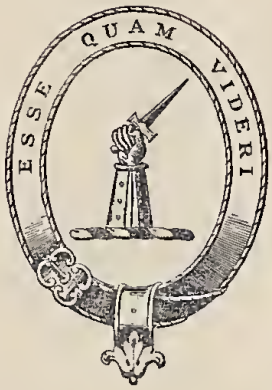

Robert Washington Oates

HINTS

TO

YOUNG BARBADOS PLANTERS.

HINTS

TO

YOUNG BARBADOS-PLANTERS.

"Seest thou a man diligent in his business? He shall stand before kings: he shall not stand before mean men."—*Proverbs* xxii, 29.

BARBADOS:
ISRAEL BOWEN, BRIDGE TOWN.

—Agrum pessimè mulctari, cujus dominus, quid in eo faciendum sit, non docet, sed audit villicum.

PORCIUS CATO.

That Estate is like to come by the worst, the Owner of which, for the work which is to be done in it, does not teach, but listens to his Manager.

LONDON: HARRISON AND SONS, ST. MARTIN'S LANE, W.C.

TO THE

HONOURABLE N. JONES PILE, CHAIRMAN.

COLONEL BRIGGS,

The Honourable N. FODERINGHAM,

The Honourable FRANCIS GODING, M.D.,

W. M. HOWARD, Esq.,

AUGUSTUS BRIGGS, Esq.,

J. T. SKINNER, Esq.,

AND

THE OTHER MEMBERS OF THE LEEWARD DISTRICT AGRICULTURAL SOCIETY.

MY DEAR FRIENDS,

When you paid me the compliment of electing me an Honorary Member of your Society, I promised, in acknowledgment of the privilege, to exert myself in promoting the interests of our Island Agriculture. The result is, this little book, which I commend to your favour and acceptance. It is, indeed, what it is

described to be, a few words of well-intended advice to our young Managers and Book-keepers, on the subject of their duties generally: and of instruction in certain principles of science connected with the great question of Manures. To this I have added some remarks on the Manufacture of Sugar.

Let it be understood that I do not come forward to teach you, or those who, like you, by their ability and experience, have earned a high reputation as Agriculturists. To you the whole library of science is open and available. You are in the habit of visiting the Mother Country, where you have ample opportunities of verifying for yourselves every point relating to Agricultural Chemistry and the manufacture of Sugar. You attend public lectures; you inspect agricultural implements of every description; you visit model farms; you go through the sugar-refineries. Not so our young Managers. They have none of these advantages. I have sought, therefore, to meet in some measure this want, by setting forth before their eyes, in this little Manual, carefully selected extracts from the highest authorities on Agricultural Chemistry, so that they may see the reason of such and such things that appertain to their work. These young men are not in the habit of reading at all; and the books to which I have referred would be "sealed" to them, on account of the technical language in which they are written.

Of the Guano monopoly I am bound to speak strongly, although in terms, I hope, not unbecoming a

gentleman. Considering that this monopoly is in itself a monstrous anomaly in an age of Free Trade, I cannot withhold the expression of my indignation at the arbitrary exactions of the parties concerned in the traffic:—whether the odium rests with the Peruvian Government or their British Agents. They have purposely kept back the importation of guano, in order that competition may be excited by a deficient supply:—thereby creating, as it were, a colour of reason for an increased price of that article. The stock of guano at the Chincha Islands is not likely to last for ever; therefore they will try to make as much out of it as they can, so long as it does last. This is the gravamen of the charge against them. Mr. Caird and other agriculturists have already spoken out on the part of the English farmers; and I take this opportunity, on behalf of my own countrymen, to protest openly against this commercial conspiracy.

On the 6th March Mr. F. Scott, in his place in the House of Commons, spoke to this effect: "Since the introduction of guano into this country, there never was a period when the imports of that article had fallen off to such an extent as they did last year. This arose not from any real deficiency in the stock at Peru, *but from the monopoly of the merchants*, who had the whole of the guano trade in their own hands, and *who kept the supply short in order to obtain higher prices.*"

I therefore call upon you, as men of spirit, to resist this intolerable monopoly in the most effectual manner by instructing your Managers to avail themselves to the

utmost of our local resources for manures; and, if necessary, by the importation of artificial substances for that purpose.

I take the liberty of calling your attention to the extracts from the writings of Professor Johnston and Mr. Nesbit, on the Adulteration of Guano, as well as to my own remarks on Manure Companies. It is high time that we should assume the defensive in this matter, and show to the world that we are capable of carrying out with practical effect a chemical analysis. The necessary apparatus is very simple and inexpensive; and you know that there are among us many gentlemen competent to undertake the task. Moral courage alone is wanting; and I trust that your Society will take this subject into consideration, with a view of bringing it before the Council of the General Agricultural Body without loss of time.

There is another question of not less serious importance, which I desire, through yourselves, to submit to the good sense of the proprietors of Barbados generally. It relates to the *education* of young lads intended for the business of Planters, who at present enter upon their calling with scarcely more school-learning, (as it is called) than just enables them to write their name, and to read after some halting fashion of their own. Surely it would be of advantage to us all, if a school, somewhat superior to the parish-school, were established, where these lads might be perfected in reading, writing, and arithmetic, with such elements of general knowledge as would naturally introduce them to the

duties which are destined, probably, to fill up the measure of their whole life?

I have no idea whatever of the scope of the operations of the Reid School of Chemistry; but of one thing I am sure, that this simple proposition of mine is not likely to interfere with the objects of that Institution. If, therefore, the suggestion should find so much favour with you, as to induce you, at some future time, to call upon me, for a more definite exposition of my views on the subject, I shall be ready to comply with the invitation.

And now I bid you heartily farewell. I can never forget that among the members of your Society, I count some of my oldest and most valued friends: and be assured that I preserve a grateful recollection of your personal kindness towards me on all occasions.

With sincere wishes for your happiness and prosperity,

Dear Mr. Chairman and Gentlemen,

I subscribe myself,

Yours faithfully,

ROBERT REECE.

11, *Oxford Parade, Cheltenham,*
May, 1857.

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[*The Reader is requested to correct for himself the following errors of press, page* 4, 9 *lines from bottom,* "emyloyer" *for* "employer;" *at foot-note, page* 24, "Catode" *for* "Cato de;" *and in some copies, at page* 155, 2 *lines from the bottom,* "coerntbalance," *for* "counter-balance."]

HINTS

TO

YOUNG BARBADOS PLANTERS.

I HAVE diligently examined the works of the best writers on Agriculture and Agricultural Chemistry, with a view of collecting for the benefit of those whom it concerns, such information on pure questions of Science as seemed best calculated to illustrate our system of cultivation in Barbados. The principal authorities to whom I have rcferred, are Jethro Tull, Sir Humphry Davy, Professors Liebig, Von Thaer, Johnston, Way, Voelcker, Stöckhardt, Mr. Cuthbert Johnson, Mr. Morton, Mr. Nesbit, and Mr. Horsley. I have also read with care the volumes on British Husbandry published under the superintendence of the Society for the diffusion of Useful Knowledge; various Essays in the Journals of the Royal Agricultural Society of England, Mr. Mechi's letters on Agricultural improvement, and pamphlets without end, by the Rev. Mr. Huxtable, Mr. Squarey, Mr. McDougall, and others; and lastly the Jamaica Prize Essays, and the Patent-office Journals. I set down, in full, this array of respectable names, to show that I have spared no labour in striving to make mysclf master of my subject; but with all respect for the learned Professors, I fear I must deal out a sort of sum-

mary criticism on their books in the aggregate, in the words of quaint old Burton, who remarks that, "as apothecaries, we make new mixtures every day, pour out of one vessel into another: we weave the same web still, twist the same rope again and again."

A few passages, also, from Roman writers on Agriculture, are inserted, not only on account of the intrinsic good sense they contain, but to prove that the laws for the management of land and cattle, and for the moral government of Estates, were the same from the beginning. The original Latin will be found in foot-notes, for the gratification of my literary friends at Barbados, who may not have the Originals at hand.*

A great book is a great evil, especially to the uninitiated; and to be able to read with advantage is an art of itself. In the case of those whose daily occupations leave but little time for reading, it is of all things the most perplexing to gather, out of scientific works, the information suited to their wants and circumstances, more particularly if the subject be treated by a course of argumentation which demands the close application of the reasoning faculties. When I have observed the bulky volumes of Von Thaer, and other giants, on the shelves of an illiterate English Farmer, I have been irresistibly reminded of the story of the silly old gentleman, who bought at a great price a Punch-and-Judy for his private amusement, but was astonished to find that the puppets would not act of themselves.

I desire, then, at the outset, to state as a proposition which I am prepared to maintain against all comers, that, except in the matter of "wide planting," we

* Scriptores Rei Rusticæ veteres Latini.—Biponti. 1787.

have not made any advance on the system of cultivation pursued by the old planters of Barbados. Nay, I will go further, and affirm, that not only are we not in advance, but that we have gone back considerably in the main principles of good management. Of course, the hardiest among those who take the opposite view, will not venture to claim any credit to themselves for the introduction of guano and other artificial manures. But to proceed. The distinguishing characteristic of the old system appears to have been to promote the fullest development of the resources of an Estate, in producing our staple crop; and the most abundant supply of food for the labourers and for the stock. It was positively a disgrace to be forced to go to your neighbours to purchase either the one or the other. Each Estate was considered to possess ample resources within itself; and it was the manager's business to draw out and develope those resources to the utmost. A sufficient amount of manure was made for the cane-preparations, when guano was not thought of: and our oxen were strong to labour without the aid of oil-cake. Let it not, however, be thought that I undervalue these substances: I appreciate the legitimate use of them: only I regard them as adjuncts, and not as essentials.

I may here be reminded, that the cane cultivation of Barbados is extended, in instances, respectively, one-third; one-half; double: but be pleased to note that the calculation is affected by the fact that whereas the old lining was four feet square, equal to 2722 holes per acre,—our modern lining varies in width 4 × 6, 6 × 6, 6 × 8, 8 × 8, and is even wider. This is easily reduced to figures. Every manager knows, or ought to know, the exact number of cane-holes per acre according to his

own particular lining; and he can readily strike the difference between this number and the 2722 of the old 4 × 4.

To make a plain thing still plainer; thirty acres lined four feet square, at 2722 holes per acre, gives 81,660 as the total. Sixty acres lined six feet square, at 1210 holes per acre, gives 72,600.

Besides it was the rule, twenty-five years ago, to apply to each cane-hole a basket of stake-manure weighing from sixty to seventy-five pounds.—In modern days, (with certain exceptions) a manager makes a brag of giving half that quantity to a cane-hole; and it is a rare thing indeed, if with even this diminished proportion, he can find manure for half his preparations. Is it that our resources for making manure are less than of old? Take the amount of the cane-tops, the cane-trash, and the megass-ashes of each hole of matured canes, the green crops of corn-meat, the potato slips, the tons upon tons of sour grass and wild bushes that may be obtained throughout the year; and say whether an honest manager might not raise manure sufficient to give a poor half basket to each hole of canes throughout the Estate. I use the term "honest manager" advisedly, for if he be an honest man, he is careful of the interests of his emyloyer: whereas, if those interests are allowed to suffer from want of attention, he is unfaithful to his trust, and to all intents and purposes dishonest, as much as if he made a false entry in the day-book.

Well then, to land which had received a certain proportion of crude farm-manure, I would not deny a dressing of guano. Knowing that the corn-meat must be removed from the land in time to complete the cane-

preparations, I would not deny oil-cake to sustain the poor beasts, throughout a period extending from the middle of October to the middle of January, during which they are necessarily engaged day by day with the grubber, and in carting the home-manure into the fields. Is this unreasonable? But I protest against the almost universal practice among our planters, of sinking the profits of an Estate in oats, oil-meal, and guano. There are those who know to their own cost that I am writing literal truth.

To expose the reckless extravagance of the modern system of management, I need only refer to a certain schedule of the expenses of an Estate capable of yielding one hundred hogsheads of sugar, which was prepared by two separate committees of practical planters, in 1846, and published under the sanction of the General Agricultural Society of Barbados.

These two committees, working independently of each other in their respective localities, were permitted access to the day-books of well-conducted (as the phrase is) estates; St. Thomas' Parish, and the Leeward District being the scene of their operations: and the sum of their calculations came within reach of each other by a few dollars: that is, the legitimate working expenses of an Estate capable of making one hundred hogsheads of sugar, are set down as being somewhat over six thousand dollars.

The St. Thomas' Committee presented the following items of expenditure in dollars on an average of ten years.

	Dollars.
Cultivation	3,000
Manager's Salary	480
Carried over	3,480

	Dollars.
Brought forward	3,480
Book-keeper's Salary	96
Apprentice	32
Accountant	64

WORKMEN'S ACCOUNTS.

Coppersmith	100
Blacksmith	60
Plumber	30
Mill-wright	50
Wheelwright	60
Carpenter	60
Mason	30
100 Hogsheads, including Cooperage and Materials	400
Lumber, *i. e.*, Plank and Boards	200
Oats, Oil-meal, and Provision	200
Foreign Manures	500
Freight of Produce to Shipping Port	150
Taxes and Export Duties	150
Loss upon Stock	300
Wear and tear of Machinery	650
	6,612

The calculation exhibited by the Leeward District Committee exceeded the above by sixty dollars.*

A system like this satirizes and refutes itself.

And yet how many families feel the bitter effects of it in the privations which they are called to bear in secret! And for what? That ignorance and indolence may escape detection in the issue of full crops which scarcely defray the cost of production.

I point at no man individually: I only reprobate with my utmost power of language the defects of a

* The members of the Leeward District Agricultural Society issued a strong protest against this reckless expenditure.

system which now seems to find favour among so many of my countrymen.

It is clear that the expenses of an Estate are first to be considered, because they must be paid before the owner can derive the slightest benefit from his investment. The affair, you see, wears two different and distinct aspects: that which it assumes in Barbados, and is open to all men; and that which is presented to the Proprietor and his family, in another quarter, and is likely to be concealed. I will grant that the Estate is kept in high order, in regard to the cultivation of the land and condition of the stock, and that even a crop, ample in number of hogsheads, is reaped from it. That is all that Barbados knows of the matter. The rest is known only to the local Accountant, the Merchant, and the unfortunate Proprietor. Never mind the amount of expenditure; how inferior the sugar, or how little it may realise in the home markets: this seldom or never comes before the public eye. The Manager keeps the secret, for his own sake, and is free to boast of his apparent success, without any chance of being contradicted: the Accountant is, by virtue of his profession, bound to secresy; while the complaints of the Proprietor are out of earshot. This is the plain truth.

I have said that the real state of the case is known to the Merchant also. And here let me remark, as an encouragement to every aspiring young planter throughout the island, that our Merchants at home are accustomed to enquire into the character of the Managers of the Estates, the produce of which is consigned to their care, and that the reputation of each takes rank accordingly. The whole result is before them. The

Bills of Exchange; the Sugar: the proportion of the former in relation to the total crop, and the quality of the latter. Nor can it be otherwise. There lies the sample upon the sale-board: be it good, or bad, the enquiry naturally arises: "Who is the Manager?" "Who boiled it?" And so the ability of the several managers comes to be discussed in public conversation.

I hold by the old Planters, then, because their system was self-supporting, or nearly so. Our tillage is not better than was theirs: our stock are not better cared for. Take the Island generally, we do not prepare half the amount of manure that they did: and most certainly we are not better sugar-boilers. I say nothing of their constant and anxious cares on account of food for the people: the main test of the ability of the manager of the olden time.

Now, our fields are all free to us for the cultivation of the cane. We take no thought about planting corn or roots, as provision for the labourers; and the one care that remains to us is to provide food for the cattle and mules. Even with these odds in our favour, our planters cannot succeed in raising heavy crops of our great Staple without the copious use of artificial manures, oil-cake, and oats. Deprive them of these, and what would become of the vaunted superiority of Barbados-agriculture?

I have already said that I do not deny myself the advantage to be derived from the judicious use of these substances: it is the abuse of them that I am arguing against.

Besides, this continuous cropping may be, after all, injurious to the land. True, it has succeeded hitherto, owing to the inordinate amount of guano and other

artificial manures which are applied at all stages of the growth of the cane. But let that pass.

You do not need to be told now, for the first time, that a small portion of land, well cultivated, will yield a more profitable return than a larger portion, imperfectly cultivated. It was a maxim among the ancients to sow less and plough better.

There is a story of one Paridius, who had two daughters and a vineyard. At the marriage of the first daughter, he gave up one-third of it as her dowry; nevertheless, his vineyard yielded the same return as before. At the marriage of the second daughter, he gave to her the half of what remained to him; still there was no diminution in his crop. "How, then," says Columella, from whom the story is taken, "is this fact to be explained? In no other way than by supposing that the third part which remained to the father was better cultivated than the whole had been before."*

One of the most remarkable modern instances of high cultivation is to be found in the history of the Rev. Mr. Huxtable's farm near Shaftesbury. This farm is about ninety-five acres; and when he took it, was a dairy farm with only ten acres arable, feeding fourteen cows, growing forty-eight bushels of wheat, forty of beans, and employing three or four hands. It now produces SIXTEEN HUNDRED bushels of wheat

* Quoted by Columella from Græcinus, who relates the story.—"Paridium quendam Veterensem vicinum suum duas filias, et vineis consitum habuisse fundum; cujus partem tertiam nubenti majori filiæ dedisse in dotem, ac nihilominus æque magnos fructus ex duabus partibus ejusdem fundi percipere solitum. Minorem deinde filiam nuptui collocasse in dimidia parte reliqui agri: nec sic ex pristino reditu detraxisse. Quo quid conjicit? Nisi melius scilicet postea cultam esse tertiam illam fundi partem quam antea universam."—Lib. 4, cap iii.

yearly, fattens FORTY head of cattle, including calves, ONE HUNDRED sheep, and EIGHTY hogs:—and gives work to twelve labourers all the year round. Mr. Huxtable's farm thus produces five times as much wheat as the usual average, and yet has increased in richness so much that he has a superfluity of manure. If men would be content to take no more land than they can afford to work properly, they would have less anxiety and more profit, and the land and the country would advance in produce and prosperity. If the soil be half-starved and half-tilled, the farmer who entered with little will come out worth less; and as to the article of labour, Mr. Huxtable's object was not how much labour he could save, but, how much labour he could employ with advantage.

In preparing this Manual for your instruction, I have not been influenced by the vanity of authorship. Nothing would have been more easy than to take the words of others, clothe them in my own phrase, and exhibit them to you as the production of my own brain. When a fact of science is to be inculcated, I would rather make use of the authority of the Professors of Science themselves. I hate second-hand authorities in all questions where the object is to attain information; and there is always present to my mind the enquiry of the imps in Macbeth: "Wouldst thou rather hear these things from our mouths, or from our Masters?"

I purpose, then, to arrange, under separate heads, extracts from the best books on Agriculture and Agricultural Chemistry. I have no particular discovery of my own to announce. My object is, simply, to place in the most lucid order, established truths, for the guid-

anee of inexperienced young planters. To them I would especially address myself, as it were, face to face, and tell them, once for all, that upon their own individual character and conduct depends the success of the Estate under their care. Rules and regulations for the government of Estates, however good in themselves, come to nothing unless administered by a careful and conscientious manager. Let a young man believe in his work; throw his whole mind into his work; and his work is already half done. Earnestness is the secret of success. There must be that fire and spirit in you which will communicate itself to those under your control. Every man's temper of mind is known to his subordinates; and they are influenced accordingly. "Like master, like man," is true to the uttermost: and be sure, that as your own energy and determination of mind, so will be the disposition to act and to obey on the part of the labourer. Be temperate and even courteous in your words; but steadfast to enforce obedience to the letter. Respect yourself, and you will be respected. To talk of the negro character as though it were something peculiar, monstrous, and out of the pale of those rules which apply to the rest of mankind, is too absurd to be refuted. It is sheer folly and nonsense. The negro character is human character. The character of the labouring population is the same all over the world. To exact the greatest amount of wages for the smallest amount of work, and to seek to secure privileges out of all reason, is the characteristic, so we think, of all whose lot it is to labour. Therefore let all your dealings with the people be based upon high principles of justice. Never break your word with them: never fall off from your bargain: and, above all things, try to regard them

as moral and accountable beings, for whose improvement and welfare you are responsible.

You must encourage, by rewards, those who are entrusted with authority, and you must be careful to accord them certain privileges. To lead these Superintendents to feel an interest in the duties of their office, you must show that you hold them in estimation; and you must also consult with some of the superior workmen concerning the work that is to be done: when they are thus treated, they think their occupation more respectable, and that they are held in esteem by him who is appointed to preside over them. They work more willingly by liberal treatment, and by the grant of any special concession in their favor, as the permission to feed some of their own stock on the lands of the Estate, or such like.*

Porcius Cato, in his work on Agriculture, devotes a special chapter to the exposition of the duties of the Manager of an Estate; and as his injunctions are wise and homely, I translate certain paragraphs for your edification.

Let not the manager be a gadder. Let him always be sober. Let him keep away from entertainments. Let him find constant employment for the household. Let him be very strict in seeing what the Owner has directed, is done. . . . . Let him give credit to no one

* Præfectos alacriores faciundum præmiis: dandaque opera, ut habeant peculium. Ad injiciendum voluptatem his præfecturæ, honore aliquo habendi sunt, et de operariis, qui præstabunt aliqui, communicandum quoque cum iis, quæ facienda sunt opera, quod ita cum sit, minus se putant despici, atque aliquo numero haberi a domino. Studiosiores ad opus fieri liberalius tractando, concessioneve, ut peculiare aliquid in fundo pascere liceat, aut hujuscemodi rerum aliis, &c.—VARRO DE RE RUSTICA. Lib. 1, cap. xvii.

without orders. Let him be careful in exacting payment where the Owner has given credit. . . . Let him not buy anything unknown to the Owner; and let him not wish to conceal anything from the Owner. Let him not have any hanger-on. Let him be the first to rise, the last to go to bed. Let him first see that the beasts have provender. Let him have the oxen looked after with the greatest diligence. Let him keep on good terms with the herdsmen, and as one motive for this, to induce them to take care of the oxen with a better will. . . . Let the cattle and oxen be well littered: let their hoofs be attended to. . . . Do every part of your work betimes; for the nature of agriculture is such, that if you are behind hand in one thing, you will be behind hand in all.*

Mediocrity is a pitiful standard. There is a lifelessness of purpose about some men, quite opposed to that energy of action, which I have so strongly urged you to cherish. Tameness of character keeps a man throughout his career just where it found him. Let us reason together. There are sins of omission, as well as sins of commission; and a man renders himself equally amenable to reproof for having left undone those things which he ought to have done, as for having done those things which he ought not to have done. You do not

* Villicus ne sit ambulator, sobrius fiet semper, ad cœnam ne quo eat. Familiam exerceat: consideret, quæ dominus imperaverit, fiant. . . . Injussu Domini credat nemini. Quod dominus crediderit, exigat. . . . Ne quid emisse velit insciente domino, neu quid dominum celavisse velit. Parasitum ne quem habeat. . . . Primus cubitu surgat, postremus cubitum eat: prius videat uti jumenta pabulum habeant. Boves maxima diligentia curatos habeto. Bubulcis obsequitor, partim quo libentius curent. . . . Pecori et bubus diligenter substernatur; ungulæ curentur. . . . Opera omnia mature conficias face, nam res rustica sic est, si unam rem sero feceris, omnia opera sero facies.—CATO De RE RUSTICA, c. v.

forget, I am sure, the practical lesson of life taught in the Parable,—how that one man improved his trust to double the original amount, while another gave up his talent just as he had received it,—neither more nor less. There is a moral electricity in earnestness which operates like lightning upon every human being within the magic circle. An opportunity,—the opportunity upon which hangs the success of his whole life, occurs once to every man. Shakespeare, with that almost divine wisdom of his, says :

> "There is a tide in the affairs of men,
> Which, taken at the flood, leads on to fortune.
> Omitted, all the voyage of their life
> Is bound in shallows and in miseries."

In these words is contained the mournful history of many a man.

One of the most distinguished Planters that Barbados ever reared was often heard to declare, that he would "never employ an old Book-keeper." The meaning of this speech is obvious.

