would require twenty or thirty laborers throughout the year, beside proper persons to rough-break the horses, previous to sending them for sale: a couple of fine English horses would promote the value of such a property, by crossing the breed.

COCOA TREE.

THE Cocoa, or Chocolate tree, thrives best when transplanted from a nursery established from the seed; slips, or suckers should be taken at about three months old, and set at from fifteen to twenty feet distance in regular rows, they will grow to the size of the British apple tree, and blossom exactly like it, but it flowers and bears all the year round. The fruit is of the shape of a Cucumber, with a small protuberance like a button at the stem, and hang in clusters from every branch; they are known to be ripe when the skin has changed color from a green to a fine rich ruddy appearance, when the button begins to change its color the fruit must be immediately gathered, and piled up in heaps as the gatherers go along, where they must remain untouched for five or six days; if for a longer period they would begin to vegetate and sprout to the destruction of the pods, which should be husked on the sixth day at farthest.

HUSKING is performed by striking with a piece of wood on the middle of the pod, which bursts it; thus opened the bean is taken out and thrown upon a moveable platform, covered with the leaves of Cocoa trees, of about four feet long and twenty inches broad surrounding the Cocoa with the branches as an hurdle, and covering it with the help of leaves; in this state the Cocoa will undergo what is called sweating, it is often left all night in the dew; and turned well morning and evening from top to bottom, covering it as before, so that when this operation has been repeated for five or six days, it is sufficiently sweated, which is known by its color, as it becomes entirely ruddy. The effect of this operation is the more successful in proportion as it is deprived of its weight and bitterness, if it has not been sufficient, it will taste bitter and smell raw, and not unfrequently sprout, there is consequently some judgment required in the operation.

Cocoa which has been successfully sweated is removed from the first platform to another, about two feet from the ground covered with mats, upon which the Chocolate is spread about three inches thick in the sun, turning it with wooden shovels, made for that purpose, during the day; this should be done for four or five days, rolling it up in the mats at night, covering it up with planks to secure it against casual rain or dew. It is requisite that there should be at all times a good supply of leaves and planks to cover it in times of rain, which would be injurious to the Cocoa; when sufficiently sweated, it should be continued to be exposed in the sun, turning it often, until it is perfectly cured, which is known by the beans cracking on compressing them in the hand, if they crack freely, they are cured, and should be put into an open and airy granary, spreading, turning, and heaping alternately, until it is quite divested of all superfluous humidity, in which state it is put up into bags and sent to market; and brings from two pound fifteen to three pounds per hundred.

PIMENTO.

The cultivation of Pimento in Bengal would create a new and lucrative branch of trade, as it is an article of commerce and always commands a quick sale from 12d. to 14d. per lb.

A Pimento plantation should be establisned by transplanting from a nursery of slips reared from the seed.

The trees should be planted as regular as possible in a Pimento walk, in rows divided by twenty feet intervals at least; the trees grow very high with a thick foliage, cattle may feed in either Guinea Grass or common pasture, beneath the trees, when the walk begins to bear.

The fruit hang in clusters from the branches and afford a charming aromatic scent, which perfumes the air to a considerable distance around, from the moment it begins to flower until the corp is picked. It begins to blossom in May, and the fruit appear in clusters immediately after.

When the clusters change their color, from a dark green to a brown, the fruit is ripe, and the pickers place themselves in the tree, and break the twigs to which those clusters hang, and crop them down to persons placed beneath, who lay them upon cloths which are spread for the purpose of receiving the Pimento that drops, and to separate the fruit from the twigs, and spreading it on those cloths in the field from morning till night, turning the fruit often, and heaping and covering it up at night from the dews. When the planter has a considerable quantity picked and wrinkled by the heat of the sun, all hands carry the Pimento home to his granary, putting up on his platforms erected at least five feet from the ground, it is put out every morning at sun rise and kept turning repeatedly until the sun is down; when it must be conveyed again to the granary, and continued to be put out and dryed in this manner till it is all turned from a green to a brown hard color, when it is put into bags and sent to market.

A Successful Pimento crop chiefly depends upon expedition in picking the fruit from the trees, and being careful in curing sufficiently by either sun or stoves, so that it may not acquire any foreign or damp air.

The parishes of St. Anns and Tralawny on the north side of Jamaica, load several large ships annually with Pimento; when Planters are well pleased with a crop and season, they give feasts to their friends under the shade of the Pimento walks; the finishing of a Pimento crop in Jamaica is a woeful day to the sheep and swine; among the poultry, young pigeons, rabbits, and the inhabitants of the woods and waters, there is equal war, for ere it be day the Pimento walks and groves resound from the fowling pieces of the planters and sportsmen; doves of various kinds, partridges, quails and guinea hens fall victims; the rivers and little rivulets are poisoned with the hogsheads of lime by which the various kinds of scale and shell fish are intoxicated, easily caught and taken from their element; the harmless Turtle which is pampering during the Pimento season now loses its head.

THIS is called a *maroone dinner;* and such are the scenes of happiness which an amicable form of society, united by acts of kindness, common good will, and mutual industry, presents in the West Indies.

TOBACCO.

AN extension of the growth of Tobacco in Bengal would be found a branch of trade exceedingly advantageous to the commercial interest of the British nations; its general use all over the world, is now so great, that with all the exertions of the cultivators in America, they are by no means adequate to the supply of the European markets.

IN Poland the cultivation of Tobacco has very recently been attempted by their government and persons conversant in all branches of it encouraged from Virginia and Maryland, to introduce the true cultivation and manufacture throughout the Polish dominions, where it can be raised only, in the short summer season.

THE ground for the cultivation of tobacco should be ploughed once or twice, and manured very highly, with either moving cattle penns or dung; rich soil out of old tanks or ditches well spread and then ploughed in, will bring it up luxuriantly, like cabbage; it is first planted from the seed, and the plans drawn and transplanted in regular rows at three feet distance, and shelter'd from the sun with plaintain leaves or other light covering, and when pretty forward or about half a foot high, the laborers should hoe-plough between the rows, moulding up the roots; this should be often repeated, keeping the Tobacco field clear of grass, or weeds and where the Tobacco appears stunted, the laborers should throw a few baskets of dung about the roots, and hoe-plough it into the earth, which would soon alter the appearance of the Tobacco; the banks of the Hoogly are choice for the produce of fine Tobacco, on account of the rich loam of the river to manure the soil.

THE leaves being ripe, which is known by their brown appearance, and breaking when bent, the stalks are cut and the plants laid to dry two or three days in the sun, after which they are loosely tied, three or four stalks together, and hung up with ropes to cross pieces of wood which are constructed at convenient distances in long open sheds, which should be built for the purpose of drying; when the leaves on those stalks are sufficiently dryed, they take them down and pull off the leaves, which are made up in little bundles, and soaked in water impregnated with a small proportion of salt, twisted and formed into rolls in which state it is sent to market; as also in the leaf.

THE principal care of the Tobacco Planter is to have his soil highly manured and pulverised by frequent ploughing, to cover the Tobacco when young, with Plantain leaves from the rays of the mid-day sun; his ground formed into beds of twenty feet broad divided by three feet trenches, in which the laborers may walk and lay up the Plantain leaves at night and as the heat of the sun abates begin to uncover; but when the Tobacco takes sufficient root in the ground to grow up and spread its leaves, then it should be hoe ploughed, and as already observed manured round the roots with the mould and manure well mixed up, or the mould of ditches or old tanks will answer. A little before the stalk brings forth its seed the plant should be lopt (as it is called among Tobacco Planters) by cutting off the top or sprouting end of the plant; this instead of letting the juices nurture into seed, converts them into the leaves and accordingly strengthens the quality of the Tobacco, taking care to cut off a few of the bottom leaves, until the Plant spreads itself out to its full growth; the quality of Tobacco depends upon the number of leaves left on each stalk, and on the lopping to prevent seeding; if the stalk runs into ripe seed they carry off the juices, and the Tobacco will be weak in consequence, but if lopt in time to retain the juices the Tobacco will be strong, proportionably to the state of the sap when cut; Tobacco from Bengal would average £ 8 per hundred in Europe; indeed no soil in the universe is better adapted for its cultivation.

A LETTER

To the Honorable Court of Directors, for the Honorable United Company of Merchants of England, Trading to the East Indies.

HONORABLE SIRS,

THE source of wealth now opened to you, by the present opportunity of encouraging the sugar manufactories in Bengal, to be carried on by the process practised in the West Indies, in making, curing, and claying Muscovado Sugar, is of such magnitude, that I think it incumbent on every man who possesses a knowledge of the subject, to display it so as that the nation may profit by it. I have, therefore, thus presumed to address you, Honorable Sirs, in order to explain those points upon which the Sugar trade of your provinces in India, must either rise to the importance which they are capable of being brought; or prove injurious to your interests, and ruinous to the inhabitants of your provinces.

HAVING lived in Jamaica sixteen years, and during that period been employed in the cultivation and management of Sugar estates, both on the North and South sides of that Island; I may venture to assert that I am a competent judge of the soil fit for planting Sugar-canes, and how far it will answer for that cultivation.—All the ground I have seen here, (Omiedpore excepted) and I am well informed the country throughout is mostly the same, consists of plains of excellent brick mould, which I assert to be the best for Sugar; and in its natural state, will yield from one to two tons per acre, by any tolerable care and attention to the West India mode of clarification, and boiling in the first process, which at present is unknown to the natives; their mode of expressing the cane-juice, and making jaggery (as they call it) being extremely unprofitable, unproducting, awkward and tedious in its process.

From the luxuriance and fertility of this country, I think it is amply competent to the supply of all Europe with Sugars; and that even the West India planters themselves might import them from hence on much easier terms, than they can afford to sell Sugars in the curing houses upon their plantations.

Since my arrival in Bengal, I have inspected the process practised by the natives, in making jaggery, which is as follows:—A farmer, or ryot, erects his work adjoining to the field of cane fit to cut; the grinding, boiling, and distil-houses, are under the same roof, only a mat supported by four sticks stuck in the ground; the boiling utensils are four small earthen pots, (called cudgeree pots) about the value of two pence.—The cane trash serves for fuel, and the mill for expressing the juice from the canes, are two small rollers from four to six inches in diameter, turned in opposition to each other by two men. When the ryot finishes the field of cane, his laborers and himself take the whole set of works on their backs, and set them down at the next field which is to be cut; but their mode of expressing the canes, is so exceedingly slow, that the juice acquires a degree of acidity, which destroys not only a considerable portion of the saccharine particles, but contaminates the whole body that remains, and which afterward cannot be corrected; indeed the cane juice is in a forward state of fermentation before the process of boiling is commenced.—The return from those contaminated juices, is the matter called jaggery, which in fact, is the sugar too much or too little boiled, made from unclarified cane liquor in an injured state; this contaminated jaggery is put into close cudgeree jars, and is fermented a second time: when a sufficient quantity is procured, they carry it in leather bags fifteen, thirty, perhaps an hundred miles on bullock's backs, or by water, to a second class of sugar manufacturers, who purchase it on very low terms, from ten annas to one rupee per maund, (80 lb.)—The second class of manufacturers boil it down once or twice again, and get ten seer of sugar (20 lb.) from the maund of jaggery; whereas the first manufacturer might with the same fuel and labor, make the maund of sugar, so as to augment his quantity 60 per cent, save labor, and better the quality.

The Jaggery is collected and thus boiled down into Sugar, by those numerous herds of intermediate traders called banians, sircars, peons; and Jaggery and Sugar which is not thus monopolized by those speculators and their representatives all over the country, is brought to the bazar of Calcutta, and is sold at the market price; in the state the Sugar appears of a soft, greasy quality, owing to the vast quantity of milk and ghee added by the jaggery boilers, with a view to recover the saccharine particles, weakened, and destroyed by the acquired acidity; hence this Sugar forms into a coagulated mass on the voyage to Europe, and proves totally unfit for the Sugar refiners, and unprofitable to the consumers. The sweets from this fermented jaggery, yields a spirit, (which is here called rum,) of a sour quality, quite different in flavor from that made in the West Indies, the sweets being of an impure and partial fermentation, before they are set for distillation.

The sugars from hence, that I saw in London, were in this soft greasy, congulated state, which shewed they were made from contaminated cane juice, and not the pure juice, as it ought to be had here, and which (from the quality of this soil) is the most grateful and rich that can be.

On my arrival in Bengal, I determined to try what kind of sugar could be produced from the canes managed in the Jamaica manner, that is, by carefully adopting the mode of guarding against acidity, and closely attending to the process of clarification; I therefore crossed the Hoogly, near Calcutta, proceeded up the Benares road, to the distance of three miles; when I came to a field of cane where the natives were making jaggery as already described,—I bargained for a number of bundles of cane, for two annas per bundle, which was the price they were selling for at the Bazar, in the neighbourhood to the retailers of Calcutta, who bought canes to eat.—I immediately sent my Bearers to purchase me one of the country mills, which cost four rupees; for cudgeree pots as boilers, eight annas; a mat two annas; and thus I fully completed my works in an hour, my Bearers turned and fed the mill, and about four o'clock had made two skips of very fine grained Sugar, which upon claying appeared to be equal to the best St. Kitt's Sugar.—The experiment I have frequently tried since with success, before several gentlemen of this settlement, by which I proved how ruinous it is to the first manufacturer, to make the juices of his cane into jaggery.—A sample of the Sugars made in the first process of boiling with this awkward apparatus, I will do myself the honor to send you by the next opportunity, which I hope will meet the full approbation of the Sugar refiners in London.

THE sugar mills as worked in the West Indies, ought to be erected in this country, at convenient distances; they will do great execution, worked by the bullocks, or buffaloes of these provinces; with those mills a quantity of juices can be expressed, so as to clarify and boil before it acquires any degree of acidity.—The process of clarification should be commenced twenty minutes at furthest after the juices are expressed; and it is known in Jamaica, as a matter of the greatest importance, to keep the cane liquor as sweet and as unaltered as possible, from the moment of its expression, till the process of clarification begins, and every means is used there for conducting it in that free and unaltered state from the mill to the boiling house; for should any old liquor lodge, it speedily acquires a degree of putrescence, which must in course more or less infect the whole body of liquor.

THE more I see of this luxuriant soil, the more I am convinced, Honourable Sirs, that you might annually import from Bengal, any quantity of sugars, and a proportionable quantity of rum, of a superior quality, without interfering in the smallest degree with the present cultivation, and manufactories of Bengal; indeed, the waste land occupied by the tigers between this and Injellee, would produce nearly as much sugar as the island of Jamaica; and as to labor, thousands of laborers may be had by the day or week, month or year, at two annas per day, or three rupees per month, the highest hire given.

THE fertility of the soil of this country is such, that it does not require the labor of one-fourth of its inhabitants; therefore, the cultivation of cane will employ thousands of poor people, which are to be seen in all parts of this country unemployed, and in real want; and inasmuch, as the cultivation of the sugar-cane destroyed annually in the west, thousands of men, women, and children by incessant toil, it will save the lives of thousands in the east, by giving them employment and sustenance.—The destruction by famines, frequent in this country, by the failure of the light crops of grain, is too well known to need any argument being made of it on this occasion; it need only to be urged, that sugar, and its slops, with little else, will support hundreds, and I may say thousands of families, as the drought of many months will not destroy that valuable and grateful plant.

THE following plan, I am well satisfied, if adopted here, would prove of the highest advantage to these provinces, and of the unmost public utility:—The natives to be instructed in the West India mode of raising cane and in grinding, clarifying, and boiling in the first process, so as to insure your sugars the market at home, and thereby secure and establish a valuable branch of trade; for which purpose, factories to be established in the different districts, at convenient distances from each other, adjoining to these buildings there should be kept under cane 1000 biggahs, or 300 acres, this would employ daily, either by the day, month, or year 150 or 200 of the poor natives called coolies, including tradesmen, at one anna and half per day, or three rupees, the very highest per month; these 300 acres of cane will make you 300 tons of sugar, worth in Bengal, 25l. per ton at least, say 7000l. I mean the strong white muscovado sugar, that will bring 70 shillings per cwt. in London; the 300 tons will get you a large sum of money at home, besides, a proportion of rum, which if made of a good quality, will always command a market in Bengal, and will amply, help the cultivation;—and if double distilled into pine, cocoanut, or peach rum, it would answer very well for exportation, as well as afford you the happy advantage of supplying your army and navy in India.—The rum at present used here, is the pernicious spirits "distilled in cudgeree jars, from the contaminated jaggery, which is collected from far and near for those distilleries," and which produces rum equally sour and unwholesome, as the very ingredients from which it is distilled.

FORMERLY, when distillation was but little known or attended to in the West Indies, with respect to the cleanliness or proportioning the different ingredients set, the rum was of such pernicious quality, that those persons who used it even in the smallest quantity, were attacked with bowel complaints, many lost the use of their limbs, and they who drank it to any excess, such as the soldiers and sailors, were soon destroyed; but happily, at this period, that disease is not known, particularly in Jamaica, owing to the very great improvement made in the distillation of rum, throughout the Island; bad rum in India, must be equally fatal to your army and navy.

THE buildings consisting of boiling and distil houses, mills, coppers, stills, cisterns, gutters, and pumps with tanks, oxen, &c. &c. for each plantation of 300 acres, will cost about 30,000 rupees, for this sum you will have a factory equal to an estate in Jamaica worth 40,000l. sterling; the value of the slaves excepted.—The detached natives would soon gain the knowledge of making good Sugar, and could afford to sell them to you at those factories on very reasonable terms so that the sugars purchased from them might undergo any necessary process to fit them for the Europe market. Another plan might be adopted, by which the Honorable East India Company would avoid the expence of the cultivation of the ground, &c. which would be to allow the natives a premium for the best produce of cane and Sugar, as the Agriculture Society do in England.—The Sugars to be bought up for your use; by agents in the different districts, and warehouses to be erected for the purpose of their claying or undergoing any other process necessary. I should be happy to be employed as a superintending sugar manufacturer, or distiller, or even in both capacities, and flatter myself, that as an individual, I have it in my power to promote the interest of the Honorable East India Company; as I am well acquainted with every process belonging to the cultivation, making and claying muscovado Sugar as well as with that of distillation, and I would undertake to make pine, peach, and cocoanut rum, equal in quality, to the best Bordeaux brandy.

IT is not possible that the people here called sircars and banians, the greatest knaves in India, can be competent, (were they even well disposed, to collect sugars of a good quality, under the direction and inspection of the residents only, who themselves can have no knowledge of the manufactures and whose time is employed and called to many other important concern, particularly as the native manufactories are detached. The husbandmen of this country will not over plant themselves, for the same field produces them the cane, the rice, the barley, the wheat, the hemp, and I may say the men to cultivate and protect it:—in short the ease and facility with which the husbandman carries on his cultivation, though not productive, is to a reflecting mind, truely pleasing, a pair of bullocks and one man in a day are able to turn up with a very simple plough, as much ground as fifteen or twenty negroes could do in the West Indies by manual labour; the whole country being either a brick mould, or inclining to it, and which is probably, the most productive sugar soil in the universe; consequently capable of supplying the Europe market annually with any quantity adequate to the consumption.

It is a fact well ascertained in England, that the British West India islands have long since ceased to be competent to the supply of Great Britain and Ireland with sugars; and that the importation of an hundred thousand tons of sugar from Bengal, into the British ports, would not make the difference of two shilling and six pence per hundred in the price of West India sugars, upon an average of any given period; this I know from experience, as I perfectly recollect the prices and demands for sugar since the year 1771.—It is likewise a known fact, that the whole of the West India-islands are not competent to furnish Europe with sugars, adequate to the increasing consumption.—The constitution of the laborious slave, though he works day and night six months in the year in the manufactory, acquires new vigor and strength during that period from the use of the sugar and its slops; and after crop from the disuse of it, falls off and contracts little nervous fevers, which are always removed if sugar can be obtained, for the sweetening his sage or contrayerva tea.

COMPARATIVE ESTIMATE OF A SUGAR ESTATE IN JAMAICA, WITH ONE IN BENGAL.

JAMAICA.

Daily employed on a 200 hogsheads estate in Jamaica, slaves old and young, ..		200
Cutting cane, ...	22	
Tying ditto, ...	8	
Wain men, ...	8	
Mule men, ...	8	
Boiling house, stoke holes, &c.	16	
Mill house and trash carriers, ...	9	
Distill house, ...	6	
Cutting cane tops for fodder	6	
Runaways, generally, ..	10	
Overseer's house.	6	
Great house, (if any) ..	12	
Looking after cattle, ..	6	
Ditto hogs and sheep, ..	6	
In the hot-house, generally,	16	
In the yaws, ...	6	
Superanuated, ...	12	
Invalids, ...	12	
Children, from 5 to 10 years, carrying grass, ...	21	
Infants.	10—200	

N. B.—This estate, if a water mill, will make ten or twelve tons per week; if with cattle, eight or ten tons.

Negroes employed out of crop, viz:

Hoiing ground for planting cane,	46
Making manure, ...	2.
Grass gang weeding young canes, children from five years old to ten, ...	30
The field gang, ...	101
Wain men, ...	5
Mule men.	3
Rat catchers, ...	8
Sick house (on an average) ..	10
Runaways, ...	10
Looking after runaways, ..	2
Looking after cattle, hogs, &c.	6
In the yaws, ...	6
Superanuated, ...	16
Invalids.	10
Manager's house, ...	6
Infants suckling on (an average)	12
Tradesmen of different occupations, ...	9
Differently employed, ..	99
Total strength, ...	200

	£.	
Say average value 50l. per head, ...	10,000	
Mules and Oxen. ..	3,000	
Value of land under cane, 40l. per acre, ...	8,000	
Waste, pasturage and negro ground. 11l. per acre, ..	1,100	
Works complete, with coppers still, &c.	10,000	
If the plantation is far from a lace of shipping, there must be a half-way grass pen to rest and feed the cattle, ...	1,000	
The value of a 200 hogsheads estate.......Currency.	33,100	
Currency 33,100l. is sterling, ...	23,612 17 0	
This property will require the addition of hired labor occasionally, or a supply of new negroes, to put in the place of those who drop off, to make from 150 to 200 hogsheads 6 cwt. each.	500 0 0	
	23,142 17 0	

Allowing 200 acres to be under cane, and yielding 200 hhds. at 21l. per hhd. in the island on average,	4,200	0 0
Interest on the capital of l. 23,642 27 at 6 per cent to be deducted, ..	1,418	11 8
Commission on the shipment in the island; ditto on the net proceeds in England and insurance home, to be deducted, ..	480	0 0

Utensils and clothing for the ne-

groes is about 500 per annum, .. 500 0 0	
2,398 11 8	
The rum paying the white peoples wages and expences in the island and therefore leaves the owner, .. 1,501 8 4	

BENGAL.

Now admitting that 300 acres of cane land was kept under cultivation, the ground valued at 4 rupees, the utmost rent per biggah, 3 biggahs to the acre, current rupees, ...	3,600
Works, coppers and stills, and all utensils to take off 150 or 200 tons sugar of, ..	30,000
Labourers, 200 daily, employed, calculating the labour of two in Bengal, to be equal to one in Jamaica, at 2 annas per diem, per annum, or 3 rupees per month, including tradesmen, &c.	7,200
European boiler and manager, at 500 rupees per month,	6,000
Horses and bullocks to work the mills, ...	1,300
Capital, C. Rs.	48,100

This property producing 150 tons of sugar on an average value in Bengal.

Annual Returns, Pounds Sterling, ...	3,000

THIS property has the advantage of the West India estate, having no hurricanes, loss of negroes or stock to encounter, as 8 or 10 rupees, at the utmost, will replace a bullock, which costs 10l. sterling in Jamaica, Many circumstances, such as the failure of the West India crops, the rage for abolishing the slave trade, and the combinations consequent thereto, concurred in rendering the first importations of India sugar, such as were sold in England the two years past, peculiarly successful;—but I am convinced, after those combinations are ended, that your India sugars, as manufactured at present, will be little sought after at the Europe markets, being much inferior to the manufacture of the West Indies; as the sugar from this country does not go so far in sweetning, as the manufacture of the West, owing to the saccharine particles having been destroyed, by the acidity acquired in the jaggery process, as I have already observed; and therefore, Honourable Sirs, it is necessary that the most serious precautions should be taken in making an early provision, by perfecting the manufacture here, so that it may answer all the effectual ends to the refiner and retailer in Britain, and thereby secure its permanency.

IT is generally conceived in this country, that the West India colonies will be rendered adequate to the complete supply of all the sugar necessary for the trade of the British dominions in Europe; but from my own experience I do not scruple to assert, that this opinion is founded in error; and to add that the West India colonies are not, nor ever can be, competent to a supply equal to the produce of former years. It is no further necessary to illustrate this truth to you, Honorable Sirs, than by observing, that the gradual abolition of the slave trade, will produce every blessing to the slaves, the masters and the persons concerned, a happy system of management will now be adopted, which will preserve the negroes and possession of the plantation to owners, tho' an estate in Jamaica making 200 hogsheads may owe in England 20,000l. sterling, which is nearly its value; and that this estate, by encouraging the propagation of the slaves, falls off to 100 hogsheads, which is worth either in the island or in England, at least 2,000 guineas upon an average—it will clear itself in 14 years by adding the growing interest to the principal, and paying off the debt by instalments, in short the planter will no longer find it his interest to over-plant himself. The conclusiòn arising from these facts, is what induces me to state it, which is that as the quantity of Sugar in the West Indies is likely to diminish, and sugar in a commercial view, is in all respects a British staple, its failure would prove of irreparable injury to the nation. From Bengal alone then can it be supported, secured and supplied effectually but it is of the greatest importance in the present infant state of the sugar trade from this country, to guard against two evils which are to be apprehended, the failure of the trade generally, through the imperfect quality of the Sugar as manufactured by the natives of this country at present, and the great loss sustained by the ignorance of the natives in the mode of clarification and boiling in the first process. Their returns are very inadequate indeed to the labor bestowed on their little fields of cane, those who are acquainted with the management and yielding of cane know, that one acre of cane (equal to three biggahs, will yield 2,200 gallons of cane juice upon an average, and that 2,200 gallons of cane liquor in Bengal, will make 20 hundred of sugar, 30 per cent better than any sugar made from jaggery. The ryot in Bengal makes his 2,200 gallons of cane juice into twenty maund of jaggery; which he sells for two rupees the maund the highest price, so that the ryot's returns are forty rupees on his three biggahs of canes; out of this forty rupees, he pays for expressing the juice, which is done by manual labour, or by awkward mills, as also his rent.

I LEFT England with Lieutenant Paterson, with whom I entered into engagements in London, to superintend his sugar manufactories in Bengal; but Mr. Paterson thought it expedient to reject my services on his arrival in this country.

I NOW beg leave, Honourable Sirs, to offer you my services, in any manner your wisdom may think proper to direct my experience in your sugar trade in this country.

I have the Honour to be,

Honourable Sirs,

Your devoted and

Obedient humble Servant,

W. FITZMAURICE.

Calcutta, January 29, 1793.

FINIS.

HAND-BOOK

OF

PRACTICAL AGRICULTURE

FOR

BRITISH INDIA AND HINDOOSTAN,

BY

LIEUT. FREDERICK POGSON.

HER MAJESTY'S BENGAL ARMY.

"MOFUSSILITE" PRESS, UMBALLA.

TO THE

PRESIDENT AND VICE PRESIDENTS

AND

MEMBERS

OF THE

Agricultural and Horticultural Society of India,

I dedicate

this Hand-Book on

Practical Agriculture.

BY PERMISSION.

For British India and Hindoostan.

BY

LIEUTENANT J. FREDERICK POGSON,

Her Majesty's Bengal Army.

VARIOUS works have been published in India on Gardening or Horticulture ; but as yet none have appeared on the important subject of Agriculture properly so called.