"It isn't my luck," and "I want a friend to bring me forward," are the cant and puling exclamations of indolent men, whose only consolation it is to rail against Fortune. There they drone on, lounging away the precious hours with easy self-complacency, looking for something to turn up for them. By and by, when they are hopelessly lowered to the degradation of despair, there is nothing left to them but to complain of the neglect of their imaginary qualifications, and to consider themselves aggrieved by the whole world in the battle of life. "Miserable comforters" all such reflections! as too many find to their cost.

Do not you like unto them. Work while in the morning of your life: work heartily. Try to get information from all sources within your reach: from books, from older and experienced Planters, by careful observation, by cautious experiments. Bend the whole force of your mind to attain a knowledge of your business. Guard the interests committed to your charge with scrupulous fidelity, being assured that in the honourable performance of your duty to another is contained its own reward.

It is scarcely necessary that I should impress upon you the importance of keeping your accounts with scrupulous accuracy; and with such clearness that they may be fit for inspection at any moment of time. You know as well as I do, that the very first act of default on your part, in this department of your duty, would be attended by the total destruction of your prospects as a man and as a planter. To an honest mind nothing so simple as accounts. File copies of your orders on the Town-agents: invoices of goods delivered: and if by accident a mistake should occur, either with yourself or the parties in town, let it be corrected instantly, while the memory of the transaction is warm with both. In the event of demur or delay, lose not an hour in communicating with the attorney or owner of the Estate. By this sort of conduct you will gain respect from all with whom you have dealings, and earn a good name for yourself.

Be careful to observe neatness, as well as regularity, in all things. This will inspire your subordinates with the like habits. In your field operations, especially, let this principle be apparent. You have heard it spoken as a cant term of reproach against such and such

a man, that he was a "head-row manager:" but you cannot, without the utmost confusion of mind, so understand my injunctions.

I advise you to exercise the strictest order and a trim neatness within the field, as well as at the outer rows. Let the ploughman be instructed to make straight furrows: let him be encouraged and rewarded for it; for a good ploughman is a valuable servant, and you yourself are not indifferent to the doctrine of rewards.

Let the liner do his office on the land, in order that the labourers may be assisted in digging the cane-holes with the utmost exactness. It should be the business of a careful person to keep the trenches and water-courses clear of obstructions by pulling up bushes, and removing stones.

Carry this principle of order with you throughout the buildings on the Estate. Examine frequently the state of the windows, doors, hinges and locks. You will not forget the old proverb which tells you of the advantage of a "stitch in time." If a shingle, or slate, or tile, is loose, do not put off till to-morrow what ought to be done to-day. For the sake of cleanliness, use the white-wash brush frequently: it will destroy vermin, too.

"Let the Manager," says Columella, "upon slack days inspect all the implements of husbandry, without which no work can be done: and frequently examine the iron tools: and let him always purchase duplicates; and, having repaired them from time to time, let him keep them safely, that so, if any of them be damaged while they are being in use, there may be no necessity to borrow of a neighbour: for there is more lost by

diverting the servants from their business, than the price of such things amounts to."*

Look into the condition of the carts with your own eyes; the rails, the boarding, the state of the wheels, that the tyers bind them tightly together; and, above all, see that the cart brasses work evenly. It makes all the difference to cattle whether the cart they are drawing be rightly and compactly put together, or whether it be uneven and dislocated. In the one case, the motion is smooth and easy: in the other, it proceeds with difficulty, by jerks and plunges. It is the carter's duty to place the empty carts, waggons, or cranks, on a straight line in the yard. Neatness in one thing, neatness in all; and, be assured, by these trifles is the character of the manager known, whether he be a man of order, or a sloven.

* Tum etiam per ferias instrumentum rusticum, sine quo nullum opus effici potest, recognoscat, et sæpius inspiciat ferramenta: eaque semper duplicia comparet, ac subinde refecta custodiat, ne si quod in opere vitiatum fuerit, á vicino petendum sit: quia plus in operis servorum avocandis quam in pretio rerum hujusmodi dependitur.—Col., Lib. 11, c. i.

THE BOOK-KEEPER.

In the effective performance of these duties, you will be assisted by the Book-keeper, whom it will be your duty, on all occasions, to instruct in the details of Estate-work. From him you must exact an almost mechanical obedience. It will be his office, at the earliest dawn of the morning, to overlook the yard, the buildings, and the cattle-pens, with the home-watchman, so that he may be able to report upon the safe keeping of each and all. He will accompany the superintendents to listen to your orders for the day's work. He will then receive the keys from you, to give out food for the stock, and whatever stores may be required. He will take the earliest moment to communicate with the field-watchmen, and hear from them their morning's report. After this, his services are supposed to be engaged according to your own special directions. No doubt each day will bring with it its proper work, the execution of which may be entrusted to his personal supervision. Otherwise, he will in turn visit the labourers at their work, the carpenters, masons, and coopers, and other workmen who may be employed on the Estate, at the time; so that, at breakfast-hour, he may be able to exhibit for your inspection a complete list of all such persons.

When the herd is driven home, he will examine the cattle, one by one, and satisfy himself that they have been cleaned. Later in the day, he will inspect the

field-work, and ascertain that the labourers have performed, each faithfully, his appointed task. This duty he will execute with the assistance of the chief superintendent, and settle the day's labour-book accordingly.

He will take care that the cattle are sent out to pasture at the hour fixed by yourself; and that they are again safely housed before dark. It will then be his duty to see them littered and fed.

After that, he will take the round of the buildings and the cattle-pens, accompanied by the home-watchman. He will then deliver up the keys into your hands, and make his final report.

It was a good custom, among the old planters, to pay some little kind compliment to the Book-keeper, on the occasion of his evening visit with the keys. He was invited to walk into the drawing-room, and partake of a cup of tea or other refreshment. The business of the Estate generally formed the subject of talk; and instructions were given for the next day's work. A little social converse of this sort was not without its good results upon the character of a young man.

A kind word, a kindly greeting, begat a kindly spirit of deference and respect towards the manager. The young especially, are open to such influences: and while the moral qualities of the subordinate were improved by such intercourse, the dignity of his superior was not impaired. Now, it is our wont to jumble cause with effect. The young men, forsooth, are vulgar and slovenly, and not worthy to be so treated. They are, indeed, degraded as a class. I regret the fact: but surely it is in our power to do something for their moral and social improvement. A young man cannot retire into utter loneliness: a companion he must have; some

one to whom he may speak a word: and being shut out from decent converse, what marvel is it that he lowers himself to the groom, and the groom's family and friends? This is bad for the young man, and bad for the people. I pray you to reform this state of things, by doing towards another, as you would yourself be done by.

"Would to Heaven many old things were still as they have been! It would certainly be far better, even in the farms of the country folks. I can recall from my childhood more than one picture of a venerable patriarch, who held the name of 'Yeoman' as a title of honour, worked among his people as their father, eat, rested, enjoyed himself, and prayed with them. The short span of a quarter of a century has produced great alterations. Now the master retreats with his family into his aristocratic parlour; and that this cessation of outward sociability, this evident separation into master and servant, great and small, this withdrawal from participation and family-life,—must result with the servants, in lessening the intimate sympathy with their employer and his interest, and relaxing their moral and religious principles,—who can entertain a doubt? Certainly, had not masters learned to care less for their men, it would not have happened, as one hears so often lamented, that men have learned to care *little* for their masters."*

* Professor Stöckhardt.

CATTLE.

Let us now begin the day with a few common-place hints about Cattle.

You are all early risers, I know. If there is work for the carts or the plough, as the case may be, see the oxen yoked, and despatched out of the yard under the care of the drivers, before you mount your horse for the field. Some carters have a cruel practice of tightening the bow round the neck of the larger beasts, to save themselves the trouble of boring a fresh gimlet-hole, higher up the head of the bow, wherein the peg is thrust which confines the trash-band. In seeing the cattle put under the yoke, then, observe that their necks work freely in the bows; for consider the torture which would otherwise await the poor animal throughout his term of labour.

In the course of your ride round the Estate, you will visit the pasture fields, and see that the herdsman and his assistants are busy in the duty of cleaning the cattle. You will appoint some person or persons to gather food and litter for them, to be brought to the sheds or pens later in the day.

It is the business of the drivers, as soon as their teams are released from the yoke, to deliver them to the chief herdsman, who will take them to water.

And now let us imagine it to be the first of June. Look upon the beasts: there they are, fat and sleek, notwithstanding their hard and constant work during the crop; and (to use a well-known phrase,) "you

KNOW THE REASON WHY." The cattle were worked, it is true: but they had plenty to eat. There lies the secret. Consequently, it is the manager's duty to stack up all the spare cane-tops during the crop, and to take advantage of the earliest showers to plant corn and wolly-pira for their provender during the ploughing season. But we know that the lands must be cleared of such things not later than the middle of October. Then oil-meal may come in, with sour-grass hay, which if moistened with salt, or molasses and water, will be not altogether unpalatable. At all events, it will carry the beasts through the season for grubbing and dunging, and until cane-tops make their appearance. "No food, no stock: no stock, no dung: no dung, no crop."

I recommend lumps of block-salt to be placed at convenient distances, under the sheds.

The calves and younger cattle demand constant attention, as they are supposed to furnish a recruit or two, each year, for the main herd of workers. Keeping this, their destination, in view, you will desire the Book-keeper to see that the very young ones have, each his portion of butter-milk, mixed with a mash of gruel, made from Indian corn meal.

The reason why Barbados cattle are stunted in size, is that they are denied, when very young, a sufficient amount of nourishment for the development of a larger frame. This is a fact: but whatever may be the diminutiveness of the native cattle, there is no doubt of their superior capability for work in our climate.

The care of calves and young cattle was another element in Estate-economy of the olden time. With the planters of that day, to buy cattle was the exception, not the rule. With the modern planters, the case is

just the reverse. To buy cattle is the rule; it being easier to purchase Porto-Rico beasts, than to give time, and pains, and care, year after year, for the raising of native calves; but wherever this principle is acted upon, I denounce the manager of that estate as an indolent, unworthy person.

TILLAGE.

Quid est agrum bene colere? Bene arare. Quid secundum? Arare. Tertio. Stercorare.*

"What is good cultivation?" says Cato. To plough. What next? To plough. And what next to that? To manure. To till the land thoroughly, therefore, should be the first care of the planter.

Jethro Tull lived and wrote in the reign of Queen Anne. He was the originator of what is termed "horse-hoeing husbandry," and his injunctions on the subject of tillage are very peremptory. Tillage with him means "pulverization;" by which, what he calls "the artificial pasture of plants" is made and increased to an indefinite extent.

Hear what the old master himself says on this all-important point.

"The first and second ploughings, with common ploughs, scarcely deserve the name of tillage: they rather serve to prepare the land for tillage.

"The third, fourth, and every subsequent ploughing may be of more benefit, and less expense, than any of the preceding ones. For, the finer land is made by tillage, the richer will it become, and the more plants will it maintain.

"It is of late fully proved, by the experience of many farmers, that two or three additional ploughings will supply the place of dung."

* Catode re rustica. Cap. lxi.

And then he quotes, from Evelyn, a curious passage in confirmation of his favourite theory.

"Take of the most barren earth you can find, pulverise it well, and expose it abroad for a year: incessantly agitated, (that is, stirred often,) it will become so fertile as to receive an exotic plant from the furthest Indics, and to cause all vegetables to prosper in the most exalted degree, and to bear their fruit as kindly with us as in their natural climates."

And, again:—

"I have had the experience of a multitude of instances, which confirm it so far, that I am in no doubt that any soil (be it rich or poor) can ever be made too fine for tillage."

Mr. Nesbit says:—

"Manure comes from the air on the one side, and the earth on the other; and a proper working of the land, and a proper exposure of it to the air, will often be as effectual as an actual dressing of visible manure; because the invisible active ingredients of the air are absorbed by the soil to be made use of by the plant."

"Other benefits, again, attend upon the ordinary ploughings, hoeings, and working of the land. Its parts are minutely divided: the air gets access to every particle; it is rendered lighter, more open, and more permeable to the roots. The vegetable matter it contains decomposes more rapidly, by a constant turning of the soil; so that wherever the fibres of the roots penetrate, they find organic food provided for

them, and an abundant supply of the oxygen of the atmosphere to aid in preparing it.

"The produetion of ammonia, and of nitrie aeid also, and the absorption of these, and of watery vapour from the air, take plaee to a greater extent, the finer the soil is pulverised, and the more it has been exposed to the aetion of the atmosphere. All soils eontain, likewise, an admixture of fragments of those minerals of whieh the granitie and trap-roeks are eomposed, whieh, by their deeay, yield new supplies of inorganie food to the growing plant. The more frequently they are exposed to the air, the more rapidly do these fragments erumble away and deeompose. The general advantage, indeed, to be derived from the eonstant working of the soil, may be inferred from the faet, that Tull reaped twelve suceessive erops of wheat from the same land, by the repeated use of the plough and the horse-hoe. There are few soils so stubborn as not to show themselves grateful in proportion to the amount of this kind of labour that may be bestowed upon them.

"It is ehiefly beeause the spade or the fork divides and separates the soil more eompletely, or to a greater depth, that larger erops have been obtained, in many distriets, by the introduction of spade-husbandry than by the ordinary mode of eulture with the plough.

"But all these benefits whieh a thorough working of the soil is fitted to eonfer, are only fully realised where the land is naturally dry, or, by artifieial drainage, has been freed from superfluous water."*

* Professor Johnston.

"I do not know whether you are aware of the composition of the atmosphere. The atmosphere is a great source of one of the forms of manure. Nitrogen exists in the form of ammonia, for example, as you detect it in your stables: it is also found in the form of nitric acid, as in nitrate of soda. Now, not only do soils absorb ammonia and also nitric acid from the air, but the air itself, by means of rain, gives, every year, to an acre of soil, a quantity of ammonia and nitric acid which would astonish you. It has been proved, by some very recent experiments, made by Barrall, a learned French chemist, that rain-water contains a quantity of nitric acid and ammonia which I have estimated to be equal to a dressing of two hundred weight of Peruvian guano per acre. If your land, therefore, is not drained, the splendid manures which descend in the rain, to the extent of which I have spoken, will run off on the surface; and, not entering the ground, will not yield more than one-third or one-fourth of their proper value, in your crops."*

"We have already seen that nitric acid, and probably ammonia, are produced in the air by the agency of electricity, and are brought down by the rains. There are continually rising into it, also, vapours and exhalations of various kinds from the earth's surface. The sea sends up a portion of its common salt, and other constituents; and the land, the numberless forms of volatile matter which arise from decaying animal and vegetable substances. As the ocean

* Nesbit.

receives all that water can carry into it, so the atmosphere receives everything that the air can bear up.

"And lest these ever-rising exhalations should contaminate the air, and render it unfit for the breathing of animals, the rains, as they descend, dissolve, wash out, and bring them back again to the soil. Thus they purify at once the atmosphere through which they fall, and bear refreshment, to the land, and the means of fertility, wherever they come."*

Sir Humphry Davy tells us that "the power of the soil to absorb water by cohesive attraction, depends, in a great measure, on the state of division of its parts; the more divided they are, the greater is the absorbent power."

In Mr. Colman's book on "Continental Agriculture," we are told that the prime characteristic of Flemish husbandry is deep cultivation, which is accomplished, in some cases, by the plough; in others, by the spade; and sometimes, conjointly by both. The practice of the Flemish Farmers is to trench the land to the depth of twenty inches or more: the land for grain being laid out in *stitches*, six or seven feet wide: in the intervals, a deep trench or ditch is dug, say of a foot in width. The next year, in cultivating the same field, a foot in width will be taken from the side of each stitch, and thrown into the ditch or open space; thus widening, of course, the next bed, to the extent to which it is cut off from the other: filling up the trench of the preceding

* Professor Johnston.

year, and forming a new trench. This is repeated year after year, until, according to the width of the stitch or bed, the whole ground is gone over to the depth of a double spading. At the same time, as the successive crops have followed each other, the ground has been improved by manure, until a fine, rich, and mellow bed of soil is formed. The object of this mode of breaking the land is to get a deep, friable soil, well enriched by dung, and, as far as possible, equally enriched throughout. This is done with great painstaking, and the whole resembles the most beautiful garden-cultivation. Even where it is ploughed, the trenches at the sides of the field, and between the beds, are cleaned out by a spade: that which is taken out is laid carefully upon the beds; and the entire process is executed with a neatness and exactness the most particular, and perfectly delightful to the eye.

I have witnessed tillage conducted on this plan, in our valley-fields, in St. George's Parish, and I am sure that the results were quite satisfactory. It is, you will observe, a sort of flat-cultivation; a system which was ably advocated some years ago by Mr. Greaves, in a communication addressed to the St. Philip's District Agricultural Society, of which he was, at that time, President.

Trenching, sub-soiling, and every kind of deep tilth, is in effect a mixing of earth: a practice which has been oftentimes substituted with success for dung. Thus marl, which, of itself, may be considered unfavourable to vegetation, is found to act, in combination with certain soils, as excellent manure: and a surface of strong, loamy clay, with the addition of sand, may be rendered an advantageous medium for the support of

vegetable life. The Egyptians were early acquainted with the benefits of this practice; and were accustomed to strew sand upon the lands, which the sediment deposited by the inundations of the Nile had made adhesive to excess. Sea-sand is, of course, the best for this purpose; and when applied in judicious proportion, will promote putrefactive fermentation, on account of the salt with which it is combined. The mechanical action of sand is to promote disintegration of the soil.

I have observed the following mode of cultivating non-rattooning land to be efficacious. Given a lining at six feet square: stock up the old cane-stump: rake into the cavity all the loose trash within reach, lightly covering the whole with the fine soil. Then drive a Ransome-plough right across the intervening space; dig the new cane-hole in the fresh unbroken ground, deep and wide; and, after a time, work the light American mule plough lengthways; that is, through the line of the old canes previously bedded.

Next in order to Tillage, is DRAINAGE.

DRAINAGE.

On this subject, every young planter may obtain for himself the very best information by inspecting the operations lately carried into effect in Carrington's Valley, under the personal direction of the spirited proprietor himself, a gentleman whose ability and experience on all matters of practical agriculture, are, unquestionably, of the highest stamp. But, whatever may be the issue of his experiments, in regard to draining by tiles, nevertheless it will be always your duty to make your SURFACE-DRAINAGE as perfect as circumstances will permit; for you cannot but be aware of the almost overwhelming force of our tropical rains. I, therefore, bid you particularly to attend to the condition of the "sucks," in the Estate under your management; deepening them, and keeping them clear from obstructions of any kind, by surrounding the main aperture with dry stone walls. You have witnessed the destruction of canes in all stages of growth, from being drowned by the water, which was allowed to lodge in the "bottoms." You must also know that these "bottoms" would produce the very largest and finest canes if they were thoroughly drained: consequently, they are well worth all the pains you may be able to bestow upon them.

My own loss in this particular is always considerable: but it was very serious indeed during the year 1855, a year of floods and torrents.

Again, not only is a portion of the crop of canes lost in these "bottoms," but you must bear in mind the extra expense of planting them over and over again throughout the earlier part of the year: planting, however, against hope, doomed to end, at the eleventh hour, in the somewhat impotent conclusion of ochroes and pumpkins.

On this subject, Mr. Nesbit observes:—

"It is a *sine quâ non*, that the soil shall be either naturally sufficiently porous for the water to descend and the air to enter: or that it shall be brought into that state artificially: that is, by proper draining. Whatever I may have to say, therefore, with respect to the application of manures in general, has no reference whatever to undrained land; but applies to land which is in such a state of porosity that air and water can enter so as to have their decided, proper action upon the soil."

IMPLEMENTS OF TILLAGE.

The most potent among these is without doubt, Ransome's Y. C. P. plough, fitted with mould-board, marked Y. L., beam, handles, and frame wrought iron, and steeled share.

A similar plough, with a double mould-board marked Y. M. T. would be useful for cutting trenches.

The American sub-soil plough, and others of a lighter description, are very valuable for our purposes.

The "grubber" is made to order in Barbados, and is the planter's most staunch ally. It is well to have a heavy and a light one on each Estate: the latter, with three teeth, can be easily worked by mules; that is, after the land has undergone preparatory tillage.

The fork is an instrument as yet unknown to us: but, as I greatly desire to introduce it to the notice of our planters, let me request your attention to the following statement.

Mr. Cuthbert Johnson, in a paper on Fork-Husbandry, in the *Quarterly Journal of Agriculture*, says, "When the soil is artificially deepened, by fork or spade trenching, or with the subsoil plough, the substratum is made porous to a much greater depth. The rain gradually sinks down to the whole depth of the porous substratum, and from thence to the furrow drains; and in time of great drought, the deep-moved ground will hold, by capillary attraction, a much greater supply of moisture for the nourishment of plants; so that

thoroughly deepening and loosening the soil, not only assists the escape of superabundant water during heavy rains, but it affords additional means of supplying healthy vegetation with moisture at those times when it is most needed.

"I have recently witnessed some rather extended operations in the introduction of the fork-husbandry into farms of considerable extent, to which the farmer's attention can hardly be directed without benefit: and in this I do not allude to what is only practicable on a small scale, the exclusive fork-husbandry; but to the use of the fork in conjunction with the plough. Some of these experiments have been carried on, for the last five years, by Mr. James Beadel, a very intelligent and excellent farmer and land-agent, of Witham, in Essex, on a farm of about 120 acres, whose soil is light, resting upon gravel."

He observes, in a recent obliging communication:—"I have annually dug from three to five acres for the five years. The soil I have operated upon is light, with a substratum of gravel, sand, and tender loam. I always dig under the furrow left by the plough, which adds one ploughing to the expense. The influence of forking, on the crops, seems to be that all root-crops are much increased in quantity; the cereal crops which follow, less injured by drought; and the land becomes much more free from annual weeds, as well as from those which are of a more permanent nature. I had recently a person with me who has made a series of very carefully-conducted experiments, in which digging has been contrasted with ploughing. He tells me that he thinks the produce of the forked land was nearly double that of the ploughed."

And when alluding to the comparative advantages of the spade and the fork, Mr. Beadel adds:

"1st. A man can dig a greater quantity of land in a given time with the fork than he can with the spade.

"My experience proves one-sixth, and it strikes me it must be so; because the chisel-pointed ends of a three-pronged fork can be more easily pushed into a hard subsoil than the continuous end of a spade. 2dly, It does not bring up so much of the subsoil as the spade, but mixes the earth more; a great portion slipping through between the prongs. 3dly, The bottom is left more uneven, and broken by the fork; which I consider a great advantage. One great objection to the plough is, I think, the smooth, glazed surface which it leaves below, and which, in many cases, I fancy, presents too great a resistance to the delicate fibres of the plant. If, too, it is correct, that in most instances, the present surface of the soil is nothing more than a portion of the subsoil improved by cultivation, it must be right to increase the quantum of corn-growing earth by subjecting more subsoil to the same operation."

The attempt thus described by Mr. Beadel (and it is a successful effort too,) is one which was, with equal success, and on a still bolder scale, attempted in Norfolk, by Mr. Mitchell; an effort which the late Dr. Yelloly reported to the British Association. That portion of his remarks which alludes to the results obtained I will give in this paper, since it answers, very completely, certain practical questions as to the working of the fork husbandry, which are sure to be proposed by those who have not seen the working of the system.

The farm of Wattlefield, in the parish of Wymondham, where the fork-husbandry on a bold scale was

first introduced, some time previous to 1837, by Mr. Mitchell,* consists of about 317 acres, of which 207 are arable, and 110 in pastures and plantations. The digging was at first carried on with the spade; but this was speedily exchanged for a strong three-pronged fork, of fourteen inches deep, and seven inches and a half wide, which is found to be more manageable and less expensive than the spade. The fork costs 4*s.* 6*d.* instead of 6*s.* 6*d.*, weighing eight pounds; and, when worked down, could be relaid at a trifling expense.