The present work is intended to meet a want much felt, and as it will supply ample information on all subjects connected with Agriculture, it will be found of use and assistance by the Officers of Government. To the British Capitalist and Indian landed Proprietor, the Tea, Cotton, and Sugar Planters of India, it will be a desideratum.

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PART FIRST.

CHAPTER I.

THE GRAIN-PRODUCING SOILS OF INDIA UNDER ASSESSMENT. —RICH SOILS, TEA, SUGAR, COFFEE, TOBACCO, AND COTTON SOILS.—SOILS FERTILE WITH AND WITHOUT MANURE.—PECULIAR OR SPICE SOILS—LAKE OR SUB-AQUEOUS SOILS. —STERILIZED OR *kuller* AND *rhae* SOILS CAPABLE OF RECLAMATION.—BARREN SOILS.

1. *What is Agriculture?*

Agriculture is the husbandman's occupation, and the art of cultivating the soil to the best advantage, so as to enable it to produce the finest and largest crops, of every description, at the lowest cost, and without exhausting and impoverishing the land.

2. *How is it practised in Hindoostan or India?*

In the most primitive and least remunerative form, the ignorance and superstition of the people causing many of them to look upon a bountiful harvest as the forerunner of approaching calamity, or death, only to be averted by giving away all grain and produce above the ordinary maximum. Hence any improvement in agriculture is carefully eschewed, and the people remain in a state of abject ignorance and squalid poverty.

3. *Is this poverty of the Agricultural classes of modern or ancient date?*

If the Gentoo Laws, and Brahminical writings, looked upon as scriptures, are to be believed, the poverty of the ryot or cultivator dates from the earliest periods of Brahminical ascendency; for we are told in the laws of *Mee-noo*, which were first translated into English by Mr. Halhed in 1775, that upwards of four thousand years ago, the ruling sovereign "Neitnum," died and was succeeded by his son "Bein" whom the Brahmins slew, for despising caste prejudices, and put his son "Perthoo," on the throne. This King asked the Brahmins,—"Why are the *ryots* of the kingdom in poverty?" and they replied,—"On account of the sins of your father, and for which reason also, the fruits of the earth are produced in less plenty, and the *ryots* also are stricken with poverty."

4. *Who was Meen-noo?*

He was a *Brahmin*, and as this race is said to be descended from the Patriarch Abraham, by his second wife Keturah, the ancient laws of Canaan may have been introduced into India by him. The name *Meen-noo* means Fish God, and is the Sanscrit for the Prophet Noah. The first chapter of these Laws of *Meen-noo* is devoted to the subject of *lending and borrowing* money at compound interest. The *ryot* or cultivator generally belonged to the *Sooder* caste, and was accommodated with money on the following terms viz: "If a loan be granted to a man of the *Sooder* caste, in that case, when the *Brahmin* pays interest one rupee, the *Sooder* shall pay two rupees eight annas; in the place of one rupee two annas, he shall give two rupees thirteen annas; and instead of two rupees, he shall be charged five."

The poverty of the ryot is thus fully accounted for.

5. *How is the condition of the modern Ryot to be ameliorated and his ignorance and poverty removed?*

By giving him instruction in Agriculture, and placing it in his power to borrow money at a reasonable rate of interest, say twelve per cent simple interest instead of 37½ per cent, the present rate.

6. *Who is to provide this money?*

In times of scarcity the beneficent Government of India lends money to its *ryots* free of cost. But if any particular description of crop is desired to be grown, the merchant or purchaser advances the funds. Thus if India is expected to supply England with cotton, the wealthy cotton mill owners, and members of the cotton trade, should provide the money and introduce improvements and manures, so as to preserve the soil from injury and exhaustion. The European capitalists might deposit their cash in the Government Treasury, leaving it to the Collector to make advances on a modification of the *tuccavee* system already in force. The capitalist would receive five per cent for his money from the Government as landlord, the *ryot* would borrow at twelve, and a sufficient margin would be left to cover expenses and yield a profit.—The crop would belong to the ryot who would sell it to the best advantage on the spot.

7. *How many kinds of soil are there in India?*

Officially five, three of which are represented by their quality or the numbers, 1, 2 and 3, barren and waste. But, properly speaking, India possesses a greater variety of soils, than any country but China, for it has Tea, Cotton, Sugar, Spice and Tobacco soils in addition to the soils met with in Europe.

8. *Describe the soils indicated by comparison of numbers, giving their common European names?*

Wheat, Indian Corn, and other grain producing lands, named after such crops, come under the first, as also does Sugarcane land. Light soils, such as produce inferior grain, and pulse crops under the second, and sandy soils under the third. There are also very rich soils, fertile soils which have become sterile, and absolutely barren soils.

9. *What is a rich soil?*

A rich soil generally contains five per cent, or one twentieth of its weight of Organic matters, in combination with clay, sand, iron, lime, magnesia and certain other fertilizing substances.

10. *What is meant by organic matter and how is it distinguished from the inorganic or opposite part?*

All substances, when set on fire burn, that portion which burns away in the fire is called the organic part, whilst that which the fire cannot consume, is known as the inorganic or mineral part.

11. *Do plants draw much of their organic food from the soil?*

Yes, the healthy growth of the plant renders this process necessary, and the quantity drawn off from the soil is always considerable, and it varies with the kind of plant, the description of soil, and with season and climate.

12. *From whence do plants derive their inorganic or mineral part?*

Exclusively from the soil, and the animal from the plant, whilst the soil derives it from the rocks from which it has been formed.

13. *In what proportions does this mineral matter generally appear in plants?*

The dried Tobacco leaf contains twenty-five per cent, or one quarter of its weight of mineral matter, which will remain after the leaves are burned to ash; other plants contain less, but five per cent of ash is about the average left by dried plants; whilst dry wood will seldom leave more than half a pound of ash, for every hundred pounds burned away.

14. *In Hindoostan, where are the richest soils to be met with?*

The richest exist in the wooded portion of the Himalayas; that near Simla has produced immense Potato crops for the past quarter of a century without being manured. The Dhoon or *piedmont* of these mountains has a soil nearly as rich, and the black cotton soils of the Deccan are the next in a peculiar description of richness.

15. *What do you mean by a peculiar description af richness?*

I mean that it is rich in fertilizing mineral matter but poor in organic or vegetable matter and that if not properly manured, it will year by year, produce less cotton, and ventually cease to do so altogether. By analysis it is found to contain in one hundred parts of soil—silex 48·2, Alumina 20·3, Carbonate of Lime 16, Carbonate of Magnesia 10·2, Oxide of Iron 1, Water and Extractive or Organic matter 4·3. It is therefore rich in Carbonates, which supply Carbonic acid gas to the roots and rootlets of growing plants, but poor in iron, which renders these Carbonates more freely soluble in water. The poorness of this soil in vegetable matter is also remarkable. But as both these substances can be replaced in the soil by proper manuring, the Cotton lands of India may be safely considered as inexhaustible.

16. *Can you give an example of a peculiarly rich European Soil?*

Yes.—The soil of the Flower Farms of *Grasse* in the lovely Cannes valley is, probably, one of the richest, as the subjoined analysis will show :—

COMPONENTS.		CANNES VALLEY SOIL.	DECCAN COTTON SOIL.
Silica and Sand	...	860·00	482·0
Alumina	..	30·70	203·0
Silicate of Alumina	...	13 00	...
Silicate of Magnesia	...	8·50	...
Organic Matters	...	22·30	*43 0
Carbonate of Magnesia	..	7·00	102·0
Carbonate of Lime	...	6·80	160 0
Sulphate of Lime	...	5·80	...
Phosphate of Lime & Magnesia	...	5.60	...
Potash Salt	...	4.80	...
Soda Salts	...	6·70	...
Carbonate of Iron	...	10 50	10·0
Carbonate of Copper	...	1·70	...
Manganese and Iodine	...	... ...	...
Loss during Analysis	...	16·60	...
Totals,	...	1000·00	1000·0

* Including water—of which the other has none.

If ladies and gentlemen who have have a passion for flowers, would imitate the above soil, which can be very easily done, they would find it in their power to grow the most delicate and loveliest flowers to perfection, which can never be attained under the present system.

RECIPE.

To the stated quantity of clean sand, and alumina or potter's clay (*chicknee mittee*), add the other components, and an artificial *Connes*, flower soil, will be the result, with which fill the flower pots.

From a study of the above analysis the practical farmer will not fail to observe that leaving out the sand and clay, all the other components are fertilizers, which if added to Cotton Manure, and so applied to the land would make the Deccan (and similar) Cotton soil most productive.

17. *What is a Fertile Soil ?*

In the Plains of India all first class (No. 1.) soils which continuously grow fair crops, without manure, are naturally fertile soils ; second and third class soils are those which must be manured to remain fertile, and their productiveness will depend on the portion of Mineral fertilizers present in each description of soil.

An inspection of the subjoined table will show, that as the fertility of a soil depends on something else besides *mud,* it would be desirable to know, by analysis, what a soil contains, before granting a long or 30 years' *Lease.*

For example, a first class Indian soil, (under corresponding rent) from constant cropping, without manure, has become impoverished, and the holder, on the fact of harvesting low crops for several years, wants to retain the land for another 30 years if his petition for a lower assessment is granted. If he gets it, all he has to do, is to manure the land, and the State suffers accordingly. But if there was an Analysis, to refer to, the Settlement Officer would say,—" The Government insists on high cultivation (which includes proper manuring), and higher rent." " If you decline, the land shall be placed under *Kham* management, be made to yield the higher *rent,* and then be leased to the highest bidder, who will be under stipulation to keep the land in proper condition."

Lands fertile with manure, and which may be *decried,* as unproductive from other causes, if first put in order by suitable manuring, and then placed under *Kham* management, could twelve months after be leased at full rates. In fact in a country so rich in manures, and so well provided with Canal irrigation *low cultivation* should never be permitted.

COMPOSITION OF SOILS OF DIFFERENT DEGREES OF FERTILITY.

COMPONENTS.	Fertile without Manure.	Fertile with Manure.	Barren.
Organic matter	97·00	50·00	40·00
Silica (in the sand and clay),	648·00	833·00	778·00
Alumina (in the clay) ...	57·00	51·00	91·00
Lime	59·00	18·00	4·00
Magnesia	8·50	8·00	1·00
Oxides of Iron	61·00	30·00	81·00
Oxides of Manganese ...	1·00	3·00	0·50
Potash	2·00	trace.	trace.
Soda } chiefly as common	4·00	trace.	trace.
Chlorine } Salt	2·00	...	...
Sulphuric acid	2·00	0·75	trace.
Phosphoric acid	4·50	1·75	trace.
Carbonic acid combined with the Lime and Magnesia ...	40·00	4·50	trace,
Loss	14·00	....	4·50
Total	1000·00	1000·00	1000·00

"The soil of which the composition is given in the first column, had produced crops for 60 years without manure, *and still contained a sensible quantity of all the substances required by plants*. That of the second column produced good crops when regularly manured, *it was in want of three or four substances only, which were given to it by the manure. The third was hopelessly barren,—it* *was in want of many substances which ordinary manuring could not supply in sufficient quntity."*—(PROFESSOR JOHNSTON.)

18. *What do all soils principally consist of?*

They principally consist of sand, clay and lime, and are scientifically divided into sandy soils, stiff clay soil, and calcareous soils.

19. *How would you distinguish these soils from one another?*

If the soil contained much lime, it would be a calcareous soil, like that of the Deccan. If more clay than sand, a more or less stiff clay soil, but if the sand preponderated, I would call it a sandy soil.

20. "*But if the soil contained two or more of them in large proportions how would you name it?*"

"A mixture of sand and clay with a little lime, I would call a loam; if much lime was present, I would call it a calcareous loam; and if it were a clay with much lime, I would call it a calcareous clay."—(JOHNSTON.)

21. *What is a Sugar-cane soil?*

The black cotton soil of the Deccan, and similar calcareous soils, wherever existing, may on being properly manured, be exalted to the position of natural sugar-cane soil, which is a brick loam (as in Jamaica, and the West Indies) extremely rich in lime and vegetable or organic matter, and contains very little salt, the presence of which is as injurious to sugar-cane, as it is to the sugar beet of Europe.

22. *In selecting land for sugar-cane, how is the planter to determine its quality, or fitness, for growing sugar-cane profitably?*

If he has no analysis to guide him, by testing a small portion of the soil, and subsoil, with diluted sulphuric or muriatic acid, or with strong vinegar. If the sample under trial effervesces, it will bear good sugar crops, but otherwise the ordinary low produce can only be expected.

23. *If the description of land on which sugar-cane is now generally grown by the Zemindar and Ryot, was manured, would it yield better crops?*

Most decidedly. The proper manure for sugar-cane is very cheap, and if applied to such land, in sufficient quantity, would make it produce an abundance of canes, rich in saccharine juice, from the plant canes, and the *rattoon* crop would be rich in proportion. In Jamaica, in very fine seasons 2½ tons (about 67½ *maunds,*) of sugar per acre have been obtained.

In India, such a return has never been heard of, but with plant canes suitably manured, and irrigated, there is nothing to prevent the Zemindar from attaining similar results.

24. *What is a Tea soil?*

In India tea soils exist at elevations of from 1,000 to 6,000 feet above the level of the sea, and they are remarkable for containing much iron and very little lime, with potash in larger, and soda in smaller quantity. The presence of manganese is one of the peculiarities of these soils.

25. *If the Tea soil is found to be inferior, is it possible to exalt or improve its quality, and how?*

Yes. In the Himalayas, decomposing rocks are constantly met with which contain much iron, as also manganese and their application to the soil would permanently improve it. The black *Muck-kole* of the hills, as also the blue, contain both these substances.

26. *What is the difference between a Tea soil and a Coffee soil?*

A coffee soil contains very little iron, and no manganese. It is rich in limes, magnesia and potash, and quite deficient in soda.

The subjoined analysis will show the reader that, the mineral matters present in tea, coffee and cocoa, must have been present in the soil in considerable quantity, to be found in different parts of the plant. It is more than probable that the inferior quality of certain Indian teas and coffee berries, is owing to the deficiency of certain important mineral matters in the soil, which if ascertained, and added to the proper description of manure, would supply the component needed, and so improve the quality of the leaf and berry.

Constituents of the Ashes of

COMPONENTS.	Infusion of Tea, Sonchong. (Lehmann.)	Decoction of Coffee, Java-Coffee. (Lehmann).	Cacao Beans, Guyaquil Cacao. (Zedeler.
Potash	47·45	51·45	37·14
Lime	1 24	3 58	·2·88
Magnesia	6·54	8·67	15·97
Peroxide of Iron	3·29	0 25	0 10
Phosphoric Acid	9 88	10 02	39·65
Sulphuric Acid	8 72	4·01	1 53
Silicic Acid	2 31	0·73	0 17
Carbonic Acid	10·09	20·50	Nil
Oxide of Manganese ...	0 71	Nil	Nil
Chloride of Sodium ...	3·62	1·98	1·66
Soda	5·03	Nil	Nil
Charcoal and Sand	1·09	0·49	Nil
Total	100·27	100 68	99·10

Few people think when enjoying a refreshing cup of tea, coffee, or chocolate, that they are actually re-building their bodies out of the restorative materials furnished by the soil, and that variations of quality depend not on the manufacturer, but upon the soil. Yet with these facts before us, little attention is paid to the constituents of the soil, and less to the components of the manure used.

27. *What is a Tobacco soil?*

All soils which are extremely rich in iron, lime and organic matters, and are of a red, redish brown, or liver colour, may be called natural tobacco soils. They will also grow superior opium crops. But without proper manuring, the best soil will not produce superior tobacco, because the soil cannot supply the large proportion of ammonia needed by this plant. The ammonia derived from porcine manure, will give the finest variety of tobacco a disagreeable taint.

28. *May not ordinary fertile soils be made to produce good Tobacco?*

Yes. There is not a garden in India, in which superior Latakia, and Havannah tobacco, could not be annually produced by proper culture. It is just as easy to grow good cabbages, as well as tobacco, and a *mallee* once properly instructed, would effect a very considerable saving in a smoker's tobacco bill.

The subject is fully discussed in the next chapter.

29. *What are Spice soils?*

The Cinnamon soil of Ceylon, is probably the most peculiar of spice soils, the next in value is the cardamom soil of Guzerat. An analysis of this soil would be of great value, as it would enable the practical agriculturist to enter on this highly profitable cultivation. Similar information on the *black pepper* soils would be a desideratum.

90. *What do the Natives of India call a Barren soil, and can such Land be turned to any use?*

The barren soils of India are generally called *Oosur*, and being very often hard indurated clay soil, neither weed nor plant will grow on them. Such lands are by no means without their value, inasmuch as a large tank if excavated in *Oosur* soil would hold water most admirably, and by supplying the means of irrigation, would greatly increase the value of the arable land, which begins where the *Oosur* ends.

31 *What is a Sterelized soil?*

In various parts of Upper India the surface soil is productive, whilst the subsoil contains large quantities of saline matters. When such lands are highly irrigated these sterelizing matters are drawn to the surface by capillary attraction and appear as an efflorescence.

The sterelizing salt is called *Rhac* in the North Western Provinces, and *Kullur* in the Punjab.

I am indebted to a medical friend for the subjoined interesting information on the subject, and I believe it will be found to agree with the Punjaub Official Report on *Rhac* and *Kullur* lands :—

"Here are some of the Analyses (London) of *Rhae* soils, in connection with one of the Canals."

TABLE NO. 1.

Rhae Soil	Specimen.	
	No. 1.	No. 9.
Sand and undecomposed Silicates	57·00	57·32
Silica combined	13·60	16·72
Soluble matters dissolved by Acids ...	23·86	20·46
Water	5·54	5·50
Total	100·00	100 00

TABLE NO. 2.

Saline matters dissolved (from No. 9) by Water.

COMPONENTS.	QUANTITY.
Common Salt	36 228
Sulphate of Soda	34·642
Carbonate of Soda	28·674
Peroxide of Iron and Alumina ...	0·092
Lime	Trace.
Nitric Acid	00·000
Magnesia	00·000
Organic Matter	00·364
TOTAL, ...	100·000

" A *rhac* soil is of course impregnated to a considerable depth. The analyses I made were of the efflorescences. These contained principally, and in nearly similar proportions, the highly soluble salts of the stream waters of the district (Peshawur), being, principally, chloride of sodium, sulphate and carbonate of soda and some sulphate of magnesia, traces of organic matter, and in some places (as graveyards, old sites of villages) of nitrates."

" Here is another table showing the law of impregnation, according to depth.

TABLE NO. 3.

Solid Saline Residue in 1,000 *parts.*

Near the Canal.	Dried at 230°Farh.	Ignited
Surface	2·796	2·403
2-feet deep	1·638	1·535
4-feet deep	0·720	0·605
6-feet deep	1·165	0·984

TABLE NO. 4.

At 5,000 Yards from the Canal.

Solid saline Residue in 1000 *parts.*

Depth.	Dried at 230° Farh.	Ignited.
Surface ...	31·280	30·873
2-feet depth	3·784	3·611
4-feet depth	5·179	4·919
6-feet depth	7·045	6·934

"So you see the singular law, that the saline impregnation is a maximum at the surface, passes through a minimum at a short distance below the surface, and again rises further down; as far as I remember the subsoil water in these cases was only about 6 feet below the surface."

A reference to table No. 2, will show that, *rhac* consists of three saline substances, of which two are fertilizers, and one a sterelizer. If there is more than two per cent. of common salt, in any soil no grain crops will grow on it.

To the Practical Agriculturist, the *rhae* soil would yield a large supply of saline manure, for if the common salt be separated by crystallization, the sulphate and corbonate of soda would become available for use. The Tables 3, and 4 show that the *rhae* is at its minimum between two and four feet of depth, and it thus becomes quite feasible to reclaim all lands so sterilized, making the sale of the salts pay towards the expences of reclamation. The presence of lime in the soil would interfere with the passage of common salt to the surface, and as long as this sterelizer was kept out, full crops of turnips, rape and oil seeds might be grown on the land, till it was sufficiently sweetened to grow oats, and subsequently wheat, and other grain crops. One hundred maunds of slaked lime, or chunam, would be required for each acre of sterilized land. Lime and clay enter into combination, and in a few years the lower subsoil would set, and so render it almost impossible for the salt to pass through. I scarcely feel myself at liberty to enter further into the subject of reclaiming such lands, on account of its being a departmental question. But it is quite clear that the more a porous soil is washed, without being limed, the better is it prepared for re-impregnation with saline matters, derived from the deep subsoil, in contact with water. If however the land be limed before being inundated, every particle of lime dissolved (that is, one grain for every six hundred grains of water,) will act, in sinking downwards, upon the corresponding quantity of alumina, and muriate and sulphate of soda, forming respectively muriate and sulphate of lime and a calcareous clay, hence it follows that, by using lime, a perfect barrier may be made, which will allow the surface water to pass through the soil, leaving its lime behind, whilst the lime, in its turn will attack the salt, as soon as it begins to rise, and stay its progress upwards.

32. *What are lake, or sub-aqueous soils?*

The beds of Indian lakes, and jheels, possess soils remarkable for their richness in fertilizing matters; so much so, that fields and lands in their vicinity, are often manured by the application of such soil. The richness is caused by this soil being the grave of countless millions of infusoria, and the final resting place of the vast hordes of organic life whose world is water.

The *singhara* or water nut, (*trapa bispinosa*, Rox,) grows to perfection when once planted in such sub-aqueous soils. This nut, like the potato, is an annual, but unlike it sows and extends itself without human interference.

The lake of Cashmeer, 5,000 feet above the level of the sea, supplies a crop of water nuts, sufficient to feed 30,000 people for five months, and yields a revenue of over £10,000 a year.

The fresh water lakes of Great Britain, and Australia, might be made to produce an inexhaustible supply of very palatable, nourishing food, if this nut was introduced.

The fresh or green nuts, are very wholesome and nice to eat. When ripe and boiled, they afford vegetable food, more nourishing than potatoes, and when sun dried, and ground, they produce a flour which will make bread, porridge, cakes and confectionary.

In concluding this chapter, I would respectfully wish to point out, that the great fresh water lakes, recently discovered by Grant, Speke and Livingstone in Africa, if even sparingly sown with the *singhara*, of India and Cashmeer, would in time, and for ages to come, feed a vast population, whilst, by its means, the want of food so much felt in Africa would be speedily supplied at an insignificant outlay.

The production of cheap cotton depends on cheap food, and what can be cheaper than a nut, which grows luxuriantly on the surface of water, and which, when dried, will keep good for years.

If this singular nut is found to grow in America, its lakes will supply first class food for feeding stock, at the lowest possible cost, whilst its introduction into Australia will make the surface of lake Alexandrina, a source of considerable wealth to the Government of that colony.

PART FIRST.

CHAPTER II.

MANURES.

THE subject of manuring land is one of vast importance to the Agriculturist. The labors and scientific researches of Professors Liebig, Johnston and Stephens, have definitely established the fact that, in order to secure the permanent productiveness of land, more *plant food* must be put into the soil than is annually taken out of it by the crops raised and harvested thereon.

The agricultural population of the Himalayas have received this important truth from their ancestors, and have, for ages, cultivated their terraced plots and fields without suffering any loss from failure or diminution of crops.

The Paharee zemindar feeds his cattle on highly nourishing leaves gathered from the trees of the forest, and, as his cattle and sheep graze at their pleasure on the rich and juicy grasses of the Hills, an ample supply of farmyard manure is always at his disposal, and he greatly increases this supply by the leaf bedding he provides for his cattle, who, by trampling it under foot, mix it up with the solid and liquid manure produced by them. But this is not all: the Paharee, as a rule, only gathers or harvests the ears of corn, leaving the straw of his rice, wheat and barley in the field; and when it is quite ripe and dry, he sets the standing straw on fire and so restores to the soil nearly the whole of the mineral matter withdrawn therefrom by the growing crop. The only portion of mineral matter permanently removed from the soil, varies from two to five per cent, being the proportions present in the grain of wheat and the husk of rice. But as he has put far more mineral matter into the land than he takes out of it, the same field has for centuries yielded him a never failing harvest. Thus the Paharee, without being aware of the fact, demonstrates, by his practice, the soundness of the views put forth by the great Professors of Europe, who have raised Agriculture to the position of a science.

The zemindars and ryots of the plains would have followed in the footsteps of the hillman or highlander, if he had the power to do so; but as he is obliged from necessity to use his farmyard manure as fuel, and to feed his cattle on straw and Indian-corn stalk, he has only an ash heap to supply him with manure. During the rains he cannot dry his cowdung cakes, and his farm-yard manure, exposed to the weather, is partly washed away and part is absorbed by the soil under the dunghill, and that which remains is of little value, as the important parts, being soluble, have been allowed to run to waste. The poverty of the ryot puts it out of his power to make a shed for his farm-yard manure, and he suffers accordingly. The filth accumulated in the village destroys his health, whilst the want of it renders his fields less productive; but these things would cease if the *Tuccavee* advance system was extended to the excavation of manure pits, outside the village, into which every thing should be thrown, daily trodden down, and strewn over with dry earth, the contents of the pit being protected from the rains by a thatch or *chupper*. The value of farm-yard manure made in open and covered pits will be better understood when it is known that Lord Kinnaird of "Inchture," caused two parts of the same field to be dressed with equal parts of farm-yard manure, made respectively in covered and uncovered pits.

The produce of the land so manured was as follows, *viz.*

Produce.	Covered.	Uncovered.	Difference.
Potatoes	11¾ tons	7½ tons	4¼ tons
Wheat	54, bushels	42 bushels	12 bushels
Straw	215 stones	156 stones	59 stones

These facts speak for themselves, and show that health and money follow in the wake of good husbandry; for the manure being accumulated under cover, the generation and diffusion of noxious gases by solar action or decomposition is prevented, and the health of the community secured, whilst evaporation being reduced to a minimum, valuable components remain fixed in the ripening manure. A covered village manure pit is therefore as much a necessity to a village, as a burying or burning ground for the dead.

A manure pit may be of any size, but it is better to have several moderate sized pits in preference to a large one, as the expense is greatly increased, without an adequate return being secured. A pit forty or fifty feet long, ten wide, and eight deep, may be made for a very moderate sum. The actual excavation need not exceed four feet, for by making use of a *Pise* frame, a beaten clay wall may be constructed all round the pit, with the earth, as dug out, thus giving four feet of solid *Pise* wall, and four feet of excavation.

It would be advisable to have a large sized *gumla* or half a cask sunk in the middle of the pit, with tile-covered cross drains leading to it, so that all liquid matters might run into the cask, or *gumla*, and be daily bailed out and sprinkled over the drying manure. The urine of the cow and horse should also be used in this manner, and will add to the richness of the manure.

The bed of the manure pit should be levelled and well beaten down, and if *kunkur*, or road metal be available, a very good floor would be secured, if a little dry lime was strewn over the surface before it was wetted and beaten down. The roof or thatch thrown over the pit should be open at both ends, and be raised at least eighteen inches above the *Pise* walls on blocks of *Pise* work made at intervals of three feet, so that free circulation of air may take place.

A *Pise* frame is simply a large brick mould which takes to pieces, on pulling out four pegs which keep it together. The handiest size is six feet by eighteen inches, by nine inches internal measurement. The planks used should not be less than 2½ inches in thickness, though three inches is to be preferred, as such planks do not give or bend when the beating down commences.

Four mallets—round at one end, and two inches square at the other—will have to be provided. These mallets should be between ten and twelve inches in length, and not more than four inches in diameter at the round end. The squared end is for driving the clay into the corners or angles of the frame.