The digging is effected by taking in about four inches of earth, at a time; pressing perpendicularly, and getting to a proper depth at two thrusts. The earth, however, is not turned out of the trench to a greater depth than ten inches, although the fork may get down as far as thirteen or fourteen; but that which remains at the bottom, in the state of what is called "crumbs," answers the purpose, equally with the earth which is thrown out, of forming a permeable medium for the roots of the plant which is to grow in it. The men prefer working together, in order that their labour may be, as nearly as possible, on the same description of soil; but each takes in about nine feet in width, so that his work can be easily measured. The plan is, to have a breathing about every half-hour; and the men never work more than the regular ten hours per day. Digging is, however, more laborious than the other operations of agriculture; though it is much less so with the use of the fork, than when the spade is employed. The labourers work the land in ridges of about nine feet in width; and the

* I lately visited the farm of Wattlefield, where I had the pleasure of meeting the intelligent proprietor Mr. Mitchell, whose kind courtesy on that occasion I desire to acknowledge.

furrows dividing them are sometimes made, by the plough, previously to digging; and sometimes, by the management of the labourers. The men receive, for the ordinary digging, twopence per rod of thirty square yards.

Professor Johnston has remarked of subsoil-ploughing, that the benefits to be derived do not cease with the first crop. In one case, he says, where an accurate account of the produce was kept, good results were apparent for five successive years after the operation: but he adds, "*The use of the fork* instead of the subsoil plough, has lately been recommended as a more efficient, and even a more economical method of opening up the under soil. I have seen it in operation; and it certainly does appear to loosen and open up the under soil more effectually than the subsoil-plough can do, and to a depth which few subsoil-ploughs are yet able to reach."

PRELIMINARY EXTRACT FROM JOHNSTON'S CATECHISM OF AGRICULTURAL CHEMISTRY.

What is the object of the farmer in cultivating the soil?

To raise the largest crops at the smallest cost, and with the least injury to the land.

What do you mean by injuring the land?

A farmer injures the land when he treats it in such a way as to cause it to produce smaller crops than it used to do.

May soil which is naturally fertile be rendered barren by continued cropping?

If the *same kind* of cropping be carried on for a long time without a proper addition of manure, the land will gradually become less and less productive.

Give me an example.

If the same field be cropped year after year with wheat, oats, barley, Indian corn; or with hay, tobacco, cotton, the sugar cane, or any other single crop, it will, at last, become unable to grow it.

Why is this?

Because all crops draw certain substances from the soil in such abundance, that, after a number of years, the soil cannot furnish these substances in sufficient quantity to the growing crop.

How would you remedy such special exhaustion?

By returning to the soil the particular substances any crops had taken out.

But with any kind of cropping, may not a fertile soil be at length made unproductive?

Yes; if the crops are carried off the land, and what they draw from the soil is not restored to it.

How is this explained?

Every crop takes away from the soil a certain quantity of those substances which all plants require. If you are always taking out of a purse, it will at last become empty.

Then you liken an exhausted land to an empty purse?

Yes. The Farmer takes his money out of the land in the form of crops: and if he is always taking out, and putting nothing in, it must at last become empty or exhausted.

But if he puts something into the soil now and then, he may continue to crop without exhausting it?

Yes. If he puts in the *proper substances, in the proper quantities, and at the proper times,* he may keep up the fertility of his land, perhaps for ever.

How much of everything must a farmer put into his land to keep it in its proper condition?

He must put in at least as much as he takes out.

To make his land better, how much must he put in?

He must put in more than he takes out.

But if he is to put into the land as much or more than he takes out, where is his profit to come from?

His profit consists in this, that he takes off the land what he can sell for much money: and he puts in what he can buy for comparatively little money.

What do you call the substances which the skilful farmer thus puts into his land?

They are called MANURES: and when putting them in, the farmer is said to manure his soil.

What substances are to be considered as manures?

Anything that furnishes food to plants may be called a manure.

What do you understand by farm or fold-yard manure?

The mixed straw and droppings of animals, which collect in fold-yards, or stables, where cattle are kept.

What do you understand by portable manures?

Such as are of small bulk or weight compared with fold-yard manure, and can easily be transported to great distances, as guano, bones, rape-dust, phosphate of lime, nitrate of soda, and many others.

How many principal kinds of manure are there?

Three: vegetable manures, animal manures, and mineral manures.

What do you mean by vegetable manures?

By vegetable manures, I mean those parts of plants which are usually buried in the soil for the purpose of making it more productive.

What do you mean by the term animal manures?

Night soil, and the dung of horses, cows, pigs, sheep, or birds.

Name the most important mineral and saline manures.

Phosphate of lime, nitrate of soda, sulphate of soda, sulphate of magnesia, sulphate of ammonia, common salt, wood-ashes, megass-ashes, soot, and lime.

VEGETABLE MANURES.

Manuring with vegetable substances, or, as it is otherwise called "green-manuring," has ever been reckoned among the most potent agents for enriching the soil. This practice is of great antiquity, and Varro, Columella, and other Roman writers refer to it as a recognised principle in farming. The former of these writers, whose treatise on agriculture was composed towards the close of a long life of experience, speaks with great distinctness on the subject. "Some things are likewise to be planted," he remarks, "not so much for immediate and present profit, as with a view to the benefit of after-crops; because, being cut down and left on the land, where they were grown, they render it more productive. On this account, therefore, if the soil be poor, it is usual to plough in, as a manure, lupines before they come to pod; and beans before they are so far advanced in pod, as that the beans may be gathered."*

Columella, too, is equally explicit on the advantages to be derived from "green manuring." He concludes the sixteenth chapter of his second Book on Husbandry

* Quædam etiam serenda non tam propter præsentem fructum, quam in annum prospicientem, quod ibi subsecta atque relicta terram faciunt meliorem. Itaque lupinum cum necdum siliculam cepit; et nonnunquam fabalia, si ad siliquas non ita pervenit, ut fabam legere expediat, si ager macrior est, pro stercore inarare solent.—Varro de re rustica. Lib. 1. cap. xxiii.

in these words. "But now, indeed, I am of opinion that, supposing the Farmer to be desitute of all these resources,"—(he alludes to ordinary fold-dung and marl,)—"nevertheless, the ready aid of lupines can never be wanting, which, if he scatters them upon poor land about the middle of September, ploughs in, and afterwards, at the right time, cuts them with the share or spade, will exhibit the same manuring effects as the best dung of animals."* He then proceeds to say, and I call your attention to his remarks, as they go to prove that vegetables, when buried in the earth, have a decided mechanical action:—"but in gravelly soils, lupines ought to be cut down when in second flower: in red soils, when in third flower. In the former case, they are worked into the land while young and succulent, in order that they may rot more quickly, and so become incorporated freely with the earth: in the other case, they are applied with more effect when their stalks are stronger and fully advanced in growth, to enable them to bear up and keep suspended for a long time the more solid clods, so that these being dried and acted upon by summer suns may be resolved into powder."

But it is high time to hear what our great Sir Humphry Davy has to tell us on this point.

* Jam vero et ego reor, si deficiatur omnibus rebus Agricola, lupini certe expeditissimum præsidium non deesse: quod cum exili loco circa Idus Septembris sparserit et inaraverit, idque tempestive vomere vel ligone succiderit, vim optimæ stercorationis exhibebit. Succidi autem lupinum sabulosis locis oportet, cum secundum florem; rubricosis, cum tertium egerit. Illic dum tenerum est, convertitur, ut celeriter ipsum putrescat, permisceaturque gracili solo: hic jam robustius, quod solidiores glebas diutius sustineat et suspendat, ut eæ solibus æstivis vaporatæ resolvantur.—Col: Lib. 11. cap. xvi.

"All *green succulent plants* contain saccharine or mucilaginous matter, with woody fibre; and readily ferment. They cannot, therefore, if intended for manure, be used too soon after their death.

"When *green crops* are to be employed for enriching a soil, they should be ploughed in, if it be possible, when in flower, or at the time the flower is beginning to appear: for it is at this period that they contain the largest quantity of easily soluble matter, and that their leaves are most active in forming nutritive matter. Green crops, pond weeds, the paring of hedges and ditches, or any kind of fresh vegetable matter, require no preparation to fit them for manure. The decomposition slowly proceeds beneath the soil; the soluble matters are gradually dissolved; and the slight fermentation that goes on, checked by the want of a free communication of air, tends to render the woody fibre soluble, without occasioning the rapid dissipation of elastic matter.

"When old pastures are broken up and made arable, not only has the soil been enriched by the death and slow decay of the plants which have left soluble matters in the soil; but the leaves and roots of the grapes living at the time, and occupying so large a part of the surface, afford saccharine, mucilaginous, and extractive matters, which become immediately the food of the crop; and the gradual decomposition affords a supply for successive years."

Professor Johnston remarks, "There are two purposes which vegetable manure is generally supposed to serve when added to the soil. It loosens the land, opens its pores, and makes it lighter: and it also supplies

organic food to the roots of the growing plant. It serves, however, a third purpose, by yielding to the roots those saline and earthy matters which it is their duty to find in the soil, and which exist in decaying plants in a state more peculiarly fitted to enter readily into the circulating system of new races.

"Decayed vegetable matters, therefore, are in reality *mixed manures;* and their value in enriching the land must vary considerably with the *kind* of plants, and with the *parts* of those plants of which they are chiefly made up."

"There are several states in which vegetable matter is collected by the husbandman for the purpose of being applied to the land; such as the *green* state, the *dry* state, that state of imperfect natural decay in which it forms *peat,* and the decomposed state of *charcoal,* &c. to which it has been reduced by art."

"A rapid decay of green vegetable matter takes place when it is buried in the soil. Hence the cleanings and scourings of the ditches and hedge-sides form a compost of mixed earth and fresh vegetable matter, which soon becomes capable of enriching the ground. When a green crop is ploughed into a field, the whole of its surface is converted into such a compost; the vegetable matter in a short time decays into a light black mould, and enriches to a remarkable degree, and fertilizes the soil."

"That the soil should be richer in vegetable matter after this burial of a crop, than it was before the seed of that crop was sown, and should also be otherwise bene-

fited, will be understood by recollecting that perhaps three-fourths of the whole organic matter we bury has been derived from the air; that by this process of ploughing in, the vegetable matter is more equally diffused through the whole soil, than it could ever be by any merely mechanical means; and that by the natural decay of this vegetable matter, ammonia and nitric acid are, to a greater extent, produced in the soil; and its agricultural capabilities in consequence materially increased. Indeed, *a green crop ploughed in, is believed, by some practical men, to enrich the soil as much as the droppings of cattle from a quantity of green food three times as great.*

"THESE CONSIDERATIONS, WHILE THEY EXPLAIN THE EFFECT AND ILLUSTRATE THE VALUE OF GREEN MANURING, WILL ALSO SATISFY THE INTELLIGENT AGRICULTURIST THAT THERE EXIST METHODS OF IMPROVING HIS LAND WITHOUT THE AID EITHER OF TOWN OR OF FOREIGN MANURES; AND THAT HE OVERLOOKS AN IMPORTANT NATURAL MEANS OF WEALTH WHO NEGLECTS THE GREEN SODS AND THE CROPS OF WEEDS THAT FLOURISH BY HIS HEDGE-ROWS AND DITCHES. LEFT TO THEMSELVES, THEY WILL RIPEN THEIR SEEDS, AND SOW THEM ANNUALLY IN HIS FIELDS: COLLECTED IN COMPOST HEAPS, THEY WILL MATERIALLY ADD TO HIS YEARLY CROPS."

"Sea-weeds decompose with great ease when collected in heaps, or spread upon the land. During their decay, they yield not only organic food to the plant, but saline matters also, to which much of their efficacy is no doubt to be ascribed."

The materials for green-manuring most frequently in use among us are wild bushes; those of softer fibre to be preferred; as the balsam, the lupine, the asclepias, the dumb-cane, the silk-grass, Spanish needle, running bonavist, and others: wolly-pira when it can be spared; and best of all, young Guinea-corn before it shoots ear. These are all at hand, in more or less abundance. For dry vegetable substances, you have cane-trash, old Guinea-corn stalks, Indian-corn stalks, and broken mill-trash, or megass. So that your resources in this respect are quite ample enough to enable you to work out into fact Professor Johnston's remark, that, "there are means whereby the intelligent agriculturist may improve the land without the aid of foreign manures." The truth is, that an economical use of the various materials found on every estate; the early reduction of vegetable matters into their component elements; and the judicious application of those substances to the fields, are the most certain means of general prosperity.

ANIMAL MANURES.

I DESCRIBED the system of our forefathers as "self-supporting;" and, the principle which I seek to establish tends to the same good end. I dare say you will agree with me that it would be advantageous to create out of the Estate itself the means of renewing the fertility of its lands; and I think I may venture to ask you a plain question to this effect: If you had a choice between rich farm-yard manure and guano, which would you prefer? I do not doubt your answer; Farm-yard manure: and for this obvious reason, that its effects are more enduring. Well then, before you set about to purchase guano, surely it becomes you to use your best exertions to raise the largest amount of farm manure which the resources of the Estate are capable of furnishing. Moreover, it will appear in due time, that we have also the means within ourselves, of mixing valuable composts, specially adapted to the Sugar-cane.

I shewed you, some time ago, that although the cultivation may be extended to double the amount of acres as compared with the old proportion, nevertheless, the whole thing resolved itself into the actual number of cane-holes: and I pointed out to you that thirty acres, at a lining of four feet square, gave a larger total of cane-holes, than sixty acres at six feet square, the average lining of our time. It was not necessary for me to add, just then, any calculation of the increased

amount of cane-tops, litter, &c.: but you could not fail to perceive how great an addition would thus be made to your resources for manure, in this respect.

The superiority of fold-yard-dung over guano aud all artificial manures, can be proved by facts within our own experience. Take the very common case of a planter bringing a piece of poor land into cane-cultivation. Note well how he trcated it. In the first place, he caused to be made up, in the field itself a pen of dung, moulded according to old custom, and of ample proportions. If the land was very poor indeed, he applied mould to it in addition. Probably, the first return from this field was moderate, and in no way adequate to the labour and pains bestowed upon it: nevertheless, our careful planter did not falter in his determination to bring the field into a high state of fcrtility. Accordingly, on the next occasion that the same field was brought into cultivation, he redoubled the application of mould and dung; and so on, again and again, until his expectations were fully realized. Most of our fields have been made what they are by this systcm, the advantages of which no man is prepared to deny. Now, as a poor unyielding soil may be converted into a rich productive onc, so by a kind of backward process, (if I may use the expression,) a rich productive soil may be suffered to degenerate into a poor unyielding one.

Without any straining of the argument, I dcsirc to apply these observations to the practice of the majority of our modern planters, who are accustomed to rely wholly upon guano for a crop.

When this manure was first introduced into Bar-

bados, while our lands were in "good heart," and still rich in the effects of the old system of dunging, one application of it was sufficient for the purposes intended. But the facility with which it could be obtained, and applied at any stage of the growth of the cane, tempted many to desert their old teaching, and to neglect the duty of preparing a full proportion of fold-yard dung. This soon became a habit. In each successive year, less and less home-dung was made up, while the importation of guano increased in a ratio corresponding to the enlarged demand for it. The effects of the rich manuring of our earlier days being scarcely to be felt, a single application of guano was of no further avail. The "recipe" was left to the discretion of the manager, as much as he pleased, and as often as he pleased: and this is the history of the whole matter.

I do not assert that no fold-yard dung is made up on each Estate. What I mean is, that the quantity is insufficient,—almost infinitesimal: and I venture to predict that unless there be an immediate and thorough reformation in our practice in this respect, our lands will become deteriorated to a very low degree.

We have, therefore, a definite point to start from: and, in the first instance, I invite your attention to the following statement of the component elements of farm-yard manure, by Professor Voelcker.

"*Chemically considered, Farm-yard Manure must be regarded as a perfect and universal manure.* It is a universal manure, because it contains *all* the constituents which our cultivated crops require to come to perfection, and is suited for almost every description of agricultural produce.

"As far as the inorganic fertilising substances are

concerned, we find in farm-yard manure: potash, soda, lime, magnesia, oxide of iron, silica, phosphoric acid, sulphuric acid, hydrochloric and carbonic acid; in short, all the minerals, not one excepted, that are found in the ashes of agricultural crops.

"Of organic fertilising substances we find, in farm-yard manure, some which are soluble in water and contain a large proportion of nitrogen, and others insoluble in water, and containing, comparatively speaking, a small proportion of nitrogen. The former readily yield ammonia; the latter principally give rise to the formation of humic acids, and similar organic compounds. These organic acids constitute the mass of the brown vegetable substance, or rather mixture of substances, which practically speaking, pass under the name of humus.

"Farm-yard manure is a perfect manure, because experience, as well as chemical analysis, shows that the fertilising constituents are present in dung in states of combination, which appear to be especially favourable to the luxuriant growth of our crops.

"Since the number of the various chemical compounds in farm-yard manure is exceeding great; and many, no doubt, exist in a different state of combination from that in which they are obtained on analysing farm-yard manure; in our present state of knowledge, it is impossible, artificially, to produce a concentrated, universal, and perfect manure, which might entirely supersede home-made dung.

"I do not refer to the mechanical effect which farm-yard manure is capable of producing. This mechanical effect, especially important in reference to heavy clay soils, ought to be duly regarded in estimating the value

of common dung: but, for the present, it may suffice to draw attention to the fact, that even fresh dung contains a great variety of both organic and inorganic compounds of various degrees of solubility.

"Thus, for instance, we find in fresh manure, volatile and ammoniacal compounds, salts of ammonia, soluble nitrogenized organic matters, and insoluble nitrogenized organic substances, or no less than four different states in which the one element, nitrogen, occurs in fresh manure.

"In well-rotted dung, the same element, nitrogen, probably is found in several other forms. This complexity of composition, difficult, if not impossible, to imitate by art, is one of the reasons which render farm-yard manure a perfect as well as an universal manure."

"If the pure dung of cattle is to be used as manure, like the other species of dung which have been mentioned, there seems no reason why it should be made to ferment, except in the soil; or if suffered to ferment, it should be only in a very slight degree. The grass in the neighbourhood of recently voided dung, is always coarse and dark green; some persons have attributed this to a noxious quality in unfermented dung; but it seems to be rather the result of an excess of food furnished to the plants.

"The question of the proper mode of the application of the dung of horses and cattle, however, properly belongs to the subject of *composite manures*, for it is usually mixed in the farm-yard with straw, offal, chaff, and various kinds of litter; and itself contains a large proportion of fibrous vegetable matter.

"A slight incipient fermentation is undoubtedly of use in the dunghill; for by means of it, a disposition is brought on in the woody fibre to decay and dissolve, when it is carried to the land, or ploughed into the soil; and woody fibre is always in great excess in the refuse of the farm.

"Too great a degree of fermentation is, however, very prejudicial to the composite manure in the dunghill; it is better that there should be no fermentation at all before the manure is used, than that it should be carried too far. This must be obvious from what has been already stated. The excess of fermentation tends to the destruction and dissipation of the most useful part of the manure; and the ultimate results of this process are like those of combustion.

"It is a common practice amongst farmers, to suffer the farm-yard dung to ferment till the fibrous texture of the vegetable matter is entirely broken down; and till the manure becomes perfectly cold, and so soft as to be easily cut by the spade.

"Independent of the general theoretical views unfavourable to this practice, founded upon the nature and composition of vegetable substances, there are many arguments and facts which show that it is prejudicial to the interests of the farmer.

"During the violent fermentation which is necessary for reducing farm-yard manure to the state in which it is called *short muck*, not only a large quantity of fluid but likewise of gaseous matter is lost; so much so, that the dung is reduced one-half, or two-thirds in weight; and the principal elastic matter disengaged, is carbonic acid with some ammonia; and both these, if retained by the moisture of the soil, as has been stated before,

are capable of becoming an useful nourishment of plants."

"Besides the dissipation of gaseous matter when fermentation is pushed to the extreme, there is another disadvantage in the loss of *heat*, which, if excited in the soil, is useful in promoting the germination of the seed, and in assisting the plant in the first stage of its growth, when it is most feeble and most liable to disease: and the fermentation of manure in the soil must be particularly favourable to the wheat crop in preserving a genial temperature beneath the surface late in autumn, and during winter.

"Again, it is a general principle in chemistry, that in all cases of decomposition, substances combine much more readily at the moment of their disengagement, than after they have been perfectly formed. And in fermentation beneath the soil, the fluid matter produced is applied instantly, even whilst it is warm, to the organs of the plant, and consequently it is more likely to be efficient, than in manure that has gone through the process; and of which all the principles have entered into new combinations.

"In the writings of scientific agriculturists, a great mass of facts may be found in favour of the application of farm-yard dung in a recent state. Mr. Young adduces a number of excellent authorities in support of the plan. Many who doubted, have been lately convinced; and perhaps there is no subject of investigation in which there is such a union of theoretical and practical evidence. I have myself, within the last ten years, witnessed a number of distinct proofs on the subject. I shall content myself with quoting that which ought to have, and which I am sure will have, the greatest

weight among agriculturists. Within the last seven years, Mr. Coke has entirely given up the system, formerly adopted on his farm, of applying fermented dung; and he informs me, that his crops have been since as good as they ever were, and that his manure goes nearly twice as far.

"In cases when farm-yard dung cannot be immediately applied to crops, the destructive fermentation of it should be prevented as much as possible: the principles upon which this may by effected have been already alluded to.

"The surface should be defended as much as possible from the oxygen of the atmosphere; a compact marl, or a tenacious clay, offers the best protection against the air; and before the dung is covered over, or as it were, sealed up, it should be dried as much as possible, If the dung is found at any time to heat strongly, it should be turned over, and cooled by exposure to air."*

"Hence it is obvious that profitable farming depends chiefly upon the skill and success with which the elements of the food of plants, extracted from the soil by cropping, are collected, preserved, and returned again to our fields, to feed the next generation of plants. The manufacture and sale of *artificial* manures have of late years been widely extended, and assumed an importance to which, until recently, they were not supposed to be entitled.

"*The preservation of the natural manures,* is, however, a primary consideration, and the first duty of the farmer

* Sir Humphry Davy.

is to look at home, and to enquire whether the excrements of his own stock, and all other manurial products of his homestead, are treated in such a way as to obtain from them the greatest amount of benefit they are capable of yielding to his farm.

"One fact should ever be kept in view in connection with this subject, which is, that while *artificial manures* are *special*, and are designed frequently for a particular crop, upon a particular soil, and are unsuitable in altered circumstances, *farm-yard manure* is adapted for all soils, and for every variety of crop; it contains all the elements, organic and inorganic, which are essential to the nourishment of plants. This cannot be said of any artificial manure whatever. And farmers have here, therefore, a manure of the right kind, if they can only preserve it in a proper *condition*, and obtain it in sufficient *quantity*. This is the problem."*

"In the management of farm-yard dung there are a few things worth noticing. Some of the constituents of farm-yard dung are volatile, and go into the air; others are soluble in water, passing away if there is too much water. Ammonia, one of the most valuable constituents of all manures, is that which is most volatile, and if you allow too great heat in the decomposition of vegetable manures, the ammonia, as it is produced, is driven off into the air. Again, if you allow all the water that falls to go upon your manure, even that which comes from the buildings and outhouses, you wash away all the soluble materials; and dung that has parted with these volatile and soluble

* McDougall.

materials is like so much green thatch, it is not more valuable, and produces no better results.

"You should, therefore, be very careful to prevent waste. One of the best methods of preventing the waste of ammonia, where you cannot put dung on the land at once, is to make compost heaps of it: in fact, nitre beds.

"I have seen to-day, while riding out near Driffield, a quantity of dung without the slightest covering upon it; a large proportion of it having been exposed to rains, which must have washed away the ammonia, the nitre, and everything else in it that was useful. If the farmer had made a layer of road-stuff, of which there are hundreds of loads within a few yards of the field, then put one of dung, then more road-stuff or soil, and so on, covering the whole with the earthy matter, he would have had a complete nitre bed; he would have had the whole of the earthy matter impregnated with the gases given off by decomposition; and he would thus have secured a much more valuable manure than the washed dung which he is now putting on his land. This nitrification can always be carried on by you. The best thing is to use some calcareous matter,—marl, or something of that kind, and to lay the dung up in such a form as to be easily mixed with it. The earthy matter will prevent its being too light, and also prevent too great decomposition. The grand point is to guard against decomposition going too far: you should take care to let it proceed slowly and regularly."*

This is exactly what the old Planters of Barbados

* Nesbit.

did, when they "moulded pens." We need not be too curious to enquire whether they understood the philosophy of the process. It is sufficient to know that they did the right thing.