To use this frame, set it up wherever a wall has to be built, and fill it with fresh dug clay to the depth of four inches, and beat it down with the mallets, (a little water may be sprinkled over the clay if it is dry,) and as soon as the mass is homogeneous, add more clay and so repeat the operation till the mould is filled. Next drive out the four pegs, and take the frame to pieces, and set it up again and make a second piece of *Pise* wall, which, on the end piece of plank being taken out, will be three inches distant from the first block. This space is to be filled up with made clay, put in by the hand, and rammed down with a stout bamboo, or bit of a pole. When this operation is over we obtain a piece of *Pise* work, 13¼ feet in length, and so on for any length. A second course is to be laid over the first, and the work continued till the desired height is obtained. The value of *Pise* work in addition to rapidity of construction, is its extreme cheapness, strength and finish, for in spite of the coolies employed, who know nothing of building, the walls will always be perpendicular, parallel to each other, and of one uniform thickness.

In the Simla Hills, the Rana's Palace and Town of *Dhamee* is so built.

The manure pit being finished, all the farm-yard manure and litter, should be daily thrown therein, and be trodden down either by men or cattle, and this process repeated till the pit is full.

The value of farm-yard manure, depends on the richness of its components in fertilising matters, and it should be remembered as a rule, that the droppings of dogs, pigeons, and poultry of every description is infinitely richer in iron and the food phosphates, than the dung of the grass fed village cow, bullock and buffalo ; therefore, bone dust, and any of the above, if added to poor manure, will improve its quality.

The droppings of sheep, goats, and camels should be kept in a separate pit; but all equine manure, and stable litter should be stored in the main pit.

All dead animals should be carefully buried, and if quick or slaked lime be obtainable, it should be strewn over the carcase, to which it will adhere if the dead animal's hide, or flesh if the hide has been removed, is slightly wetted with water. The carcase should then be covered over, and protected from the attacks of wild beasts. The pit when opened will be found to contain a skeleton and earth and mould, very rich in animal or flesh manure.

This should be taken out, and added to the sheep manure pit.

The bones of the skeleton should be broken into small bits, one inch, or one and a half inch pieces, and these should be made into manure as follows, viz.:

Bone Manure.

Fill a one dozen case, with broken bones, and toss them into a small pit, and add half that quantity of sand or soil, and so proceed till all the bones are used up.

Then moisten the mixture of bones and soil, with cold water, and turn it all over, twice or thrice, and cover the pit or hole with a mat, or straw "jhamp." In a short time the bones will ferment, and heat, and gradually crumble down into a fine powder, which must be stored for future use.

Bones consist of *gelatine* or glue and bone-earth, and this latter is a compound of phosphoric acid and lime. According to Professor Johnston, "100 lbs of bone-earth as it is obtained by burning bones, contains 40 to 45 lbs of phosphoric acid." This acid is artificially obtained by burning phosphorus in the air, and 227½ lbs of it, are produced from every 100 lbs of phosphorus so burned.

Phosphoric acid enters into combination with Soda, Potash, Lime, Magnesia and Iron, and forms their phosphates.

They are all present in our grain crops (rice excepted), in sugarcane, and grape juice, in clover, lucerne, and rich grasses, as also in milk of every description, and, finally, in the blood and flesh of man, bird, beast, and fish. The value of a grain or cereal depends on its richness in these food phosphates, and the soil which contains them in abundance, produces the best of grain, grass, milk, cheese, and meat; and hence it follows that poor and exhausted soils cause the degeneration of bone and muscle in both man and beast. Compare the hill man with the man of the plains, the hill pony with the *tattoo*, the wheat of the hills with that of the plains: in each case, the inferiority is owing to a deficiency in the food phosphates; and to make this good, suitable manures must be used. Of these, bone dust is one, and unburned *kunkur limestone*, "kunkur" marl, and the soft shelly limestone, of the great Nujjufgurh jheel near Delhi, are the others. All these limestones contain magnesia, and phosphate of lime, and by being reduced to dust or powder they are at once available for use as manures.

These *kunkur* limestones when calcined and slaked, yield the carbonate of lime, or *chunam* of the bazar, which is also a valuable manure for sour and sterelized lands; such as the *rhae* and *kullur* lands of the Northern and other *Doabs*.

To make Cold Carbonate of Lime Manure.

Dig the "kunkur," and reduce it to powder or dust, and store it for use. This substance plays a most important part in the preparation of composts.

Leaf Manure.

In the Himalayas, during the months of April and May, the forest lands are covered with fallen leaves. If these leaves be collected, and watered with a weak solution of saltpetre water, they will soon turn into leaf mould; and if this in its turn be moistened with a weak aqueous solution of sulphate of iron, a compound is obtained, which when mixed with farm-yard manure, will meet all the requirements of the tea planter. The proportions and other information will appear under the head "Tea."

Squeezed Sugarcane, or Megass Manure.

Whatever may be the quantity of sugar in 100lbs of sugarcane, one-third of that quantity remains in the squeezed cane, or megass, which is used as fuel. If this sugar could be extracted, every 101¼ lbs of megass would be found to contain 45 pounds of carbon, (or plant food,) and 56¼ lbs of water.

By Professor Ure's analysis 100 lbs of sugar consists of 43·38 of carbon, and 56·62 of water. It is therefore apparent, that the megass contains a very large proportion of carbon, and is consequently well fitted for conversion into manure.

It is stated in Doctor Ure's "Dictionary of Arts, Manufactures and Mines," that one acre of good land is reckoned to produce 56,673 pounds weight of sugarcane, which yields 3,477 pounds of *sheerah* or pot extract, or in Indian weights 683 maunds 16½ seers of cane, and 42 maunds of syrup. Their difference, 641 maunds and 16½ seers, represents the quantity of megass available for fuel. These 641 maunds of megass when burned will leave 33 maunds 9½ seers of ash or mineral matter ; and if from this quantity (1329½ seers) three per cent (39·87 seers), or one maund be deducted for the vegetable alkali or potash, the remainder, or 32 maunds, 9½ seers, is the amount of mineral matter, drawn out of the soil by the harvested sugarcane crop.

It therefore stands to reason, that the acre of land has had 32 maunds of mineral matter removed therefrom and unless the loss is more than made good, the land will yield but a poor return, when the rattoon crop is dug up. The growing plant derives its carbon, partly from the carbonic acid gas present in the air, and partly from the soil ; hence the necessity for restoring carbon to the soil. By the present plan the 33 maunds of ash can only be restored to the soil, by converting the 26,598 seers (or 53,196 lbs) of megass into manure. The practical farmer or planter preserves 292½ maunds of carbon, or plant food, from destruction, and in addition saves all the mineral matters which may be present therein.

The reader may verify this calculation by bearing in mind that every 102 seers of megass contain 45 seers of carbon.

It will be shown in due course, that by utilizing the megass in place of using it for fuel, sufficient manure of the best quality will be obtained, from one acre of sugar-cane, to put six acres of growing cotton under high cultivation ; and as this important result will be attained without the aid or use of any farm-yard manure, its value will be fully understood by the cotton planter.

To prepare the Megass Manure.

With a chaff cutter or chopper, cut or chop the megass as received from the sugar mill into two inch pieces, and allow it to dry. Next make a pit, sixteen feet long, ten broad, and two deep, and fill it to the depth of six inches, with chopped megass, which must now be well wetted, or watered with a solution of saltpetre. Then strew prepared pounded kunkur dust over its surface, and lay down a second course of dry megass, which water as before, and then a fresh layer of kunkur dust, with megass over it, and so proceed, till the pit is filled and has received the last covering of limestone dust, which is to be wetted with plain water.

Throw a mat over the contents of the pit, and remove it every third or fourth day, when the entire surface of the heap is to be well sprinkled with water, say two or three *mussucks* full ; the object in view being to keep the contents moist, as this produces decay. This process is to be repeated four or five times, at the above stated intervals. When the megass has been twenty days in the pit, the contents should be turned over with forks, and be well mixed together, be moistened for the last time, and be allowed to decompose for another ten days, when the manure should be stored in a dry *cucha* well with a thatch thrown over it. Tread the manure well down, or beat it down with non-stampers. Proceed, as before, to make a fresh supply.

It is to be understood that the chopped megass is to be stored for future use. This should be done near the sugar works, and if the white ants are to be feared, the weakest solution of sulphate of copper dissolved in water, if sprinkled over the drying megass, will protect it most effectually from their ravages.

To make the Prepared Kunkur Dust.

Dig any quantity of *kunkur*, and reduce it to powder in the same way that brick-dust is made from pottery and broken bricks.

Weigh out thirty-two maunds of *kunkur* dust, or the same quantity of slaked lime, if the former is not procurable, and eight seers of the sulphate of iron, bazar name *kus-sees*.

Have ready eight *ghurrahs* or water-pots, filled with cold water, and dissolve eight ounces, or ¼ seer of sulphate of iron in each, and having previously levelled and spread out the heap of limestone dust, proceed to sprinkle the solution of iron over it, till the eight *ghurrahs* are absorbed; let it dry, and then repeat the dose as before, and so continue till the whole of the iron has been dissolved in water, and absorbed by the *kunkur* dust. In this manner at leisure moments, any quantity of ferruginous lime may be prepared and kept for use.

These thirty-two maunds of *kunkur* dust, or slaked lime, will suffice for 26,598 seers, or 663 maunds of megass.

The megass manure so made will contain, irrespective of water which is not taken into account,

Of carbon, ...	maunds	292	0
Of *kunkur* dust, ...	,,	32	0
Of saltpetre, ...	,,	2	16
Of sulphate of iron, ...	seers	0	8
	Total mds.,	326	24

This quantity of manure divided by six, gives 54 maunds, or two tons, to the acre of land under cotton.

It is essentially a cotton manure, which farmyard manure is not, and the fact is proved by the great production of leaves and wood, but very little cotton from land manured.

" The total constituents of cow dung are as follows, viz

Water		69·58
Woody fibre		26·39
Animal matters		2·58
Mineral Matter,		
Salt	0·08	
Sulphate of potash	0·05	
Sulphate of lime	0·25	
Carbonate of lime	0·24	
Phosphate of lime	0·46	1·08
Carbonate of iron, ...		0·09
Sand and waste		0·28
	Total	100·00"

(DR. URE.)

The richness of cow dung in animal matter, and its poorness in carbonate of lime and iron, causes the cotton plant, when manured with it, to run into leaf and wood.

Carbonate of lime supplies carbon to the sap of the cotton plant. Iron enriches the sap, and makes the plant vigorous and productive. Potash causes the lime to dissolve freely, and so prepares it for the roots and rootlets of the plant, and the mineral matters present in the megass provide more iron, and all the phosphates.

A reference to the analysis of cow dung will show, that in 400 grains of it, *about* one grain of carbonate of lime is present. The pound therefore contains seventeen grains. The hundred weight, 4 ounces, 156 grains ; and the ton, 5 lbs 7oz. 61 grs.

Under these circumstances, it is simply impossible to expect an increase of cotton wool from cotton plants manured with cow dung.

Sugarcane Manure.

The sweet juice of the sugarcane is a perfect food, inasmuch as it contains an ample supply of carbon, gluten and mineral matter.

To restore the thirty-two maunds of these matters taken out of the soil, by one acre of sugarcane, a compost must be made of farmyard manure, bone dust, *kunkur* dust, lime or marl, saltpetre, and sulphate of iron, in proper proportions, which will be given under the head "Sugar Planting."

It should be carefully remembered that night soil is never to be used for manuring either the sugar beet, or sugarcane, because this otherwise valuable manure contains a large percentage of culinary salt, or muriate of soda, and a very small quantity of salt is sufficient to interfere with the production of sweet sap in the cane; whilst its presence in beet juice prevents that sugar from crystallizing.

THE Poppy being exclusively grown for the SUPREME GOVERNMENT OF INDIA, in Benares and Behar, the permission of His Honor the Lieutenant Governor of Bengal was sought and obtained on the subject of improving its cultivation.

The Opium manufactured in the Himalayas, contains 50 per cent more *morphia* than that of the plains of India. This fact was placed on record in the journal of the Horticultural Society of India, as the result of an official analysis.

The commercial and medicinal value of opium depends on its richness in *morphia*, of which that of Smyrna contains fourteen per cent. The Opium of Persia and India is rich in narcotine, and poor in morphia; hence its inferiority, but with suitable manuring the former may be decreased, and the latter increased.

All narcotics thrive in soils rich in potash and iron, and they require an ample supply of nitrogen for their full and perfect development. Nitrogen is present in ammonia and nitric acid, in the following proportions: viz., "Fourteen pounds of nitrogen and three of hydrogen make seventeen pounds of ammonia."—(JOHNSTON.)

"Nitrate of potash, or the saltpetre of commerce, contains in 100 parts 46·55 of potash, and 53·45 of nitric acid" (URE,) therefore saltpetre is a compound of oxygen, nitrogen and potash.

"*How do ammonia and nitric acid enter into plants?*"

"They are dissolved by water in the soil, and are "taken up, in a very dilute state, by their roots."

"*What substances are formed in plants by the aid of nitric acid, ammonia, and other compounds containing nitrogen?*"

"Those vegetable substances, which, like gluten, contain nitrogen."

(JOHNSTON)

The best Turkish opium contains 11·4 per cent of gluten, and as this is present in the milk or juice of the poppy, a manure rich in nitrogen is indispensible.

Poppy Manure.

The bits of broken pottery and brick, existing near every village potter's kiln, and outside the *kulal khana* or village liquor shop, should be collected and reduced to powder, *i. e.*, be made into *soorkhee*, which is to be wetted with cold water holding saltpetre in solution ; and allowed to dry. When dry, it is next to be similarly moistened with water holding the sulphate of iron in solution ; after which it is to be dried and stored for future use.

To three parts of this prepared *soorkhee* add one part of farmyard manure, made under cover, or one and a half parts if taken from the exposed dung-hill. Mix well together, and after the operation the poppy manure will be fit for use.

The process of manufacturing this manure may be carried on at leisure moments from April to August, and if kept under shelter in a pit it will keep good till wanted.

This manure may be applied either broad cast over the young poppy crop at weeding time, and so be dug into the soil, or it may be used like common manure, and be ploughed into the land before sowing.

PROPORTIONS.	mds.	srs.
Soorkhee, ...	300	0
Shorah, or saltpetre, ...	3	0
Kussees or Sulphate of iron of the bazaar, ...	0	12
Farmyard manure, ...	100	0
Total, ...	403	12

This quantity is to be divided into six parts (of 67 maunds each) and applied in the manner indicated to six acres of land, which will now bear a rich crop of poppy for four years, and yield opium in greater quantity, and of better or higher quality.

The brick dust used in this manure is rich in the carbonate of iron, and as *soorkhee* has a chemical affinity for saltpetre and ammonia, its particles will always contain a considerable supply of these fertilizers, and this may be permanently secured, by annually manuring the land with farmyard manure, to which saltpetre, dissolved in water, has been added, in the proportion of twenty seers of nitre, to the hundred maunds of farmyard manure. Twenty maunds of such manure to the acre will be ample.

The quantity of iron which should annually be made good to the soil, can be definitely ascertained by the analysis of poppy ash, made by burning one hundred pounds of dry poppy stalks, from which the pods should be removed and separately burned, and analysed. The sum of both will represent the quantity of mineral matter taken of the soil by the poppy crop.

In the Simla Hillls the poppy seed is sown after the 15th of September, and before the 15th of October. The young plant is vigorous and hardy, and is not affected either by the frost or snow of the winter months. In the Plains a frost almost destroys the poppy crop, and I consider that this is entirely owing to the deficiency of the milk, or sap, in iron, potash and nitrogen.

The preponderance of water, causes the sap to approach the freezing point, and so kills the growing plant.

Tobacco Manure.

The Tobacco, is also a narcotic but it differs from Opium in a very peculiar manner, for its leaves possess the power of converting a portion of the nitrogen absorbed from the soil, into the muriate of ammonia. If a green tobacco leaf be reduced to a paste in a mortar, it has the usual smell of the leaf; but on the addition of a little quicklime, the smell of ammonia becomes apparent, and the fact may be chemically demonstrated by holding a feather, previously dipped in vinegar, or muriatic acid, over the paste, when dense white fumes will appear, showing that ammonia is escaping from it in the form of an invisible gas.

The tobacco of India is inferior in quality to that of Turkey, Persia, and America ; this is entirely owing to its being cultivated in the wrong place, by the wrong person. Tobacco like tea, and opium requires capital, (for it is an expensive and most exhausting crop,) of which the *zemindar* has little, and the *ryot* none.

It is grown near ordinary villages, instead of near Cities, large towns and first class villages ; hence the ground can never be properly manured, nor superior tobacco produced.

The Tobacco plant is the best friend of the sanitarian, for it will consume an amount of effete animal, vegetable and mineral matter, of which few tobacco smokers have any conception. Thus one hundred pounds of dried tobacco leaf contain, on the average, no less than twenty-five pounds of mineral matter, derived directly from the manured land.

"According to the recent analysis of Possett and Reimann, 10,000 parts of green tobacco leaves contain—6 of the peculiar chemical principle *nicotine* , 1 of *nicotianine*, 287 of slightly bitter extractive ; 174 of gum, mixed with a little malic acid ; 26·7 of a green resin ; 26 of vegetable albumen ; 104·8 of a substance analogous to gluten ; 51 of malic acid ; 12 of malate of ammonia ; 4·8 of sulphate of potash ; 6·3 of chloride of potash ; 9·5 of potash which had been combined with malic and nitric acids ; 16·6 of phosphate of lime ; 24·2 of lime, which had been combined with malic acid ; 8·8 of silica ; and 496·9 of fibrous or ligneous matter." (Doctor Ure.)

From this analysis we may draw the conclusion. that the extent of land which produced ten thousand pounds of tobacco leaves, was deprived of no less than seventy three pounds of mineral matter, by them. It should also be remembered that nearly the whole of the vegetable solids, amounting to 1,182¼ pounds, was drawn from the soil, which not only must have been of the richest description, but most highly manured. These facts show, that in order to grow superior tobacco, the soil should be of the best, and the manure of the highest quality. It is for this reason that tobacco should be grown near cities and large towns, as they are capable of producing a very large supply of such manure at the very lowest cost.

The ground having been selected, it should be marked off into plots, seventy yards square, and a trench from 12 to 16 inches deep, as many wide, and 70 yards long, should be opened at every 4½ feet from centre to centre. These trenches should be gradually half filled with night soil from the city or town, and be at once covered up with the excavated soil. Suppose a cart load of night soil fills the trench to a depth of six or eight inches, and fifteen or more yards in length, this extent of trench must be forthwith filled up with soil, and a ridge made with the surplus. This process is to be repeated till the entire plot is disposed of, when another one is to be taken in hand. Ten days after the last trench has been filled, the land should be cross ploughed, to the depth of a foot, and a sufficient quantity of *kunkur* dust applied as calcareous manure, which should be ploughed in and the land allowed to rest, till near sowing time. When this period approaches, manure the field with *prepared soorkhee*, to which a sufficient quantity of bone dust, or mineral phosphate of lime, has been previously added, and plough it in ; finally make a compost, of two parts of farmyard manure, and one part of sheep, goat and camel dung manure ; and before mixing together, water the former with a solution of muriate of ammonia, and apply the compost so made to the surface of the land, plough it in, and leave all further tobacco planting operations to the native cultivator or *ryot*, who will now be enabled to produce superior tobacco, if supplied with choice seed. But once the crop is ready, the preparation and conversion of the leaf into marketable tobacco, must be placed in more intelligent and wealthier hands.

The proportions of the components needed for making tobacco manure, will be given under the head "Tobacco Cultivation."

Fossil Manure, or "Phosphate of Lime"

In SPAIN entire mountains are formed of this salt It is composed, according to Doctor Wollaston, of 48·5 lime, and 51·5 of phosphoric acid.

I have not the least doubt, that vast deposits of this valuable manure exist in various parts of India, and also at no great distance from UMBALLA.

The labors of FALCONER and CAUTLEY brought immense deposits of fossil bone to light, in the Sewallick range, and as these bones have undergone calcareous petrefaction, their disintegration, or reduction to powder, would produce an ample supply of the phosphate of lime, for agricultural purposes. Such manure, if applied to the *stud pasture lands*, would cause them to produce grass rich in *bone earth*, which would shortly be followed by the greater development of bone and muscle in the colts and fillies reared in the Royal Indian Studs. If the locality was carefully explored, I venture to predict that deposits of crumbled down fossil bone would be found, and the discovery would be of great value, for with the Railway at Umballa, and the Jumna and Ganges Canals, near Saharunpore and Mozuffernuggur, the entire Northern Doab, could be manured from this source.

The valley of the Nerbudda has also its fossil bone deposits, and with the Railway at Jubbulpore, that vast tract of land could be made to produce cereals and grain crops of the best quality. But this is not all, for by the use of such manure the land would be restored to strength, and its fertility would be greatly increased; so that it would then be capable of producing an average wheat crop of four quarters, (or 23 maunds 5¾ seers,) per acre, which it only now does in the most favored localities, and under the most favourable circumstances.

The value of this phosphate will be better understood when it is known, that 100 lbs. of English wheat ash, contains no less than 46 lbs of phosphoric acid to 3 lbs of lime and 12 lbs of magnesia.

The human bone contains in the hundred parts, 53·04 of phosphate of lime, 11·3 of carbonate of lime, 1·16 of phosphate of magnesia, and 1·20 of soda with a very little salt. This will show that if the soil is poor in phosphate of lime, magnesia and carbonate of lime, the grain or wheat will be the same, and the bones of the man or child reared on such food, must of necessity be weak and slight.

The bones of the ox will yield the best manure for all grain crops, and especially wheat, and Indian corn. They contain in the hundred parts, 57·35 of phosphate of lime, 3·85 of carbonate of lime, 2·05 of phosphate of magnesia, and 3·45 of soda, and salt.

The bones of sheep and poultry will make the best manure for oats, rye, beans and *dalls* of every kind, and for turnip crops, as also for colza, and all oil seed crops. The former contain in the hundred parts, 80 of phosphate of lime, and 19·3 of carbonate of lime; the latter 88·9 of phosphate of lime, and 10·4 of carbonate of lime.

The bones of the frog and fish will produce the best manure for rice, barley, the large and small millets, potatoes, and carrot crops. The former contain 95·2 per cent of the phosphate, and 2·4 of the carbonate of lime; the latter 91·9 per cent of phosphate, and 5·3 per cent of the carbonate of lime.

In countries where frogs are abundant, they should be freely used as manure; they may be caught in nets, and be thrown for a few minutes into a tub or cask of lime wash, which will destroy them; after which, they ought to be mixed with chunam or lime, and be buried in a manure pit. Fish manure is made in the same way. The lime should be sprinkled over three inch layers of fish and frogs alike; it will hasten their decay and enrich the manure.

On the Malabar and Coromandel Coasts, vast quantities of fish may be caught, and made into valuable manure in the above manner.

Magnesian Manure.

In the *Simla Hills*, disintegrating magnesian limestones are common, and this substance reduced to powder and applied to the land, would answer all purposes. In the plains of this Presidency, we have no magnesian limestone; but a very efficient substitute is met with in the steatite, or soapstone. It is the *sael khurree* of the Punjab, and the *sung-jurras* of Agra, and the North Western Provinces. I believe it is produced in the Gwalior territories, and sent to Agra, where it is made into all sorts of ornamental trifles. As the component of a manure, it stands next to the fossil bone. Steatite consists of "silica 44, magnesia 44, alumina 2, iron 7·3, manganese 1·5, chrome 2, with a trace of lime."—(Ure.)

It has been shown in Professor Johnston's Tables, that 100 lbs. of wheat and Indian corn ashes contain, respectively, 12 and 16 lbs. of magnesia, and as 5,000 lbs. of grain would produce the above quantity of ash, three acres of land would be annually deprived of 28 lbs. of magnesia, if it produced a wheat and maize crop annually as in India. By a simple calculation it will be found, that two *seers* two *chittacks*, and 100 grains of soap stone, contain one *seer* and 8 grains of magnesia. Therefore in order to replace the 28 lbs. of magnesia, taken out of the soil, 30 seers of soap-stone dust or powder will have to be applied to the three acres, and this could be most effectually accomplished, by mixing the bone dust, or fossil phosphate dust, with the steatite powder.

In the Madras Presidency, the native carbonate of magnesia is met with, and is used for making a beautiful lime mortar or cement. "*Magnesite* dissolves very slowly in muriatic acid, and gives out carbonic acid, in the proportion of 22 parts by weight, to 42 of the mineral, according to my experiments."—(Dr. Ure.)

To use *Magnesite*, as a component of manure, roast the stone, previously broken up to the size of road metal, and then reduce it to powder, which is to be mixed as before, with phosphate of lime. The same quantity will suffice, as it is nearly as rich in magnesia as the steatite.

Metallic Manures.

Iron and Manganese.

The ashes of black tea contain iron and oxide of manganese, in the proportion of 3·29 per cent of oxide of iron, and 0·71 per cent of the oxide of manganese.

The black *mukkole* of the Himalayas contains iron and manganese, and as steatite is sold in the Simla bazaar, tea manure may be enriched accordingly.

The SULPHATE OF IRON, or *kussees* of the bazaar, is met with all over India, and is a most valuable manure. Its solution when applied to fruit trees, makes the fruit, produced, more sweet and juicy. It contains 26·10 of iron, 29·90 of sulphuric acid, and 44 of water in 100 parts.—(Dr. Ure.)

With the exception of wheat, all grain crops contain more or less sulphuric acid. Oats contain most, and amongst root crops the turnip extracts the largest quantity from the soil.

The SULPHATE OF COPPER, though not a manure, is of great use to the agriculturist; for if wheat, peas, gram, or other seed be soaked for ten minutes in its aqueous solution, neither rats, mice, white ants, or the common ant, will touch it when sown.

To make the solution, dissolve 1 lb. of sulphate of copper (native name, *neela too-teeah)* in eight gallons of cold water. Gunny bags, string, twine, cotton tent ropes, cordage of every description, cloth, bamboos, tent pegs, hedge poles, planks, beams, and railway sleepers, if immersed in this solution, become white-ant proof. Fresh cut timber if soaked therein is quickly and permanently seasoned. A one inch green plank, will require 24 hours soaking, and a railway sleeper 24 hours, for each inch in thickness.

Mud plaster (or *gara*), made as usual, and subsequently tempered with this solution, becomes white ant proof. A godown floor made of beaten *kunkur* or broken brick, if watered with it, will be avoided by the termites.

If any person accidentally drinks the solution, (which is rank poison) its effects will be neutralised by administering a thick cold syrup: of sugar and water. To make it, fill a tea cup, three parts full, with sugar, and fill up with cold water, stir till dissolved, when administer to the poisoned person; repeat every hour till cured. Three doses will suffice. The sugar decomposes the sulphate, and metallic copper is deposited, which is not poisonous, and will pass off. Persons poisoned with verdigris, *acetate of copper*, formed in cooking pots or *degchees*, should be similarly treated. An emetic, or a purge will remove the inert copper. Mustard in hot water produces the former; a full dose of Holloway's pills, *kala dana*, or senna leaves, the latter.

Saline Manures.

SULPHATE OF SODA is the *kharee neemuck* of the bazars, and it consists of sulphuric acid and soda.

"40 lbs of sulphuric acid, and 31 lbs of soda, form 71 lbs of dry sulphate of soda."

"44¼ lbs of dry sulphate of soda, and 55¾ lbs of water, form 100 lbs of *crystallized* sulphate of soda or common glauber salts."—(JOHNSTON.)

All grain and root crops contain soda and potash. The latter is supplied when nitre is used in preparing a manure; and when the presence of the former is desired, the sulphate of soda should be dissolved in water, to which slaked lime or *chunam* should be added, and the acid allowed to act on the carbonate of lime, when two valuable manures will be produced, viz., sulphate of lime and carbonate of soda. Beans, turnips, potatoes, Indian corn, lucerne, clover, ryegrass, and meadow hay, are especially benefitted by composts in which the sulphate of lime and carbonate of soda are present.

Further information on this point, will appear under those heads.