I have heard, of late, much nonsense talked, by ignorant persons, about pens composed of "pure tincture," as they affectedly call it:—how that, if mould is to be applied at all, it should be put into the land at once, and not first on cattle-pens: this passage from Mr. Nesbit, however, and the extracts from Mr. McDougall's pamphlet, which follow, completely set the question at rest.

"The instant that dung or urine is voided, and comes into contact with the air, it is liable to decomposition: some of its elements assume the gaseous form, and pass into the atmosphere; others are broken down, and become so easily soluble in water that they are readily removed in solution; so that if animal excrements be exposed for a sufficient time to air and moisture, they continually decrease in value till they become utterly *effete*, nothing remaining but woody fibre and other matters equally worthless. This process is pregnant with mischief. The loss of manure is not the only, nor perhaps, the greatest evil suffered by the farmers. The decomposition of animal manures yields gases of the most noxious character, and most detrimental to health; and where it is permitted, the evil consequences are an unsanitary condition of the atmosphere in and around the stables, cow-houses, piggeries, &c. where the animals are kept;—a lowering of the general health of the locality, from which neither the farmer, his family, nor his servants can escape;—a

greatly increased liability to disease, especially among cattle, which are constantly inhaling an atmosphere charged with fermenting emanations from their own dung."

Amazing as it may seem to some, it is nevertheless true that many farmers have a prejudice in favour of a strong smell of putrid dung upon their premises: they have been so long accustomed to it;—it appears to them so natural and necessary a thing in a farm-yard, that they would feel as if all were not comfortable without it.

These emanations consist chiefly of sulphuretted hydrogen, and phosphuretted hydrogen, two poisonous gases in combination generally with ammonia. To gentlemcn who have a partiality for these smells I would say, "You cannot indulge in a more expensive luxury. You cannot enjoy it but at the cost of your manure, and by greatly increasing the susceptibility to disease both of yourself and your stock."

The precise cost of a stink in money, it is difficult to estimate, but if intelligent farmers will attempt the calculation, it will convince them that no fœtid emanation arises from the farm-yard, which does not carry away money's-worth on its wings to dissipate in the air.

"An approximate calculation may be made, but it will fail to give a correct idea of the injury and loss sustained, by the want of a better system than the one now in use. The carefully-conducted experiments of Sprengel will enable us to arrive at a result sufficiently near the truth to demonstrate the general fact. A

stall-fed cow will void 15,000 lbs. of urine in a year: this will yield 240 lbs. of ammonia (this is in addition to the phosphates of the urine and all the other excrements): of this 240 lbs. of ammonia, no less than 162 lbs. are annually lost by the ordinary mode of treatment,—or rather neglect,—of the urine. Ammonia cannot be purchased by the farmer for less than sixpence per lb.: 162 lbs. of ammonia at sixpence per lb. is 81*s.*, the annual valuc, per head, for stall-fed cattle, of the manure lost from the urine alone; (the loss on the other excrements is proportionally great). This 81*s.* worth of ammonia is dissipated in the air, generating disease and impoverishing the soil."

The same author remarks, in reference to this subject:

"*Whoever fails to employ some neutralising substance to combine with the ammonia which is produced in so great a degree during summer, suffers a loss of manure which exceeds all belief. It is indeed only a gaseous substance, and not a solid material visible to the eye, which thus escapes and is lost; but, for all that, it is of greater importance to the nourishment of plants, than perhaps any other portion of the excrements.**

"It has long been a growing opinion with chemists, that ammonia and phosphate of lime are the two most important and valuable elements of plants, and, consequently, of any manure which is to aid in the development of vegetable life. This opinion has been founded, in the first place, upon numerous analyses of various manures; and, secondly, upon practical experiment.

"It has been proved, for example, that, in two samples

* McDougall.

of farm-yard dung, the one which gives the best crop in practice, contains, on analysis, the largest amount of ammonia and bone-earth. It is a well-known fact, that the seeds of a vegetable contain more nitrogen (ammonia) and phosphate of lime than any other portion of the plant: and it is also well known that the dung of animals fed upon seeds is more valuable than that of others fed only upon hay, straw, or roots: hence the practice of feeding animals upon oilcake (crushed linseed), to obtain a better quality of dung. That ammonia and bone-dust are the most valuable of manuring principles, may also be inferred from the fact, that the artificial manures most used by the farmer are those which contain the greatest quantities of these elements, and that these manures are precisely those which fetch the highest price in the market."*

"The death and decay of animal substances tend to resolve organised forms into chemical constituents; and the pernicious effluvia disengaged in the process seem to point out the propriety of burying them in the soil, where they are fitted to become the food of vegetables. The fermentation and putrefaction of organised substances *in the free atmosphere* are noxious processes: *beneath the surface of the ground,* they are salutary operations. In this case the food of plants is prepared where it can be used: and that which would offend the senses and injure the health, if exposed, is converted by gradual processes into forms of beauty and of usefulness: the fœtid gas is rendered a constituent of the aroma of the flower, and what might be poison, becomes nourishment to animals and to man."†

* Nesbit. † Sir Humphry Davy.

Let me now sum up the whole matter in a few words. Farm-yard dung, among other constituents, contains that which is volatile, and escapes in the air; and that which is soluble, and liable to be washed away by rains. The former we have often smelt: the latter, unfortunately, we have too often seen, in streams of dark-coloured liquid, as it trickled from the cattle-sheds. The volatile element, an ammoniacal gas, can be fixed and retained by moulding or marling the heap: as to that which is soluble, you can protect yourself from loss by the simple precaution of a well-built and cemented wall round the pen.

Horse-manure is very beneficial to the land, from the fact of its containing a larger proportion of ammoniacal and nitrogenous ingredients than any other kind of farm-yard manure. That the urine of the horse is of a very superior description is evident from the effects to be observed on those patches of soil wherever it has fallen. In the feeding of horses it is found that the animal produces, in solid dung and urine, three-fourths in weight of what it consumes. It is calculated that a well-fed horse will give nine-and-a-half tons of solid and liquid manure per annum.

Intimately connected with this branch of our subject is the question relating to the proper application of dung to the land. And here I cannot do better than place before you the maxims of the ancients on this important point. "Wherever dung is to be spread," remarks Columella, "it is fitting to plough it in and cover it, lest it part with its strength from the scorching exhalations of the sun; and that the earth being mixed with the nourishment to be derived from it, may thereby be enriched. So, then, when loads of dung are laid

upon a field, there ought not to be 'thrown out' a greater quantity than the ploughman can work into the land in the same day."*

"Great waste," remarks Mr. Cuthbert Johnson, "is often made in putrescent manures, after they are carted on the land: instead of being immediately covered or incorporated with the soil, we not unfrequently see them exposed for days together in the hot rays of a scorching sun, or to the injurious influences of a dry wind."

Keeping before your mind, then, the "volatile" and the "soluble" elements of farm-yard manure, you will, I am sure, appreciate the justness of the observations of this writer: and when you are about to apply dung to the land, you will take care to engage a sufficient number of labourers, not only to throw it out, but to hoe up soil enough to cover it from the action of the air and sun.

* Disjectum deinde protinus fimum inarari et obrui convenit, ne solis halitu vires amittat, et ut permixta humus prædicto alimento pinguescat. Itaque, cum in agro disponentur acervi stercoris, non debet major modus eorum dissipari, quam quem bubulci eodem die possint obruere.—Col., Lib. 11, c. v.

MINERAL MANURES.

LIME AND MARL.

"When Lime, whether freshly burnt or slaked, is mixed with any moist fibrous vegetable matter, there is a strong action between the lime and the vegetable matter; and they form a kind of compost together, of which a part is usually soluble in water.

"By this kind of operation, lime renders matter which was before comparatively inert, nutritive: and, as charcoal and oxygen abound in all vegetable matters, it becomes at the same time converted into carbonate of lime.

"Mild lime, powdered limestone, marls or chalks, have no action of this kind upon vegetable matter: by their action they prevent the too rapid decomposition of substances already dissolved; but they have no tendency to form soluble matters.

"It is obvious from these circumstances, that the operation of quicklime, and marl or chalk, depends upon principles altogether different.

"Quicklime, in being applied to land, tends to bring any hard vegetable matter that it contains, into a more rapid decomposition and solution, so as to render it a proper food for plants. Chalk and marl, or carbonate of lime, will only improve the texture of the soil, or its relation to absorption: it acts merely as one of its earthy ingredients. Quicklime, when it becomes mild, operates

in the same manner as chalk; but in the act of becoming mild, it prepares soluble out of insoluble matter.

"It is upon this circumstance that the operation of lime in the preparation for wheat crops depends; and its efficacy in fertilizing peats, and in bringing into a state of cultivation all soils abounding in hard roots, or dry fibres, or inert vegetable matter.

"The solution of the question, whether quicklime ought to be applied to a soil, depends upon the quantity of inert vegetable matter that it contains.

"The solution of the question, whether marl, mild lime, or powdered limestone, ought to be applied, depends upon the quantity of calcareous matter already in the soil. All soils are improved by mild lime, and ultimately, by quicklime, which do not effervesce with acids; and sands more than clays."*

Sir Humphry Davy, as you may probably know, is considered to be the Father of Modern Chemistry; and every line of his writings is entitled to our unqualified respect. Indeed, notwithstanding the new light which has been thrown on Agricultural Chemistry, by Liebig and other Professors of the day, Sir Humphry's Essays on the subject are still regarded as the Text-book, beyond which there is no appeal.

Now the extract, which I have quoted above, exhibits in the simple language of philosophy, the principle upon which Barbados Planters have been accustomed hitherto to act in regard to the application of lime to the land; but it may not be altogether without profit for you to be informed of what has been written on the

* Sir Humphry Davy.

same subject by Mr. Nesbit. Before, however, I proceed with any quotations from his Essay on the "Use and Abuse of Lime in Agriculture," I would venture to remark that the free use of lime in our field preparations is attended by a particular and special influence on the juices of the cane; so much so, that the liquor scarcely requires more than one-half of the usual proportion of "temper lime" in the racking-copper. This is a marked and very important effect of lime in the culture of the cane, and demands your most thoughtful attention, inasmuch as it bears directly on the manufacture of sugar.

In treating of lime, Mr. Nesbit clears the way by a few observations on the nature of "Limestone," which, he says, is never found in a state of absolute purity; but, on the contrary, is discovered to contain a certain amount, varying in proportion, of moisture, silica, iron, alumina, phosphate of lime, and sulphate of lime. And he adds—"It is perfectly obvious that limestones must be the better for any phosphate of lime which they may contain. As you are continually putting into the soil bones and other substances, because they contain phosphate of lime, it is evident that those limestones which contain the largest proportion of phosphate of lime are the most valuable, supposing the other constituents to be the same."

Limestones contain, one to four per cent. of phosphate of lime: but taking the average at one per cent., and assuming that ten tons of limestone, give five tons of lime, (these five tons containing the whole amount of phosphate of lime in the ten tons of unburnt stone,) it follows, according to Mr. Nesbit's calculation, at five tons of lime per acre, that you put, on the same propor-

tion of land, two hundred weight of bone-earth, a dressing which will be advantageous to the soil for years to come.

"You will thus see," he adds, "that my opinion upon this part of the subject is, that it is not the purest kinds of limestone which are calculated to confer the greatest benefit upon the farmer, but that those which contain a certain amount of what are called impurities, are the best adapted to agriculture; because they convey to the soil other constituents besides the calcareous matter."

"It has been found that the use of marly substances, containing calcareous matter, is equivalent to the use of lime itself. It does not seem to make much difference, generally, whether you use calcareous matter merely in the state of carbonate of lime, or use chalk disintegrated by frost, or whether you use quick-lime itself. Although there has been a deal of dispute on the point, yet I do not think the experience of farmers has proved that there is much difference in the result between the use of quick-lime or marls, or of soft limestone disintegrated by the action of the air. And, indeed, I cannot see how there can be much difference. If hard limestone is burnt into lime, when it has absorbed moisture, it becomes a very fine powder, a finer one than could ever be produced by mechanical means. This powder, or slaked lime, absorbs the carbonic acid of the atmosphere, and again becomes the same carbonate of lime that it was before being burnt. But its mechanical condition is now entirely changed. Instead of being a hard solid mass, it is a white friable powder. Burning is chiefly useful in the case of hard solid limestones, because by that means they are reduced to a powder, and in this

state they will readily act upon any substance in the soil. Many persons have supposed that caustic lime exerts a great and peculiar action in the soil, but to me this appears very doubtful. The chief use of burning hard limestones is, in my opinion, that it reduces them to that minute state of division in which they act most readily on the soil. I am not at all singular in this opinion. Nearly all chemists who have investigated the matter, have, I believe, declared that lime in its caustic state, does not exert any peculiar action, but that it is in the state of carbonate of lime that its peculiar influence is witnessed.

"Lime, whether in the caustic state or in the state of carbonate of lime, has a distinct action on the mineral ingredients in the soil. In our chemical analyses, if we want to liberate potash and soda from an earth, we heat it red-hot, in a crucible, with lime, after which operation we can get all the potash and soda from the soil by the action of water alone. Even if we merely mix a quantity of soil with some lime and water, so as to make a kind of milk of it, and leave it for five or six months; at the end of that time, on filtering the liquid, we shall find a considerable amount of alkali dissolved out of the soil. In like manner, when you put a quantity of lime on your land, and allow the atmosphere to act upon it, the rains dissolve it; it becomes intermixed; and, as it acts upon every portion of the soil with which it is in contact, a considerable amount of alkali, which is necessary for the growth of plants, is liberated for that purpose.

"But lime acts powerfully, not only on the mineral, but also on the organic matters in the soil.

"All good soils contain a considerable amount of vegetable matter, or have the power of absorbing from

the air substances adapted to the formation of vegetable matter.

"When you have lime in the soil, whether it be put there in the state of lime or in that of carbonate of lime, you have at once a determinate action on the organic matters, and also a greater power of absorption from the air. You have the decomposition of roots and plants and other vegetable *débris* very much augmented by the presence of the carbonate of lime. These substances are not able of themselves to decompose with sufficient rapidity to furnish the greatest available amount of nutrition to the growing crop. There can be no quick decomposition, for the simple reason that the substances which would be produced by decomposition would find nothing with which they could unite; but in carbonate of lime you have a substance with which the different vegetable acids, formed in the various phases of decomposition, can unite at once. It is a well-known fact, that it is on soils which contain a great amount of organic matter, or which have not been under plough for a great many years, that lime produces the most marked effect. If you have worked your land for many years as arable land; if you have ploughed it, and sown it, and reaped crops from it to such an extent as materially to have affected the organic matter of the soil, and the stores of ammonia which it has absorbed from the air, lime will do little or no good. But if the case be otherwise, you will find lime produce the very best effects, because it immediately brings the stores of nitrogen and the organic materials in the soil into the best possible state for plants to act upon them.

"It is, then, my distinct opinion, that lime ought to be used on such soils as contain a large amount of

organic matter;—and, when using it on arable lands, never to trust to it alone, but to use other manures as well, though they ought not to be applied at the same time as quick-lime. You all remember the old proverb:—

'The use of lime without manure
Will always make the farmer poor.'

—And that saying is perfectly true.

"There is another action of lime which I wish to mention. You know, of course, that most limestones contain sulphate of lime. Rain brings from the air a quantity of carbonate of ammonia, which being a volatile salt, easily evaporates again: but if there be any sulphate of lime in the soil, the ammonia does not evaporate, because as soon as it comes in contact with the sulphate of lime, the carbonate of ammonia becomes sulphate of ammonia. A change takes place again after the superfluous moisture has evaporated from the soil, for the sulphate of ammonia re-acts on the carbonate of lime, and carbonate of ammonia is again given out. This is a very curious fact.

"There is yet another point which I wish to notice, namely, that without the presence of carbonate of lime in the soil, you can never have the full action of any description of manure. If there be sulphate of ammonia in the soil, you cannot suppose that it will be taken up into the plant as sulphate of ammonia; it must be decomposed before the ammonia can be absorbed. There is something required to unite with the sulphuric acid, and this is furnished by the carbonate of lime. There must, therefore, be carbonate of lime in the soil, and if you have that, you will have the sulphate of

ammonia giving its ammonia freely to the growing plants. You could not usefully apply guano, or any other artificial manure, without a proper amount of carbonate of lime in the soil. You see, therefore, that it is necessary to have a certain amount of lime in any soil whatever, if you wish to cultivate it to the greatest advantage.

"The system of Tull is dependent upon the principle of the exposure of soils to the air. You must in this case have a proper amount of lime in the soil, or you can never have that proper absorption of manuring properties from the air upon which the system almost wholly depends."*

"The quantity of quick-lime laid on at a single dressing, and the frequency with which it may be repeated, depend upon the kind of land, upon the depth of the soil, upon the quantity and kind of vegetable matter which the soil contains, and upon the species of culture to which it is subjected. If the land be wet, or badly drained, a larger application is necessary to produce the same effect, and it must be more frequently repeated. But when the soil is thin, a smaller addition will thoroughly impregnate the whole, than where the plough descends to the depth of eight or ten inches.

"In arable culture, larger and less frequent doses are admissible, both because the soil through which the roots penetrate must necessarily be deeper, and because the tendency to sink beyond the reach of the roots is generally counteracted by the frequent turning up of the earth by the plough. Where vegetable matter

* Nesbit.

abounds, much lime may be usefully added; and on stiff clay lands, after draining, its good effects are very remarkable. On light land, chiefly because there is neither moisture nor vegetable matter present in sufficient quantity, very large applications of lime are not so usual, and it is generally preferable to add it to such land in the state of compost only.

"The largest doses, however, which are applied in practice, alter in a very immaterial degree the chemical composition of the soil. The best soils generally contain a natural proportion of lime, not fixed in quantity, yet scarcely ever wholly wanting. But an ordinary liming, when well mixed up with a deep soil, will rarely amount to *one per cent.* of its entire weight. It requires about 400 bushels (twelve to fifteen tons) of burned lime per acre, to add one per cent. of lime to a soil of twelve inches in depth. If only mixed to a depth of six inches, this quantity would add about two per cent. to the soil.

"Though the form in which lime is applied, the dose laid on, and the interval between the doses varies, yet in Great Britain, at least in those places where lime can be obtained at a reasonable rate, the quantity applied amounts, on an average, to from seven to ten bushels a year.

"The most remarkable visible alterations produced by lime are;—upon *pastures*, a greater fineness, sweetness, closeness, and nutritive character of the grasses;—on *arable lands*, the improvement in the texture and mellowness of stiff clays, the more productive crops, their better quality, and the earlier period at which they ripen, compared with those grown upon soils to which no lime has ever been added.

"This influence of lime is well seen, when limed is compared with unlimed land; or when soils, which are naturally rich in lime, are compared with such as contain but little.

"But this superiority gradually diminishes year by year, in land artificially limed, till it returns again nearly to its original condition. On analysing the soil when it has reached this state, the lime which had been added is found to be in a great measure gone. In this condition the land must either be limed again, or must be left to produce sickly and unremuncrating crops.

"This removal of the lime arises from several causes.

"1. *The lime naturally sinks;*—more slowly perhaps in arable than in pasture or meadow land, because the plough is continually bringing it to the surface again. But even in arable land, it gets at last beyond the reach of the plough, so that either a new dose must be added to the upper soil, or a deeper ploughing must bring it again to the surface.

"2. *The crops carry away a portion of lime from the soil.*

In proportions varying, of course, according to its products, respectively; and although much of the lime is undoubtedly returned in the cane-trash, the tops, and the manure; nevertheless, the land cannot fail to suffer a certain annual loss of lime from this cause.

"3. *The rains wash out lime from the land.*—The rain-water that descends upon the land holds in solution carbonic acid which it has absorbed from the air. But water charged with carbonic acid is capable of dissolving carbonate of lime; and thus, year after year, the rains,

as they sink to the drains, or run over the surface, slowly remove a portion of the lime which the soil contains. Acid substances are also formed naturally by the decay of vegetable matter in the land, by which another portion of the lime is rendered easily soluble in water, and therefore readily removable by every shower that falls. It is a necessary consequence of this action of the rains, that lime must be added more frequently, or in larger doses, where much rain falls, than where the climate is comparatively dry." *

"*What weight of quicklime is obtained from a ton of limestone?*

"About half,—that is, a ton of pure limestone yields about 11¼ cwt. of quicklime.

"*Does quicklime increase in weight when slaked?*

"Yes: one ton of *pure* quicklime becomes 26⅓ cwt. of slaked lime.

"*Does quicklime fall to powder of itself, when left exposed to the air?*

"Yes: it absorbs water from the air, and gradually falls to powder.

"*Does quicklime drink in (absorb) anything else from the air?*

"Yes: it gradually drinks in carbonic acid from the air, and returns at length to the state of carbonate.

"*When it has thus returned to the state of carbonate, is it better for the land than before it was burned?*

"Yes: it is in the state of a far finer powder than could be got by any other means, and can thus be more thoroughly mixed with the soil.

* Professor Johnston.

"*What is it usually called when it has thus returned to the state of carbonate?*

"It is usually called mild lime, to distinguish it from the quick or caustic lime.

"*Does quicklime act in a different way upon the land from mild lime?*

"It acts very much in the same way, but more quickly.

"*How do they both act?*

"They act principally in four ways—*first*, by supplying the lime which all plants require as part of their food; *second*, by combining with acids in the soil, so as to remove the sourness of the land; *third*, by gradually disposing the vegetable matter of the soil to change into soluble food for plants; and, *fourth*, by acting upon the mineral matter of the soil so as to fit it for entering into the roots of growing plants.

"*Would you bury lime deep, or would you keep it near the surface?*

"I would always keep it near the surface, as it has a natural tendency to sink.

"*To what land would you apply quicklime rather than mild lime?*

"I would apply quicklime to peaty soils, to heavy clay soils, to arable lands which are very sour, and to such as contain a great deal of vegetable matter.

"*In what state is slaked lime said to produce the most lasting effect on hill pasture?*

It is said to produce a more lasting effect, when applied after it has become wet by exposure to the air and rain, than when put on in a dry and newly-slaked state.

"*Will the same quantity of lime produce as great an effect upon wet as upon dry or drained land?*

"No: the same quantity will produce a greater effect upon drained or naturally dry land than upon wet land.

"*What quantity of quicklime is usually added to arable land in this country?*

"It is usually added at the rate of eight or ten bushels a-year to each acre.

"*Is it added every year?*

"No: it is added every *rotation,* or every second rotation, or sometimes only once in nineteen years.

"*Would you rather apply the lime in large doses at long intervals, or in small doses at shorter intervals?*

"If I applied a large dose of lime at the beginning of my occupation of a farm, I would apply smaller doses at the end of each *rotation,* or at the end of every second rotation, to keep up the quantity of lime in the land.

"*Why does lime require to be repeated?*

"Chiefly for three reasons—*first,* because the crops eat up every year and carry off a portion of the lime; *second,* because a portion of it sinks into the subsoil; and, *thirdly,* because the rains are always washing a portion of it out of the land.

"*Is it proper to mix guano with quicklime?*

"No: because the quicklime sets free the ammonia contained in the guano, and causes it to escape into the air.

"It is of practical importance, however, to bear in mind that quicklime does not drive off ammonia from the *fresh* droppings of birds or animals. It rather tends to preserve fresh droppings from fermentation, and from the loss of ammonia. Hence fresh nightsoil is dried with less loss when previously mixed with lime. Hence also quicklime may be added with safety to fresh

urine, though it may expel ammonia from such as has fermented.*"

Professor Johnston's statement that it requires about four hundred bushels of burned lime per acre, to add two per cent. of lime to a soil of six inches in depth, makes me bold to relate a fact within my own experience. I once limed a field at Bannatyne, in 1840, a portion of it being stiff clay, to the extent of one gallon of quicklime to each cane-hole (four feet square lining); that is, something less than five hundred bushels of slaked lime per acre!!! The field, for several years previously, had failed to give an adequate return for the labour and pains bestowed upon it; so, I determined to lay on lime with unsparing hand. My neighbours were shocked, as well they might be, at the audacity of the experiment: however, nothing daunted, I carried out my plan to the end. The liming was completed in the month of September. At the close of November, I caused the lime to be raked out of the cane-holes, and spread over the banks and distances:—and afterwards I gave to each hole half a basket of yard-dung. It turned out to be the very best field of canes on the Estate; taking the merest trifle of "temper lime" in the boiling-house;—and, in 1844, on my return to Barbados, I saw very respectable third crop canes cut from the same land.

I have, now, (1857,) a field under canes which has been limed in the more modest proportion of two pints of slaked lime to each cane-hole; about thirty-eight bushels per acre.

The late Mr. President Best was accustomed to apply

* Professor Johnston.

a half-pint or pint of slaked lime to each hole of his growing crop, as a preventive or cure of blight: now, as he was a first-rate agriculturist, and this was his invariable practice year after year, we are led to the conclusion that it was perfectly successful for the purpose intended.

You will have learned from the writers whom I have quoted on the subject, that lime can be used with more benefit on soils which contain a certain amount of organic matter. You must always keep this important condition present to your mind: moreover, you will not fail to note the fact, that in lands from which canes have been reaped, there is left behind a large and extensive net-work of fibrous roots,—to say nothing of the great mass of cane-stump itself; the whole combining to make up a surprising amount of vegetable *débris*, which only wants the aid of lime to be converted into immediate nourishment for a succeeding crop. Therefore, you perceive, by a clear inference, that you will be justified in applying lime, in moderation, on each occasion that the same fields are brought into cultivation for canes.

Mr. Nesbit also informs us, that there is another fact of considerable importance connected with the use of lime, namely, that there may be an absence of lime even in those soils which rest upon limestone itself. In the county of Kent, for example, he states, that, where limestone has been within six or twelve inches of the surface, there was not a thousandth part per cent. of lime in the soil: and, he adds, that, farmers in other counties of England were actually applying chalk to chalky and loamy soils, with manifest advantage.

I am the more desirous to impress you with the

results of Mr. Nesbit's observations on this point, from the circumstance, that our lands in Barbados rest either upon pure limestone, or upon other bases of a kindred nature.

The practice of using marl as a manure is of ancient date, and there is, in the treatise of Columella, a passage to that effect, which has not escaped the notice of modern writers on the subject.

This writer tells us that, in cases where the farmer is unprovided with dung, marl may be used with advantage; referring to the practice, in this respect, of his Uncle Marcus, "a most learned and diligent agriculturist," whose custom it was to apply chalk and marl upon even gravelly soils with marked success. A result of the same kind as that to which our attention is directed by Mr. Nesbit.*

I have long been persuaded that our native marl contains a fair per centage of phosphate of lime, with other valuable constituents, and if I can induce you, by such representations as it may be in my power to offer, to use it copiously on the land, in the stables, and cattle-pens, I shall be vain enough to take some merit to myself on account of the suggestion. In my stables I cause to be laid down a substratum of marl, about four inches thick, with a view to absorbing the urine, and so fixing the ammonia,—that valuable constituent which, as you have been told, so quickly evaporates, and is lost in the air. As the dung increases under the

* Si tamen nullum genus stercoris suppetet, ei multum proderit fecisse quod M. Columellam, patruum meum, doctissimum et diligentissimum agricolam, sæpenumero usurpasse, memoria repeto, ut sabulosis locis cretam ingereret, &c., &c.—Col. lib. 2, cap. xvi.

I dedicate this notable exemplification of the doctrine "Similia similibus" to my excellent friend Dr. G***.

horses and mules, layers of marl may be added from time to time. This is my practice.

Apply it also in baskets-full to the preparations,—at the side of the cane-holes;—it will have a mechanical as well as a chemical action on the soil.

One particular sample of marl, which I discovered in Barbados, is pronounced by Mr. Horsley, an analytical chemist of very high reputation, to contain in every hundred parts:—

Silica and insoluble matter	2·00
Carbonate of lime and magnesia	92·00
Phosphate of lime	6·00
	100·00

The late Dr. Ure has remarked:—"When canes grow on a calcareous marly soil, in a favourable season, the saccharine matter gets so thoroughly elaborated, and the glutinous mucilage so completely condensed, that a clear juice and a fine sugar may be obtained without the use of lime."

This *dictum* of Dr. Ure, although put in rather strong terms, seems to corroborate an old saying among Planters, that "sugar is best made in the field."

COMPOST MANURE.

This seems to me the proper place to consider the question of composts, a subject which demands great attention on your part, not only on account of their intrinsic value, but because they will be ever found a present and ready help when most needed. I do, indeed, hope that you will be induced to adopt means for increasing the amount of fold-yard manure,—decidedly the richest and best substance you can lay on the land:—and the more I reflect upon our extraordinary resources in this respect, the more am I convinced that it is quite within our power to make up a quantity sufficient to give to every cane-hole its proper portion. But in every estate there are fields not possessed of fertilizing qualities in equal proportion with others,—perhaps, it may be, from a closer cropping of guinea-corn, or some other exhausting product; which, therefore, demand stronger manure. To supply this extra demand in certain fields, compost manure will be found your most trusty ally. The materials are,—lime, marl, sand, turf, clay, (burnt or unburnt,) salt, soot, and wood-ashes.

I purposely exclude from this catalogue, megass-ashes, because I think they can be applied with more advantage separately: and while I am on this particular point, let me remind you of their immense value as a manure. Observe, that you have the opportunity of applying them throughout the crop-season, on Satur-

days and other idle or slack days: moreover, there is greater economy in using them according to this plan; for, you know, from actual experience, that the custom of heaping up the ashes outside the stoke-holes is attended with lamentable waste. Have you not remarked, so often as the stoker has tossed out his basket of ashes, that the wind has carried off probably one-fourth of its contents;—the finest, and, therefore, the most valuable particles? As one means of guarding against this waste, I advise that the old coal or soot-hogsheads be placed near the stoke-holes to receive the ashes. In default of old hogsheads, you can easily put together a sort of frame of boards, which will, of course, answer the same purpose. A few words from Professor Johnson will clinch the subject:

"The ash of the sugar-cane is rich in those saline substances *without which the cane cannot thrive.* I may safely hazard the opinion that some, at least, of the exhaustion of their lands, complained of by West India planters, is owing to their neglect of this valuable ash; *and that the large importation of foreign manures, now had recourse to, might, by-and-bye, be in some measure dispensed with, by carefully collecting, grinding, and returning it to the soil.*"

Common Salt. The fertilizing properties of salt have been stated at length by Mr. Cuthbert Johnson;—1st, that *in small proportions* it promotes the decomposition of animal and vegetable substances;—2ndly, that it destroys vermin, and weeds, which are thus converted into food for plants;—3rdly, that it is, in itself, a direct constituent or *pabulum* of plants, it having been ascer-

tained that vegetables, produced on land to which it has been applied, do actually contain an increased proportion of common salt ;—4thly, that, in moderate quantity, it acts on plants as a stimulant ;—and, 5thly, that it renders the earth more capable of absorbing the moisture of the atmosphere: a property of the very first importance ; since those soils which absorb the largest proportion of moisture from the atmosphere are always the most valuable to the cultivator.

Soot. This valuable manure, remarks Mr. Cuthbert Johnson, is composed of charcoal, an oil, salts of ammonia, some muriatic acid, lime, magnesia, silica, and other foreign matters. All these substances are the natural food of vegetation ; the carbon gradually combines with the oxygen of the atmosphere, and is converted into carbonic acid gas, which is readily absorbed by the roots and leaves of plants.

Professor Johnston, too, contributes important testimony to the value of soot. "I have lately examined," he writes, "several varieties of soot, and find that it contains from eighteen to forty-eight per cent. of mineral matter, consisting of earthy substances from the coal, carried up into the chimney by the draught, and of gypsum and sulphate of magnesia, derived from the lime of the flue, and the sulphur of the coal. It contains, besides, from one to two per cent. of ammonia, chiefly in the state of sulphate. These proportions of ammonia, calculated in the state of sulphate of ammonia, are equal to from five and half to twelve per cent. of the whole weight of the soot. It is not wonderful, therefore, that its effects should resemble, and even rival, those of the nitrate of soda, and of the sulphate of ammonia."

Burned Clay, as a top dressing, is pretty generally used throughout England, and seems to be a favourite manure with the farmers. Professor Johnston tells us that it is usually laid on, in large doses, from fifty to one hundred tons per acre; and that its action on the soil is twofold,—mechanical and chemical. It acts mechanically, he observes, by rendering the soil more friable; chemically, on account of the presence of most of the mineral substances,—potash, soda, lime, magnesia, phosphoric acid, &c., which plants require for their sustenance.

Clay, in its natural state, is comparatively insoluble, and therefore incapable of yielding any nourishment; but, when burned, its constituents are so far altered that by the action of the atmosphere and the rain, it is in a condition to give out those mineral ingredients which have been already enumerated.

Sir Humphry Davy has remarked that "when clay or tenacious soils are burnt, they are brought nearer to a state analagous to that of sands."

Unburned Clay and *Turf*, (that is, the weeding of the upper surface of the land with the grass upon it,) will be found excellent adjuncts to our compost heap, of which we will speak anon.

"*Sand.*—This is merely the dust produced by the attrition, or friction of rocks and stones, and is generally considered as pure silica or silicic acid, consisting of the metal silicium united to a certain portion of oxygen.

"In an agricultural point of view, the action of sand may be considered more mechanical than otherwise, as it divides and makes the soil lighter.

"There are many rocks and stones containing silica

in combination with potash, and these, by long efflux of time, and other circumstances, have become decayed, and reduced to so pulverized a state, as to be readily acted on by moisture, and thus absorbed into the structure of plants, and are necessary for their growth. This silica is also found to a large extent in the straw of wheat and other plants. In some cases, silica exists in combination with lime, forming a silicate of that body, and is attributable to the caustic lime used on the soil."*

"*Wood-ashes* contain," according to Professor Johnston, "among other substances, a portion of common *pearl-ash* in an impure form, mixed with *sulphate* and *silicate* of potash. These substances are all valuable in feeding, and in preparing the food of plants, and hence the extensive use of wood-ashes as a manure, in every country where it can be readily procured."

"Wood-ashes," says Mr. Cuthbert Johnson, "contain a very considerable proportion of the phosphates of lime and magnesia. The phosphate of lime, it will be remembered, is the chief fertilizing constituent of bones,"—the manure above all others best adapted to the growth of the cane. "Wood-ashes also contain a considerable proportion of carbonate of potash,—a salt which is more or less present in all vegetable substances, and for which, therefore, it must be highly serviceable as a food. The carbonate of potash, too, promotes the dissolution of dead vegetable substances: it must likewise, from its attraction of moisture from the air, promote an

* J. Horsley.

increased supply to the soil. Wood-ashes are often very judiciously added to common manure, the quality of which is much improved by the mixture. The leaves of trees when burnt generally produce more ashes than the branches or stem: herbs produce four or five times, and shrubs three or four times as much as either. All vegetables produce more ashes, if burnt when green, than when they are previously dried."

As you now are tolerably well acquainted, from the best authorities, with the constituent elements of the various materials which I propose to mingle in our compost heap, let us proceed to construct it according to some rule of proportion. First then, we must select a place where to carry on our operations,—a large pit, which may or may not, according to circumstances, require to be surrounded by a protecting outer wall, or mound of earth, to guard against the washing of heavy rains.

I would commence, then, by laying a foundation of earth,—the weeding of the surrounding soil, for example, with its surface-grass and grass-roots: next, I would lay on a stratum of quick-lime, hot from the kiln: then, a very light covering of marl: after that, a layer of that salt which is commonly known as agricultural salt: then, a substantial layer of marl, and sand: on that, a layer of soot, or wood-ashes, if you have any; and then repeat this series of layers, until the heap is of sufficient size, taking care to cover the whole mass, at the last, with clay, or some tenacious earth. In default of salt, sea-water may be poured over the heap. The entire mass must be allowed to remain undisturbed for two or three months, during which period a gradual

decomposition will take place: muriate of lime and soda will be formed, and the heap become encrusted with alkali.

"There is another advantage (I use Mr. Cuthbert Johnson's words) to be derived from the adoption of this process, beside the formation of soda, viz: that the muriate of lime is one of the most deliquescing or moisture-absorbing substances with which we are acquainted; and, in consequence, whenever it exists in a soil, the warmth of the sun has much less influence on it than it would otherwise have."

"I would especially warn those who try the effect of a mixture of salt and lime," adds the same writer, "not to use it before decomposition has taken place. After it has been well mixed together in a dry state, it should be allowed to remain two or three months undisturbed, and then applied at the rate of from thirty-five to sixty bushels per acre. It is necessary to give the mixture time for decomposition, since that process proceeds very slowly, and is not to be hastened in any way."

Here, then, we have within ourselves, the means (for we can, if we please, dispense, by native substitutes, even with salt and soot, as you have seen,) of making a valuable compost, active in its effects on our soil, and, in no sense, exhausting. It would render us independent, to a great extent, of the artificial manure markets in England, and I am quite satisfied in my own mind, that it would be attended by special benefit to our canes.

Nitrate of Soda.—Professor Stöckhardt informs us

that large districts of this salt are found in America, whence whole ship-loads of it are exported under the name of Chili Saltpetre. Mr. Parkes (quoting from Bowles' "Introduction of the Natural History of Spain,") says, that it is also found native in Spain; and saltpetre is so abundant, that if every other source was destroyed, the soil of that country alone could furnish all Europe with a sufficient supply to the end of time, without the addition of either alkali or acid.

In regard to these deposits of nitre, Mr. Way, consulting chemist to the Royal Agricultural Society of England, lately presented the report of his chemical examination of the mineral specimens received at the Foreign Office from Pernambuco, and transmitted to the society by direction of the Earl of Clarendon. The most remarkable of these specimens was one of almost pure saltpetre, which Professor Way valued at 38*l.* per ton. The nitrous deposits whence this specimen had been obtained extended beyond a range of 20 miles.

Further communications have also been received from the Foreign Office, announcing the discovery of immense tracts of other saline substances in the neighbourhood of Para in Brazil.

Nitrate of Soda, according to Professor Johnston, consists of nitric acid and soda (in 85 parts, 54 of nitric acid and 31 of soda),—and its beneficial action on plants depends chiefly upon its supplying nitrogen and soda to the growing crops. He remarks elsewhere that saltpetre and nitrate of soda have a peculiar influence upon *young* vegetation. Applied to sugar-canes, they have been found largely to increase the crop, and even in

the second year after application, to add much to the luxuriance of the fields.

Mr. Nesbit states that Boussingault, Payen, and many others of our first practical agricultural chemists, have come to the conclusion that the value of different manures varies nearly in ratio to the amount of nitrogen they contain. If this proposition be true,—as I do not presume to doubt,—think what a wonderful substance is nitrate of soda!

The urine of quadrupeds contains much potash, and this acquires nitric acid from the atmosphere. In the reign of Charles the First, great attention was paid to the making of saltpetre in England. Certain patentees were authorised, by royal proclamation, to dig up the floors of all dove-houses, stables, &c., the proprietors at the same time being prohibited from laying any such floors with anything but mellow earth.* Old mortar contains a large proportion of nitrate of lime.

A mixture of common agricultural salt and nitrate of soda—in the proportion of four to one—is highly recommended. So powerful a manure must not be used in excess. The cost of it varies, I am told, from 18*l.* to 21*l.* per ton. Nitrate of soda is adulterated with Epsom Salts, the crystals of both being similar, and therefore undistinguishable to the eye; but easily to be detected by the chemist.

Ammonia is obtained or occurs wherever organic substances are undergoing *putrefaction* and *decay*. Carbonate of ammonia is evolved from all vegetable and

*"For the maintaining and increasing of the saltpetre mines of England, for the necessary and important manufacture of gunpowder."—Proclamation, 1625.

animal substances which contain nitrogen, when they putrify or decay: hence the pungent odour of stables and manure-heaps. If you put a bowl containing muriatic acid or diluted sulphuric acid in such places, the odour vanishes, and the muriatic acid is gradually converted into muriate of ammonia, and the sulphuric acid into sulphate of ammonia. Thus we possess in the acids a simple and cheap means of purifying the air in such places. Putrid urine contains so much carbonate of ammonia, that it is used instead of soap-water for washing wool, and, indeed, even for the preparation of muriate of ammonia itself.

The nitrogen of organic substances combines with hydrogen, at common temperatures, to form ammonia, with oxygen, at common temperatures, and with a strong base, to form nitric acid in nitre-beds. But it escapes altogether with free access of air.

The salts of ammonia afford an excellent manure for soils. They are the principal ingredients in many kinds of manure; *and therefore we should endeavour to prevent the escape of ammonia from dung-heaps, by sprinkling them from time to time with diluted sulphuric acid, or by strewing gypsum* (or, what is infinitely better, our native marl,) *over them,* whereby sulphate of ammonia is formed, which does not volatilize at common temperatures. When bones decay, carbonate of ammonia is likewise produced from the gelatine; and to this is to be ascribed the second beneficial influence which pulverized bones exercise upon the growth of plants. Those plants which grow wild can receive only so much ammonia as they get from the air: but by manuring we give a much larger quantity of it to cultivated plants; and thus is in part explained the far greater fertility of

manured land in comparison with that which is *not manured.*

Ammonia affords another example of the circulation in the great economy of nature, similar to that presented in the instances of carbonic acid, and water, the two other principal sources of nourishment for the vegetable world: and we cannot but be astonished at the simple manner in which the Creator has connected life and death with each other. *During the process of putrefaction and decay, the dead animals and plants are converted into carbonic acid, water and ammonia; and from these three products of decay are reproduced all the innumerable plants which cover the surface of our earth.* —This is from Professor Stöckhardt's book on Chemistry.

Sulphuric Acid is the oil of vitriol of commerce, and is ordinarily used for the purpose of rendering soluble the substances of which bones are composed. But moreover it has a peculiar and direct influence in itself on the soil. Professor Stöckhardt affirms that if a field be irrigated by diluted sulphuric acid, in the ratio of one part to one thousand parts of water, the soil will be made more productive. The reason is, that the sulphuric acid decomposes and renders soluble several kinds of earth; whereby soluble sulphates are formed, which are absorbed by plants, and accelerate their growth. The market price of concentrated sulphuric acid is 12*l.* 10*s.* per ton, or thereabouts.

Sulphate of Soda is the substance called Glauber's salts, and consists of sulphuric acid and soda. It makes an excellent mixture with nitrate of soda. 5*l.* per ton.

Sulphate of Magnesia is Epsom salts, to which we

have lately referred, and is composed of sulphuric acid and magnesia. 5*l.* per ton.

Sulphate of Iron is common green vitriol, which, applied to plants in the form of a weak solution, has been observed to strengthen them, and to give them a brighter green. Professor Johnston further remarks that it may be applied with advantage to diseased frui' trees.

Sulphate of Lime is gypsum or plaster of Paris, which we have had occasion to mention so frequently. Our native Barbados marl is infinitely superior to this substance.

STILL-REFUSE.

Still-refuse goes by the name of "Dunder" in the other Colonies, a term which is derived from a French word, signifying something "over and above." You will remember it by our own word "redundance." When well-managed there is scarcely a more valuable manure. There are two modes of applying it in the liquid state, either directly to each cane-hole, at the rate of one pint per hole; or, indirectly, by saturating the cattle-pens with it. For the most part, this manure is much neglected among us, being allowed to flow into an open pond to leeward of the still-house, where it suffers all the loss from evaporation during many months; in fact, until it is completely dried up. The residuum then obtained is in but very diminished proportion. I have never yet seen a satisfactory analysis of "Dunder," but I believe that it contains those constituents which render it a powerful fertilizer. Among these a large proportion of phosphate of lime is pre-eminent. The obvious way of preserving this manure in all its integrity, is by allowing it to flow into a sufficiently large and deep tank, previously filled to the brim with grass weedings, bushes, mould, and marl, in alternate layers or strata.

It is greatly to be wished that the General Agricultural Society of Barbados would obtain for the guidance of the planters, authentic analyses of all our native substances adapted for manure. I offer this suggestion with every feeling of respect and good-will towards the society.

GUANO, AND ITS ADULTERATIONS.

Hactenus arvorum cultus,—I HAVE gone thus far in my little Manual when I am informed by common fame that the supply of Peruvian guano is about being exhausted; and I confess that my spirit rejoices within me at the prospect of the downfall of a monopoly which boded ill for us. But *uno avulso, non deficit alter*,—no sooner is the failure of guano, in one quarter of the globe, reported in the newspapers, than lo! a compensating supply of a similar substance is announced to be discovered in the other Hemisphere. The Chincha Islands are to be supplanted by their dactylic antipodes, Koorya Moorya, butting and bounding, as I am credibly told, on some outlying corner of the dominions of His Highness the Imaum of Muscat.

The first attempt to bring away a cargo of guano from this locality was met successfully by force of arms on the part of the native Arabs, and the English commander was discomfited and fled. But if his troops had consisted of agriculturists, the issue might have been different.

> "Tum vero ad vocem celeres, qua buccina signum
> Dira dedit, raptis concurrunt undique telis
> Indomiti Agricolæ."

I could give the muster-roll of a regiment of Planters, with a good old Colonel at their head, whose deeds in the fore-front of that day's battle would have emulated the headlong charge of Balaklava. Nothing like hard neccssity to urge men on-

ward. With a brigade of "invincibles" from Barbados, and GUANO for a watchword and a prcy, the defeat of that day might have been changed into victory.

Nevertheless, we are to have guano, as it seems: let not my friends be troubled on that score. It is our fate, and we cannot resist it; therefore, I will say out my say about that substance for the benefit of us all.

"*Guano*, writes Professor Johnston, "is the name given by the natives of Pcru to the dung of sea-fowl, which in former periods used to be deposited in vast quantities on the rocky shores and islands of their coasts, and the fertilizing effects of it depend mainly upon the amount of ammonia which already exists in it, or which may be found in it by further decomposition, and on the proportion of phosphates which are present in it." Again, "It is one of the valuablc qualities of guano, that it contains a mixture of so many of those substances on which plants live. The only ingredient in which it is manifestly defective is *potash*, of which it usually contains less than one per ccnt; and hence an admixture of wood-ashes would be likely to improve its action upon the crops, in such soils as do not naturally abound in potash."

Mr. Way, consulting chemist to the Royal Agricultural Society of England, gives from seventy-eight analyses the mean composition of Peruvian guano, at,

Moisture	13·67
Organic matter and salts of ammonia	52·05
Sand	1·83
Carried forward	67.55

Brought forward	67·55
Phosphate of lime and magnesia	22·78
Phosphate of lime	15
Alkaline salts, containing 3·34 phosphoric acid equal to 6·89 soluble phosphate of lime	9·67
	100·00

A far more philosophical analysis of guano has been given to me by Mr. Horsley.

Urate of ammonia	26
Oxalate of ammonia	40
Phosphate of ammonia	12
Sand and organic matter	7
Moisture	15
	100

"Of all the artificial manures, Peruvian guano is perhaps not only the most concentrated, but is, from its composition, adapted to the greatest variety of crops. The chief mineral constituents of plants,—lime, magnesia, potash, soda, chlorine, sulphuric acid, and phosphoric acid, (the latter the most important,) are found in guano. Nitrogen, the most valuable constituent of manures, is found in Peruvian guano in great abundance, and in a condition adapted for vegetation."

"That the excrementitious matter of birds, fed upon an unlimited supply of animal food, would of itself have powerful fertilising properties, might almost have been taken for granted, without either calling for the opinion of the chemist, or the experimental proofs of the farmer. But both chemist and farmer alike bear testimony to the high position assumed by guano in the catalogue of manures: the former, by comparing its composition with that of other known fertilising bodies; the latter, by actual trial in the field."