Impure native Carbonate of Soda, or Sujjee Mittee.

This substance appears as an efflorescence in certain soils, but in place of being a *sterelizer* like *reh* and *kuller*, it is a fertilizer. The *dhobees*, or washermen, use the earth so impregnated for washing clothes ; and the commercial *sujjee*, or crude carbonate of soda, is produced from this earth, in the same way that saltpetre is made from nitrous earth.

Nitrate of Soda.

This salt is met with in the Delhi district and elsewhere. It is also a fertilizer. I believe the natives call it *shora khar*, and saltpetre can be made from it.

" *What does nitrate of soda consist of*" ?

"It consists of nitric acid and soda."

" 54 lbs of nitric acid, and 31 lbs of soda form 85 lbs of nitrate of soda." "100 lbs of nitrate of soda contains 16½ lbs of nitrogen.—(JOHNSTON.)

The agriculturist should bear these facts in mind when making composts. Thus if 85 pounds of the nitrate of soda be dissolved in water, and the solution be applied to six tons (or 162 maunds) of farmyard manure, the 31 lbs of soda, will suffice to keep three acres of land rich in soda for at least four years, during which period eight grain crops could be gathered from them ; *i. e.*, one full wheat, and one full maize crop annually.

Calcined Limestone or Lime Manure.

When limestone, or *kunkur*, is calcined or burned in a kiln, it parts with its carbonic acid and becomes caustic or quicklime.

This when slaked by the addition of water, falls into a fine white powder, which is called slaked lime. When exposed to the air, caustic lime will absorb moisture therefrom, and fall into powder. This is called spontaneously slaked lime, and makes the best lime or *pucca* mortar.

" 28 lbs of lime, and 22 lbs of carbonic acid make 50 lbs of pure limestone."—(JOHNSTON.)

" One ton of pure quicklime becomes 26⅓cwt. of slaked lime," (JOHNSTON,) therefore the builder and agriculturist should always purchase unslaked lime.

When a ton of pure limestone, lime shells, or *kunkur* is calcined, about 11¾ cwt. of quicklime is produced.

In Northern India certain lands irrigated by the Ganges, Jumna and Punjaub canals produce a saline efflorescence which is called *rhae* and *kullur*, by the natives. Whenever, and wherever this takes place, the previously fertile land becomes sterelized. The chemical composition of this sterelizing salt is known to the Government, (its analysis will be given when received from the Punjaub Government) ; and as the matters present will enter into chemical combination with quick and slaked lime, these lands may be reclaimed and restored to pristine fertility, if so treated. But the subject being Departmental, it will, no doubt, in due time be attended to by the proper officers.

A few maunds of lime should always be kept in store by the agriculturist, for use as occasion may require, but for purely manuring purposes the *kunkur* dust will be found most efficient.

Vegetable or Green Manure.

Sea Weed.

On the Eastern, Malabar and Coromandel Coasts, great quantities of sea weed are thrown ashore during the monsoons, and if collected and properly treated, a very large supply of manure would be derived from this source.

" *Is not sea-weed, or sea-ware a very valuable manure?*"

" Yes, wherever sea-weed can be obtained in large quantity, it is found to enrich the soil very much."

" Sixteen loads of it are reckoned equal to 20 tons of farmyard manure. The use of sea weed has doubled the produce of the isle of Thanet in Kent ; and on the Lothian coasts it adds 20 shillings an acre to the rent of land which has a right of way to the sea."

" *How is it employed?*"

" It is spread over the land, and is either ploughed in, or is allowed to rot and sink in, or it is made into a compost."

How would you prefer to make a compost of sea weed?

"I would mix the sea weed with earth, and with shell, sand, or marl, if they were to be had, and would turn over the mixture once or twice before using it."—(JOHNSTON.)

"By manuring land with sea-weed large crops of potatoes are obtained, but to have them of the best quality, this manure should be ploughed in early in the season, before the potato planting, when they will be found as dry as when raised by farm yard manure"—(JOHNSTON.)

With a good supply of *kunker* dust, or sea shells, roasted and then reduced to powder, the natives of the Indiancoasts would be able to make sea-weed compost at their leisure. They could, by its use, greatly increase the productiveness of their rice crops.

On the coast, all soils, which contain little vegetable matter will be greatly benefitted by the use of sea-weed compost.

Green Crop Manure.

IN Upper India, the zemindar sometimes sows *moth dall* on light sandy soils, and when it is in pod, he ploughs the standing green *dall* crops into the soil. This is called ploughing in green manure. Turnips, rape, lupins, or anything else may be similarly ploughed in green to enrich the soil.

Green Indigo Manure.

THE lands near Indigo Factories, would be greatly improved if the steeped green indigo plant was used as manure, and ploughed in as soon as taken out of the vats. The land so manured would after being limed, produce heavy sugarcane crops. At present the steeped plant is wasted. It is piled into a heap, which heats most rapidly and passes into charcoal. But if on being taken out of the vat, each bundle of plant was dipped into a small vat, holding a solution of *kharee neemuck*, or sulphate of soda, it would be deprived of its heating powers, and, if kept moist, would very soon pass into vegetable manure of high quality.

The wealthy and intelligent Indigo Planters of India, have it in their power to become great producers of cotton and sugar, simply by using megass manure for the former, and indigo stalks, or steep waste, for the latter. Thus the indigo crop, which is raised with very little manure, gives a large supply of soft woody fibre to manure sugarcane, which in its turn supplies cotton manure, and the cotton wood yields fuel for the sugar furnaces.

Dry Vegetable Manure

IT is to the interest of the Agriculturist, to grow certain crops, which after paying all expenses and yielding a profit, will still leave a large supply of refuse matter, which may be turned into manure, or plant-food.

Of such plants, the sun-flower is the most valuable, for it yields oil and oilcake, and its leaves, stalks, and large seed vessels are available for conversion into manure.

To prepare such manure:—As soon as the seeds are ripe, cut off the calyx, which contains the seed and put them into the sun to dry. After the seed crop is removed, cut down the standing sun-flower stalks, or crop close by the roots, and remove it to the farm. An acre of land under this crop will give several cart loads' of stalk, which should be cut up into two and three inch pieces with a chaff cutter, or chopper, and be allowed to dry in the open where cattle cannot get to it. When the whole crop has been so treated, chop up the seed vessels, and add them to the heap. When dry prepare a sufficient quantity of sulphate of soda solution, made by dissolving one chuttack of *kharee neemuck* in a *gharrah* of water; having prepared sixteen *ghurras* of the solution, cause the chopped stalks to be wetted therewith, and then make a second supply of the solution, or as many more as may be needed to wet the entire heap. Turn over the heap so that every part of it may be moistened,—after which beat or tread it down, so as to compress the mass. It is to be left alone for four days, when the entire heap should be slightly sprinkled with water, so as to keep it damp and moist. This watering is to be repeated at intervals of four days till decomposition sets in, and when this is completed a large supply *of dry vegetable manure* will be produced, which should be stored in a pit for future use.

In this manner the stalks of the Jerusalem artichoke, *Hybiscus sabdarita*, and *Esculentum*, or any thing else of a like nature, may be chopped up, dried and converted into manure.

This manure is the nearest approach to megass manure, and it may be used for cotton land, if first moistened with sulphate of iron water, and then mixed with *kunker* dust, which has been moistened with saltpetre water, and allowed to dry, before being added to the manure.

If it be mixed with farmyard manure, bone dust, or fossil phosphate of lime, and steatite dust, the compost may be used for wheat and all grain crops.

Rice Husk Manure.

Every sixteen hundred maunds of *paddy*, or unhusked rice, produces six hundred maunds of husk; which if added to farmyard manure will improve it, and still more so, if the rise husk be burned to ash before being used The food phosphates do not exist in rice, but they are all present in considerable quantity in its husk, and when this is burned an ash is left which, in addition to a very large proportion of pure transparent silica, contains the phosphates of soda, potash, lime, magnesia, and iron; therefore rice husk ash, when mixed with farmyard manure, (in the proportion of three parts of ash to one of manure,) produces a very valuable compost for wheat maize and *jooar* or large millet.

The Chinese are a rice-eating nation, and rarely use milk or cheese, but their remarkably intelligent ancestors have taught them how to manure their blood, (*i. e.* keeping up a constant supply of the phosphates,) by boiling their rice, in a clear solution of rice husk ash water, and the strength, flesh, bone and muscle, of the Chinese shows what the food phosphates will effect.

The millions of Bengal also eat rice, but the Bengaleo boils his rice in plain water, and his physical inferiority proves that the use of food, deficient in phosphates, produces degeneration.

APPENDIX

To the preceding Chapter.

Fossil Phosphate of Lime.

It will be interesting to the Agriculturist, and general reader to know that, the fossil bone deposits of the Sewallicks, are practically inexhaustible, as the following information will show :

" ' On the departure of Dr. Royle for Europe in 1832, Dr. Falconer was appointed to the charge of the Botanical Garden at Saharunpore, about twenty-five miles from the Sewalick hills.

" ' In 1832, Dr. Falconer commenced his field explorations by an excursion to the Sub-Himalayan range, and from the indication of a specimen in the collection of his friend and colleague, Captain, now Sir Proby, T. Cautley, he was led to discover vertebrate fossil remains *in situ* in the tertiary strata of the Sewallick hills.

" ' A brief notice of the fact, extracted from a letter, appeared in the *Journal of the Asiatic Society of Bengal* for 1832, vol. i., pages 97 and 249. The search was speedily followed up with characteristic energy by Captain Cautley in the Kalawala Pass, by means of blasting, and resulted in the discovery of more perfect remains, including miocene, mammalia genera. The finding, therefore, of the fossil fauna of the Sewalick hills was not fortuitous, but a result led up to by researches suggested by previous special study, and followed out with a definite aim in India.

" ' Early in 1834, Dr. Falconer gave a brief account of the Sewalick hills, describing their physical features and geological structure, with the first published section, showing their relation to the Himalayas (*Jour. As. Soc. of*

Bengal, vol. iii. page 182). The name Sewalick had been vaguely applied before, by Rennell and others, to the outer ridges of the true Himalayas and the lower elevations towards the plains. Dr. Falconer restricted the term definitely to the flanking tertiary range, which is commonly separated from the Himalayas by valleys or Dhoons. The proposed name was not favorably received at the time by geographical authorities in India; but it is now universally adopted in geography and geology, as a convenient and well proved designation. Captain Herbert, in his Mineralogical Survey of the North-Western Himalayas, had referred the Sub-Himalayas to the age of the "new red sandstone." Dr. Falconer, on his first visit to the Sewalick Hills, inferred that they were of a tertiary age, and analogous to the *molasse* of Switzerland (*Jour. As. Soc. of Bengal*, 1832, vol. i. page 97). Thirty years of subsequent research by other geologists have not altered that determination, although our exact knowledge of the formations has been greatly extended. The researches thus begun were followed about the end of 1834 by the discovery, by Lieutenants Baker and Durand, of the great ossiferous deposits of the Sewalicks near the Valley of Markunda, westward of the Jumna and below Nahun. Captain Cautley and Dr. Falconer were immediately in the field, and by the joint labours of these four officers, a sub-tropical mammalian fossil fauna was brought to light, unexampled for richness and extent in any other region then known. It included the earliest discovered Quadrumana, an extraordinary number of Proboscidia belonging to Mastodon, Stegodon, and Elephas; extinct species of Rhinoceros, Chalieotherium, Equus and Hippa-rion, Hexapostodon, Hippopotami and Merycopotamus; Ios and Hippohyus; the colossal ruminant Sivatherium, together with species of Camel, Giraffe, and new types of Bovidæ; also species of Cerous and Antelope, and Capra; Carnivora belonging to the new genus Sivalaretos and Enthydriodon, Felis Machairodus, Hyæna, Cania, Sutra, &c. Among the Aves, species of Ostrich, Cranes, &c.; among the Reptilia, Monotars and Crocodiles of living and extinct species, the enormous Tortoise *Colossochelys Atlas*, with numerous species of Emys and Trionyx; and among fossil

Fish, Cyprinida and Silicisda. The general facies of the extinct Fauna exhibited a congregation of forms participating of European, Asiatic and African types. A series of memoirs by Dr. Falconer and Captain Cautley, descriptive of the most remarkable of the newly discovered forms, appeared in the Asiatic Researches of the *Journal Asiatic Society of Bengal* (vols. xiii to ix inclusive,) and in the *Geological Transactions*. The Sewalick explorations soon attracted notice in Europe, and in 1837 the Wollaston Medal in duplicate was awarded for their discoveries to Dr. Falconer and Captain Cautley by the Geological Society, the fountain of geological honors in England."

I am indebted for the above to " E. Rs." Pamphlet on the Sewalicks, and Deyra Dhoon. Published at the *Pioneer* Press.

INORGANIC MANURES

CONSIDERED

IN RELATION TO SOILS

AND THE BETTER

ECONOMISING OF FARM-YARD MANURE,

BY

THOMAS BLUNDELL, M.D.,

Member and formerly President of the Royal Medical Society of Edinburgh;
Member of the Royal Physical Society; Member and formerly
President of the Plinian and Natural History
Society of Edinburgh, &c., &c.

[illegible]

[illegible] fields will be treated with manures, (alkaline silicates, and salts of [illegible] in chemical manufactories, exactly as at present medicines are [illegible]

LONDON: HAMILTON & CO., PATERNOSTER ROW.

WISBECH: E. JOHNSON, BRIDGE STREET.

1845.

TO

WILLIAM SPIKINGS, ESQUIRE,

Tydd Marsh, Lincolnshire.

MY DEAR SIR,

THE eagerness which you have ever evinced to inquire into the action of manures upon the soil, and of both in the economy of vegetable life,—in other words, your desire of obtaining a clearer insight into the Chemistry of Agriculture and Vegetable Physiology—the readiness with which you have adopted my views on many points—and the generous frankness of your offer to allow me a particular portion of your farm, for an experimental field, in order to follow out any experiments I had, or might hereafter have, respecting the efficiency of the *inorganic* over the *organic* constituents of soils and manures—coupled with the many proofs of your friendship—induces me to inscribe this short Essay to yourself, as a mark not only of the respect with which I regard your zeal in the prosecution of scientific principles in farming, but as a pledge of that cordiality I trust I shall ever entertain towards you.

THOMAS BLUNDELL.

WISBECH, *February*, 1845

PREFACE.

I AM aware it may be said, perhaps, that I have written the following Essay more as an indirect means of puffing off certain Compound Fertilizers I am about to offer to the notice of the agricultural public, than with any view to the emoluments arising either from the mere publication of the work itself, or for the sake of extending the boundaries of agricultural science.

Such cavillers will be pleased to bear in mind, however, that they are not of necessity compelled to buy these same Compound Fertilizers, merely because I choose to expatiate upon their merits and place them foremost in the long catalogue of artificial manures. All I can say, or rather shall say, to those who may hold such an opinion is, that before they draw their conclusions they had better first read the Essay through, and be quite sure they comprehend the merits of the question, both as regards the manner in which the subject of farm-yard manure is treated, and the comparative estimate drawn between vegetable organic matter, and saline inorganic compounds.

To the more liberal-minded man I need only request his attention to the consideration of the great, and to the farmer, important question, "What are the substances which constitute the food of plants."? And if he shall satisfy himself that this point has been cleared up—if, from the arguments advanced, he shall be convinced that results may be expected from the judicious application of mineral and saline inorganic matters to his crops, greater than he had before calculated upon (or from the ordinary farm-yard manure)—he may, perhaps, be induced to make a few experiments, in order to obtain an estimate of the relative value of such artificial fertilizers.

All that I insist upon is, that every crop is far more dependent upon certain inorganic matters, (found only, in any efficient quantity, in the very best farm-yard and stable manure, or contained in staple soils) than upon mere vegetable matter in a state of decay.

It is now upwards of seventeen years since I fully satisfied my mind that plants, the seeds of which were made to vegetate in pure sand, could be brought not only to their maximum size, but to full maturity, by simply furnishing them with a solution of those salts containing for their bases those matters found in the ashes of vigorous plants of the same family or species.

These experiments led to others, which further convinced me that the same species of plants could be maturely developed upon the same soil (taken from an average staple wheat land, and placed in flower pots), for several years in succession, *without any other manure* than a similar supply of alkaline and earthy fixed salts diffused in diluted urine.

It is admitted on all hands that the only true principle, in a rational system of agriculture is, as far as respects manuring, to render back to the soil those matters that have been removed by the previous cropping. To have told a farmer, however, of the old school, some twenty years ago, that he might successfully cultivate wheat upon the same ground, without the use of any farm-yard manure, and this for several years in succession, you would have incurred no other penalty less than his contempt at the boldness and effrontery of your assertion!

As we know, then, that each family of plants, in order to attain perfection, requires to derive certain substances from the soil, or the manure applied to it, it is upon the knowledge of what these substances are, and in what manner they are best adapted to serve the purposes of a luxuriant vegetation, that the

Compound Inorganic Fertilizers—recommended in the following Essay—are calculated and prepared: being so varied in their constituent parts as to be exactly adapted to the different crops the practical farmer may be, respectively, desirous of cultivating.

In the compilation of this little work, I am ready to acknowledge that the writings of Davy, Liebig, Sprengel, Bacquerel, Saussure, Macaire Princep, Thenard, and Struve have been freely cited, and such portions selected as I found to answer my views; while the tables of Schubler have also been laid under contribution.

I have endeavoured to avoid, as much as possible, the use of technical terms; and although, in some instances, this has been a matter of difficulty, I have, nevertheless, adopted a style and a form as little repulsive as the nature of the subject would admit.

The practical agriculturist will see that, so far from under-estimating the value of farm-yard manure, I have laboured to lay down such principles as will enable him not only to increase the quantity he makes annually, but to add at least *threefold* to its quality and value, by the fixation of those ammoniacal salts and compounds which would be otherwise chiefly dissipated by fermentation and putrefaction.

Indeed it has been the consideration of the great importance of the inorganic constituents of manures, and in how far they act in the economy of vegetation—coupled with the knowledge of what food our commonly cultivated plants require from the soil, in order to become fully developed—that is, as far as regards size, quantity, and quality—that has induced me to superintend the different processes in the preparation of the Vegetable Fertilizers; a descriptive account of whose characteristic nature and properties, as compared with ordinary farm-yard manure, occupies some portion of the following pages.

T. B.

WISBECH, *February*, 1845.

ESSAY

In introducing three distinct fertilizing manures to the notice of the practical agriculturist, I must beg to be excused if I enter somewhat minutely into a detail of the nature, quality, and composition of manures in general, their mode or means of action, as well as the more judicious or economical method of their application.——In doing this I trust to be understood as by no means attempting to undervalue farm-yard manure:—it being the object of this Essay rather to invite the practical farmer to a better system of hoarding and husbanding the produce of his crew-yard and stable—by the admixture with the manure of such materials, within his reach, at but little cost, as the latest principles of modern science have introduced—than to pretend to such mountebank-quackery, as to persuade him, that by using this or that compound fertilizer, he may do without farm-yard manure altogether!

The great use of mere stubble, straw, green-crops, refuse animal and vegetable matter, as weeds, &c.; as also unfermented or half-decomposed litter, ploughed into a soil, is, to furnish it with *humus*, or vegetable matter, in a state of decay. Every fertile soil must necessarily contain a certain quantity of this substance, which, although it by no means furnishes the principal nutriment of plants—as was until lately supposed—it is, nevertheless, highly valuable in supplying a constant source of carbonic acid to the soil, so as to be absorbed by the roots of the young plant. *Vegetable mould*, which is almost identical with *humus*, is a variable mixture of fine divided earthy matters, with the decaying remains of animal and vegetable substances; or it may be said to consist of earth and humus in a state of decay: woody fibre in a state of incomplete decomposition, when mixed with earth, may also be regarded as *vegetable mould.*

The conditions requisite for the development, nutrition, and growth of a plant, may be briefly summed up as follows—viz: first, The presence of substances yielding *charcoal* and *nitrogen*, as elements necessary to the growing structure; second, Of water, as furnishing in its composition two very important elements, *oxygen* and *hydrogen*, besides adventitious matters; and third, Of a soil to yield the mineral, earthy, saline, metallic, or other *inorganic* compounds essential to vegetable life.*

Carbonic acid yielding *carbon*, or charcoal—ammonia, or its compounds, yielding *nitrogen*—and water, *oxygen* and *hydrogen*, are, then, amply sufficent to furnish plants with the *elements* necessary for the formation of all their structures or organised parts.

* By *inorganic* compounds, salts, or substances, we mean generally such matters as are not composed of any regular arrangement of cells or vessels, as animal and vegetable structures are. For instance, lime, flint, gypsum, common salt, earths, &c., have no regular vascular organization; and although they enter into the frame-work of both animal and vegetable structures, we still denominate them as *inorganic*: while *organic* substances may be characterised as being formed under the influence of the *vital principle*, and are compounded of *four* elements only, viz.—*charcoal*, *nitrogen*, *oxygen*, and *hydrogen*: we call these the four *organic* elements, as they alone constitute all animal as well as vegetable structures.

Now the *carbonic acid* required by plants, is generated in the soil by the decomposition of vegetable matter, and so presented at once to their roots; while it is also absorbed by their leaves from the atmosphere.

Ammonia, likewise, is furnished by the putrefaction of animal matters in the soil, or by the decomposition of ammoniacal compounds contained in manures; ammonia is also precipitated from the air, in which it always exists, to the soil, by every fall of snow or shower of rain which descends to the earth.

The *inorganic* matters, which play such an important part in the economy of plants, consist of certain mineral substances, as the alkalies *potash* and *soda;* the alkaline earths *lime* and *magnesia;* and these are variously united with silicious earth or flint, phosphoric and other acids, together with the oxides or rust of certain metals, as iron and manganese.

The last-named substances serve such peculiar functions in the vegetable organism, that many of them must be viewed as forming absolutely essential constituents of particular parts, as the roots, stem, and seeds. Thus, then, we find that the air and the soil afford the same kind of nourishment (carbonic acid) to the leaves and roots of plants: the former (air) containing an almost inexhaustible supply of carbonic acid and ammonia;—the soil, by means of its *humus*, or decaying vegetable matter, generating fresh carbonic acid to supply the roots; whilst during winter and spring, the snow and rain bring down a sufficient quantity of ammonia, to satisfy the production of the leaves and blossoms.

Upon an average fertile soil, under a good state of tillage, there is, perhaps, no manure for the generality of crops, that can surpass the dung manure of horned cattle

The quantity of silicious earth found in the ashes of wheat-straw is truly astonishing, were we to regard it as merely adventitious; but when we bear in mind that all the plants of the same species—viz., all the grasses invariably contain this substance, and that none of them can arrive at maturity unless grown upon a soil containing potash and silicious earth, we are compelled to admit that it is as essential an ingredient in the earthy frame-work of these plants, as bone-earth is to the mature development of the bony frame-work of man and animals. This silicious compound, in whatever way introduced into the organs of the young plant, would seem to be the material from which the woody fibre first takes its origin: acting as a kind of nucleus, around a particle of which the charcoal, furnished by the carbonic acid, incipiently solidifies; precisely as a saturated solution of alum or sugar-candy, will crystallize, or congeal, on a rod of wood or string-thread.

The stem, then, requires the presence in a soil of an alkali united with flint; and the seeds require the presence of the earthy phosphates, viz., the phosphates of lime and magnesia, in order to bring them to full maturity. Here, then, we trace the abstraction, from the soil, of a large amount of alkaline matter, together with other earthy and saline compounds.

To attempt, therefore, to cultivate the same kind of plant in succession, is upon principle impolitic, and in practice disadvantageous; and this fact has long pointed out the expediency of the rotation cropping.*

For instance, if we follow wheat after beans, peas, and

* There are some partial exceptions to this apparently sweeping assertion —for instance, tobacco, hemp, the Jerusalem artichoke, rye, and perhaps oats, may be cultivated in close succession, provided we use proper manure to supply them with alkaline salts.

lentils, we are almost certain of obtaining a more than average crop; inasmuch as these plants only very sparingly exhaust the soil of those inorganic principles, absolutely necessary to the growth of wheat.

We find, then, that different plants withdraw very different amounts of inorganic matters from the soil; and that the substances required by one plant are not requisite to the development of another, as we may remark upon rich alluvial soils—South Downs, in Sussex—where beans and wheat are grown in alternate crops for years together. Peas and beans both yield albuminous matter:—peas giving 35 in every 1000; beans only affording 31 parts of albumen in 3840 of their flour. They contain, however, other matters analogous to animal matter; the dried leaf of the bean, when burnt, gives off a smell approaching to burnt feathers—thus proving the existence of azotised or nitrogenous matter:—hence the decay of the roots and leaves of beans and peas, in the soil, must furnish principles capable of becoming a part of the glutin or bird-lime like ingredient of wheat. Again, we can raise upon the same soil, upon which only one crop of wheat will grow and yield to any advantage, *two* successive crops of barley, or *three* of oats: that is, two such barley crops or three of oats, only abstract from the soil that amount of inorganic constituents, as would be withdrawn by one crop of wheat: 100 parts of the straw of wheat yielding 15.5; of barley straw 8.5; and the straw of oats 4.5 of ashes per cent. respectively: the same is seen in the analysis of the grain of these plants;—for instance, the quantity of soluble salts and earthy phosphates in 100 parts of the ashes of wheat, barley, and oats, is—

Wheat	91.66
Barley	61.5
Oats	25.0

As we have spoken of the *inorganic* compounds called silicates and phosphates, as silicate of potash, and phosphate of lime, magnesia, and ammonia, we will briefly consider the sources of these salts, and their economy, or part they serve, in the physiology of vegetable life. Phosphoric acid is contained in all soils capable of cultivation; and although its quantity per cent. is scarcely appreciable, yet even the barren soils of our heaths are found to contain traces of it. This acid also exists in many minerals, as *galena* or green lead ore, in which the acid is united with oxide of lead:—in *clay-slate*, which forms the most extensive of all strata, in which it is united with clay, forming *wavelite;* and in the mineral called *apatite*, in combination with lime.

Plants, therefore, primarily derive their phosphoric acid from the soil in which they grow, and in their turn yield it to animals: as we find its salts, to the amount of from 55 to 85 per cent. in their bones, and in certain proportions, more or less, in every part of the animal organism.

The ashes of the grain of wheat contain as much as 76 per cent. of phosphoric salts; while the ashes of wheat straw and hay contain from 11.5 to 12 per cent. of the same salts. In the grain of wheat, barley, and oats, we find phosphates of magnesia and ammonia; and this same acid, in combination with alkalies, (potash and soda,) or alkaline earths, (lime and magnesia,) and metallic oxides, has been detected in the ashes of all plants hitherto examined. Such being the case, it is evident that these substances must play a very important part in the economy of vegetation: and that this is the fact, may be satisfactorily demonstrated, if we cause plants to grow in mixtures of mineral matter, in which these earthy and saline phosphates are carefully withheld: the plants may vegetate, but will never produce reproductive seeds.

Adult animals consume with their food a much larger proportion of these phosphoric compounds, than is necessary for the maintenance of their frames and tissues; and this redundant quantity* is consequently eliminated or rejected in the urine and solid excrements, to be again assimilated or appropriated to the use of future plants. This, however, is not the case in young animals; the excrements

* Some idea of the quantity of phosphate of magnesia contained in grain and its husk, may be gathered from the composition of a concretion or stone, lately taken from the lower bowel of a horse, the property of Charles Boucher, Esq. This concretion weighed the enormous weight of 21¾ lbs., and measured 28½ inches in circumference. This was removed, after death, by Mr. Amis of Wisbech. About a year ago, the same veterinary surgeon dislodged from the rectum of another of Mr. Boucher's horses as many as thirty-three of these concretions. "The animal died from a twist in the bowel," and on the following day, thirteen more of these stones were removed: making altogether forty-six in number. In all these concretions some foreign matter, as a bit of flint, mortar, and even rag, formed a nucleus for the deposit of the material of these stones: the largest of which was about the size of a duck's egg. All these concretions appear to be composed of the same compounds. The analysis of a part of the large one, and one of the smaller calculi, gave me the following as the composition of these intestinal concretions:—

Phosphate of Soda	11.0
Phosphate of Magnesia & Ammonia	70.0
Phosphate of Lime	5.0
Silicious Earth	7.5
Mucous & Vegetable extractive Matter, with oxide of iron	6.5
	100

The food of these horses consisted of ground beans, cut hay, and bran. Now as beans and hay contain only a very small portion of the phosphates of lime and magnesia, we must search the bran for the presence of these matters; and an analysis of the ashes of 100 parts of bran gives 4.16 of soluble salts, 46.5 of earthy phosphates, and 0.75 of flint and oxide of iron.—These soluble salts consist of phosphates of soda and ammonia. Miller's horses, being generally fed with bran in their food, are very subject to the formation of these intestinal concretions.

of young stock never being so rich either in earthy phosphates or azotised matters, as those of full-grown animals—and for a sufficient reason;—nature requiring the greater part of these materials in building the bony frame-work and muscles of their growing bodies.——But plants require other inorganic, or mineral matters, besides earthy and alkaline phosphates;—for instance wheat, oats, barley, and, in fact, all plants of the family of the grasses, must receive a certain quantity of potash or mild alkali, in order to arrive at maturity and strength. It would be impossible to bring any of these plants to full perfection—to reproductive seed-bearing—upon a soil containing neither the earth of flints nor alkaline salts: since this salt, silicious potash, is never absent from the organism of all such plants in a vigorous state. This *silicate of potash* is a species of *soluble glass;* and is composed of finely-divided flint or sand, rendered soluble in water by the action of the alkali contained in the soil or manure; and in this state becomes fitted to be absorbed by the roots of the plant; afterwards, by its living powers, to be appropriated in forming the solid frame-work of the stem.* But it may be asked, from what source does the soil derive all this valuable alkali, apparently so indispensably necessary to the whole vegetable kingdom?——The great reservoir of potash is traceable to all minerals containing alumina or the earth of clay; and as these minerals are very widely-diffused over the face of the globe, we have an ample store of this alkali in all strata derived from felspar and *clay-slate*; the former containing from 17 to 18 per cent., and the latter from 2 to 3 per cent. of potash. Other mineral substances also contain this alkali, as *loam*, from 1½ to 4 per cent.; while

* Silicate of potash exists also in wood and in some peat ashes; and is found in the ashes of all ordinarily cultivated plants.

basalt contains from ¾ to 4 per cent. of potash, and from 5 to 7 per cent. of soda.—*Mica* contains from 3 to 5 per cent. of soda, and *Leolite* from 13 to 16 per cent. of both alkalies taken together. The great influence exercised by aluminous earth, upon the life and growth of plants, thus finds a ready and two-fold explanation; on the one hand from their invariably containing the two alkalies, potash* and soda, and on the other from the power or property they possess of attracting and retaining both water and ammonia from the atmosphere.——Although aluminous earth is itself very seldom found in the ashes of plants, still it yields also the earth of flints, which is always present in plants, having entered them, as we have before observed, by means of the alkalies always present in these particular soils.†

Since, then, we can prove that all plants abstract both alkalies and alkaline earths from the soil, and as one plant imbibes twice the amount of another, and three times as much as a third, so we have a clear insight of the value of the rotation of crops; especially as nearly all the plants in

* If upon clay or marl soils we add quick-lime, we shall liberate the potash they contain: and this gives us a ready test for detecting this alkali in argillaceous soils. Thus if 2 parts of marl be mixed with 1 of quick-lime, and water added, potash may be found in the liquid after the mixture has digested for the space of a day or so.

† The ashes of various kinds of plants, according to the soil on which they grow, contain different quantities of alkaline and earthy bases—and in some instances these bases are capable of replacing each other: thus, in the salt-worts (plants producing only fossil alkali or soda), when their seeds are brought from the sea-coast and sown in our gardens, the plants springing from these seeds yield both potash and soda; but the seeds from the garden plants, when again sown, produce plants which contain only salts of potash. In the same manner magnesia may replace lime, and this again take the place of magnesia. When lime exists in the ashes of plants in large proportion, then we find the usual quantity of magnesia to be much diminished; and likewise when magnesian earth predominates, then the lime or potash decreases. In many kinds of ashes not a trace of magnesia can be detected.

the family of the *legumens*, as the Windsor and kidney beans, field beans, peas, lucern, lentils, buck-wheat, and tares, extract only minute quantities of alkali from the soil on which they grow, and scarcely any earthy phosphates: hence these plants are said to belong to those which are termed *fallow-crops*. Indeed it is upon principle more beneficial to a soil, that it should grow some one of these fallow-crops, rather than lie a dead fallow—particularly so if it be deficient in vegetable matter; for as all these plants draw so little upon the soil, and as they all yield vegetable albumen, or matter approaching to the white of egg, it is very evident that they must, (like plants in their normal growth,) derive all their azotised matter, as they do their charcoal, from the atmosphere.* Now it is equally demonstrable that such plants, if ploughed into the soil, at that period of their growth when they contain the most nourishment, viz., at the time of flowering, they will enrich that soil with all their *nitrogenous principles*, and add to it, at the same time, the whole of their *carbonaceous matter* to decompose into rich vegetable mould. That plants and trees do not derive their nourishment from the humus of the soil, in *its unaltered state*, is proved by the fact, that immense forests are often found growing in soils absolutely destitute of car-

* There are many plants which would seem to be altogether independent of the soil and its *humus*, or vegetable mould, for their nourishment. Those gigantic plants—the palms, ferns, and reeds, (whose vegetable remains are still found in our coal formations,) now growing only within the tropics, are a class of plants to which Nature has given the power, by an immense extension of their leaves, to dispense with nourishment from the soil. These plants, then, derive the greater part, if not all their food from the carbonic acid and water of the atmosphere. Many of the verdant plants of warm climates, are such as possess only a mere point of attachment to the soil, being independent of it for their growth. Again, the plants affording wax and caoutchouc, attain perfection in the most sterile sands of the tropics, where it is impossible they can obtain any nourishment through their roots.

bonaceous matter; while the extensive prairies of America fully prove that the charcoal necessary for the sustenance of a plant, may be extracted by it from the air.

Too much reliance has often been placed upon the quantity of vegetable matter supplied to soils in the shape of manure; and we frequently hear the practical farmer express his disappointment in the results. But the question is, did that very soil—the crop from which had so disappointed his expectations—absolutely require such an inordinate dressing? or was it deficient of those inorganic matters which his crop required? These are questions which but a slight acquaintance with organic chemistry, would have enabled him at once to decide. Vegetable mould, or humus, is a product of the decay of vegetable matter; and if we but glance at meadow and forest lands, which are not manured, we find that instead of a decrease of this material, there is, on the contrary, actually an annual increase. It is not denied that humus is not beneficial to every soil; but its leading influence only depends upon furnishing, by its progressive decay, a certain portion of carbonic acid, for a limited period, to the roots of the young plant; for after the formation of its leaves, the roots of the same plant begin to excrete carbonaceous matters back to the soil; thus rendering to it more carbon than the plant has previously taken from it:—the true value of all vegetable manures depending more upon the relative quantity of inorganic matters they can furnish to a soil, rather than upon any specific quality of the mere fibrous vegetable matter itself; however serviceable such humus may be as a textural constituent of soils, and as affording carbonic acid by gradual decay.

From these considerations it will be seen, then, that in addition to the general conditions necessary for the growth of plants—as heat, the elements of atmospheric air, light, and moisture—there are certain other substances which are found to exert a peculiar and especial influence on the development of particular families, or distinct orders of plants; so that before any rational system of agriculture can be laid down and acted upon, it is absolutely necessary that we should inquire, (since these substances are either already contained in the soil, or supplied to it by manure), first, of what materials the soil itself is composed—and secondly, what are the component parts, organic and inorganic, of the manures so supplied.

"The general object of agriculture," says Liebig, "is to produce, in the most advantageous manner, certain qualities, or a maximum size in certain parts or organs of particular plants. Now this object can be attained only by the application of those substances, which we know to be indispensable to the development of those parts or organs; or by supplying the conditions necessary to the production of the qualities desired. The rules of a rational system of agriculture should enable us, therefore, to give to each plant, that which it requires for the attainment of the object in view. The special object of agriculture is to obtain an abnormal development and production of certain parts of plants, or of certain vegetable matters, which are employed as food for man and animals, or for the purpose of industry."

To accomplish these ends it is quite clear that the wants and habitudes of each family of plants must be studied, and the principles of their culture confirmed by chemical investigation. Now the means employed for effecting these two purposes are very different. The same authority above quoted thus explains himself,—"The mode of culture employed for the purpose of procuring fine pliable straw for Florentine hats, is very opposite to that which must be adopted in order to produce a maximum of corn from the same plant;" and Liebig further insists upon the necessity of attending to the nature and composition of all manures as applied in the cultivation of particular crops, or the produce to be raised from them. "Peculiar methods must be used for the production of nitrogen in the seeds; others for giving strength and solidity to the straw, and others again must be followed when we wish to give such strength and solidity to the straw as will enable it to bear the weight of the ears." "We must proceed," he goes on to say, "in the culture of plants in precisely the same way as we do in the fattening of animals."

That plants cultivated for the use of man and animals—seed-bearing plants—do require more than the ordinary influences of air, heat, and moisture, and that they depend, for their growth and the full development of their seeds, upon the soil and the manure we supply to them, the experience of ages has fully established. What, then, are these substances contained in every fertile soil? and what is it that constitutes a barren or fertile soil? These questions admit of very easy solution by simple chemical analysis; as each may be detected, separated, weighed, and examined. By comparing, then, a few specimens of soils, of well-known fertility, with such as are sterile or but little productive, it is evident we shall arrive at correct conclusions; for it is certain that nothing less than an accurate acquaintance with the composition and characters of a standard soil, will enable us to ameliorate a barren one. All soils primarily derive their origin from the crumbling and wearing down of the fragments of different rocks and mountain strata: hence their properties depend on the nature of their principal component parts. Three or four mineral substances, commonly called earths, for the most part compose our arable land; these are clay, sand, lime, and magnesia; and a due admixture of all these is necessary in order to constitute what may be considered a fertile soil.

In addition to the above-enumerated ingredients of a fertile soil, we may include the oxides of iron and manganese; animal and vegetable matters in a decomposing state, and saline, acid, or alkaline combinations.

If a soil consists of pure sand, or is derived from pure limestones, in which there are no other mineral matters except flint, chalk, and silicate of lime, we may pronounce it as absolutely barren. Now as magnesian earth only constitutes a small portion of any soil and is often absent altogether, we must seek for the fertilizing properties of a good soil in the argillaceous earth or clay. All the earths, which enter into and make up our arable soils, are derived from what are called the primary unstratified and stratified rocks.

Thus in order to trace *how* our hardest mountain-rocks are convertible into other strata, and these strata again into fertilizing soils, we have only to examine a piece of primitive rock—granite, for instance, by the simple means of chemical analysis, and we shall find in it nearly all the materials requisite for constituting the earthy base of the finest and most productive soil. Time and the combined influences of water, air, heat, and frost, effect the gradual segeration and ultimate decomposition of the component parts of our hardest mountain-strata, as completely and effectually as the more rapid chemical processes. Granite consists of three distinct ingredients, viz., *quartz*, (flint, sand or silicious earth,) *felspar*, and *mica*. Now both the felspar and mica are very compounded substances: they each contain *silicious earth*, *clay*, *lime*, and the *oxide of* *iron;* but in the felspar, the lime is usually united with *potash* or *vegetable alkali,* while in the mica the lime is conjoined with the earth *magnesia,* and the mineral alkali called *soda.* Such are the results of our analysis of *granite,* in which we discover all the earths, together with potash and soda, so necessary to form the bases of our common soils.

Silica—silicious earth, flint, or sand, needs little description; it is distinguished from the other earths by its insolubility in either spirit of salt, aqua-fortis, or oil of vitriol; though it dissolves in the alkalies forming substances called silicates; thus performing all the parts of an acid.

Lime always occurs in soils in the form of chalk or united with carbonic acid, as carbonate of lime, which is easily disengaged from it with effervescence by most of the other acids. It is also found combined with phosphoric acid; it dissolves in nitric acid (aqua-fortis) and muriatic acid (spirit of salt), forming soluble compounds; and forms with sulphuric acid (oil of vitriol) a substance, difficult of solution, called gypsum: unlike flint, it is not soluble in alkalies.

Clay, too, needs little descriptive notice; when pure, it appears as a white powder; it is soluble in acids and alkaline liquors; with sulphuric acid it forms our common alum. As met with in soils, it contains potash, and often ammonia.

Magnesia exists in soils generally combined with carbonic acid—(the common magnesia of druggists)—it is insoluble in caustic alkalies, but dissolves in all the mineral acids; and is distinguishable from all other earths found in soils by its ready solubility in solutions of alkaline carbonates, or carbonates of potash and soda saturated with carbonic acid.

There are two well-known *oxides of iron,* the black and the brown; the former is the scales separated upon the blacksmith's anvil, and the latter the rust formed upon iron exposed to the air. The oxides of iron sometimes exist in soils combined with carbonic and other acids, and are distinguished by forming ink with solutions of galls or oak-bark and Prussian blue with prussiate of potash.

Manganese is a heavy black mineral, and is used in bleaching; it is known from all other substances by evolving from muriatic acid a yellow suffocating gas called chlorine.

Vegetable and animal matters are known by their sensible qualities, and by their property of being decomposed by heat—the animal portion emitting the smell of burnt woollen rags or feathers.

The saline compounds found in soils, are common salt, sulphate of magnesia (Epsom salt), sometimes sulphate of iron (green copperas), nitrates of lime and magnesia, sulphate of potash, and carbonates of potash and soda.

The silicious earth in soils is usually combined with clay and oxide of iron, or with clay, lime, magnesia, and oxide of iron, forming gravel and sand of different degrees of fineness.

The carbonate of lime (chalk) is usually in an impalpable form; but sometimes in the state of chalky sand.

The magnesia, if not combined in the gravel and sand of soils, is a fine powder united with carbonic acid.

The impalpable part of the soil, which is usually called clay or loam, consists of fine sand, clay, lime, and magnesia; and is, in fact, usually of the same composition as the hard sand, but more finely divided.

The vegetable and animal matters (and the first is by far the most common in soils) exist in different stages of decomposition. They are sometimes fibrous, sometimes entirely broken down, and mixed with the soil.

To form a just idea of the different soils, it is necessary to bear in mind the composition of the compound nature of granite, and by extending the imagination a few steps further, we may conceive different rocks* in a state of decomposition, and ground into parts and powder of various degrees of fineness from coarse sand to impalpability; with some of their soluble parts, as potash and soda, dissolved in water, and that water adhering to the mass, and the whole mixed with larger or smaller quantities of the remains of vegetables and animals in different stages of decay.

We have seen, then, that in addition to the calcareous, silicious, and argillaceous earths of the felspar, it contains also the oxide of iron and potash. Now as the iron is only in a state of partial oxidation, it rapidly absorbs oxygen both by its power of decomposing water and from the

* The following table will show pretty accurately the similarity of composition of different mineral substances.

	FLINT	LIME	CLAY	MAGNESIA
Clay-slate	49.23	5.54	14.56	2.24
Mica	46.35	0 to 6.1	36.8	5.75
Felspar	64.20	6.75	18.40	——
Serpentine	28.25	10.24	6.45	33.1
Hornblende	42.24	12.24	13.92	13.74

In addition to these substances—

	Black Oxide of Iron.	Brown Oxide of Iron.	Potash.
Clay-slate contains	20.7	—	4.7
Mica ,,	——	7.3	9.22 & 3 to 5 per ct. soda
Felspar ,,	3.0	—	16.95

Manganese is found in many minerals, and in masses, as in the grey hydrous peroxide, containing 97.83 per cent; also in

Common garnet, containing .... 5.49 per cent.
Hypersthene ,, ... 5.29 ,,
Hornblende ,, a trace to 2.00 ,,

atmosphere. This increase of oxygen augments its bulk, renders its texture more friable, and tends thereby mechanically to segregate the particles of the rock:—the lime and the potash are acted upon in their turn by their strong affinity for water, and the power they equally possess of absorbing carbonic acid from the atmosphere, converting the lime into *chalk*, the potash into *mild alkali:* and these causes we see act both chemically and mechanically. In this manner, therefore, the disintegration and decomposition of the *felspar* and the *mica* is effected:—the former containing a larger proportion of argillaceous earth—acting as a kind of cement to the stone—forms a fine clay now mixed with the chalk and mild alkali; while the *mica*—more effectually resisting decomposition—crumbles down and mixes with it as sand of different degrees of fineness; but which likewise, in the process of time, yields to the same operating influences: ultimately rendering up its lime, oxide of iron, and magnesia, to commix with the other ingredients of the felspar. Of the *quartz*—the least decomposable of the three, from its more simple nature—it appears in the form of either gravel, flint, or sand, of various degrees of fineness; and as its iron passes, by the absorption of oxygen, from the dark or *black* oxide, into the *brown* or *red*, it is more or less coloured.

From what has been said concerning the production of soils from rocks, it is evident that there must be at least as many varieties of soils as there are species of superficial rocks—in fact, there are many more; so that any attempt at a scientific classification would be a vain labour. Davy laid down the general distinctions as follows:—"That the term *sandy*, for instance, should never be applied to any soil that does not contain at least seven-eighths of sand;" and that "sandy soils which effervesce with acids, should be dis-

SCHUBLER'S CLASSIFICATION AND NOMENCLATURE OF SOILS, AS RECOMMENDED BY DR. DAUBENY.

(From the Journal of the Royal Agricultural Society of England, Vol. III. p. 156.)

Names of Different Descriptions of Soil.			Proportion of Ingredients in every 100 Parts.				Agricultural Designations and general Rela[illegible] with Reference to their Produce.
CLASSES.	ORDERS.	SPECIES.	CLAY.	LIME.	HUMUS.	SAND.	
1. ARGILLACEOUS SOILS.	Without Lime	Poor........	Above 50	0	0. to 0.5	The Remainder.	*Land for Wheat and Spelt.*
Above 50 per cent. of Clay.		Intermediate..	.. 50	0	0.5 to 1.5		The calcareous kinds not too rich in and not too poor in sand and humus, give
Not more than 5 per cent. of Lime.		Rich........	.. 50	0	1.5 to 5.0	..	returns. Wheat, spelt, barley, rape, beans,
	With Lime	Poor........	Above 50	0.5 to 5.0	0. to 0.5	..	and clover, flourish in it especially. Those
		Intermediate..	.. 50	0.5 to 5.0	0.5 to 1.5	..	in humus are still suited for oats.
		Rich........	.. 50	0.5 to 5.0	1.5 to 5.0	..	
2. LOAMY SOILS.	Without Lime	Poor	30 to 50	0	0. to 0.5	..	*Land for Barley.*
Not more than 50 nor less than 30 per cent. of Clay.		Intermediate..	30 to 50	0	0.5 to 1.5	..	The soils which are rich in humus, and co[illegible]
Not more than 5 of Lime.		Rich........	30 to 50	0	1.5 to 5.0	..	lime, are well suited even for wheat and
	With Lime	Poor........	30 to 50	0.5 to 5.0	0. to 0.5	..	and often approach nearly to the foregoing [illegible]
		Intermediate..	30 to 50	0.5 to 5.0	0.5 to 1.5	..	They are, moreover, suited for Triticum dic[illegible] (Emmer), one-grained wheat (Einkorn),
		Rich.	30 to 50	0.5 to 5.0	1.5 to 5.0	..	oats, rape (Reps), flax, and clover.
3. SANDY LOAMS.	Without Lime	Poor........	20 to 30	0	0. to 0.5	..	*Land for Barley and Oats.*
Not more than 30 nor less than 20 per cent. of Clay.		Intermediate..	20 to 30	0	0.5 to 1.5	..	Less suited for wheat and spelt than th[illegible]
Not more than 5 of Lime.		Rich........	20 to 30	0	1.5 to 5.0	..	mer soils, but even better adapted for Tr[illegible]
	With Lime	Poor........	20 to 30	0.5 to 5.0	0. to 0.5	..	dicoccum and T. monococcum, as well [illegible]
		Intermediate..	20 to 30	0.5 to 5.0	0.5 to 1.5	..	rye. Potatoes, turnips, and other roots
		Rich	20 to 30	0.5 to 5.0	1.5 to 5.0	..	well in it.
4. LOAMY SANDS.	Without Lime	Poor........	10 to 20	0	0. to 0.5	..	*Land for Oats and Rye.*
Not more than 20 nor less than 10 per cent. of Clay.		Intermediate..	10 to 20	0	0.5 to 1.5	..	Barley thrives well in those rich in h[illegible]
Less than 5 per cent.		Rich........	10 to 20	0	1.5 to 5.0	..	They are also well suited for buckwheat. V[illegible]
	With Lime	Poor........	10 to 20	0.5 to 5.0	0. to 0.5	..	spelt, and clover do not succeed.
		Intermediate..	10 to 20	0.5 to 5.0	0.5 to 1.5	..	
Containing more than	carbonized or acid Humus.	Loamy......	30 to 50	or without Lime.	.. 5.0	..	and oleaginous plants; the loamy and san[illegible]
		Sandy.......	20 to 30		.. 5.0	..	especially adapted for oats, and in most

tinguished by the name of *calcareous sandy soils,* to distinguish them from those that are silicious. The term *clayey* should not be applied to any land which contains less than one-sixth of impalpable earthy matter, not considerably effervescing with acids. The word *loam* should be limited to soils containing at least one-third of impalpable earthy matter, copiously effervescing with acids: and a soil to be considered as *peaty,* ought to contain at least one-half of vegetable matter."*

All soils capable of cultivation possess, more or less, the property of absorbing moisture from the atmosphere; and this in proportion as they contain a greater or less quantity of impalpable materials with vegetable and animal matter—the most fertile absorbing the largest quantity and in the shortest given number of hours: hence this quality affords us one method of judging of the productiveness of land. "When this power is great, the plant is supplied with moisture in dry seasons; and the effect of evaporation in the day is counteracted by the absorption of aqueous vapour from the atmosphere, by the interior parts of the soil during day, and by both the exterior and interior during night. The stiff clays, approaching to pipe clays in their nature, which take up the greatest quantity of water when it is poured upon them in a fluid form, are not the soils which absorb most moisture from the atmosphere in dry weather. They cake, and present only a small sur-

* It is evident that there are many intermediate mixtures of all these; and that until we have more accurate analysis, we cannot make out a scientific classification: even the classification of Schubler, recommended by Dr. Daubeny, (Journal of the Royal Agricultural Society, vol. 3, p. 156,) is defective, as containing no enumeration of the quantity of magnesian earth, silicates, and earthy phosphates.

The annexed is Schubler's Table of the classification and nomenclature of soils.

face to the air; and the vegetation on them is generally burnt up almost as readily as on sands. The soils that are most efficient in supplying the plant with water by atmospheric absorption, are those in which there is a due mixture of sand, finely divided clay, and carbonate of lime (chalk), and some animal or vegetable matter; and which are so loose and light as to be freely permeable to the atmosphere." The power of soils to absorb water from the air, is much connected with fertility. With respect to this quality, carbonate of lime and animal and vegetable matter are of great use in soils; they give absorbent power to the soil without giving it likewise tenacity: sand, which also destroys tenacity, on the contrary, gives little absorbent power.

Davy found 1000 parts of a celebrated soil from Ormiston, in East Lothian, which contained more than half its weight of finely divided matter, of which 11 parts were carbonate of lime (chalk), and 9 parts vegetable matter, when dried at 212°—(water boils)—gained in an hour by exposure to air saturated with moisture at the temperature of 62°,—18 grains.

1000 parts of a very fertile soil from the banks of the river Parret, in Somersetshire, under the same circumstances, gained 16 grains.

1000 parts of a soil from Mersea, in Essex, worth 45 shillings an acre, gained 13 grains.

1000 of a fine sand, from Essex, worth 28 shillings an acre, gained 11 grains.

1000 grains of coarse sand, worth 15 shillings an acre, gained only 8 grains; while

1000 of the soil of Bagshot-heath, gained only 3 grains.*

* The following Table from Schubler, (Journal of the English Agricultural Society, vol. 1, page 196), shows the comparative power of different

I have been thus minute, but I trust not tediously so, in giving a sketch of the origin of soils, their composition, nature, and chemical characters, with a view of leading the practical farmer to a correct estimate, that the intrinsic value of any particular soil depends more upon its mineral contents than it ever can do upon any quantity of vegetable manure that may be supplied to it. Farmers have too often been led away by early prejudices, and have too obstinately followed the steps of their great-grandsires, smiling with supercilious contempt at any thing which would divert or drive them from their beaten track and blind routine. "Give me plenty of muck, and you may try your new-fangled notions yourself," is a fair specimen of the general reply we obtain from a certain class of the old stagers; and truly has it been remarked by Professor Liebig, that when an otherwise intelligent farmer is asked "in what way and in what manner manure acts, we are answered, by the most intelligent men, that its action is

earthy substances to absorb moisture in given times; and will serve to illustrate the text.

Kinds of Earth.	1000 grains of earth spread on a surface of 50 square inches, absorbed in			
	12 hours.	24 hours.	48 hours.	72 hours.
	Grains.	Grains.	Grains.	Grains.
Silicious Sand	0	0	0	0
Calcareous Sand	2	3	3	3
Gypsum Powder	1	1	1	1
Sandy Clay	21	26	28	28
Loamy Clay	25	30	34	35
Stiff Clay	30	36	40	41
Grey pure Clay	37	42	48	49
Fine Carbonate of Lime (chalk)	26	31	35	35
Fine Carbonate of Magnesia	69	76	80	82
Humus (or vegetable mould)	80	97	110	120
Garden Mould	35	45	50	52
Arable Soil	16	22	23	23
Slaty Marl	24	29	32	33

covered by the veil of *Isis*;* and when we demand further what this means, we discover merely that the excrements of men and animals are supposed to contain an incomprehensible *something*, which assists in the nutrition of plants and increases their size!" The methods employed in the cultivation of land, are different in every country and in every district; and when we inquire the cause of these differences, we receive for answer, "that they depend upon circumstances." "No answer," says Liebig, "could show ignorance more plainly; since no one has ever yet devoted himself to inquire what these circumstances are."

The revolution, however, of every half century produces a wonderful change in the habits, manners, and customs of a nation: nay the very sentiments and feelings of the people undergo a progressive change by gradually overcoming old-established dogmas, and throwing off the fetters of ignorance and superstition; and happily in the present age a spirit of enterprising inquiry is abroad, which promises a more enlightened understanding, and as a consequence, an enlarged liberality. Scientific institutions are multiplying in every part of Europe, and men begin at length to apply themselves with sober seriousness to the benefits which accrue from the yearly discoveries in science and the arts. Among these there is no one branch over which science is capable of throwing her light with more lustre, than that in which all mankind are equally benefited, viz., the business of agriculture—the improvement of the methods of culture of the soil, and consequent increase in its powers of production. There is no avocation, engag-

* The inscription on statues of the goddess was thus—"*I am all that has been, that shall be, and none among mortals has hitherto taken off my veil.*" The word "Isis," according to some authors, signifies "ancient,"—hence the inscription.

ing the time and occupying the attention of man, in point of utility, that can be compared to that of the pursuits of agriculture,—since upon it belongs the production of our food,—on it depend the riches of states, and the prosperity of all commercial enterprise. It is impossible, however, that the agriculturist can fully take advantage of the discoveries in science, unless he will make himself better acquainted with the nature, character, and composition of the different soils he is about to cultivate; as upon every farm he will meet with many varieties of soil, and as such, demanding opposite methods of culture.