"A question now arises whether the fertilising properties of guano will be expended in the first year of its application, or whether its operations will be discernible in after periods. If we examine the chemical constitution of guano, we shall find it to occupy the medium position between those manures which, being altogether soluble, are somewhat transient in their effects, and that other class, which, like bones, are only slowly decomposed in the land, and yield their manuring principles with a certain degree of difficulty. Guano in fact, possesses every advantage of both. From analyses which have been made, it is found that about one-half of the fertilising properties of guano are soluble in water, and therefore adapted for the instant nourishment of plants. The other half continues long in the soil, eliminating nourishment for vegetables by slow decomposition. The soluble phosphoric acid, which it has been found necessary to produce artificially from bones by sulphuric acid, exists naturally in guano. If a guano contain in the whole, say twelve per cent. of phosphoric acid, and seventeen per cent. of ammonia, we shall find that water will dissolve about six per cent. of phosphoric acid, equal to about thirteen per cent. of phosphate of lime in a soluble state, and at least eight per cent. of the ammonia. Guano is thus adapted, by its insoluble matter, for the lighter soils, where infiltration might too rapidly carry away the soluble matter; and by its soluble constituents it is fitted for heavier lands, where decomposition being slower, a supply of soluble manure is required at once.

"The fact of so considerable a portion of soluble phosphates existing in guano is of great importance, as we have in a natural form that which we are obliged to

produce artificially, in other manures, by the action of acids upon hones and other insoluble phosphates.

"In fact, good guano partakes of the nature of superphosphate of lime, as it contains hoth soluhle and insoluhle phosphates. These together generally amount to the average quantity found in commercial superphosphate of lime."*

Professor Johnston follows on the same side; hut he does not speak with equal confidencc of the permanency of the action of guano. The sum of his judgment merely amounts to this: that its heneficial effects extend to two crops at least, *provided it be applied in proper quantity*. But you must bear in mind that these remarks are directed to the products of English agriculture. Consider what an immense amount of nourishment is required for a full bunch of canes, and decide for yourselves whether it he possihle for guano of itself to supply this great need. Indeed, the price to which it has now arrived, with the prospect of an indefinite advance hefore us, seems to forbid the application of it, in the proportion, I mean, which many of our planters have heen accustomed to use. Besides, there is an evil behind this which it hecomes us to note: that the higher the price of guano, the greater the temptation to adulterate it. But as this is a ticklish point, prohahly it will be hetter to hear what the analytical chemists have to say upon it.

"*Adulterations of Guano.*—In consequence of the

* Nesbit.

high price of guano, the great demand for it, and the ease with which the unwary farmer may be imposed upon, guano is adulterated with various substances, and to a great extent. Impositions even have been practised by selling, as genuine guano, artificial mixtures, made to look so like guano that the practical man in remote districts is unable to detect it. A sample of such pretended guano, which had been sold in the neighbourhood of Wigtown, and had been found to produce no effect upon the crops, when examined in my laboratory, was found to contain, in the state in which it was sold, more than half its weight of gypsum,—the rest being peat or coal ashes, with a little common salt, sulphate of ammonia, and either dried urine, or the refuse of the glue manufactories, to give it a smell. I could not satisfy myself that it contained a particle of real guano. Burnt earth and brick-dust are now prepared of various shades, and in fine powder, in special manufactories, for the purpose of mixing with guano and with artificial manures. These facts show how important it is that the farmer should possess some means of readily, and at a cheap rate, testing the costly manures he employs."*

"The high manuring value of guano, and its extensive sale, combined with the want of knowledge among farmers as to the genuineness of the article, and their manifest reluctance to be at the expense of a chemical analysis, have, together, induced many fraudulent dealers to adulterate this manure systematically, to a great extent."

* Professor Johnston.

"It is, indeed, scarcely possible to give persons at a distance an idea of the extent to which guano is adulterated in London and some other large towns.

"The demand of the farmer for *cheap* manure, acting upon the trade, through the medium of the unscrupulous dealer, has given rise to a fraudulent, and hitherto successful business.

"A most extensive and profitable trade is at present carried on by parties who practise the compounding of specious-looking ARTICLES, to mix with guano; these they supply to dealers in that manure.

"Sand, marl, clay and chalk, limestone, bricks, tiles, gypsum, ground to a fine powder, constitute the materials used to sophisticate guano, and for which the farmer is destined to pay a high price. The marls are in particular request. These, mixed in proportions to counterfeit the colour of guano, are sold to roguish dealers, *who introduce a little genuine guano* to give the necessary odour. Some recent actions, however, brought against parties who have sold adulterated guano, in which heavy damages were obtained, have contributed in a slight degree to arrest this nefarious traffic. But the real remedy lies with the farmer himself, who ought to prosecute vigorously those who impose upon him.

"One way in which you should endeavour to secure yourselves is by dealing with first-rate men; men who have a character to lose, and who are, therefore, not likely to adulterate. At the same time, I must confess that I see no effectual security except that which consists in your having samples of the bulk you buy analysed. Look at Scotland. The Scotch farmers have their samples analysed, and the bulk tested; and they

have often recovered damages when the two have not corresponded."*

But the crowning wickedness of all is set forth in an extract from a Liverpool paper, and quoted by Professor Johnston, in the seventh edition (1856) of his smaller work (page 234) on Agricultural Chemistry, published a short time before his death.

"Four vessels recently sailed hence for guano stations ballasted with gypsum, or plaster of Paris. This substance is intended for admixture with guano; and will enable the parties to deliver from the vessel a nice-looking and light-coloured article. Parties purchasing guano are very desirous of having it delivered from the vessel, as they believe they obtain it pure. The favourite material for the adulteration of guano, at the present moment, is umber, which is brought from Anglesea in large quantities. The rate of admixture, we are informed, is about 15 cwt. of umber to about 5 cwt. of Peruvian guano, from which an excellent looking article, called African guano, is manufactured."

"*In selecting a good guano,* the following simple observations will aid the practical man.

"1. The drier the better: there is less water to pay for and to transport.

"2. The lighter the colour, the better also: it is the less completely decomposed.

"3. If it has not a strong ammoniacal smell, it ought

* Nesbit.

to give off such a smell when a spoonful of it is mixed with a spoonful of slaked lime in a wine-glass.

"4. When put into a tumbler with water, stirred well about, and the water and fine matter poured off, it ought to leave little sand or stones."*

"*Guano,* which in recent times has been in such demand as a manure, owes its efficacy chiefly to the *uric acid* contained in it, or, in so far as this has already undergone decomposition, to the *ammoniacal salts* formed from it; and, in part also, to inorganic *salts* (sulphate, phosphate, and muriate of potassa, soda, lime, magnesia, &c.) present in it. On account of the great difference in the article, it is indispensable that the farmer should test it before its application. This is done with sufficient accuracy for agricultural purposes in the following way:

"*Experiment a.*—Pour some strong vinegar over guano; no perceptible effervescence should ensue. A brisk effervescence would indicate an admixture of carbonate of lime.

"*Experiment b.*—Heat half an ounce of guano in an iron spoon over an alcohol lamp, or upon glowing charcoal, till it is burnt to a white ash; good guano should only leave behind, at the most, one dram of ashes. How much alkaline salt this ash contains may be ascertained by extraction with hot water; what remains are earthy (lime and magnesia) salts. The inferior sorts of guano often yield, after burning, three-quarters of ashes.

"*Experiment c.*—Treat half an ounce of pulverized guano several times with hot water, and decant the

* Professor Johnston.

liquid after it has become clear on settling; then dry and weigh the muddy mass which finally remains; it should not weigh more than a quarter of an ounce."*

The principle of natural guano consists in the existence of a little free uric acid, with uric and phosphoric acids in combination with ammonia and a certain portion of lime, forming urate and phosphate of ammonia and phosphate of lime. Perhaps one of the best modes of ascertaining this by analysis would be—

1. To reduce to powder a small portion, say 100 grains, of the guano to be tested.

2. Put the powder on a paper filter, supported by a funnel, in a glass vessel, or in the ring of a retort stand, and pour over it a hot solution of caustic potash; then, observe whether any smell of ammonia, (like hartshorn,) is given off: this may be further tested by holding over the fumes a piece of moistened turmeric paper, which will immediately become reddish-brown: allow as much of the solution of caustic potash to pass through the filter as will extract all soluble matter, which it will to the extent of from eighty to eighty-five per cent, until it becomes colourless; leaving behind a mixture of carbonate, oxalate, and phosphate of lime, with a little sand and organic matter. We shall then have a dark, red-coloured liquid of a strong, pungent odour: this liquid must now be *heated* until all smell of ammonia disappears. If to this solution you add muriatic acid, or spirit of sea-salt in excess, an abundant crystalline precipitate of a reddish-brown hue will be obtained, not unlike the red gravel in man. This constitutes one of the principles of urine, and is called uric acid.

* Professor Stöckhardt.

3. Next, this brown crystalline deposit may be rendered perfectly colourless by re-dissolving it in a fresh solution of caustic potash, with a small proportion of animal charcoal, gently heating it for a few minutes, filtering, and then acidifying the liquor with muriatic acid, and collecting the precipitate on a filter, and evaporating it to perfect dryness by a gentle heat, such as we obtain from a steam-bath.

4. If this *decolorised* precipitate be treated with strong nitric acid it will be dissolved with an effervescence. The solution should now be evaporated to dryness by the heat of the water-bath, when the subsequent addition of a few drops of strong ammonia-water to the hot residuum will develop a spendid purple-red colour,—indicating the existence of animal matter, and forming the well-known "murexid" of Liebig. A stronger proof of the genuineness of guano, could not be obtained by any other process: *for had a strong acid, such as nitric or muriatic acid been used in the first instance, any earthy matter which may have been mixed with the guano would have been dissolved: but by using the solution of caustic potash instead, the guano only will be dissolved to the extent stated; and thus any adulterating material is sure to be detected by its insolubility in that menstruum.*

I had the pleasure of witnessing this simple and satisfactory experiment performed by Mr. Horsley himself in his laboratory.

"Setting aside, for the present altogether, the question of the adulteration of guano, we shall find that even the genuine sort will sometimes vary in its relative value, which shows the necessity for inquiry, through

the medium of a practical chemist, into the composition of any sample, before purchasing; as the following instances prove.

"A party obtained two samples for analysis, one from Gloucester, and another from Worcester: each sample was offered as the genuine Peruvian guano; that from Gloucester being quoted at 12*l.* 10*s.* per ton, whilst the Worcester sample was 15*l.* per ton.

"The Gloucester sample, besides yielding the usual quantity of ammonia, &c. dissolved in *boiling water* to the extent of 73 per cent.; but the Worcester kind only 55 per cent.; which goes to prove that high prices are not always a criterion of the quality. 'Try before you buy,' is a most valuable motto to be observed in the purchase of guanos, whether natural or artificial. The analysis of a well-known-scientific chemist will prevent much disappointment as well as loss of money, in buying a comparatively worthless article in mistake for the genuine."*

As we have heard of Jamaica guano, I subjoin the analysis of a sample, which I myself saw. It was perfectly worthless.

"ANALYSIS OF JAMAICA GUANO.

	per cent.
Organic matter, humus, or vegetable mould	35
Inorganic matter, carbonate of lime with traces of phosphate of lime and sulphuret of iron	65
	100

"This sample was *perfectly destitute* of those principles usually associated with guano, such as uric acid and ammonia, on which their efficacy mainly depends."†

* John Horsley, F.C.S. † John Horsley, F.C.S., Analytical Chymist.

MANURE COMPANIES.

Adulterations such as those to which we have referred, are not confined to guano, but are systematically adopted in the manufacture of all artificial manures. Adulteration is, in point of fact, become a science, and is one of the chief characteristics of the age we live in. I have been assured, on the very best authority, that there is no one article in regular demand for public use, whether of food, clothes, furniture, or anything else you can name, for which there is not some spurious substitute, prepared, in many instances, by processes the most elaborate and costly. Suppose a Joint-Stock Company to be started in any part of England, for supplying the public with any article of commerce, the first care of the directors is to secure the means which science affords,—not for the object of producing a pure article for the use of the people, but to see how cleverly they can adulterate the article in question, in order to make greater profit for themselves. This system is now a popular theme for lectures throughout the United Kingdom. Books are written on the subject, and every public channel is in requisition to make these schemes of deception patent to all: but as yet without effect. Let a Joint-Stock Company be formed for the purpose of supplying artificial manures, for example:—the first thing to be done is to find out some shrewd, needy, unscrupulous fellow, just so far acquainted with the principles of chemistry as to be able to compound an

ingenious counterfeit of the real thing. Such knaves abound :—for there are manure manufactories in almost every large town in Great Britain ; but they are no more to be classed with the learned and high-minded Professors of chemistry than a pettifogger in the law with one of the Judges of the Court of Queen's Bench.

It is on this account that almost every sample of manufactured manure, imported by our planters into Barbados, has proved to be an utter failure—a failure for which there is no legal redress, as the rogues know well, for, by no operation of *habeas corpus* can these *vile bodies* be haled before the judgment-seat of Sir Bowcher Clarke. Can it be matter of wonder, then, that our countrymen are restricted to the use of guano alone ?

At a meeting of the London or Central Farmers' Club, which took place in February last, Mr. Robert Baker, of Writtle, an eminent agriculturist, and a man of character, thus spoke out in the presence of gentlemen from all parts of the country,—distinguished chemists,—and manure-dealers :—

" Having spoken of what might be termed natural manures, he would say a word or two with regard to those manures which were strictly artificial, and in which there was now so much competition. Some of these manures were very valuable, and their utility was becoming more and more appreciated. He would recommend all present, in procuring them, not to deal with any but persons of repute, and persons whom they knew to be trustworthy. He had had samples of manure sent to him as presents by manufacturers, accompanied with a request that he would be kind enough to state his opinions as to the results. Having

tried the experiment, and found the result satisfactory, he could not do otherwise than report favourably: but what was the consequence? Why, he was afterwards blamed by farmers, who said that in consequence of seeing his name appended to a certificate, they had bought manure, which produced no such effect as had been described. The truth was, that the manure sent to him, and that which was afterwards sold to his friends, were totally different in quality. (Laughter.) This showed the necessity of caution in purchasing artificial manures. There ought in all cases to be a written guarantee as to the constituent properties of the article; and then, if these were wanting, the seller could be held responsible. The urate he had found very serviceable. Blood-manure and wool-manure were also used with great advantage, which was the best or the cheapest he was unable to say. To show the necessity of vigilance in such matters, he would remark that, about two years ago, a new article was announced as being exceedingly beneficial; and it was observed that it was much cheaper than guano. After a large number of persons had been caught by this statement, the matter was investigated, and it was afterwards declared in print that an article which was sold for 7*l.* per ton was not worth more than from 25*s.* to 30*s.* An action was threatened; but the fear of the trade in the article being cut up root and branch by exposure, prevented it from being brought."

I beg you to note that the assembled company saw cause for merriment in Mr. Baker's account of the base fraud which had been practised by the manure-dealers, upon himself and his brother farmers.

Mr. Nesbit gives, at page 125 of his latest work on

Agricultural Chemistry, analyses of good and bad samples of that most valuable manure, superphosphate of lime. The valuation of the good sample is set at 6*l.* 18*s.* per ton; the bad at 2*l.* 4*s.*: both sold in open market at the same price.

ANALYSIS OF GOOD SUPERPHOSPHATE OF LIME:

Moisture	19·82
Organic matter	20·72
Silica	2·80
Soluble phosphate	10·25
Insoluble phosphate	16·60
Hydrated sulphate of lime	29·81
	100·00
Ammonia	2·00

Hitherto the great chiefs of science have been referred to by farmers, as a last and only appeal against fraudulent dealers; and their analyses have been received, in courts of law, as conclusive evidence. But it is said that when matters are at the worst, we may look for amendment; and I think I find a hope of better things in the prospectus of a new company, called the "British Patent Manure Company," of Manchester, in which it is stated that their manures will be manufactured under the immediate inspection of Dr. Sheridan Muspratt, one of the most distinguished professors of chemistry in the Kingdom, and a gentleman of high character.

"This Company's Manures" (I quote from the prospectus), "are prepared on the principle, that they contain *all the ingredients* of the best Peruvian guano, and in a better and more assimilative form, besides *other mineral matters* which are known to play *a most*

important part in the vegetable kingdom; all the salts being in more *exact proportion* for the complete development of the crops for which they are suited, than is found in guano; consequently, independently of price, they are far cheaper."

Analysis yields the following centesimal results, which show the richness of the compost:

Phosphate of lime Phosphate of magnesia	18·97
Superphosphate (soluble phosphate)	7·34
Sulphate of lime	5·03
Sulphate of magnesia	6·94
Chlorides of potassium and sodium	3·77
Ammoniacal salts	16·01
Silicate of Potassa, &c.	4·77
Nitrogenous matter, &c.	24·21
Water	12·96
	100·00

This manure will be applied precisely like guano, and its price is fixed at eight guineas per ton.

Last year I ventured upon the "*Poudrette de Bondy;*" but in consequence of the drought which prevailed during the later months, I am not in a condition to speak positively as to its efficacy. But I believe in it for all that. The difficulty is with the people themselves,—to get them to put their hands to it. In my case, I was obliged to use a kind of "pious fraud" to overcome their prejudices.

ANALYSIS OF POUDRETTE DE BONDY:

Moisture	23·20
Organic matter	28·05
Carbonate of lime	7·73
Carried over	58·98

Brought over.....	58·98
Phosphate of lime.....	12·50
Silica.....	24·65
Sulphate of lime	3·87
	100·00
Nitrogen (equal to)	1·76
Ammonia	2·13

Among those who have made known to the farmers of England the fraudulent practices adopted at manure-manufactories, no one has spoken out so plainly and so boldly as Mr. Nesbit. The strong language which he has been driven to use, almost wears the appearance of prophecy. At the conclusion of his Lecture on Artificial Manures, he says: "If agriculturists generally were vigorously to pursue the plan of getting their manures analysed, I believe its necessary effect would be to put a stop to adulteration, to drive the dishonest dealers from the market, and to leave the manure-trade in the hands of honest and honourable men." Even now, while I am writing, I observe in *The Times* an advertisement of another Manure Company, under the very highest auspices as regards the rank and character of its promoters; and with the name of Mr. Mitchell, Fellow of the College of Chemistry, as the presiding genius of the establishment. Therefore, I am bound to modify my remark that, hitherto, the representations of lecturers on the subject of manure-adulteration have been without effect.

This new Company is called the "British Agricultural Company," with a large capital, in 100,000 shares, at one pound each; and it is proposed to manufacture, by a patent process, manure from the contents of cess-

pools and the blood of slaughter-houses. It will be supplied at one-half the cost of Peruvian guano, which it fully equals in fertilizing qualities. So runs the Prospectus.

The mention of the ingredients of this manure which the "British Agricultural Company" design to turn to good account, ought to remind us that we, too, in Barbados, have been long in the habit of neglecting our own local resources in this respect.

I am afraid we must abandon, for the present, all hope of bringing *night soil* into use. I say, for the present, because I think it not improbable that, when we are better acquainted with the effects of certain deodorizing substances, we may be able to compound something similar to the Poudrette. But let me earnestly recommend that steps be promptly taken for the saving of *bones* throughout the Island. When it is considered how great an amount of bones of fish, and fowl, and cattle, and sheep, and pigs, may be obtained in Bridge Town and the Garrison,—not to take the country into our calculation,—and by how simple a process they can be converted into a most useful manure for our canes, I think that an enterprising individual might make a good living for himself, by carrying out the suggestion.

A small perquisite to domestic servants would give them an interest in preserving the bones, and refuse animal matter, of the house to which they belong. The same plan might be adopted in the Garrison, and throughout the shipping, and as the scheme enlarged itself, agencies might be established in Demerara, Trinidad, and other places where bones are not required as manure.

"The introduction of bones as a fertilizer," says Mr. Cuthbert Johnson, "is perhaps one of the most important and successful agricultural efforts of modern days, and has been certainly one great means of sufficiently increasing the national production of corn, to keep pace with an annually growing population."

Again, "There is, perhaps, no manure of whose powers the chemical explanation is more easy; for of the earthy and purely animal matters of which bones are composed, there is not a single particle which is not a direct constituent or food of vegetables; thus, if carbon, hydrogen, and oxygen are found in the abounding oil and cartilage of bones, they are equally common, nay, ever present in all vegetable matters: and if carbonate of lime and phosphate of lime are almost equally common in plants, they are still more universally present in all bones.

"Crawfish-shells, lobster-shells, egg-shells, &c., are all composed of the same ingredients as bone. The poor of Dublin are often employed for the purpose of pounding oyster-shells for the use of the cultivator of the soil; and a similar plan might, I should imagine, be very advantageously adopted elsewhere; for, although such shells do not contain the same proportion of phosphate of lime as bone, yet they contain a sufficient quantity to render them highly valuable as fertilizing substances."

To these we may add sea-shells of every description.

Professor Johnston explains the mode of preparing bones for the use of the planter, in the following passage:—

"For the purpose of bringing bones into a state in

which the substances they contain can be more readily taken up by the roots of plants, and at the same time more uniformly distributed through the soil, the method has been adopted of dissolving them in sulphuric acid. For this purpose, the bone-dust is mixed with one-half its weight, and sometimes with its own weight of sulphuric acid, (the oil of vitriol of the shops), previously diluted with from one to three times its bulk of water. Considerable effervescence takes place at first, from the action of the acid upon the carbonate of lime in the bones; but, after two or three days, with occasional stirring, the bones are entirely dissolved or reduced. The solution or paste may now be dried up with charcoal powder, with dried or charred peat, with sawdust, or with fine vegetable soil;" or, better still, with our native marl.

A better receipt to make super-phosphate or bone-manure:—

"For every bushel of bone-dust, from twelve to fifteen pounds of strong sulphuric acid (oil of vitriol), mixed with from five to eight parts of water, are required."

If any considerable quantity is to be made, a second-hand butt or hogshead will form a convenient vessel for the purpose; into this place a layer of bones, and sprinkle them with water from a watering-can; then another and another layer, sprinkling each time with water, until the vessel is nearly full: then pour on the acid, and stir all well together.

ANALYSIS OF SOILS.*

"There are four substances termed earths, viz.: Carbonate of Lime (Chalk), Carbonate of Magnesia, Alumina (Clay), Silica (Flint or Sand), which, to a greater or less extent, are found in almost every soil.—The organic remains of animals and vegetables are, also, frequently associated with these primitive earths. It is, therefore, essentially necessary that the agriculturist should, in order to reap the full benefit of his labour, and the capital expended on his land, ascertain, by a course of systematic experiments, the quality and composition of the soil, as possibly it may be either too rich or too poor for the kind of crop he wishes to grow. To do that properly requires some little care and judgment in the selection of the samples to be experimented on. He must not be content with merely taking one, but several samples from different localities, and at different depths, for it very often happens that although the superior or uppermost layer may be the same throughout a field, yet the subsoil, a few inches immediately below it, shall differ most materially. The quantity of any sample need not be large, perhaps; one or two hundred grains would be sufficient.

Soils in general, however, present certain exterior and physical characters which may, in some measure, guide the experimenter. For instance: those containing

*I desire to express my obligations to Mr. Horsley for his valuable assistance in the preparation of this chapter of my work.

iron, called *ferruginous,* are usually either of a reddish or yellowish colour. *Calcareous,* or chalky soils, are white and soft to the touch; whilst the *silicious,* or sandy soils, on the contrary, are *rough* to the touch, and scratch glass, &c.

"Having described the general character of soils, a few short, simple, and, at the same time, practical rules for their analysis may not, perhaps, be out of place here.

"THE APPARATUS

necessary for making experiments on soils and manures can be obtained of Messrs. Horne and Thornthwaite, Newgate Street, London, price (packed in a box) 2*l.* 12*s.* 6*d.*, and are as follows:—

Pair scales (common apothecaries')
Small fine-wire sieve, for separating stones from soils
Naphtha spirit lamp
Cylindrical earthenware hood and support for the vessels to be heated
Copper water-bath and dish for the same, for drying precipitates, &c.
Evaporating dishes, three or four medium sizes
Wedgewood mortar and pestle
Wedgewood funnels, two sizes
Filtering paper
Glass measures, one half-pint and one two-ounce
Glass rods, for stirring fluids
A spatula
A set of small earthenware crucibles, for burning off organic (animal and vegetable) matters
Retort stand, with rings for supporting funnels, &c.

"CHEMICALS.