We have already pointed out the leading component parts of the soil in general, and we will now explain the second point of our inquiry; or what are the component parts of manures, and in what way do they act as, or become assimilated into, the food of plants?

There are perhaps no two questions possessing a higher degree of importance to the practical farmer, than the solution of these inquiries. Of what matters manure (farm-yard, the excrements of animals, urine, &c.,) is composed, we can readily ascertain by analysis; but in what way a plant possesses *the power* of decomposing the compound constituents of such manure—as ammonia, carbonic acid, water, &c.,—is one of those mysteries which is only referable to what is called the vital principle—for instance, the most powerful action of galvanism hitherto known, is found too feeble to decompose carbonic acid, and yet a mere sprig of any green plant will effect such decomposition with facility, by simply exposing it to the influence of solar light, in water holding this acid in solution. To speculate, therefore, upon such an inquiry would be foreign to the subject-matter of a limited essay: it being sufficient for our present purpose to know that such is the ultimate fact.

In the seed of every plant we recognise a certain *force* or power of growth—this force tends to the development of a simple germ, and under the favourable influences of air, heat, and moisture, surrounded by proper nourishment, this germ progresses to a plant;—this force, then, we are content to call the *vital force*, or vitality.

Reverting, then, to farm-yard manure as a principal source of supply to our arable lands, we find that its active properties and relative value depend upon the quantity of nitrogenous matters and inorganic substances it contains. As we cannot admit that any single element (as oxygen, hydrogen, nitrogen, or charcoal—phosphorus, sulphur, &c.) is generated by the vital principle, it is quite certain that every constituent of the body of man and animals is derived from plants; all these elements being found in plants and soils, and again in the animal organism. Hence all those inorganic matters of plants, not required for the support of the animal organism, are expelled from it, either in the form of liquid or solid excrements. If we collect the products of the putrefaction of animal matter, we find them to consist of carbonic acid and ammoniacal gas, till ultimately only a residue remains, which consists chiefly of phosphoric acid united with lime, and other salts in their bones. In this way, then, the carbon or charcoal, and the oxygen of the animal tissue are restored to the air, from whence the plants derived them; while the nitrogen and hydrogen also unite to escape into the atmosphere in the form of ammonia; both these compounds, in the cycle of time, becoming subservient to the growth and maintenance of a future generation of plants!

Again, as the phosphoric acid was primarily derived from the soil by the plants, which became assimilated or converted by the animal organism into the tissue or substance of bone, so, in like manner, it must be regarded as a powerful manure, or essential constituent of plants: hence it follows that by exporting this phosphate of lime (bone earth) from the soil in the fattening of cattle, we must sooner or later impoverish the soil; and that unless we artificially restore it back, it would be impossible long to preserve the fertility and productiveness of such a soil. Animal matters, therefore, render back ammoniacal salts to the soil and air, and the soil becomes regenerated with the phosphates of lime and magnesia, together with other salts, by the application of manures containing bone earth as a constituent.* If we examine the composition of solid and fluid animal excrements, we ascertain what substances the soil receives when these matters are applied to it either alone or mixed, or as they exist in farm-yard and stable manures. What then, it may be asked, are these substances in animal excrements, which exert such an influence upon vegetation? are all excrementitious animal matters of a like nature and power, and do they in all cases serve as nourishment to plants by an identical mode of action?—We have already shown that the mere vegetable fibre of all manures serves only to replace the humus of the

* Phosphate of lime (or bone earth) may be made artificially—thus if we place a bit of the inflammable substance called phosphorus (which is distilled from decomposed bones by the aid of charcoal,) in a little saucer placed in the centre of a common dinner plate, the bottom of which is covered with water, set fire to the phosphorus by a hot wire and invert a glass bell-jar over the plate, we shall find it rapidly filled with a dense white vapour, which after a short time will condense on the internal sides of the glass jar, and become absorbed by the water. This water will now be found to taste quite sour or acid, and if carbonate of lime (chalk) be gradually added to it, till it ceases to hiss, a white powder will fall down, which is phosphate of lime: a substance identical with the powder of a well-burnt bone.

soil, and as a textural constitutent add to its friability and power of absorbing moisture from the air, and by its gradual decomposition of supplying carbonic acid to the roots of the young plant.

We will here digress for a few pages in order to consider the effects of green crops, alternate cropping, and the chemical action of paring and burning.

We have before observed (p. 18) that when green crops are to be employed for enriching a soil, they should be ploughed in, if it be possible, at the time when the flower is beginning to appear, for it is at this period that they contain the largest quantity of *soluble* matter, and that their leaves are most active in forming *nutritive* matter. Green crops, as *white mustard*, *Indian corn*, *lentils*, *buck-wheat*, *tares*, &c., pond weeds, the paring of hedges and ditches, or any kind of *fresh* vegetable matter, require no preparation to fit them for manure. When ploughed in their decomposition proceeds slowly beneath the soil; the soluble matters are gradually dissolved, and the slight fermentation—checked by the want of a free communication of air—tends to render the woody fibre *soluble*, without occasioning the rapid dissipation of gaseous matter. It has been urged against the practicability of this important means of enriching the soil, particularly in North Britain—first, "The want of a due appreciation of its value; second, The lateness of the harvest, and consequent slowness of growth between the time of sowing the plants and that of ploughing them in; third, Its being inadmissible except at particular points of the rotations in common use; and fourth, The carrying out to an unwarrantable extent the principle, that green vegetable substances, to be profitably employed as manures, ought to be, in the first place, used as food for animals." All these arguments, however, do not apply to the south and west of England, nor to the general system of Norfolk farming; and as we know the fact that such crops draw but very sparingly from the soil, it will be granted, as a matter of course, that *the amount of produce that can be so raised is a portion corresponding to what the crops have drawn from the air*, above what was contained by the manure in the soil. Now the decay of such vegetable matter, when placed beneath the surface of the soil, proceeds more or less rapidly according to the composition of the soil in which it is so buried, and on its greater or less porosity. Thus it will ensue quickly in a calcareous or chalky soil; for the power of organic matters to absorb *oxygen* (one of the constituents of air) and to putrefy, is much increased by contact with the alkaline constituents, and by the general porous nature of such kinds of soil which admit of the free access of air. Hence, in *heavy* adhesive soils, consisting of loam or clay—although such crops, when ploughed in, tend to render them more porous by a division of parts, and thus materially add to their textural character—still the decomposition of the vegetable matter proceeds more gradually: the more impervious nature of such soils preventing the play of the atmospheric oxygen.

We have before shown that the *inorganic* substances of all plants are derived exclusively from the soil, and that, as each crop removes a certain portion of these, the soil must become more or less deteriorated, unless this supply can be maintained by the decomposition of *mineral* matter in the soil—which even in those derived from clay-slate, basalt, and the felspars, is but a limited source—or by the application of such manures containing these inorganic substances, obtained from sources foreign to the farm.

It follows, therefore, that if we raise a fallow crop, and that this crop draws nearly the whole of its weight from the air, and we plough this into the soil at that period of its growth when it is capable of furnishing the most soluble and nutritive matters to the soil, we gain all that amount of carbonaceous matter to become serviceable, or minister to other succeeding crops of a more profitable kind.

Poor soils, that is, such as contain but little decaying organic matter, or vegetable mould, are thus surprisingly improved by this means; and when we consider that those plants which furnish the most valuable food for man and animals, are almost all incapable of cultivation on such poor soils, while they draw more largely on the soils than any other plants for their support, we must be convinced, that if we can, from time to time, raise such a fallow-crop as withdraws but little or nothing from the soil, but extracts its nutriment from the atmosphere; that by such a system we must considerably add to the productiveness of our poorer lands. In the selection of plants for attaining these important ends, the farmer should employ those which grow rapidly; which are chiefly nourished at the expense of the air, capable of autumnal growth, and that they are hardy, and suitable to the soil and climate. One great advantage obtained by the employment of *green crops* is, that they more speedily and completely decompose than dry manures—as long litter and unfermented straw. The same may be said of these crops or other vegetable matter, in a dry state, as then a change has already taken place in its sap, which for some time resists the combined action of air and moisture; hence (as we shall more fully show hereafter), mere *dry straw*, when introduced under the surface soil, decomposes slowly, requiring to be mixed with substances capable of more rapid decomposition, as the solid and liquid excrements of cattle. This is not the case, however, with green succulent plants, which contain in their sap, at the time of flowering, not only albumen but other azotised matters highly susceptible of decomposition; and which, once commenced, speedily induces decay in the woody and cellular structure of the plants.

Such, then, being the ready susceptibility of succulent plants to enter into decomposition, it is obviously of great importance to plough them in to such a depth as will prevent the drying action of the air on the one hand, but at not too great a depth to hinder the access of air, whereby to prevent decay from taking place;—three or four inches, according to the tenacity or permeability of the soil, will in general suffice for this purpose. The preference the farmer may give to such plants as he may use for the purpose of green-manuring, should depend, likewise, upon the circumstances of season, climate, soil, and rotation, whether he selects peas, vetches, buck-wheat, aftermath clover, lupine, rye, spurrey, rape, &c.; each of these may deserve a preference in particular localities, of which the practical agriculturist will have but little difficulty of judging.

The breaking up of old pastures is, in one sense, but a green-manuring, although farmers generally are not in the habit of viewing it in this light; for when thus made arable, not only has the soil been enriched by the slow decay of the plants which have left soluble matters in the soil; but the leaves and roots of the grasses living at the time and occupying so large a part of the surface, afford excrementitious matters—saccharine, mucilaginous, and extractive—the gradual decomposition of which affords a supply of food for future plants, by furnishing carbonic acid, which is the true source of the carbon, or the base of the woody fibre of plants.

In such strong soils, where the naked fallow is indispensable and the seasons are favourable, there can be no doubt but that by raising one of the above-mentioned crops, in time to be ploughed in, before the season of sowing winter wheat, would be attended with the best results; not that such an expedient is intended altogether to supersede the system of common manuring, but simply as a means of breaking the texture of such soils, and thus increasing their permeability. In all stiff clay farms where the rotation is short, or where, from the want of fallow-crops, the sources of other manures are much curtailed, such a system cannot fail to work much improvement, not only in the textural character of the soil itself but in the amount of the produce of the future crop cultivated; for it should be recollected that if wheat is one of the crops intended to be grown, it is one most benefited by such a system of tillage and manuring.

It would be impossible in a limited essay of this kind, to enter fully into the discussion of any one subject; but connected with fallow-cropping, we will cursorily glance at the effects of summer and winter *fallowing*. There can be no doubt that, except in some instances already noticed, the benefits arising from fallows have been much over-rated. Thus a summer fallow or a clean fallow may be sometimes necessary in lands overgrown with weeds, particularly if they are *loamy sands* which do not admit of being pared and burnt with advantage (though by proper management no land would be in such condition), but it is certainly unprofitable as part of a general system of husbandry. In a summer fallow a period is always lost in which vegetables might be raised either as food for animals or (by fallow crops) as nourishment for the plants that are to succeed; and in a stiff soil the texture is not so much improved as when it is exposed to the effects of a winter's frost, when the expansive powers of ice, the gradual dissolution of snows, and the alternations from wet to dry, tend to pulverize it, and to mix its different parts together. Hence the old method of summer fallowing has to a great extent, in Norfolk at least, given place to the cultivation of turnips, beet-root, potatoes, and such root-crops as are cultivated in drills. Although these root-crops grow best in the more friable loams and porous soils, still by the system of under-tile drainage, now becoming so general in this country, and the use of improved implements of tillage, such as the clod-crusher, many of the stiff clays and loam soils that were formerly *fallowed*, are now made to produce fallow-crops; thus saving a year out of four, without any material deterioration of the other crops of the rotation; and at the same time considerably augmenting the amount as well as enriching the quality of the farm-yard manure. Nothing will tend more to improve stiff clayey soils than thorough drainage; and the price of draining tiles is now no longer an impediment—the increased produce of the first two years, not to take into the estimation the permanent value of the land, will doubtless repay the outlay.*

The cultivation of grain-crops, which upon stiff soils recur so frequently, often causes weeds to spring up, which partly by shedding their seeds before the gathering of the grain-crops, and partly by the extension of the roots of perennial species (living more than two years), accumulate

* I have seen a drain-tile manufactured by Mr. T. Cunnington of Wisbech, which not only possesses great strength, but which, from its shape, (being a curved arch resting on a firm flat bottom) would bear the weight of the trampling of a horse without breaking. These tiles are 1 foot in length, by 2, 2¼ to 3 inches inside diameter, and cost 25 to 28 and 30*s*. per thousand according to the length and size. There is another drain-tile also made by Mr. Cunnington, at the same price and of the same size, drawings of which will be found engraved on the plate.

to such an extent as to demand a great deal of labour and tillage to extirpate them from the soil. Whenever the soil will at all admit, however, of the cultivation of root-crops, these weeds and roots may be destroyed during the preparation of the land for these crops, and by the subsequent hoeing and tillage that the cultivation of fallow-crops in drills so well admits of. Cases, however, may occur where, from carelessness or mismanagement, land, capable of producing root-crops. becomes so infested with weeds as to require a whole summer's fallow to clean it effectually. Before we can understand the chemistry of fallowing, we must consult the physiology of vegetable life, and ask ourselves how or why it is that plants of the same species do not thrive upon the same soil when grown in succession?

It had been long observed that a field which had become unfitted for the growth of one kind of plants, would, nevertheless, grow another of a different species, hence arose the system of the rotation of cropping; but as agriculture had not sought the aid of chemical principles, the farmer was still left in the dark as to the cause. When, however, he shall understand the nature of the substances which each species of plants requires for its nourishment, whether to be drawn from the soil itself, or derived from manure; and when he shall arrive at the knowledge of what those substances are, that one generation of plants returns to the soil, upon which another can flourish; then will he duly appreciate those means of help which an inquiry into science cannot fail to supply, and not till then will he understand the art of making a rational application of chemical discoveries.

The experiments of Macaire Princep prove beyond all doubt that many plants are capable of emitting certain extractive matters from their roots, and that these excretions are greater during the night than by day. For instance—to come to the point as to the practice and value of the rotation of crops, as wheat after peas or beans—if we cause a plant of the family of the *Legumens* (peas, beans, tares, lentils, &c.,) to grow in water, we shall find that this water acquires a brown colour. If, then, we place other plants of the same species in this water, we shall find that they are not only impeded in their growth, but fade prematurely. If, however, we cause corn plants, as wheat, or barley, to grow in this same water in which the *legumens* sickened, they not only grow vigorously in it, but, after a time, the brown colour of the water becomes sensibly diminished; thus proving that a certain quantity of the excrements of the *legumens* has been absorbed by the corn plants..

The view taken by Decondolle is, that the roots of plants imbibe soluble matter of every kind from the soil, and thus necessarily absorb a number of substances which are not adapted to the purposes of nutrition, and as such, must subsequently be expelled by the roots and so returned to the soil as excrements. Now although the excrements of a carniverous animal contain no constituents fitted for the nourishment of another of the same species, "it is nevertheless possible," says Liebig, "that an herbiferous animal, a fish or a fowl, might find in them certain undigested matters capable of being digested in their organism, from the very circumstance of their organs of digestion having a different structure. This is the only sense in which we can conceive that the excrements of one animal could yield matter adapted for the nutrition of another." That this reasoning is correct, no one surely will dispute. If then, one kind of plants, by their roots, excrete matters back to the soil, which serve as the food of other plants of a different species, we obtain at least a mechanical idea of the effects of a rotation system of cropping. But the main question as to what these matters are? whether, as Decondolle supposes, they are drawn from the soil, or whether they are, in part at least, derived from the atmosphere, remains still to be discussed. We have shown that different plants withdraw dissimilar materials from the soil; one plant extracting alkaline, another acid, a third earthy phosphates, and a fourth mineral matters, into their several structures. Again, we see that some plants are almost entirely independent of the soil for support; whilst in the case of pine-forests, and meadow-land, the soil receives considerably more carbonaceous matter excreted by the roots, than what the plants derived from the soil.

It is quite certain that as excrements cannot be assimilated or again digested by the plants which rejected them, the more of these excrementitious matters which the soil contains, the less fertile must it be for the plants of the same species. These excrementitious matters may, however, still be capable of assimilation by another kind of plants, which would thus remove them from the soil, and render it again fertile for the first. And if the plants last grown also expel substances from their roots, which can be appropriated as food by the former, it is evident they will improve the soil two ways. Now the experiments of Macaire Princep afforded, as their main result, that the characters and properties of the excrements of different species of plants are different from one another, and that some plants expel excrementitious matter of an *acrid* or resinous character, others *mild substances* resembling gum. The former of these may be regarded as poisonous, the latter as nutritious. The investigations of the same able chemist afford positive proof that the roots, probably of all plants, expel matters which cannot be converted in their organism either into woody fibre, starch, vegetable albumen, or gluten; since their expulsion indicates that they are quite unfitted for this purpose. Again, it is certain that these gummy and resinous excrements could not have been contained in the soil; and as we know that the *carbon* of a soil is *not diminished* by culture, but, on the contrary, *increased*, we must conclude that all excrementitious matters which contain carbon, as gum and resin, must be formed from the food obtained by the plants from the atmosphere. Let us see what these excrements are, and in how far they are produced? Both gum and resinous matter, to which these excrements are likened, are compound substances, consisting of carbon and the elements of water, produced in consequence of the *transformations* of the food, and of the *new forms* which it assumes by entering into the composition of the different organs of the plant. M. Decondolle's theory is, properly, but a modification of an earlier hypothesis, which supposed that "the roots of different plants extracted different nutritive substances from the soil, each plant selecting that which was exactly suited for its assimilation." According to this hypothesis, the matters which are incapable of assimilation by the organs of the plant, are not extracted from the soil; while Decondolle considers that these matters *are returned* to it in *the form of excrements*. Now both these views will explain how it happens that after corn, *corn* cannot be raised to advantage; nor peas after peas; but they do not explain how a given district of soil is improved and fitted for the growth of future plants by such land lying *fallow*, and how this amelioration takes place in proportion to the care and pains with which it is tilled and kept free from weeds;

soil. In those soils which contain a large excess of inert vegetable matter, the destruction of it by burning must be beneficial, as the carbonaceous matter and alkaline fixed salts contained in the excess of vegetable fibre will be of far more service to the future crop than such excess of vegetable fibre otherwise could be. The process of burning renders the soil less compact, less tenacious and retentive of moisture; and when properly applied, may convert a surface soil that was stiff, damp, and in consequence, cold, into one powdery, dry, and warm; and far better adapted as a bed for vegetable life.

All soils, therefore, that contain too much dead vegetable fibre, and which consequently lose from $\frac{1}{3}$ to $\frac{1}{2}$ of their weight by inceneration; and all such soils as contain their earthy constituents in a fine state of division, as the stiff clays and marls, are improved by burning. The very reverse, however, is the case if we apply this process to coarse sands in which vegetable matter is deficient, or even in rich soils containing a due mixture of the earths; and in all cases in which the texture is sufficiently loose, or the organic matter of the soil sufficiently soluble; in such cases the process of torrification never can be advantageous. It is evident, therefore, that this method of improving the land ought only to be had recourse to when it contains a superabundance of dead vegetable matter on the surface, as in the case of a drained marsh or peat. Whenever it has been applied to poor silicious sands or thin heath land, in which little organic matter is present (especially where the burning has been followed by overcropping), it is not to be wondered at that such land has become unproductive. The constituent nature of a heath soil considered, it would be a far more judicious method to induce a decay of its inert vegetable matter by the application of lime and farm-yard manure, than to resort to so destructive a process as that of burning.

The beneficial effect, however, of burning strong marl and stiff clay soils, rests entirely upon chemical doctrines. The advantage of spreading burnt clay and the ashes of soils containing iron upon our fields, although so long considered incomprehensible, admits of a very simple explanation. The virtues of the process were formerly ascribed to the great attraction exerted by dry clay and ferruginous earth for water; but it will be recollected that common dry arable land possesses this property in as great a degree. The true cause of their action is this:—The oxides (rusts) of iron and clay are distinguished from all other metallic oxides by their power of forming solid compounds with ammonia: they therefore absorb ammonia from the atmosphere and rain water which always contain this gaseous substance. In like manner all minerals, containing clay or the oxide of iron, possess this property of absorbing ammonia from the atmosphere, and of firmly retaining it in their substance. Thus the peculiar odour exhaled by moistening pipe-clays and minerals containing clay, with caustic potash, is owing to the presence of ammonia. Soils, therefore, which are manured with burnt clay and the oxides of iron, act by absorbing ammonia—an action which is much favoured by the increased porosity of their texture, while they equally prevent the escape of the ammonia by the chemical property they possess of forming compounds with it. The process of paring and burning of such clay soils has also the secondary influence already alluded to, viz., that of rendering the land more porous, and, therefore, permeable to air and moisture. The effects of such conditions are that this absorbed ammonia is capable of being separated from these soils by every shower of rain, and so conveyed to the roots of the plants in a soluble state: thus acting over and over again the same part as if the plants were watered from time to time with putrid urine. In those soils containing a large excess of vegetable matter, the operation of burning will furnish a large quantity of charcoal, which will not only tend to loosen and give porosity to stiff clays, but it also possesses the very remarkable property of absorbing many times its own bulk of ammoniacal gas; indeed, after being recently burnt, it is capable (according to Saussure) of absorbing ninety times its volume of ammonia, which it again readily parts with on moistening it with water. Decayed woody fibre approaches very nearly to charcoal in this power. Decayed oak-wood, previously dried, absorbs seventy-two times its volume of ammoniacal gas! These facts explain in the most satisfactory manner the further action of *vegetable mould*, which is woody fibre in a decayed state; for not only does it furnish carbonic acid, but it acts a further or secondary part in absorbing and retaining ammonia and water; thus supplying the plant with all the essential requisites for its growth and development—water, carbonic acid, and ammonia, containing all the elements necessary for the support of animal and vegetable life!

Resuming our subject (p. 34) on the action of animal excrements—it was formerly supposed that the action of the solid excrements of animals depended upon the decomposition or decay of inorganic matters, which replaced the humus or vegetable mould, and on the presence of certain compounds containing nitrogen, which assisted in the production of gluten and other substances abounding in this element. The *solid* excrements of animals, however, are found to contain too small a portion of nitrogen to act any prominent part in the nutrition of plants. "We may form," says Liebig, "a tolerably correct idea of the chemical nature of the animal excrement without further examination, by comparing the excrement of a dog with its food. When a dog is fed with flesh and bones, both of which consist of organic substances containing nitrogen, a moist white excrement is produced which crumbles gradually to a dry powder in the air. This excrement consists of the phosphate of lime of the bones, and contains scarcely one hundredth part of its weight of foreign organic substances."

The like comparison holds good in respect to the solid excrements of all other animals, as contrasted with their food: the process of nutrition extracting nearly the whole of the nitrogen from the food, in order to increase the animal structure or to supply its waste; and this being the case, the excrements must necessarily contain less of this element than what existed in the food consumed. Thus 100 parts of dried horse-dung (equal to 400 parts of fresh) contain only 0.8 of nitrogen. Calculating that the animal from which this dung was voided, to have been fed upon beans, oats, and hay, (the beans especially abounding in nitrogen,) we must be satisfied how little such dung can exercise any powerful influence on the development of corn plants. When, however, this dung becomes mixed with the liquid excrement or urine, as it does in stable manure, it becomes a material possessing a much greater power, inasmuch as it now contains a larger amount of nitrogenous substances, or animal salts and compounds, containing this element in abundance. If we analyse the urine of a horse, we find it composed, in 1000 parts, of a peculiar anamalised substance called *urea* (7 parts); a peculiar acid called hippuric acid, united with soda, (24 parts); and various other salts and water (969 parts.) Now all these solid matters of the urine contain a large amount of nitrogen. During the decomposition of urine—in other words, when it becomes putrid, it undergoes a change, giving rise exclusively to the production of ammoniacal salts; while the most important compound, urea, is converted into carbonate of ammonia. In human urine we find as much as 3 per cent. of urea, and more than 2 per cent. of ammoniacal salts, with about 1 per cent. of inorganic matters, which must act a very important part in the soil, by supplying soluble food to the plants growing in it,—in other words, by enabling the plant to form gluten in the seeds, as in wheat, rye, and barley. Hence, when we employ animal manure in the cultivation of grain and those vegetables which serve as provender to cattle, it affords a convincing proof that the nitrogen which is found in the seeds, &c., of such food, is derived from the ammonia which such manures contain.

Gluten is a substance possessing highly nutritive qualities; and predominating in wheat over all other grain, causes it to rank highest in the scale of vegetable food. This gluten contains nitrogen, and as any particular wheat or other grain contains more or less of this substance, in such a ratio is it valuable as food.* It is evident, therefore,

* The analysis of different kinds of Wheat affords according to the soil and season, very striking differences in the quantity of gluten, or thus—

French Wheat contains	12.5	(Proust.)
Bavarian ditto	24.0	(Vogel.)
Winter Wheat	19.0	(Davy.)
Summer ditto	24.0	„
Sicilian Wheat	21.0	„
Barbary ditto	19.0	„
Meal of Alsace Wheat	17.3	
Wheat—grown in the Botanical gardens of Paris—	26.7	

While a specimen of Winter Wheat only yielded... .. 3.33 per cent. of that if we apply a manure rich in compounds, containing nitrogen and other inorganic substances, we shall augment the production of the grain as well as increase the amount of the gluten which such grain contains. The action, then, of all manures of animal origin, in as far as regards the appropriation of nitrogen by the plant, is entirely dependent upon the quantity of ammonia or its compounds which such manures can generate. Let us, for example, contrast the difference between the same kind of wheat grown upon a soil manured with cow-dung, and the same soil manured with human urine:—100 parts of wheat from the cow-dunged soil yielded 11.95 of gluten and 64.34 per cent. of starch; whilst 100 of wheat from the urinised soil afforded a maximum of 35.1 per cent. of gluten. Here then we see that the different modes of culture produced different results: cow-dung containing only a very small quantity of matters yielding nitrogen—the urine supplying this element in abundance.

Reverting to farm-yard manure, we will summarily examine its nature and composition. Taking it as a whole we may consider it as a varied mixture of fermenting or fermented litter and straw, with the solid and liquid excrements of cattle. Now as these excrementitious matters abound in all the fertilizing elements of plants, we will endeavour to trace their source. We see by the food consumed by men and animals that they increase in size and weight from the earliest period of their existence until they have attained full maturity. Every constituent part of the animal organism, we again repeat, must then have been primarily derived from the vegetable kingdom; since we

gluten.—Such great discrepancies must be owing, or referable, to some cause either in the composition of the soil or the quality of the manure made use of in their cultivation.

cannot admit of any one *element* being generated by the *vital power* or *principle.** We have shown, too, that those inorganic matters which are not immediately required for the purposes of nutrition are voided as excrements. Four elementary bodies compose all the organised parts of animal and vegetable structures. Charcoal and the elements of water (oxygen and hydrogen) constitute the greater part of all vegetable matter; while these same elements united with nitrogen form or compose all animal structures. All vegetables, however, contain more or less of an appreciable portion of nitrogen or azotised matter—which if it does not absolutely enter into the composition of a particular organ, is, nevertheless, found in the fluids which circulate through it. Thus the starch of wheat is destitute of nitrogen, but it exists in the gluten of this grain.† The analysis of hay shows it to contain about one per cent. of nitrogen.

Nitrogen is contained in the sap of plants, and is an essential constituent of vegetable albumen, and indispensable for its production; it is also contained in the seeds and fruits of all plants. Indeed from the quantity of nitrogen contained in different substances used as aliments, their relative nutritive qualities may be deduced. This fact is clearly made out in the following table, translated from

* Vitality is the power which each organ of a plant or animal possesses of constantly reproducing itself; for this it requires the supply of substances which contain the constituent elements of its own substance, and are capable of undergoing transformation. *All the organs together, cannot generate a single element, as carbon, nitrogen, or a metallic oxide.*

† Gluten is easily separable from the flour of barley, wheat, or rye, by making it into a paste and washing it under a stream of water; the starch separates as a fine milky powder, leaving a tenacious substance in the hand :—this is the gluten.

Boussingault (*Annales de Chimie*, Nov., 1836). It merits the attention of every stock farmer.

SUBSTANCES COMPARED. — 100 parts of Good Hay being taken as a Standard.	Per centage of water lost in drying at 212 deg. Fahrenheit.	Per centage of Nitrogen in the dried substances.	Per centage of Nitrogen in the substances not dried.	Theoretical Equivalents.	Practical Epuivalents.
Common hay	11.2	1.18	1.04	100	100
Hay, red clover, cut in flower	16.6	2.77	1.76	60	90
Clover, green	....	....	0.50	208	...
Lucerne, hay	16.6	1.66	1.38	75	90
Ditto, green	....	....	0.38	347	...
Vetch halm, dried	11.0	1.57	1.41	74	83
Wheat straw	19,3	0.30	0.20	520	400
Rye straw	12.2	0.20	0.17	611	400
Oat straw	21.0	0.36	0.19	547	400
Barley straw	11.0	0.26	0.20	520	400
Potatoes	92.3	1.80	0.37	281	200
Jerusalem artichokes	75.5	2.20	0.42	248	205
Cabbages, hearted	92.3	3.70	0.28	371	429
Carrots	87.6	2.40	0.30	347	319
Mangle-wurzel	90.5	2.70	0.26	400	397
Turnips	91.8	2.20	0.17	612	607
Beans	7.9	5.50	5.11	20	...
Peas, yellow	16.7	4.08	3.40	31	30
French beans, white	5.0	4.30	4.08	25	...
Lentils	9.0	4.40	4.00	26	...
Vetches	14.6	5.13	4.37	24	...
Rape cake	10.5	5.50	4.92	21	...
Maize	18.0	2.00	1.64	63	59
Buck-wheat	12.5	2.40	2.10	50	...
Wheat	10.5	2.38	2.13	49	27
Rye	11.0	2.29	2.04	51	33
Barley	13.2	2.02	1.76	59	54
Oats	12.4	2.22	1.92	54	61
Wheat flour	12.3	2.60	2.27	46	...
Barley flour	13.0	2.20	1.90	55	...

The first three columns require no explanation. The fourth, entitled "*theoretical equivalents*," shows the weight of each aliment, which is equivalent to, or can replace 100 parts of good hay. The numbers in this column are calculated from the quantity of *nitrogen* contained by the different aliments in their natural state, and the chief interest in the table is the comparison of the numbers thus found, with those of the fifth column entitled "*practical equivalents*." These practical equivalents indicate the weight of each aliment required to maintain an adult healthy animal for a given time at a uniform weight—the same standard being adopted as in the fourth column.

These examples of the quantity of nitrogen found in different aliments, will be sufficient for our present inquiry, our object being to examine the inorganic matters found in the dung of animals. If we take the analysis of the excrements of different animals living upon vegetable food, we shall arrive at what substances the soil receives through their means. Thus 1000 of horse-dung dried at a little above the boiling heat of water, lost 714 parts of water and left 286 of a dry vegetable mass, which when burnt left 17 parts of ashes; and these, when subjected to analysis, gave

Silicious earth	6.4
Phosphate of lime	0.8
Carbonate of lime	3.0
Phosphates of magnesia and soda	5.8
	16.0

The following table of Boussingault contains substances, several of which are almost exclusively used as the food of man—wheat-flour being taken as the standard, and estimated at 100: as the leaves of cabbages, the roots of carrots, and potatoes, may be ground down into powder, when dried at the heat of boiling water (212°); these dried matters are, in the table, designated flour. The equivalents are all theoretical, that is, they are calculated from the *nitrogen* they contain, and the numbers express the weights of the respective substances that are equivalent to 100 parts of wheat flour:—

Substances.	Equivalents.	Substances.	Equivalents.
Wheat Flour	100	Haricots, White	56
Wheat	107	Lentils	57
Flour of Barley	119	Hearted Cabbage, White	810
Barley	130	Flour of ditto	61
Rye	111	Potatoes	613
Buck-wheat	108	Flour of ditto	126
Maize	138	Carrots	757
Beans	41	Flour of ditto	95
Peas, Yellow	67	Turnips	1335

After a very careful analysis of the ashes of horse-dung—the animal being fed upon bran, oats, and hay—I found, as indeed what I had calculated upon, a much greater proportion both of alkaline fixed salts and earthy phosphates ; the bran accounting for the greater proportion of the latter compounds. Thus 100 grains gave—

Sulphate of potash	5.25
Common salt and muriate of potash	15.00
Phosphate of lime (bone earth)	14.50
Phosphate of soda and magnesia	16.25
Carbonate of lime (chalk)	14.75
Silicious earth (fine flint)	33.00
Sulphate of lime (gypsum) with oxide of iron	1.00
	99.75

The above examples will be sufficient to show us the composition of the ashes of dung; but it is evident they do not furnish us with the amount of nitrogen contained, upon which much of the value of all manures depends.

The three following analyses exhibit the organic composition of dung, with the amount of ashes per cent. The first is from Liebig, the second and third are by Boussingault, (*Annales de Chimie*, t. lxxi, pp. 122 and 134.)

	Solid excrement of a cow.	Solid excrement of a milch cow.	Solid excrement of a horse.
Carbon	44.00	42.8	38.7
Hydrogen	5.84	5.2	5.1
Oxygen	34.17	37.7	37.7
Nitrogen	3.59	2.3	2.2
Ashes	12.40	12.0	16.3
	100.00	100.0	100.0
Water	609.22	610.3	404.2
	709.22	710.3	504.2

It is necessary, however, here to remark, that the above analyses do not furnish a fair contrast between the excrement of a cow and that of the horse, inasmuch as equal weights of dung were not employed; it, however, shows us that five parts of horse-dung, provided none of its constituent parts be lost by fermentation, are quite equal to seven of the dung of cows and oxen. By referring to the two analyses of the excrement of the milch cow, and the one not giving milk, it will be seen that the dung of the latter is far richer in *nitrogen:* this element being withdrawn to furnish the albumen or curd of the milk. Again, for the same reason, the urine of a milch cow contains less nitrogen than that of a cow which does not yield milk. It is a well known fact, too, that a cow giving a plentiful supply of milk, cannot be fattened—the constant drain upon the system of the animal, preventing the accumulation of fat and muscular fibre.

The solid as well as liquid excrements of horned cattle contain, comparatively, a large proportion of potash; indeed, all the potash contained in the food consumed by them, is again discharged in their excrements. The same may be said of the dung of the horse, and that of the sheep: the dung of oxen and sheep supplying the soil with silicate of potash, and some salts of phosphoric acid—the excrement of the horse, also, affording silicate of potash, with a large per-centage of lime, soda, and magnesia. If, then, the litter of these animals be fairly commixed with their solid and liquid excrements—the straw of such litter, also, affording both silicate of potash and earthy phosphates—and this straw-litter be putrified, or thoroughly fermented, this silicate of potash and these phosphoric salts are precisely in the same condition, as adapted to the service of plants, as they were previous to their being assimilated by the animal organism. If, therefore, the farmer will make the most of his manure—if he will be guided by rational principles, in the collecting and preserving of such manure, by fixing its ammoniacal salts, it is evident the soil of his corn-fields will alter but little; as he will thus restore to it all the salts but those exported in the shape of cattle and grain. This loss, then, in every well-tilled farm, if he would maintain its productiveness, must be supplied either by fallow, by laying it down in grass, or by the judicious application of some compound inorganic manure, containing silicates and earthy phosphoric salts. In the analysis of the urine of swine, we discover a large quantity of phosphate of magnesia and ammonia—hence the value of pig manure for white crops. It is the urine of animals, indeed, commingled with their solid excrements, and absorbed by the litter, which forms the active as well as most valuable part of their manure. The urine of animals may be kept till its ammoniacal constituents decompose, or until it becomes almost putrid, without sensibly evolving the ammonia; but when it is mixed with their dung and the litter of their stalls, it imparts to them the power of becoming pungent, or of emitting free ammonia. The urine of all animals is found to differ according to the age, condition, and habits, the nature of its food, and the water it drinks. The urine, however, under all circumstances, is highly valuable; and as we have already shown that the urine of horses, oxen, and swine, is particularly rich in silicates and phosphates, so it behoves the farmer to adopt every means within his power, to guard especially against any loss of this highly fertilizing compound. If he will be at the pains to examine the analysis* of the urine of the horse and cow—bearing in mind that all the compounds enumerated are the direct food of plants—he will discover the incalculable loss he has annually sustained by allowing this liquid, together with the drainings of his dung-heap, to run to waste. This loss, undoubtedly, has arisen from the farmer having under-estimated the value of urine as a manure; but when he is told that less than 20 parts of the urine of a horse, 55 of that of man, and 90 parts of the urine of horned cattle, are each equal to 100 parts of good farm-yard manure, he will surely, in future, adopt the

* 1000 Parts Urine of a Cow.

Urea (rich in nitrogen)	40
Lactate of ammonia, &c.	30
Phosphate of lime	30
Muriates of potash & ammonia	150
Sulphate of potash	60
Carbonates of potash & ammonia	40
Water	650
	1000

1000 Parts Urine of a Horse.

Carbonate & phosphate of lime	11
Carbonate of soda	9
Hippurate of soda	24
Muriate of potash	9
Urea (rich in nitrogen)	7
Mucilage and water	940
	1000

recommendations of science, by collecting it in proper reservoirs, and fixing its ammonia by gypsum, or sulphuric acid (oil of vitriol.)* Thus 50 head of cattle will produce sufficient ammonia, which when saturated with sulphuric acid, will manure 43 acres of land; and if we allow 1½cwt. of the mixed alkaline fixed salts to an acre of grain-crop or grass—a dressing amply sufficient—then, as every head of adult cattle annually produces 309lbs. of such salts, so 50 such cattle would produce 6 tons, 18 cwt. of these salts, a quantity quite sufficient to dress 92 acres. Indeed, if we estimate the value of animal urine from the nitrogen alone which it contains, it is a far more valuable substance than most practical men have thought it.

Now as hay contains about one per cent. of nitrogen, and as an ox may be calculated to consume from 25 to 28lbs. of hay daily, it is evident that from 4 to 4½ ounces of nitrogen must be assimilated. This would furnish 5 ounces 3 drachms 42 grains of ammonia. This amount of ammonia entering into the composition of the fleshy part of the animal, would furnish about 8½lbs. of muscular fibre—a quantity larger than its daily increase in weight;

* Boussingault found that a milch cow, giving 18.8lbs of milk per day, voided in 24 hours above 18lbs. of urine, or 6598lbs. per annum, of which the fixed alkaline and earthy salts alone would amount to 309lbs.; consisting of phosphate of lime, muriate, sulphate, and carbonate of potash. If, however, we take Boussingault's estimate of the quantity voided to be correct, we shall find, by calculating at 4 per cent. the quantity of urea (13196) convertible into carbonate of ammonia, that a farmer feeding 50 adult cattle would possess a local source of ammonia equivalent to 2639lbs. (assuming the urea to yield only one-fifth of free ammonia,) which when fixed by neutralising it with sulphuric acid (oil of vitriol) would yield 7245lbs., or 3 tons 4½ cwt. of solid sulphate of ammonia. This amount of sulphate of ammonia, allowing 1½ cwt. to the acre, would suffice to dress 43½ acres of grain-crop after lea, with a certainty of adding largely to the return both of grain and straw.

this redundant ammonia, or nitrogen, is then eliminated, or excreted, by the kidneys, as the potash of the food is from the bowels.

Supposing, then, we only obtain $\frac{1}{4}$ part of dry matter from 100 of fresh cow-dung, we might argue that 28lbs. of hay would exercise an equal influence upon the growth of plants as 100 of recent cow-dung; but this is opposed to all experience; the nitrogen must, then, be sought for in the urine. As 18 lbs. of urine are equal to 138,240 grains, this quantity will yield 5531 of urea and 284 of ammonia, (in combination with benzoic (hippuric) and lactic acids, forming salts,) so that we obtain, as a whole, 1398 grains of ammonia, or a quantity equal to 2 ounces 7 drachms 18 grains. Now as these 1398 parts require 3266 of sulphuric acid, to produce a fixed or neutral salt, so by collecting this urine in proper tanks, and keeping it *acid* by oil of vitriol, we secure more than 9½ozs. of sulphate of ammonia, as the daily yield. We see, then, that the urine of a single cow, properly preserved and fixed by vitriol, will furnish in the course of one year, 1 cwt. 109lbs. 3 ozs. 6 drs. of this salt: a quantity sufficient to dress 1⅓ acres of land.

If we digest horse-dung with water, we obtain a yellow-looking liquid; and by evaporating this liquid, we find it to contain, besides some vegetable matter, from 3 to 3½ per cent. of phosphate of magnesia and salts of soda. Upon treating the undissolved portion of this dung with hot spirit of wine, we obtain a resinous matter, nearly similar to what is found in the gall of the animal, while the residue is little or nothing more than dry vegetable matter, which burns away without emitting any peculiar smell. The ashes left by the combustion of 100 parts of dry horse-dung, we have already seen, amount to from 12 to 16 per cent.: consisting principally of phosphate and carbonate of lime and magnesia, contained in the corn; and silicate of lime and potash, as chiefly existing in the hay and straw: so that by 1½ to 2 tons (3360 to 4480lbs.) of fresh horse-dung (equivalent to only 120 or 140 of dry dung,) we add to the land from 730 to 940lbs. of vegetable matter and altered gall, and from 150 to 278lbs. of different saline substances and inorganic matters, according to the nature and quality of the food consumed. It is, then, to the amount of the saline and inorganic parts found in the ashes of plants, and contained in manures, that we must chiefly look for their value in promoting vegetation: inasmuch as these compound saline substances form part of the composition of the hay, oats, beans, cake, turnips, straw, &c., with which the animals may be fed.

The *dry* dung of oxen, sheep, and black cattle, yields as much as from 8 to 25 per cent. of inorganic matters, consisting of phosphate and silicates of lime and potash and common salt—according to the fodder, or provender, supplied as food. That the quality of the food enhances the fertilizing power of the manure, is a point of fact, no practical farmer will deny. As we have already remarked, that the whole of the alkali contained in the food of oxen, is again discharged in their excrements, so the same fact may be noticed as regards the other inorganic constituents of their food, either when they are not adapted to enter into their organization, or when they are present (as in corn and cake) in superabundance. Hence, by the food of the animal, we increase or diminish the value of its manure.

In many parts of the country the little farmers have burnt the dry dung of cows for fuel; and we may often see the ashes of such cow-turf, instead of being carefully husbanded, thrown into some adjacent ditch, or scattered by the road-side hedge.

The dung of horned cattle, however, fed upon oil-cake, is particularly rich in earthy phosphates—more of these substances existing in such food than can be taken up by the animal organism; hence the excess is discharged with their fœces, and is in a state or condition exactly adapted for assimilation by future plants.

We have before observed, that the value of any manure may, in a great measure, be founded upon the relative quantity of nitrogen it contains; and it is upon this principle that the table of MM. Boussingault and Payen is drawn up.—(*See Annales de Chimie et de Physique*, 3*me. Serie*, t. iii, p. 65, *et* t. vi, p. 449.)

If we examine Boussingault's table, we shall find that the excrements of horned cattle, sheep, and horses, contain at most but a very small quantity of azotised matter, (nitrogen,) and that all manures of this kind, are, in such respect, of a very variable and relative value; but on reviewing their composition, we are enabled to determine upon what soils they are best adapted. Thus, in soils consisting chiefly of lime and sand, and which contain little or no silicate of potash, and phosphates of lime and magnesia, the manure of black cattle and horses will supply the deficiency, and, indeed, upon such soils, are quite indispensable; but their value must necessarily be much less, when applied to soils containing an excess of clay; as all soils derived from the rocks called basalt, granite, porphyry, clay-slate, and even mountain-limestone, contain the alkali, named potash, in considerable quantity: to such soils a compost manure made of human excrements, and containing mineral salts, (as gypsum and Epsom salts,) would promise an ample return for the outlay, as such a compost would furnish the necessary phosphates and magnesia, of which such soils are deficient.

This brings me to advert to the culpable neglect of allowing privy-soil to drain away: the generality of privies attached to old farm-houses in the surrounding counties, being placed in some convenient locality, over, or emptying into, the garden ditch, where this valuable soil becomes, in the process of time, gradually dissipated, or, finding its way to the larger water courses, is ultimately conveyed to the sea!

If the farmers would annually contract for all the night-soil of the villages and surrounding towns, and mix this with powdered clunch, or chalk, soot, or charcoal, coal ashes, and gypsum, they might preserve such a compost for any length of time unimpaired, and yet deprived of all noxious effluvia. All the farmer would have to do before using it, would be to mix it, if too moist, with as much dry mould or ashes, as will render it friable, and consequently, capable of being drilled with the seed, or sown broad-cast.*

In like manner it behoves every farmer to sink a dung-reservoir in some part of his farm-yard; not only to collect the drainings of his manure, but by means of properly con-

* According to the analysis of Berzelius, 100 parts of human fœces, contain,

Berzelius.	
Albumen, or matter analogous to the white of egg	0.9
Bile	0.9
Mucilage, fat, and other animal matters	16.7
Saline matter	1.2
Undecomposed food	7.0
Water	73.3
	100.0

Playfair.

According to this chemist 400 parts of human fœces leave 100 of solid matter, consisting of—

Carbon (charcoal)	45.24
Hydrogen	6.88
Nitrogen (average)	4.00
Oxygen	30.30
Ashes	13.15
	100.00

The ashes of these experiments contained both phosphate of lime and magnesia.

structed under-drains, to conduct the whole of the urine from his cow and bullock-sheds, stables, pig-cotes, &c. When the farmer shall be told the fact, that 56 pints of human urine contain as much azotised matter (nitrogen) as is contained in 3 cwt. of cow-dung, or 6½ cwt. of fresh horse-dung, he may form a tolerably correct estimate of the value of preserving this important part of manure as effectually as possible. Hence, in the construction of houses for cattle, and courts for manure, the most complete arrangements should be made for conveying all the urine of cattle, by means of proper drains running the whole length of his cow-sheds, stables, and pig-cotes, into one or more common reservoirs; so placed and constructed as to receive, also, the whole of the liquid from the dung-heap and farm-yard.

The urine and water of dung-hills, otherwise too often allowed to drain away, or collect in pools, there speedily to decompose, and thereby lose nearly two-thirds of its virtues, may be thus collected, and all its valuable ammoniacal salts and azotised compounds, preserved by simply adding, from time to time, either a little calcined gypsum (plaster of Paris), about one peck or one and a half stone to every 60 gallons, or stirring into the urine a quantity of sulphuric acid (oil of vitriol), sufficient to keep it slightly acid:—a point easily ascertained by testing a small portion of the liquid with a little pinch of powdered chalk—if the chalk sinks through the liquid without *hissing*, it is a proof that the liquid of the tank is not sufficiently acidulated. These tanks, when full, may be emptied by means of a portable pump, and the liquid now containing sulphate of ammonia, (one of the richest fertilizers we possess), may be either applied by the water-tank cart to the meadow-land, and upon young corn in spring, or over the compost dung-hill during winter. By this means the water only is evaporated, as the ammonia, now a fixed salt, becomes incorporated with the organic matters of the manure, or in case of the meadow, presented to the direct influence of the roots. The farmer is little aware of the great loss he annually sustains, by allowing the liquid of his farm-yard and dung-hill to drain away, or collect in pools, there to become stagnant; nor can he rightly estimate what he would gain by strewing gypsum, twice a week, over the litter of his crew-yard, stables, piggeries, and cow-sheds, as, also, over each layer of his dung-hill, as he, from time to time, either carted his manure or turned it over to excite its fermentation. The quantity to be strewn over such manure, must depend upon the quantity of dung and manure produced—to every 10 cart-loads (calculating each at 15 cwt.) one bushel of the powdered gypsum may be added—this is about one part to 200, by weight, supposing the bushel of gypsum to weigh 6 stones 5 pounds.—The same quantity of gypsum may be again added on turning over the dung-heap during its fermentation.

Now the fermentation, and consequent decomposition of manure, as it takes place under ordinary circumstances, is always attended with the evolation of what is called the ammoniacal or volatile alkali. Vegetable matter, in a state of decomposition, giving up its elements in contact with water and atmospheric air:—in other words, the compound elementary affinities, as it were, destroyed, by virtue of more simple affinities, the separated elements now arrange themselves under stronger attractions;—the charcoal unites with oxygen to form gaseous *carbonic acid;* another portion of oxygen unites with an atom of hydrogen to form *water;* while the remaining elements of hydrogen and nitrogen, presented to each other in what is called the *nascent* state, now unite to form *ammonia!* Such is the simple arrangement of the elementary atoms of the complex compounds of animal and vegetable matters; being, for the most part, composed of *three* and *four* elements, their affinity for each other, as a *tripple*, or four-fold combination, is weaker than the affinity of the same elements is to form more simple, yet more powerful, compounds: as in the binary, or two-fold, state of union—viz., *carbonic acid*, *water*, and *ammonia*. Now as it is these three compounds which constitute the food of all plants, the practical farmer cannot be too often reminded of the absolute necessity of guarding against any loss of the ammonia of his manure; since it is in proportion as this invigorating compound is supplied to a growing plant, that enables it to absorb carbonic acid, and thus appropriate more carbon into its growing organism.

These decomposing processes are, however, not confined to the body of the dung-hill; they are continued, more or less slowly, when manure is introduced under the surface-soil; whether this manure be *rotten*, half decomposed, *as litter*, or ploughed into the soil in a *green state*. In this way, then, the ammonia and carbonic acid are gradually supplied to the young plant; and hence the rapidity of growth upon hot-beds, where these compound substances are supplied in excess.

Seeing, then, the important part played by ammonia in the development of vegetable life, we might here make some stringent remarks upon the worse than folly of carting hot pungent manure, and laying it in heaps, a fortnight or more, before ploughing it in! The farmer cannot calculate the irreparable loss he thus daily, nay hourly, sustains. Let him, however, take a given quantity (say 1lb.) of such manure, hot from the dung-hill, and another like quantity from a small heap, exposed for a fortnight to the air, and digest each, separately, in a quart of rain-water, rendered slightly acid by a little oil of vitriol; filter each solution through blotting paper, and then evaporate off the water in a slow oven; let him then weigh and compare the amounts of the solid matter left, and he will, in future, only cart away from the dung-hill as fast as he can plough in and sow his grain! But even this state of things is far from complete; and the farmer has suffered a loss of, at least, one-third of the value of his manure, by allowing decomposition to extend so far as to convert his heap into *short muck*. This arises from the volatilization, or dissipation, of the carbonate and free ammonia. We have shown that animal urine abounds in ammoniacal salts, and other animal compounds. These salts are feebly united with some animal acid; as the *hippuric*, *uric*, and *lactic*. As soon, then, as fermentation takes place in a dung-hill, made from the litter and excrements of the stable, cow-house, or pig-cote, a decomposition of these animal acids more or less rapidly ensues—the *nascent*, or newly generated *carbonic acid*, unites with the liberated *ammonia*, and forms a *carbonate of ammonia;* but even this salt, from the increasing temperature of the fermenting mass, becomes volatile, and is thus dispersed, along with the watery vapour, into the atmosphere. Here, therefore, the manure loses considerably in its powers of promoting vegetation. It was upon calculating such loss, that Sir H. Davy was inclined to conclude, that, although not so rapid in its results, the ploughing in of *half-decomposed litter*, was, in the ultimate, the more economical plan;—and, certainly, upon heavy clay lands, his theory was correct: as it not only acts its office as a *manure*, but it renders such soils more porous and divisible, and consequently, more free for the admission of air and water. Upon no one subject, however, has Sir Humphrey been more misunderstood. He by no means lays it down as a law, for the general adoption of the practical farmer; but only throws out the hint conditionally, and as *a guard* against the farmer allowing his manure, for all purposes, to go so far as complete decomposition, or the state of *rotten muck*.

It did not, however, occur to the mind of this great philosopher, that by the application of gypsum, in powder, or by watering such manure with diluted *mineral* acids, (as oil of vitriol or spirit of salts,) that the decomposition of the manure might still be promoted, without any sensible loss or escape of its ammoniacal constituent parts.

In recommending the practical farmer, therefore, to strew gypsum, twice a week or so, over the surface-litter of his crew-yard, it is necessary that we give him some reason, by proving to him his recompense, for such outlay and labour. He must understand, then, that when gypsum is brought in contact with the ammoniacal, or volatile salt of the fermenting manure, the latter becomes fixed, that is, its ammonia unites with the mineral acid, or sulphuric acid, of the gypsum, and forms a salt no longer volatile, viz., the *sulphate of ammonia*. The same salt constitutes the great fertilizing property of common soot; the value of which material, as a top dressing, experience has long taught the farmer. The refuse liquor of the gas-works, likewise, contains this salt, in combination with the carbonate of ammonia; so that by the addition of sulphuric acid to this liquor, in order to neutralize the alkali, we may apply this liquid, at once, to the young plant, by the water-tank cart; or by evaporating the liquid to dryness, we may obtain the sulphate of ammonia in a solid form; so as to drill it in with the seed, or sow it broad-cast in the spring.

For the above reason, seeing that during the fermentive, even to the putrefactive stage of decomposition of our dung-hills, there is thereby a considerable loss sustained by the evolation of vapourous ammoniacal salt and free ammonia into the atmosphere, we earnestly recommend the farmer to water the dung-heap, from time to time, with diluted sulphuric acid, in order to arrest the ammoniacal fumes, and thus prevent the dissipation of this most valuable salt into the air; there to do him no more good than it will do his neighbour! One quart of sulphuric acid *(oil of vitriol)* added to 18 or 20 gallons of water, in an old cask or brewing-tub, will be sufficiently strong for this purpose; and the acid liquor may be applied by means of either a portable force-pump, or by the common garden watering-can, over the whole surface of the fermenting dung-hill. The sulphuric acid can be bought for 12s. per cwt., a mere trifling cost; while the labour is also a mere nothing! By one cwt. of oil of vitriol, thus expended, the farmer secures more than 3½ cwt. of the sulphate of ammonia, which would otherwise be lost: worth at least 20s. per cwt., and one of the greatest fertilizers he can posses.*

* We are not here speculating upon, or pre-imagining, a result—we speak from actual facts, and the experience of a fair trial. Mr. Charles Hugh Wooll, an intelligent agriculturist, at Upwell, in the Isle of Ely, some six or seven years ago, allowed the author to carry out such an experiment, by purchasing the acid, and giving him a heap of half decomposed, and still decomposing dung, to operate upon: estimated to contain 300 loads, or 225 tons, of manure. This experiment was perfectly satisfactory; and convinced the author, as it did his friend, of the perfect efficacy of the application. At from four to five o'clock in the morning, prior to the experiment—before the sun had gained the horizon—clouds of vapour, loaded with pungent ammonia, might be seen and smelt at a considerable distance; indeed the whole fermenting mass was completely enveloped by a dense white smoke. After the second application of the acid, however, while the vapour was still seen, yet the air at the surface of the heap was perfectly

If the farmer shall have adopted the recommendations of the author of this essay, and sprinkled gypsum twice a week over the surface of his crew-yard, then, by watering the manure and compost heaps with this tank solution of sulphate of ammonia, he will materially hasten their decomposition, by exciting fresh fermentation; and as the heap increases in temperature, the watery parts only of the liquid can evaporate, leaving the salt of ammonia crystalized, and entangled in the manure, precisely as if the dry salt had been strewn broad-cast over every thin layer of the heap.