Blue litmus paper, for testing acids by the *red* colour produced
Yellow turmeric paper for testing alkalis by the *brown* colour produced
Half-pint bottle muriatic acid (spirit of sea-salt)
Half-pint bottle sulphuric acid (oil of vitriol)

Half-pint bottle pure nitric acid
Half-pint hottle strong solution of caustic ammonia
Half-pint hottle strong solution of caustic potash, for detecting ammonia hy the hartshorn smell given off on its addition to any soil or manure
Quarter-pint bottle solution of yellow prussiate of potash, for detecting iron hy the *blue* coloured precipitate produced
Quarter-pint solution of oxalate of ammonia, for throwing down lime as an oxalate
Quarter-pint solution of phosphate of soda, to throw down magnesia
Quarter-pint acetic acid for distinguishing oxalate of lime, from the phosphate, hy the insoluhility of the former in this acid
Quarter-pound nitrate of ammonia, for aiding the complete combustion of organic matter contained in any soil
Half-ounce hottle nitrate of silver, for showing the existence phosphates
Four-ounce hottle carbonate of ammonia

I.—*The Density of the Soil.*

"The gravity of the soil, *i. e.*, whether it be light or heavy; this may be ascertained by the amount of *moisture* it contains; thcrefore, by taking, say one hundred grains of a soil, and subjecting it, in a dish, to the continued heat of a water-bath until it ceases to lose weight, we are able to determine, by one operation, the perccntage of both aqueous and solid matters.

II.—*Estimation of Organic Matter by Ignition.*

"Weigh out one hundred grains of the soil, place them in a small earthenware crucible, and insert it in a *clear* fire, at an angle of about forty-five degrees, so that *no dust* shall get in, and allow it to assume a *bright red heat* for about half an hour, or till no gases are given off; then take it out, and when all is cold, weigh the contents. The loss will be the organic matter which

has been dissipated. Sometimes the addition of a little nitrate of ammonia is used to effect the *complete destruction* of all organic matter; the nitrate of ammonia volatilizing with it at the same time. The residuum, of course, will be the mineral, or inorganic matter.

III.—*Estimation of Matter soluble in Water.*

"Weigh out one hundred grains, and boil them for some little time in *distilled,* or rain-water (if the other is not at hand), then project the whole on a filter, dry the residue on a plate, in the oven, and note the *weight* of the insoluble portion. The difference will probably consist of alkaline salts, and soluble organic matter, extracted by the water.

IV.—*Estimation of total amount of soluble Matter.*

"Weigh out two hundred grains, and add to it in an evaporating dish, muriatic acid (spirit of sea-salt) in *excess,* or till it no longer dissolves any more: an *effervescence* occurs, and continues for some time, indicating the existence of a carbonate or carbonates,—the gas which is given off being carbonic acid. This solution (which should be divided into two parts, we will call A and B) must be filtered, and the residuum well washed with distilled or rain-water. The residuum may possibly consist of silica or alumina, with a little insoluble organic and metallic matter.

V.—*Estimation of the Alumina and Silica in a mixed state.*

"Next, let the residuum be first treated as described in the second experiment, and after all organic matter

has been *burnt off,* boil it in a strong solution of caustic potash: if it becomes dissolved, the addition of muriatic acid in *excess* will determine whether it be silica or alumina, or a mixture of both. If the latter, at first a thick *gelatinous* precipitate will be formed, which, should it become re-dissolved, on the addition of more acid, indicates the existence of alumina; on the other hand, a *granular, sandy,* and insoluble precipitate, will prove it to be silica, which can be separated by filtration, when the addition to the filtered liquor of an excess of a solution of caustic potash will again precipitate the alumina in a gelatinous state, and, if required, it can be washed, dried in an oven, and its weight ascertained.

VI.—*Estimation of the whole amount of earthy Matter.*

"We will now proceed to experiment with a part of the solution A first obtained (see Experiment 4). This may possibly contain either lime, magnesia, or a little alumina as the earthy bases. Oftener, however, the two former, with perhaps some iron, and sometimes manganese. By the addition of a solution of caustic ammonia to the liquid, until it is *slightly* alkaline; which state can be ascertained by test papers: a more or less bulky white precipitate will be obtained. This must be projected on a filter, well washed with rain or distilled water, and dried in an oven, or otherwise: it is then ready for the next operation.

VII.—*Estimation of Alumina.*

"First of all, we must search for alumina, which is easily dissolved out by boiling the dried powder in a solution of caustic potash, which has *no action* on lime

and magnesia. Again project on a filter, and *well wash the residuum* with water, and reserve it for the next operation. If the filtered liquor had extracted any alumina, the addition of a little acid, to neutralize the potash, will precipitate that earth in a *gelatinous* form.

"For all practical purposes, this may perhaps be considered a sufficient analysis of the earthy bases; the present residuum being probably lime or magnesia, or a mixture of the two earths, which, from their analogy to each other, may be classed together; but if it be desired to know whether they *both* exist, this is easily determined by adopting the following simple process; hitherto the separation of them having always been a *difficult* problem for chemists to solve.

VIII.—*Estimation of Lime.*

"To the *dried* precipitate, add so much strong sulphuric acid (oil of vitriol) as will just cover it: after a few minutes, dilute with four or five times that quantity of water, and, when it is cold, filter off the soluble portion, which may possibly be a solution of magnesia, (if that earth exists at all,) the lime being rendered so *comparatively insoluble* that only a mere trace will then be found in the liquid.

IX.—*Estimation of Magnesia.*

"Saturate or neutralize the acid by introducing a few pieces of carbonate of ammonia (smelling salts) until bubbles of gas *cease* to rise, then *decant* the liquid, add thereto a sufficient quantity of a solution of oxalate of ammonia as will precipitate what little lime remains, and pass the liquid through a filter till it is clear. When

no more *opacity* is induced, the lime is extracted, and magnesia probably exists, which can be proved by the addition of a solution of phosphate of soda, followed by a few drops of strong solution of ammonia. On stirring the mixture *briskly*, a crystalline precipitate of the ammonio-phosphate of magnesia falls; thus completing the analysis of the earthy bases. By passing the mixture, through a filter, collecting the precipitate (without washing, as it will dissolve away), drying it in an oven, and then heating it in a crucible to bright redness, the residuum will consist of one-third magnesia.

If the weight of the dried earths has been first taken, by noting the weight of the magnesia obtained, that of the lime also, will be known by subtraction.

X.—*Estimation of Iron.*

"Having now ascertained all the earthy bases, we will take the other portion of the liquid B (Experiment 4). The addition thereto of a solution of the yellow prussiate of potash, will produce a more or less *deep blue*-coloured precipitate, known as Prussian blue, which is insoluble even on the addition of any strong acid, but readily dissolves with the loss of all its colour in a solution of potash. This proves the existence of iron in the soil.

XI.—*Estimation of Phosphates.*

"The next and last thing to complete the analysis of a soil, is to ascertain if any phosphates exist; and, as it is seldom that they are other than earthy in character, and derived probably from the organic remains of decayed animals and vegetables, we shall, of course, find them in the acid solution, for they are insoluble in

water. Having made a solution of the soil in nitric acid, diluted with two or three times its weight of water, add so much potash as will exactly neutralize it. By this proceeding, we precipitate the earthy bases which were before held in solution, combined with phosphoric and nitric acids. If, therefore, phosphates exist, the addition to the filtered solution of a few grains of nitrate of silver (lunar caustic) will show it, by a lemon-yellow coloured precipitate (phosphate of silver) being formed. Phosphate of lime is a most valuable constituent in soils where corn and other grain-crops are grown; hence the use of bone-manure, called superphosphate. Bones, consist of fifty per cent. of phosphate of lime, and by digestion in sulphuric acid, are rendered soluble, and capable of being readily assimilated or taken up as nutritive matter by growing crops.

"If it be desired to know the nature of the *alkaline* salts extracted from a soil by simple digestion in *plain* water: after allowing it to stand some time, filter it, and then evaporate it to perfect dryness in the water-bath, and divide it into three portions.

Ammonia.

"If to one portion, dissolved in a little distilled water, and filtered, we add a solution of caustic potash, ammonia will be *evolved*, if it exists at all, which can be detected by the *hartshorny* smell, as well as by holding over the fumes a piece of moistened yellow turmeric paper, which is stained brown by ammonia.

Potash.

"Take another portion of the dried salt, and similarly dissolve in water. The addition of a solution of chloride

of platinum, will, if potash exist, produce a yellowish crystalline precipitate; or some tartaric acid may be boiled with the solution, when white crystals of bi-tartrate of potash, or cream of tartar, form.

Soda.

"To another portion, a solution of the meta-antimoniate of potash will reveal the presence of soda, by a white precipitate being formed.

"*The acids* which were combined with the above bases may be easily inferred by testing different portions of the solution of the salts; first, with a little nitrate of silver: if a milkiness ensues, chlorine is evident. If, on the addition to another portion of a solution of nitrate of barytes, a milky white precipitate forms, that indicates sulphuric acid. If a yellow precipitate is formed, on the addition of nitrate of silver, phosphoric acid exists, except where the salt has been burnt: in that case, there is a white precipitate; or by a solution of nitrate of uranium, the yellow precipitate from which, unlike the phosphate of silver, dissolves in muriatic acid, and is insoluble in ammonia. If, on the addition of lime-water to another portion, a milky precipitate forms, then that shows the existence of carbonic acid. Nitric acid can be detected by projecting the dried salt, on some red-hot coal, and observing if it burns and crackles; or by mixing a teaspoonful of strong sulphuric acid (oil of vitriol) with two or three table-spoonsful of water, and adding a drop or two of a solution of the sulphate of indigo. On the application of the heat of a spirit-lamp, and introducing a few grains of the salt *supposed* to contain nitre, the blue colour will

be *destroyed*, in consequence of the formation of *nitrous* acid, which bleaches the indigo: or by mixing a little of the salt with water in a wine-glass, placing therein a crystal of sulphate of iron, then gradually pouring down one side of the vessel, so that it should not *mix with the water*, about as much strong sulphuric acid as will just cover the crystal. If nitre exists, there will be a *pinkish*-coloured margin formed at the under part of the water, where it rests upon the oil of vitriol; the crystal, also, will present a pinkish appearance."

PART II.

THE MANUFACTURE OF SUGAR.

In this Second Department of our Manual, wherein it is proposed to treat of the Manufacture of Sugar, it may be of advantage to commence with a few simple hints relating to certain preliminary matters, as they follow in order. Let us see what these are. First of all, there is the Mill to be looked after, and all that appertains to it:—the soundness of the timbers;—the state of the cog-work;—the brasses, whether they be worn away;—the arms;—the points;—the sails, and sail-cord;—the condition of the main cistern, strainers, and pipe. This brings us to the Boiling House, where there is much to be examined,—the staunchion and its gutters;—the molasses-cistern; and, very especially, the state of the windows, that they shut closely;—the racking-coppers;—the tayches, with the scummers, ladles, and pails;—the flood-gate, that it works freely;—the dipper and its valve; and, lastly, the wooden coolers. All these are to be carefully examined by the manager himself, in order that they may be repaired, if necessary, in good time: otherwise, for want of this foresight, the crop may be delayed some days, to await the convenience of the mill-carpenter, the plumber, or the mason. For you cannot fail to perceive that if every manager puts off these workmen until the last moment, some must be disappointed, to the great loss of the owner; and the workmen themselves exalted to an undue estimate of their own personal and particular

importance: a state of mind not at all unusual with this class.

Again, there are the necessary stores to be provided: mill-grease, a jar or two of temper-lime to begin with, wood-hoops, truss-hoops, nails, boards, and staves. All these stores should be laid up ready for use at an early time, that the coopers may be set to work in the month of October. By this arrangement you will be able to inspect their workmanship as it proceeds; and see for yourself that the hogsheads are honestly put together, both as relates to the thickness of the staves, and the full allotment of nails.

On the subject of hogsheads I will add a few more hints, which I commend to your attentive consideration. I wish it were the practice throughout the island to make hogsheads of one and the same size, and this wish of mine would not be altogether futile if the District Agricultural Societies would issue a positive recommendation to this effect. One good result from an arrangement of this nature would be to insure a more correct estimate, by comparison, of the crops of estates respectively. I speak for those absentee proprietors who are not competent to look into the merits of the case, as it stands at present, and who, for the most part, have the very vaguest ideas on the subject. To them a hogshead is a hogshead: their own crop seems equal, in number of hogsheads, to that of their friend, Mr. So-and-so; and yet, somehow or other, the upshot of the transaction, when it comes to net proceeds of sale, is against them.

For my part, I prefer a forty-inch hogshead: but I should have no objection to comply with a general understanding in favour of a thirty-nine-inch truss.

The staves should be the best Norfolk Inspection, it being false economy to use staves of inferior quality. Next, as to the number of nails required for each hogshead, I am sure we have much yet to learn. I have known an allowance of one hundred and eighty eightpenny and forty tenpenny nails per hogshead. On the other hand, I have been informed, on good authority, that strong hogsheads have been made for sale in town with a proportion of only one hundred and fifty nails in all, except the heading. Therefore, this is another and equally important question to be settled by general arrangement.

The rough treatment which hogsheads experience during the process of stowage on board ship, renders it absolutely necessary that we should provide against this evil in some measure, by inserting two lining hoops. The late Mr. Wood, whose memory will ever be regarded with great veneration by his friends, was accustomed to have every nail in the hogshead clinched.*

There is another thing, too, which will materially contribute to the strength of the hogsheads: which is, TO FILL THEM WITH SUGAR TO THE TOP, AND AFTERWARDS TO RAM IT DOWN. I am free to declare that, in consequence of careless casking of sugar in Barbados, hundreds and hundreds of hogsheads come to market only two-thirds filled. It stands to reason, therefore, that under such circumstances the headings of these hogsheads are easily crushed in, thereby affording an outlet for the sugar within: whereas, if the hogsheads had

* I am accustomed to order, for my own use, from Messrs. Thomas and Robert Lang of Bristol, nails of extra length and weight, as

Coopers'	8d.	$2\frac{1}{4}$	inches.
Carpenters'	10d.	$2\frac{2}{3}$	„

been tightly filled and rammed, in the first instance, they would have been enabled, by the very compactness of the mass, to have resisted almost any amount of pressure.

There is one other observation I would make in this place. I advise you to select with care the thickest and best boards for the heading and footing of the hogsheads; and to see as far as you can, that the knots in the wood present the larger end inwards: for if, by a not unfrequent accident, the knots happen to be forced out, there will be so many wide openings through which the sugar will surely escape.

I object to the common custom of "gunning off" the hogsheads, as it is called, and leaving them exposed to the weather. If there is room enough in the buildings, I recommend you to have them finished completely, and, each with its heading cut and thrown in, packed away under shelter. The chief objection to the system of exposing the hogsheads is that they become embrowned by the action of the sun and wind, in consequence of which they are subjected to a second course of trimming and paring for the sake of neatness, when they come to be finished off for use. Our aim is to make them as heavy as we can, to meet the tare in England.

Keeping this latter requirement in view, you will not allow the staves to be chopped more than is absolutely necessary; for the chips and parings being, by universal concession, the perquisite of the Cooper, he is tempted to push his privilege to the utmost, without thinking of the rights of the owner. This little rivalry of interests can always be settled with good humour between yourself and the worthy mechanic.

The cutting of the canes is in itself an operation of

considerable importance. Each separate cane must be made the most of: that is, cut close down to the "stool," or stump, and at the top, up to the last perfect joint. This work must be diligently watched from first to last.

Cane-tops being of great value, as food for the cattle, they are to be collected day by day, and stacked while green, in ricks or heaps outside the field; whence they can be more conveniently removed.

The manner in which the carts are loaded with canes is, also, of importance, and is a task not to be performed negligently, or with over-haste. This is too often the case where the carters are paid by the load; and hence it is that we see canes littered over the high road which leads to the mill. As soon as you have cut well into the field, it will be of advantage to make a smooth passage for the carts, by levelling the edges of the cane-holes, which will make the work easier to the cattle, by taking off the strain produced by unequal and jerking motion. Prevention is better than cure, and it will be cheaper to incur the expense of a little extra labour than to pay for the repairs of a broken cart; not to mention the hindrance to business.

THE MILL.

The superiority of horizontal over vertical rollers is an undisputed fact. A series of experiments, conducted under the personal auspices of one of our most experienced and intelligent planters, W. M. Howard, Esq., goes to prove that the average yield of juice from one hundred pounds weight of canes shows eleven per cent. in favour of the horizontal roller.

HORIZONTAL ROLLERS.	JUICE.	TRASH.	VERTICAL ROLLERS.	JUICE.	TRASH.
Lower Burney	68	32	Upton	60	40
The Belle	70	30	Chance Hall	58	42
Drax Hall	68	32	Harrisons	53	47
Bright Hall	60	40	Husbands	52	48
Chequer Hall	66	34	Hope	53	47
	$66\frac{2}{5}$			$55\frac{1}{5}$	

The first point, then, as you see, in favour of horizontal rollers, is the increased percentage of cane-juice: the second, that they are fed with more ease, one boatswain being quite equal to the task: the third is, that the canes can be distributed more equally and with greater regularity along the rollers, thereby causing less strain upon the entire machinery; and also, delivering the megass, for the most part, whole and unbroken. In those colonies where steam-power is adopted, horizontal rollers offer an additional advantage, since extra machinery is universally attached to them for the pur-

pose of bringing up the canes from below, and taking away the megass.

But to make sure of these advantages it is necessary that the rollers should be properly braced: and you must see to it yourself, not only when the mill is first set to work in the early morning, but also at stated periods throughout the day. It is usual, I believe, to leave the nipping rollers apart, to the extent of nearly three-quarters of an inch: the delivering-roller being screwed up to something less than the eighth of an inch. But there is no general rule. The thing should be submitted to a test until you have ascertained exactly the degree of bracing suited to your particular mill.

If you will again cast your eyes over the table of experiments set forth above, you will not fail to observe that even in the case of horizontal rollers the most striking differences in the results are apparent,—varying from four to ten per cent. This fact will enable you to form a more accurate opinion of the comparative merits of the several rollers.

M. Eugene Peligot, a French chemist, after a recital of his various experiments on cane-juice, winds up the subject in these words:—

"Hence the sugar-cane contains, theoretically, ninety per cent. of juice; but the crushing of it is so difficult, and its texture is so spungeous, that it hardly yields, upon an average, fifty per cent. at Martinico: it is probable that, by means of improved machines, and washing the megass, the above fifty per cent. could be greatly exceeded."

I do not know what amount of technical *qualification* may be contained in the word "theoretically:" but if

M. Peligot means to assert, as an absolute fact, that one hundred pounds weight of canes contains ninety pounds of juice, I have only to say that it is a stark impossibility. I utterly deny it. It is as untrue as that two and two make five. The utmost quantity of juice *proved* to have been extracted from the cane, by horizontal rollers, is as seventy-two to one hundred pounds. The megass, weighing twenty-eight pounds, was flattened to the thinness of a sheet of paper, and was to all appearance dry. Let us grant that, "theoretically," three or four, or even five per cent. remains in this residue of wood and fibre; and that, by additional maceration and washing, it could be extracted: I meet this at once by declaring that the sugar obtained by so elaborate a process would not be worth the cost of any experiment. Be that as it may, I CHALLENGE ANY CHEMIST, FRENCH OR ENGLISH, TO PRODUCE, AS A FACT PALPABLE TO MY SENSES, ANY RESULT APPROACHING TO NINETY PER CENT. OF JUICE FROM THE CANE. I suspend my claim to the slightest measure of attention to any opinion I have advanced, or any advice I have ventured to offer in this publication, upon this issue. I will have nothing to do with technical quibbling, or words used in a non-natural sense;—I challenge proof of the alleged fact—such proof as may be worked out in practice by us.

I repeatedly witnessed the trial of Mr. Bessemer's toy-mill in London, and I understood from him that seventy-five per cent. of juice was the maximum to be expected from it. But in all calculations of this kind, the advantages proposed are to be set against the first cost of the new machinery, and the constant expense of working it. On this we take our stand.

I have already stated that one of the greatest advan-

tages to be derived from horizontal mills, is that the megass is delivered, for the most part, whole and unbroken; and I need not point out the importance of this condition as affecting your stock of fuel. It is our custom in Barbados to pack the megass, in the first instance, as it comes raw from the mill, in small "cocks," shaped gable-wise: from thence, supposing you are not from hand to mouth in regard to fuel, to a larger heap or rick, where it is stacked away until needed. But this system is only good in fair weather. It is really good for nothing in a wet crop season: therefore, I strongly recommend a megass-house to be built capable of containing fuel sufficient for five hogsheads of sugar; a precaution absolutely necessary in Barbados, where the crop proceeds from the moment the first cane is out, day after day, week after week, without intermission, until all is over. The temptation of higher wages proves so strong to our people that we cannot induce them to do any other work; so that, in self-defence, each manager urges his crop on to the end, whether it rains or shines. "He that regardeth the clouds shall not reap;" and so, as we are, one and all, compelled to follow the fashion, nothing remains but that we should render ourselves independent of the variations of weather, so far as circumstances permit.

I shall have something to add on the subject of fuel in another place.

THE BOILING HOUSE.

As I desire to believe that you have not been indifferent to the "note of preparation," which has been sounded in all that relates to the condition of our external machinery, I now come to consider the important processes to be carried on within the boiling-house. The conversion of cane-juice into sugar is the sum and crown of the year's labour: the key-stone of the arch. It is a work which calls for the exercise of your best faculties, as upon your success in this department depends the prospect of your advancement.

I look around me in the expectation of observing the most scrupulous cleanliness throughout the building: the inward roof thoroughly swept, so that there may be no chance of old soot-flakes dropping into the liquor, and on our heads;—the walls white-washed;—the pavement scrubbed;—the tayches burnished to a golden brightness;—the jar of temper-lime at hand; and the cane-juice beginning to flow into the racking-copper. While it is flowing, let us consider the nature of this juice.

It is palpable to our senses that it is composed of water, mucilaginous matter, and crystallizable sugar.

The water, you know, escapes in vapour, during the process of boiling or "evaporation." The mucilaginous matter is *partly* separated by the application of lime, and partly in the molasses, a small proportion remaining

in the sugar itself. The crystallizable sugar is the great result.

The clarification of the juice is the first point to be attended to. The fire should be lighted under the copper as soon as it can be done without risk of charring it; for cane-juice being quickly acted upon by the air, and so rendered liable to fermentation, cannot be too soon submitted to the influeuce of heat. The temper-lime is now to be dissolved.

Brande, in his book on Chemistry, thus speaks of the solubility of lime in water:—"At a temperature of 60° Fahrenheit, what we may term cold water, 750 pints are required for the solution of one part of lime: *boiling* water, as Dalton first observed, does not dissolve so large a quantity; one part of lime requiring 1280 parts of water at 212° for its solution. Water at 32°, that is, at freezing point, has its solvent power so much augmented that one part of lime is soluble in 656 parts of water at that temperature!"

From this statement it would seem that lime is best dissolved in *cold* water.

Some of this solution is to be applied to the liquor when it has reached a certain heat; say, when it is just about too hot for you to bear your finger in it. I request you to be careful to mark this. As to the proportion of lime per hundred gallons, it is impossible to lay down any general rule. Your own experience will have already shown to you that it may depend upon a question of soil, of manuring, or of degree of ripeness in the cane. You will therefore regulate, by the most watchful observation, the quantity of lime to be apportioned to each racking-copper, testing the liquor repeatedly in the tempering-glass, until it exhibits the

requisite brightness. You will observe, too, that when there is a sufficient amount of lime, the particles of dirt as they descend to the bottom of the glass, assume a uniformity of shape. The tempering being completed, the fire will be continued until the thick, dark scum on the surface of the liquor opens in various places, or "cracks," as it is termed. This is an evidence that it has reached boiling-point; when the fire is to be immediately withdrawn.

The late Mr. Hewitt, who was, without question, the best authority in Barbados on the subject of sugar-boiling, was accustomed to lay the greatest stress upon the process of clarification. His peculiar strictness on this point amounted to a sort of prudery, and was so well understood by his managers that they were compelled to regulate that operation to the utmost nicety, well knowing that, in case of neglect being brought home to them, instant dismissal from the estate would be the consequence. And Mr. Hewitt was right. What is worth doing at all is worth doing well. Attention in one thing, attention in all. The same care that provides for the correct tempering of cane-juice in the first stage, will be evident in all the equally important after-parts of the process.