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free from the presence of ammonia! The application of the acid was continued now, both morning and night; till the amount of 1½ cwt. was expended; after which, though the dung continued to ferment, there was no appreciable extrication of ammoniacal gas. Here, then, the surface of the heap being saturated with free sulphuric acid, any gaseous ammonia that might be disengaged during decomposition, as it rose through the manure, would be absorbed by the acid, and converted into a *sulphate of ammonia.* The same intention would be answered by sprinkling a coat of gypsum, (plaster of Paris,) about a quarter of an inch thick, over each and every layer of the dung-heap, as it is carted from the straw-yard, and then placing a layer of half an inch thick on the surface of the manure heap. After the heap has remained a month, it may be turned over; and if then pungent with ammonia, it would be well to apply a little acid at the instant of so doing; at the same time adding another broad-cast of gypsum to each successive layer of manure. This, till set about, may appear a tedious process; but the extra labour and expense will be amply compensated for, in the increased value of such manure: 5 ton of which will be quite equal to from 12½ to 15 of ordinary farm-yard manure! In like manner, the strong pungent stench of the stable, pig-cote, and cow-house, may be neutralized, and these places rendered sweet and wholesome in a few minutes, by merely watering them with the diluted sulphuric acid, (1 quart to 8 gallons of water); the neutralization takes place immediately; and the result, in point of increased value of such manure, is, at least, *three fold!* The same results are obtained, if coarsely powdered gypsum is strewed over the litter of the stalls, and in those parts of the stable and cow-sheds where the urine of the animals collects; and in stables this plan is, perhaps, the least objectionable.

We often hear the old maxim, that, "muck is the mother of gold," and yet the value of manure—I mean the intrinsic value of its soluble inorganic parts—would seem to be overlooked by the generality of practical farmers; or surely they would be more solicitous about its increase, and take more pains to prevent its liquid parts from running to waste. Thus it is no uncommon thing, throughout the country, to witness dung-hills carted to the road-side, and all the rich liquid manure draining from them, to find its way to the adjacent ditch! Can anything be more inexcusable than this practice? Can anything betray a greater want of the knowledge of what matters are the food of plants? He cannot surely know that he is thus losing, at least one-third, if not half, of the value of such manure, and, consequently, to what extent he is exhausting his land, by such culpable negligence; instead of increasing, or at least maintaining, its productiveness? The adage, then, that "muck makes gold," would seem to be either forgotten or but little attended to.

We have already seen (p. 49,) that the urine of horned cattle and horses is, independent of its ammoniacal salts, particularly rich in salts of potash, and contains, also, some earthy phosphates; it is richer in urea (a very azotised substance,) than human urine, but contains a much less amount of phosphoric and ammoniacal salts than the latter.

Berzelius, upon whose estimate we may rely, gives us the following as the composition of the urine of a healthy man.—1000 parts contain—

Water	933.0
Urea, uric acid, lactate of ammonia, and other organic matters, containing nitrogen	48.24
Sulphates of potash and soda	6.87
Phosphates of soda, ammonia, lime, and magnesia	5.59

Sal ammoniac and common salt...........................	5.95
Mucous of bladder, 0.032, and flint 0.03	0.35
	1000

Now the urea, uric acid, lactate and phosphate of ammonia, and sal ammoniac, contain a large quantity of azotised matter, or *nitrogen;* and hence enable the plants, supplied with these compounds, to assimilate, or acquire a greater proportion of carbon, from the atmosphere, than they otherwise would do; while the plants thus rendered vigorous and healthy, become more capable of extracting from these azotised compounds, the elementary principle of *nitrogen,* so essential to the mature development of their seeds. The other inorganic substances of the urine, (amounting to about one per cent.,) consist of saline matter, which would possess precisely the same action on the soil, whether they were merely dissolved in water, or as they exist in the urine. This small quantity, however, of inorganic matter, will not, evidently, account for the fertilizing power of animal urine; hence this powerful influence depends upon the urea and other ammoniacal salts, as lactate, phosphate of ammonia, &c.

When urine is allowed to putrefy spontaneously, or in fact, when it passes into that state as it becomes employed as a manure, all its urea is converted, by decomposition, into lactate of ammonia and *volatile carbonate* of ammonia, (concrete smelling salts of the druggists,) and it is for this essential reason, why it is economically expedient to neutralize, or fix these compounds, by decomposition with plaster of Paris,* or directly, by the addition of oil of vitriol to the recent urine.

* To illustrate my meaning, of what is called "*decomposition,*" by a diagram, we must bear in mind that gypsum, or plaster of Paris, is a com-

Through the kindness of my friend, Mr. Jas. Hazledine, of Warburton, in Cheshire, I have had the accompanying plate engraved, of his farm premises, showing his construction of a dung-water tank, and the drains leading to it. This tank was made in the spring of 1844.

EXPLANATION OF THE PLATE.

a.—Dung water tank, built of stone and puddled at the bottom and outsides. Length, 24 feet—width at the bottom, 2 feet 9 inches—depth, 3 feet, [all inside measure.] Contents, 8 cubic yards. The bottom of the tank is laid with flag, and the top covered with strong flag. At the lower, or south end of the tank, a double wall was made, and a cavity of a foot, well puddled.
b.—A longitudinal section of the tank.
c.—A cross section of the tank.
d.—Under-drain from manure heap.
e.—Under-drain from down spout of building.
f.—Under-drain from shippons, and main drain from pig cotes, stables, &c.
g.—Under-drain from stable.
h.—A down spout of building, emptying into the main dung-water drain f, and without which it would soon be choked up.
i.—Under-drain from pig cotes.
k.—Under-drain from privies, &c.
l.—Under-drain from spout.
m.—Under-drain from milk-house.
n.—Under-drain from the slop-stone, and from the soft and hard water pumps.
o.—Hard water pump.
p.—Soft water pump. N.B. A terris cistern under back kitchen.
q.—Slop-stone.

pound substance, consisting of sulphuric acid *(oil of vitriol,)* united to lime as a base; while volatile salt is composed of carbonic acid and ammonia.

Now when these two compound substances (gypsum and volatile salt,) are brought into contact, they mutually exchange their acids and their bases, thus—

The sulphuric acid and ammonia unite to form a salt no longer volatile, viz., sulphate of ammonia.	GYPSUM: Sulphuric acid : Lime Ammonia : Carbonic acid :VOLATILE SALT.	The lime and carbonic acid unite to form carbonate of lime or chalk.

When oil of vitriol is added to urine, it displaces both the lactic and carbonic acids, and unites directly with their ammonia.

It cannot be too often insisted upon the great negligence of throwing chamberlee away, instead of adding it to the contents of the dung tank. 1000 pints of urine contain 69lbs. of fertilizing matter, which, in an agricultural point of view, is worth at least 24s. per cwt. Now as every adult person voids nearly 1000 pints of urine annually, this loss amounts to an avarage of 12s. per head. Again, to estimate its value by comparison; if 5 tons of farm-yard manure, per acre, is requisite to maintain the farm in good heart, then, calculating from Boussingault's table, about 4 cwt. of the solid matter of urine, would, in fertilizing power, produce a like effect, it being from 25 to 33 times the power of such manure.*

If, then, we estimate every 1000 parts of the urine of a cow, also, to yield 69lbs. of solid fertilizing matter, then, as the quantity voided is stated by Sprengel to be 15000lbs. annually, we find 9 cwt. 27lbs. as the product, worth at least 20s. per cwt. Under the present bad economy of the farm-yard, all this amount of liquid is either allowed to run to waste, or become decomposed, which, if properly

* Calculating that three pints, daily, is the average of the urine voided by each adult person, then, in the parishes of Wisbech and Walsoken, containing 10,000 inhabitants, there will flow down the river, or be otherwise lost, as much fertilizing matter annually, in the urine alone, as would supply manure to a farm of 1500 acres, yielding a return of 4500 quarters of corn, or an equivalent produce of other crops; and if we estimate the quantity of night-soil thrown into the river, in the course of one year, by the emptying of privies, &c., from the parish of Wisbech alone, it would, when properly made into compost, be sufficient to manure 1143 acres for turnips, wheat, and barley—that is, the wheat and barley grown after manuring for turnips: this is the annual amount, calculated from pretty accurate data, as thrown into our river; but provided all could be collected, then, 10,000 inhabitants, calculated to void half a pound each, would produce sufficient night-soil to keep 2715 acres of arable land in good heart—and yielding 8147 quarters of a grain crop, &c.

collected and its ammonia fixed, would be an invaluable manure for young corn and grass land, as well as for watering the manure heap, and to excite fermentation of the farm-yard litter. Indeed, if all the urine of the farm-yard, cow and bullock sheds, stables, piggeries, &c., were collected and properly preserved, a much less amount of guano and other extraneous manures, would require to be imported into this country, or with a continuation of bone-dust, and such artificial manures as contain phosphoric salts for their bases, the produce of the country would be greatly increased.

We have entered sufficiently far into the examination of the urine and solid excrements of animals, (which form a part of all good farm-yard manure,) as shows us upon what substances they exert their influence upon vegetation; and we have seen that this influence mainly depends upon the relative quantity of animal organic matter, and saline inorganic salts, which such manure, or dung, contains:—further, we have traced the high fertilizing power of such manure to be, in value, in proportion to the quantity of nitrogen contained in its ammoniacal salts.

When, then, the practical agriculturist shall consider the importance of the inorganic constituents of the soil and of his manures, and shall duly calculate the amount of alkaline and phosphoric salts, removed and exported annually by grain and cattle from the soil, then, and not till then, will he see the imperative necessity of maintaining "*the heart*" of such soil, by the timely application of such manures, as will restore to it its withdrawn fertilizing compounds. Let him bear in mind that every coomb of barley abstracts 5lbs., while every coomb of wheat withdraws 4lbs. of such salts from the soil.

The following table represents the amount, *in pounds*, of the different quantities of alkalies, earths, and acids, (united as salts,) as withdrawn by a four-course system from one acre of a soil, such as that of Norfolk—estimating the turnips at 25 tons, barley 9½ coombs, clover and rye-grass each one ton, and the wheat at 25 bushels.—*(Johnson's Lec., p. 326.)*

	Turnip roots	Barley.		Red clover	Rye grass.	Wheat		Total.
		Grain	Straw			Grain	Straw	
Potash	145.5	5.6	4.5	45.0	28.5	3.3	0.6	233.0
Soda	64.3	5.8	1.1	12.0	9.0	3.5	0.9	96.6
Lime	45.8	2.1	12.9	63.0	16.5	1.5	7.2	149.0
Magnesia	15.5	3.6	1.8	7.5	2.0	1.5	1.0	32.9
Alumina (clay)	2.2	0.5	3.4	0.3	0.8	0.4	2.7	10.3
Silica (flint)	23.6	23.6	90.0	8.0	62.0	6.0	86.0	299.2
Sulphuric acid (oil of vitriol)..	49.0	1.2	2.8	10.0	8.0	0.8	1.0	72.8
Phosphoric acid (bone acid)..	22.4	4.2	3.7	15.0	0.6	6.6	5.0	51.5
Chlorine (spirit of salt)	14.5	0.4	1.5	8.0	0.1	0.2	0.9	25.6
								970.9

If we examine the contents of the first column, we must see the absolute necessity of not only manuring for turnips with farm-yard manure, in order to furnish the alkaline salts, (as sulphates, muriates, and silicates of potash and soda,) but of the great advantage we gain by applying bone-dust, or some *compound fertilizer*, containing phosphoric acid as an ingredient, in order to furnish the requisite quantity of phosphoric salts—as the phosphate of lime, magnesia, and soda.

Upon the principle of the rotation of crops we are enabled to grow two kinds of plants at the same time upon the same soil; the one not materially robbing the other, or first crop, of any of those inorganic salts requisite to its full development.

How very opposite, however, to these facts, would stand the case of following wheat after wormwood or tobacco, both these plants drawing largely upon the soil for those materials required by the wheat, especially for the growth of the straw: thus while 1000 parts of vetches only abstract 27 parts, and 1000 of beans 20 parts of potash—1000 of wormwood would withdraw 73 parts of the same alkali from the soil. After the abstraction of so much potash from the soil, it would be a vain labour to attempt the cultivation of wheat, as there would remain too little alkali in the soil to unite with silicious earth, to form the silicate of potash, to insure the crop of wheat.

Our wheat crops, however, have often other companions growing with them, by no means friends to the farmer: as the *wild camomile* and *Scotch broom.* These plants greatly impede the growth of corn plants; nor is this at all to be wondered at, when it is known that their ashes yield as much alkali (7½ per cent.) as is withdrawn by the corn plants themselves. Again, the *darnel*, *cockle-weed*, or *tares*, and the *fleabane*, *chickweed*, and *groundsel*, are too often allowed to grow with our corn crops. Now these weeds blossom and bear seed at the same time as the corn; so that when growing with it, they draw part of the component matters of the soil—every 100 parts of the ashes of tares containing 40 per cent. of carbonate of potash—so that in proportion to the vigour of their growth, that of the corn must decrease: the one depriving the other of part of its proper food. There are plants, however, which require little or no potash at all for their growth, and yet attain a considerable size—viz., the *poppy*, which generates in its organism a peculiar vegetable alkaloid, called *morphia*: serving all the purposes of a true alkali. Indian corn, *Zea Mays*, and the Jerusalem artichoke, contain either no potash, or only traces of it; and for this reason, (the potash of the soil being of no use to them,) they may be cultivated without rotation, on the same soils, for several years in succession: particularly if the straw and herbs (or their ashes) be returned to the soil after reaping the crop.

As we have already considered the composition of animal bones—that they contain from 60 to 70 per cent. of the phosphate of lime, and from 1½ to 4 per cent. of phosphate of magnesia—and as we have also shown that these same materials exist in the seeds and straw of all corn plants, we will examine the proportiou of these phosphoric salts in different kinds of farming produce: thus—

100 Parts of Plants yield in Ashes per Cent.

Wheat	2.4	14.6
Straw of Wheat	7.0	
Bran of ditto	5.2	
Barley	2.8	7.0
Barley chaff	4.2	
Oats	4.0	9.1
Straw of Oats	5.1	
Rye	2.3	6.0 ?
Straw of Rye	3.6	
Peas	3.1	14.4
Straw of Peas	11.3	
Jerusalem Artichokes..	6.0	8.8
Stems of ditto	2.8	
Hay of Red Clover	7.7	
Potatoes	4.0	
Turnips	7.6	
Mangle Wurzel	6.3	

In the above table we see at once the quantity per cent. of ashes yielded by each part of the plants employed, as well as the average of the grain, straw, &c. taken together, as 14.6 for the grain, bran, and straw of wheat;—that is to say, the crop, if removed from the soil, will be considered to extract 14.6 per cent, *weight*, of the whole crop. The straw of wheat, however, as well as of other white crops, varies according to the soil upon which it is grown; thus on chalky soils it is 16.5; on a clay soil only 6.5; and Davy found the average 15.5: from these the average is 11.37.

COMPOSITION OF 100 PARTS OF THE ASHES.

100 Parts of the Ashes of the following Plants contain,	1 Salts soluble in water, &c.	2 Earthy Phosphates.	3 Earthy Carbonates.	4 Silicious Earth, or finely dried flint.	5 Metallic Oxides, or rusts of metals.	6 Loss in the analysis.
Wheat	47.16	44.5	...	0.5	0.25	7.6
Bran	4.16	46.5	...	0.5	0.25	8.6
Wheat Straw.....	22.5	6.2	1.0	61.5	1.0	7.8
Oats	1.0	24.0	...	60.0	0.25	14.75
Barley	29.0	32.5	...	35.5	0.25	2.8
Barley Chaff......	20.0	7.5	12.5	57.0	0.5	2.25

This table exhibits the analysis of wheat, oats, and barley, giving in the first column the relative quantities of soluble salts; in the second the earthy phosphates of lime and magnesia—showing the strengthening quality of wheat over oats and barley. The earthy carbonates are inconsiderable, (third). The fourth and fifth columns, however, show the large quantity of alkali which must be withdrawn from the soil, in order to render such an amount of flint soluble. If wheat yield 47 of soluble matters, and 44½ per cent. of earthy phosphates, viz., 91½—these numbers, with the loss in the analysis, come near to the average of six different kinds of wheat, viz., 95.

To explain the action of bone earth, or that of flint and potash, more fully, it will be understood that the roots of plants cannot take up, or imbibe, either bone-earth or the earth of flint, in the solid state. The phosphoric acid of the bone-earth is introduced in combination with either alkalies, as potash and soda, or as a soluble phosphate of an alkaline earth, as lime and magnesia; while the flint must be united with either potash or soda (in the state of "*soluble glass*") before it can be assimilated by the organism of the plant.

The advantage of fallowing land, then, depends entirely upon the production of fresh supplies of that peculiar compound of flint and potash (soluble glass) which has been removed or withdrawn by previous cropping.——————So essential, indeed, are these inorganic compounds to the life, vigour, and productiveness of the plant, that it would be next to impossible to bring any one of the family of the grasses—and wheat, oats, and barley, are but grasses improved by culture—to full maturity, whose solid framework is silicate of potash, unless both flint and potash exist in the soil. In some plants flint would appear to perform the office of woody fibre, as in the *Equisetaciæ*, (mare's-tail,) and bamboos, in the same way as the crystallized oxalate of lime does in many of the lichens or mosses.

Again, as all the seeds of the tribe of grasses contain phosphoric acid, united with magnesian earth and ammonia, these inorganic matters ought to exist in every soil, upon which these seeds are sown, or in vain shall we look forward to reap a golden harvest. As we have shown, in like manner, that all plants of this class require silicated alkaline earths in order to perfect their stems or straw, and that unless the straw is so perfected the grain will never attain its full development, so of necessity must every soil also contain these inorganic materials, unless we supply such soil, or the plants growing in it, with such a manure, or *fertilizer*, as shall contain these essential ingredients *ready formed* for absorption, by the young plant: since it is this compound substance *(a species of soluble glass)* which excites in the plant the power of secreting the first particle of woody-fibre: in other words, which causes the incipient deposit or formation of wood—the plant still continuing to accumulate this silicious material through every part of its structure.

Without these requisites—*inorganic compounds of alkaline and phosphoric salts; silicated alkalies and alkaline earths*—the plants may become herbs, but never fructifying seed plants.

Of so much importance, indeed, are the inorganic matters to all our arable soils, and as constituents of the manures we employ to them, that we may very safely select any analysed soil, or compost inorganic manure, for any plant, if we will only examine the composition of the ashes of its seeds and straw. If the *soil* or the *manure* shall be found to contain *the materials* found in the *ashes* of the *straw* and *seeds of any plant*, we may rely upon such a *manure*, or such a *soil*, as fitted to the *healthy growth and full development of that plant.*

This, then, most indisputably satisfies us that the *mineral and saline inorganic matters* of a soil or a manure, are of far more importance in agriculture than has hitherto been given credit to. It matters not what each plant, or natural family of plants, takes from the soil—that is, whether it be silicious earth, lime, or magnesia, potash, soda, phosphoric or sulphuric acid, some *two or more* of these it must acquire in order to attain perfection. Thus it is not every plant that requires silicated alkalies or earthy phosphates—for instance, the *wood-sorrel* abstracts potash only: the sharp sour taste of its juice being dependent upon the presence of oxalic acid. The saline plants called *salt-wort* and *jointed glass-wort* (which grow abundantly in our salt marshes—the latter being often sold for samphire,) appropriate in their structure crystallized common salt, or at least, in the absence of this, some salt of a similar nature—as muriate of potash, &c. So the solid parts of the roots of the common *marsh-mallow* contain more phosphate of lime (earth of bones) than of woody fibre; while we find the leaves of the common *lead-wort* covered with fine horn-like or scaly processes of crystallized carbonate of lime, (marble).

Thus, then, we see that all plants require alkalies or alkaline earths, *as a base*, with which to unite with some acid to form salts or saline compounds. In the grasses and corn-plants they exist as *silicates* and *phosphates;* in others the alkali is united with *tartaric acid*, as in the common field-sorrel and juice of grapes; in others with *oxalic acid*, as in the wood-sorrel; in others with *citric acid*, as in lemon juice, &c. Again, in lichens we see *lime and oxalic acid;* and this same earth, with *carbonic acid*, supplying the place of wood: while in the marsh-mallow we find *lime and phosphoric acid* preponderating over the woody fibre of the roots!

From the foregoing arguments and facts as to the part played by the *inorganic* compounds of the *soil*, or of the *manure* we employ in the production of food for man and animals, we are compelled to admit that the only rational principle—the true—the fundamental principle—in agriculture, as far as regards the application of manures to the soil, or of the fitness of the soil itself to the growth of any particular species of plants, is, on the one hand to restore to it those constituents which have been removed by the crops, or to maintain its staple quality by what may be termed artificial means; in other words by supplying the soil with those inorganic compounds found in the ashes of the plants themselves through the three respective stages of their growth—viz.: the young plants, their flowering, and seed-bearing. To accomplish these ends I have endeavoured to lay down some few principles by which to enhance the value of the farm-yard manure. I have attempted to convince the practical farmer of the loss he sustains by neglecting such points, while I have also laboured to point out the simple, cheap, and expeditious means by which he may remedy the evil, with considerable advantage to himself, for a very *inconsiderable outlay.**

It is true I have not entered upon the nature and properties of many of those manures which have been recommended—and some deservedly so—to the farmer; such as lime, common salt, gypsum, saltpetre, nitrate of soda, guano, glauber salt, bone and sulphuric acid, rapecake, gas liquor, &c.: the limits of a mere Essay altogether precluding such notices in detail: nor have I at all entered upon either the merits or demerits of those many articles which figure in the manure market under the titles of vegetable fertilizers and artificial guanos: since not one of the latter is accompanied by any statement (to the farmer) of what materials

* If the practical farmer should raise an objection to the adoption of my views as regards the expense of the construction of a dung water tank, &c., I beg leave to reply to him in the terse language of Mr. Mechi's fifth letter in the Farmer's Magazine for September, 1844:—"The iron gutters and pipes to our roofs may be found fault with on account of the expense; but I really cannot see the utility or profit of the present custom, that is, putting good and costly manure on straw and then washing it all out again by tens of thousands of gallons of pure water off the roofs, taking especial care that it shall poison the horse pond, *and then run down to enrich some stranger's meadow at the first flood.* I hope, in fifty years' time, the farmer who does this will be considered insane. The idea of a man throwing away his manure with his left hand, and, with his right, paying money to bring it back again all the way foom Peru or Africa, seems too ludicrous for the nineteenth century." Admirable reasoning, and completely to the point.

such compounds are made up or composed. Like quack nostrums, they profess to remedy every evil and to cure innumerable diseases; but the inventors are none of them candid enough to declare upon what principle this amount of good is to be effected. The manures, or three compound Inorganic Fertilizers I propose to offer to the agricultural public, are fabricated upon the principle of the wants of each respective crop of the rotation system. For instance, where the grasses and white crops are required, that manure containing *silicates* and *phosphates* in excess, would be the best adapted, whether used at the time of drilling in the seed, or mixed with common manure, or as a top dressing in spring.

Again, where *wheat* follows *beans*, only these ingredients will be withdrawn by the latter, which that plant requires: in other words, which it can assimilate or appropriate to its own individual use, as an essential component part of its organism or structural parts; leaving in the soil, besides its own excrementitious matters, *the alkaline phosphates and soluble silicates* of the compound manure for the use and appliances of the succeeding wheat crop: these compound substances being *perennial*, that is, lasting over two or more years. In like manner of the generality of other crops; the only essential difference mainly resting as to the growth of the crop when first commencing with these manures—and this principle holds equally good when they are used as a top dressing in the spring.* The dif-

* These manures, being for the most part soluble, admit of being dissolved and diffused in water, and so applied by the water tank cart, in the same way as Liebig directs the composition or solution of bone in sulphuric acid and water: an advantage, in many circumstances, as dry seasons, &c. of the highest importance. Again, as the *potential ammonia*, or ammoniacal salts, as well as silicates of these manures are not volatile, the action of the

ferent ingredients composing these manures, or compound fertilizers, are calculated from the exigencies of the plants to be grown in the common rotation system, ascertained by the chemical analysis, of what inorganic matters each crop draws from the soil during the different stages of growth. The great and important use of chemistry to the agriculturist consists, first, in enabling him to ascertain the proper food of all those plants it is his province to cultivate; second, of the proper method of preparing and applying suitable manures; and third, of ascertaining the nature of the soil, so as to vary the composition of his manures according to the presence or absence of those inorganic materials which are requisite to the full development of the particular crop he is about to cultivate. By this means he will be able to supply whatever matters are required by each plant, as well as the quantity and proportion to serve for assimilation, by the crops in perspective. If, then, these ends are attainable, and if the soil, or the compound manure, can furnish to the present as well as leave to the succeeding plant all the nourishment each requires, and that in a condition capable of being easily assimilated, we may fairly calculate, under average seasons, as a certain result upon reaping a good crop. Again, it is a certain fact that by the use of these compound manures many soils that are now termed almost wholly *unproductive*, may be rendered not only productive and fruitful, but may be further brought into that condition, as by a continued

sun and air will not, as in guano, evaporate them from the soil; they will, on the contrary, remain fixed till removed by the growing vegetation; while another important feature characterizing these compounds is, that they attract humidity from the atmosphere, and thus supply a constant source of moisture to the plants, as well as presenting their active ingredients in the only way in which the plants can absorb them, viz., *in a state of solution.*

use of the manures, they will continue to raise the same amount of the same crop for three or four years in succession, where only one crop can now be raised to advantage once in the same number of years. As we know for a fact from chemical analyses, that certain crops do withdraw certain substances from the soil, and that such a soil becomes unfitted for raising a second or third similar crop in succession; so, then, do we know, too, as a fact, equally certain, that if we supply to a soil those matters abstracted from it by the previous crop, it will continue to produce a second, third, and fourth crop of the same plant every year: at least this argument holds good so far as corn-crops are concerned. With those plants which accumulate numerous long and strong roots, an objection to too frequent a succession may be raised, but not in the more delicate ones of the corn tribe.

From these short arguments it will be seen, that the compound manures I propose offering, are not only fertilizers, but that, like bone, they administer to the other crops in succession; for, independent of the ammoniacal and alkaline fixed salts which enter into their composition, their base is a preparation from bone itself. I am thus candid as to the general nature of these compound fertilizing manures, because I know how very easy it is for any scientific chemist to corroborate or refute my assertion. The secret of their preparation alone remains with me: that is, so far as the actual compounds of their composition being the result of chemical decomposition. All I shall say further here, is, that I have, during the period of fifteen years, put each of these manures to the test at different times, and in no one instance have I been disappointed in the result of any one experiment, even though in these trials, I only used the compound ingredients of each manure separately: the preparation of the *soluble silicates* alone excepted—my experience of the important efficacy of which, has been confined to and within the last five years; but with confirmations so ample, that I am compelled to rank these compounds as *foremost*, and on many soils, as *absolutely indispensable in the cultivation of corn plants.* As it is my intention to publish a prospectus of these "Compound Inorganic Manures," fully explaining their action and for what crops to be applied, I need merely here specify that the price will not exceed 25s. per acre, for wheat, rye, oats, and barley, peas, beans, grass, turnips, mangle wurzel, potatoes, &c.

In conclusion—I trust the enlightened and liberal minded agriculturist will admit, that I have at least, pointed out to him the necessity of better preserving the manures of his own farm; and he will give me some credit for my candour, when I assure him, that if he will only do this, he will have little need of expending his capital upon guano or any other artificial manures: convinced as I am, that by such means the importation and sale of such articles will be less required; or by their application the produce of the country will be materially increased.

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