A portion of clay mixed with water into a kind of batter, is often used in Barbados to render the clarification of cane-liquor more perfect. This plan has ever been adopted at Mount Wilton, and the sugar of that estate, from whatever cause, has always ranked highest in the English markets. Alum in solution is sometimes employed instead of clay. This substance is obtained from alumina or clay, by an admixture of sulphuric acid, whence it acquires the name of sulphate of alumina.

Alum is derived far back from a Grcek word signifying "salt."

There can be no important objection to the use of a moderate quantity of alum to correct the effects which result from an overdose of lime; for, while it leaves in solution a small proportion of sulphate of potash, a salt which is inoffensive, it abstracts the excess of lime, and the feculencies which were united with it, and thus renders them soluble. Lye-water is used extensively in Brazil, I am informed, but from the carbonate of potash contained in it, the sugar is rendercd deliquescent or moist.

The ashes of megass or cane-trash are sometimes used to assist the process of defecation, where the juice is considered to be sour or otherwise impure. But in such cases, carbonate of potash, commonly but erroneously called "salt of tartar," which is obtained from wood-ashcs, will answer the end more effectually.

Albuminous matters, such as white of eggs, isinglass, have been often used to render the defecation of cane-juice more perfect. Mr. Cargill tells us, that it was a practice of the old Planters of Jamaica to steep in water the bark of the bastard cedar-tree (which contains mucilage in abundance), until the liquid attained the consistence of white of egg. A pail-full of this was thrown in the racking copper. Sir Humphry Davy has remarked that the juice of the ochroe contains albumen in such quantity that it is employed in Dominica in clarifying the cane-liquor. Albumen is likewise prcsent in large proportions in the Papaw-tree.

On those estates where the clarification is effected upon the principle of "Subsidence," the liquor is allowed actually to boil up in the racking copper, for

two or three minutes: and afterwards, to flow into large shallow vessels, lined with thin copper, called "settlers." Here the dirt sinks rapidly to the bottom, the liquor being drawn off by a cock placed just above the line of residuum.

A chemist of high standing has informed me that this is certainly the most scientific mode of promoting the defecation of cane-juice; but my own experience does not confirm the opinion of this gentleman. I have repeatedly examined into the matter, on estates where the utmost attention is paid to all the processes within the boiling-house: and, moreover, I have fairly worked out the experiment by comparison, on my father's estate, the Hope, Christ Church, where the soil is for the most part calcareous, and the cane-juice as pure as in any part of the island. I therefore have a right to pronounce, with some authority, on this question; and I declare that there is no difference whatever between the two modes of clarification: nay, that, as to the "settlers," there is rather a liability to waste, which, *cæteris paribus*, "settles" the question with me.

Filter-bags, imported from England, without reference to expense, have also been used among us for the purpose of clarification; but with no manifest advantage whatever.

Mr. Archbald's compound of clay, lime, and animal charcoal, has also received a fair trial, and has done no good for us.

Of the three samples exhibited by Mr. Archbald which were tested in my presence, that which contained the largest proportion of animal charcoal was decidedly effective,—as a discolourant: but it would render the use of filter-bags absolutely necessary. This, you see,

would leave us no better off than before: for cane-liquor, clear as it may be, is sure to become discoloured by the harsh action of the fire, as soon as it reaches a certain point of density. I shall have occasion to recur to this circumstance hereafter. I must, however, call attention to a particular condition in all experiments by English chemists relating to the defecation of sugar:—it is that these experiments are made upon *sugar-and-water*, and not upon *cane-juice*. This makes all the difference.

This mixture was puffed off some years ago in the *Anti-Slavery Reporter*, when occasion was taken to vent abuse, according to the spiteful instincts of that Journal, against the West Indians generally, for neglecting the means of improving the quality, and increasing the amount of their sugar-crops; both of which advantages were promised to us by the patent in question.* The article was demolished by a plain statement of facts in reply, from our friends at Mincing Lane: and if Mr. Archbald himself, as it was more than suspected at the time, suggested this calumny against the West Indian Proprietors, merely because they refused to be persuaded in respect to the benefits to be derived from his particular compound, I have only to say, that he could not have taken a more effectual mode of putting himself out of court. I repeat, then, distinctly, that his composition received a

* It was upon the extravagant assertion of M. Peligot, (to which I have already referred,) and which has been repeated far and wide, to our prejudice, by a host of pretenders to science, that this piece of malignity on the part of the *Anti-Slavery Journal* was grounded. M. Peligot and Mr. Archbald supplied the premises: and, by a process savouring more of ill-nature than logical exactness, the conclusion was against us, as a thing of course. *Hic nigræ succus loliginis.*

fair trial at Oughterson's Estate, under the superintendence of Mr. Connell, and that it did not improve the sugar one whit.

In fine, every chemical or mechanical agent of whatsoever kind and description, whether under the warranty of men of science or quacks, which has been pronounced likely to promote the complete defecation of cane-liquor, or the improvement of sugar, has been put to the proof, and found wanting: found wanting, I mean, in producing a result remunerative as compared with the expense of the means employed.

Filter-bags, vacuum-pans, Gaddesden-pans, (of which I myself have had sad experience,) centrifugal machines, all have turned out to be failures, or ruinous in this respect: and it is with us now very nearly as it was a century ago with our forefathers.

The process of clarification being now completed, the liquor should be allowed to remain a quarter of an hour at least in the racking-copper, before it is drawn down into the main battery. Here, under a fiercer fire, other feculencies will rise to the surface, to be taken off by the boiler-men with their scummers, as quickly as possible. You must watch most narrowly the whole of this operation as it proceeds from tayche to tayche, urging and encouraging the men to clean the liquor to transparent brightness. Neither your attention nor theirs must be suffered to flag for a moment. The colour of the froth, a faintly-pale straw-colour, will indicate that the liquor has been properly tempered; and when the juice is boiled to a certain density you will have another test for ascertaining this fact, by observing the short crisp cut of the syrup as it drops from the outer edge of the scummer. The boiling pro-

ceeds until it is evident that the syrup has arrived at the point of crystallization: it now rises in full, massive wide-spreading waves: and granules are distinctly apparent. To see the thing more plainly, you have only to plunge the ladle into the tayche, and draw it out with the back uppermost, when the crystals of the sugar will be visible and palpable to touch, if you choose to make the experiment. The fire is now withdrawn, and the contents of the tayche emptied.

The granulated syrup is then passed, either by means of ladles or the dipper, into a shallow copper receiver, where it is allowed to remain, being stirred occasionally for the purpose of bringing about a thorough and more general crystallization. The time allotted to this part of the process is regulated by the length of the interval between the "skips;" except in large boiling-houses, where there is space sufficient for an extra receiver. There is no doubt whatever that the more perfect the crystallization at this stage, the more perfect in the end will be the sugar. For observe; when it was customary to pot Muscovado sugar for the use of the Proprietor's or Manager's family, it was always so contrived that the quantity required for each pot, (about ten gallons,) should be left behind in the receiver, and stirred and stirred again, until it had almost reached a point of consolidation. It was then put into the pot, and even after that, occasionally agitated with a little rod. Now you all know that the crystals of pot-sugar are of much larger size than of sugar cured in hogsheads after the common fashion: and this, I think, proves to demonstration, that the process of crystallization should be for the most part effected before the sugar is allowed quite to harden in the wooden cooler. By and by we

shall come to speak of a clever process, which, although the very reverse of this, nevertheless deserves a special examination. Meanwhile, let us hark back to our text in regard to crystallization before consolidation: a result which is obtained, (to each his due) by means of THORNE'S REVOLVER.

THORNE'S REVOLVER.

The idea of a half-cylinder with a wheel of revolving rods inside, was undoubtedly borrowed from Gaddesden's pan: but the process of crystallization being conducted without the aid of fire, Mr. Thorne was saved from being prosecuted on account of any infringement of that patent. In Gaddesden's pan, the evaporation of the syrup was effected at a low temperature, owing to the unceasing motion of the wheel of revolving rods within; and crystallization was thereby enabled to proceed at one and the same time. Thorne's Revolver is merely a sort of appendix or supplement to the sugar-tayche; and is used, in lieu of the old-fashioned receiver of which we have spoken, for the purpose of promoting crystallization alone. Moreover, the high premium exacted on account of Gaddesden's patent, coupled with the repeated failure of the pan itself, had the effect of forcing the invention of some other machine to accomplish something like the same results; and this was the origin of Thorne's Revolver.

It is generally built to contain sugar enough to fill a hogshead, and skip after skip is emptied into it until the required quantity is attained, the wheel being turned slowly, with regularity, and continuously from first to last. If the sugar be "strong" and of best quality, crystallization will be completely effected in a few minutes:—with such rapidity, in fact, that it is necessary, whether you wish or no, to pass it at once into

the wooden coolers. Under such circumstances, it will harden throughout without any appearance of froth on the surface: and this is especially to be noticed when the sugar is boiled "high." On the other hand, when the juices are less pure, the sugar boiled to a "lower" pitch, and the skips thrown off with more rapidity, then the revolver is observed to perform its own peculiar work more definitely, and with more striking results. In this case, the time required for perfecting crystallization, counting from the last skip thrown in, will probably extend from two to three hours.

And now, the contents having been discharged into a wooden cooler, a strange appearance will present itself, varying in character according to the quality of the sugar, and the degree of moisture in the atmosphere. As the larger crystals of sugar settle down, so a thin syrup will rise to the surface, surmounted by a foul, viscous froth. Being suffered to remain in the cooler for two or three days, the thin syrup above mentioned will continue to form new but smaller crystals, so that when the time has arrived for putting the sugar into hogsheads, there will be but a small residue of syrup.

This seems to be the proper place for me to discuss the question of supposed loss from the use of the revolver. Before I adopted the plan on my own Estate, I visited those boiling-houses where the process was carried on most efficiently and successfully:—Friendship, Spring Hall, and Greg Farm. I am indebted to the courtesy of Mr. Edgehill, at that time (1854) in command at Spring Hall, for the idea of a calculation on the subject which I afterwards verified by careful and elaborate experiments, and made known

to the public in the columns of the "Barbadian" newspaper.

The percentage of loss in regard to the froth and thin syrup of which we have spoken, is declared to be as ten in the hundred: but I think that we can explain it away altogether in this manner.

First, let us take for granted this ten per cent. of deficiency in the gross amount of sugar shipped from the Estate; that is, *nine* instead of *ten* hogsheads. My proposition is, that there are actually more pounds' weight in the *nine* hogsheads of revolved sugar than in the *ten* made according to the old system;—and thus I make it appear.

Counting by long hundreds, the loss upon sugar cured by the old system is declared for certain to be fifteen per cent.; and frequently very considerably more.* The loss upon revolved sugar is stated to be, at most, eight or nine per cent., down to six and a half: and in the case of my own and other sugars, I can confidently assert that it has been repeatedly less than five per cent. I write this advisedly, having before my eyes at this present moment, weights of twenty-three hogsheads of Bannatyne sugar, giving an average of one ton and fourteen pounds per hogshead.

In 1855, the average gross weights of seventy-two hogsheads of sugar, manufactured at Bannatyne, under my own eye, were the merest fractional trifle under nineteen cwt.

* In a vessel freighted with 500 hogsheads, the hold, although open in two places throughout the day, for the purpose of keeping it cool, was yet found to reach 98° Fahrenheit, the temperature of the water being 84°, and of the air, in the day-time, 86° or 88°. That sugar is generally acted upon by this heat is evident from the difference of appearance that the voyage only often occasions.

My case is therefore proved; and I am, moreover, in a condition to claim the extra benefit of the froth and syrup:—the froth for the still-house; the syrup for the molasses-cistern: and I have saved the cost of making a hogshead besides.

It was my practice to reboil the thin syrup into a sugar of inferior quality.

Another advantage in favour of revolved sugar is the increased size of the crystals, which enhances its value in the home markets to the extent of a shilling or two, as compared with the ordinary Muscovado. Weight and quality, therefore, combine to make up long odds in favour of the revolver.

But it is time to pass on to the consideration of another mode of manufacturing sugar, which may be distinguished as GREAVES'S PROCESS.

GREAVES'S PROCESS

is so called after the name of the intelligent Manager of the Lower Estate, who was the author of it.

We have seen, in the case of the revolver, that the process of crystallization is promoted by keeping the syrup in a liquid state for some hours; but Mr. Greaves's plan is founded on a principle directly opposite. A small revolving wheel with rods, or little paddles, is fixed across a spacious but shallow wooden cooler, into which the contents of the sugar-tayche are discharged: this little revolving wheel is then whisked round with great rapidity: first, to the right; afterwards to the left: in the course of five minutes, the syrup is cooled down and brought to a degree of density fit for the wooden-cooler, where it is to remain to be solidified into sugar. The crystals *are not larger than those produced by the old plan;* but the average weight of the hogsheads is enormous. In this consists the peculiar and distinctive merit of the process. Indeed, I have seen a catalogue of the weights, consecutively, of fifty hogsheads from this Estate, amounting to an average, as far as my memory serves, of nearly a ton each: a result surpassing that obtained by revolved sugar. In March, 1856, I challenged this question to the proof, by comparing the weights of *two* of my own hogsheads, made by the revolver, with *two* hogsheads from the Lower Estate. It is scarcely necessary for me to say that the truss, and all other conditions of the

experiment, were similar. The result was against me: Mr. Greaves's sugar beating mine by nearly ¾ cwt. in Barbados, and quite ¾ cwt. in London. I have, therefore, issued instructions for the adoption of his process at Bannatyne, and the Hope: for, weight and quality being about the same, it is to be preferred to the trouble attendant on the use of the Revolver. I therefore take this opportunity of acknowledging and thanking Mr. Greaves for his valuable contribution to our experience in sugar-making.

COOLING AND CASKING.

We have arrived at that part of our subject which relates to the solidification of the sugar, the necessary apparatus for which consists simply of wooden-trays or coolers, varying in shape and size according to the extent of space afforded by the boiling-house. In the revolver, and in Mr. Greaves's process, we have already noticed two different and opposite methods of effecting crystallization: the former, by the slowest possible means; the latter, by the most rapid. It is, therefore, a sort of open question whether sugar should be cooled slowly; as, for example, in a close warm room: or quickly, by having the trays exposed to the direct action of the air. For my own part, I prefer that process of cooling most in accordance with the principle upon which crystallization was induced or brought about; but in either case, I think it highly desirable that you should provide an ample supply of coolers. I have known instances where sugar has been allowed, as a part of the system, to remain in the coolers for one week, with considerable advantage. The sugar at Newton Estate has been casked on this principle for some years, and the result as to weights has been very satisfactory. On the other hand, I have casked sugar twelve hours after it was discharged from the skipping-tayche, and with no more than the average loss per hogshead. Be it, however, as it may, enough has been said on this head: and the question may now be fairly

left to your discretion. The operation of casking comes next in order, the last, but not least in importance. There are, as you have heard, opinions equally well supported for *hot* casking, and for *cold* casking. As usual, the middle way is the safest: and I give my voice, therefore, in favour of a blood-warm temperature, just about the point where you can let your finger rest on the sugar without inconvenience.

I would apply the same rule of moderation to the cutting of the sugar in the coolers for casking, neither shaving the mass too finely, nor spading it out in great clods or lumps. In the former case, you will incur the risk of totally destroying the grain: in the latter, especially if the sugar be *cold*, it is almost certain that the filling of the hogshead will be incomplete; as thus, the large lumps resting edgeways against each other leave hollow spaces between; from which it follows as a consequence, that as the sugar goes through its course of after-curing in the reeking hold of the ship, these lumps will be sure to melt into one mass; and the general body of the sugar will recede from the heading, which, being thus deprived of support from within, will, as I have elsewhere said, be easily crushed in by the superincumbent cargo.

There is one other observation which I must make in regard to the casking of sugar, which I desire to express, not in the form of a passing remark, but with all the emphasis of a peremptory maxim. It is that the hogsheads be well filled, in three separate proportions; one-third at a time, and at three separate times. By obeying this injunction, you will never fail to obtain respectable average weights, at the least.

When the sugar is sufficiently cured in the hogshead

for shipment, it will be of advantage to use the rammer. In fact, the sum total of all your efforts amounts to this,—THAT THE HOGSHEAD MUST BE FILLED TO THE BRIM, AND MADE TO HOLD AS MUCH AS POSSIBLE.

In all that I have said concerning the boiling of sugar, I have confined myself, strictly, to a description of the method in common use among us. I offer no suggestions of my own in regard to the amendment of our modern system by any scientific agents. Moreover, I am convinced that, so long as our batteries are constructed upon the present primitive system, we can entertain no reasonable expectation of improving the complexion of our Muscovado sugar to any great extent. This accounts for the failure of the filter-bags. Indeed, I have always observed that sugar up to a certain density exhibits an exquisitely transparent clearness: beyond that density, and the period when granulation is being formed, discolouration commences. Within the last three or four years, it has been sought to counteract this evil by the introduction of sugar-tayches of extra thickness;—that is to say, $1\frac{1}{2}$-inch at the bottom, where the fire plays with fiercest effect, reducing gradually to where the $\frac{3}{4}$-inch at the neck or pinning of the vessel. This plan has some show of reason, and has been attended with partial success.

But if I have nothing further to suggest on the subject of sugar-making, nevertheless, I have much to say to our young managers and book-keepers in regard to

their duties in this particular department of their business.

THE MANAGER IS BOUND TO KEEP A SUPERINTENDING EYE OVER THE WHOLE.

THE BOILING-HOUSE, HOWEVER, IS HIS HEAD-QUARTERS.

The Book-keeper is supposed never to quit his post within the boiling-house. His sentry-walk extends from the racking-copper to the skipping-tayche, and it is expected of him that he should be always on the alert. There is to be no divided empire between him and the head-boilerman. The duties of each are distinct: the book-keeper as the responsible chief in command; the head-boilerman as the agent in carrying out the various processes of sugar-making.

It is the book-keeper's part so to order his conduct that it shall inspire the labourers and work-people with respect towards himself. When good manners, good language, intelligence, faithfulness, and unwearied diligence are manifestly seen in him, then will his subordinates, in their turn, become impressed with the importance of their own duties; and thus will be brought about a sort of unanimous working together, whereby the business in hand will be more effectually accomplished.

I have already observed that the making of sugar is the sum total of the labour and expenditure of the year; —of its cares and harassing anxieties: and the thing should not be suffered to be as of nought, for want of personal superintendence on the part of those whose duty it is to direct the work. The operation is simple enough in itself; but it does require the most watchful attention. Indeed, the whole art of sugar-boiling seems

to resolve itself into a question of morals rather than of mind,—of conscientiousness than of chemistry; and he is sure to succeed best who, honestly and out of his heart, strives to do his best. Hundreds of samples of sugar from Barbados, exhibited on the broker's sale-board, are highly discreditable to the parties concerned; discreditable alike to the manager and proprietor. Our merchants and many of my fellow-countrymen know this to be the fact; but from a sort of supineness produced by long habit of endurance, the evil is permitted to go on. But it is time for this state of things to come to an end. Let there be no more lethargy; no more folding of the hands to sleep. It is an age of activity: let us act up to the spirit of the age; and by the exercise of our native energies, present to the sister-colonies an example of industry and intelligence that shall command their admiration.

To treat of the distillation of Rum formed no part of the original plan of this work; nevertheless, I cannot forego the opportunity of adding a few general remarks on the subject. It is now an admitted principle among the Planters of Barbados, that it is not profitable to make rum on a small scale: moreover, as the greater part of the island is wanting in natural springs, and as rum cannot be made without an abundant supply of water, it is more than probable that the cost of constructing suitable tanks, and keeping them in repair, would go to coerntbalance any profits to be anticipated. Indeed, a large number of proprietors have done away

with the distillery altogether, and except on some of the largest estates, it is the rule with those who still adhere to the practice, to make no more rum than can possibly be avoided. In order to obtain every available atom of sugar, it is customary to re-clarify all the tayche-skimmings and sweet-refuse of the racking-coppers, in a vessel by itself; and I have heard more than one intelligent planter declare that his increase of sugar in relation to the whole crop was as ten per cent.

My own experience, if it does not absolutely confirm this calculation, goes somewhat nearly towards it:—and I can assert upon the authority of the faithful person who has superintended the operations of my own distillery at Bannatyne, for the last three years, that the cost of fuel is of itself an item large enough to deter us from attempting the process. Under these circumstances, I have not thought it necessary to give my mind to the consideration of rum-making as a science, and I am, therefore, satisfied to dismiss the subject by recommending you to observe the two main requisites of a well-ordered distillery,—cleanliness and ventilation.*

* As it is of importance to have an adequate supply of "light" for carrying on our operations within the distillery and other buildings, I would suggest the adoption of "*glass tiles*" (so to call them) to be placed in squares on the roof, about the size of an ordinary window. These tiles are shaped exactly like those of clay in common use with us, and may be procured from Mr. Wm. Taylor, 14, Great St. Andrew Street, Seven Dials, London, W.C., price 7d., 10d., 1s., and 1s. 3d. each, according to thickness.

FUEL.

The materials for fuel in aid of megass are coal, and what is termed, patent fuel: but I was accustomed many years ago to prepare a mixture of clay and fine coal, rolled into balls, which answered the purpose exceedingly well.

The idea was suggested to my mind by the following extract from the Philosophical Transactions, No. 460, and dated 1741. Nevertheless I afterwards ascertained that the practice of making this kind of fuel was quite familiar to our old Planters. The extract is headed

"An Account of Coal Balls made at Liege.

"I shall endeavour to give an account of factitious coal made at Liege. The method in which it is made is as follows:—Take one-third of unctuous clay (such as brewers use to bung their vessels; in it there must be neither sand, gravel, nor stone): and two-thirds of coal-dust; mix and make them incorporate well together: cast them into round balls or bricks, and you may put them on a coal fire, and they will burn directly: but if they are made in summer time, and laid to dry for use in winter, they will light sooner.

"Thus you have a hot, clean, lasting fire, not at all offensive to the smell.

"The dust is the refuse of the mine, and may be here of the coal merchant's yard; so that this fuel comes exceedingly cheap.

"Nor is it necessary to put so much coal-dust; for

some clay (particularly what I use myself in the country) will do if mixed with two-thirds of clay and one-third coal-dust; and the true proportion of the mixture must be found by experience. But it is always better to put in too much than too little coal-dust at first, because men are too apt to be discouraged in making experiments.

"I have heard that at Liege they burn both lime and brick with it: but, as I never saw it done, I cannot affirm it.

"It appears that this fuel was known in England in the year 1628; and it is said to have been discovered by Hugh Plat in 1594.

"There is an account of it printed in the essays for the month of December, 1716; where it is proposed to be made with the black ouse of the Thames, and for fourpence per bushel.

"I have used this coal and clay mixed upwards of ten years; and by experience I find it to answer very well. It is a most excellent fire for roasting, for heating of irons, or warming a room: I use it in my kitchen, laundry, parlour, and library."

Although it cannot be ascertained by exact calculation what amount of fuel is wasted in those dense volumes of smoke which are poured out of the boiling-house chimneys, nevertheless it is an admitted fact that our loss in this respect is very great, and that it is high time to consider whether it may not be within our power to bring about a more perfect system of combustion. Of all the practical questions of this eminently practical age, none is so little understood as the doctrine of flues. The attention of the great manufacturers in England has been directed to this impor-

tant subject for many years, without any general advantage, and to this day the Act of Parliament, relating to the consumption of smoke, remains for the most part a dead letter. Whether it be dependent on draught or otherwise, we cannot tell,—but it is very certain that the apparatus or plan which is successful in one furnace turns out to be an utter failure in another. Patent after patent for improving the construction of flues, makes its appearance—but the majority of them seldom survive a second trial. They die and no man regards them.

I, too, have made it a part of my task to look into this matter,—but, to this late hour without any satisfactory result. In many furnaces, the smoke is conducted by a side-channel back again into the main flue, and there subjected, a second time, to the chance of ignition. This plan, as I am informed, has been adopted in Barbados,—in some instances with success; but as oxygen is necessary to the life of fire, it seems to me that the only way by which entire combustion of smoke can be effected, is by the *judicious* introduction of air, through various small apertures all along the line of flue. Probably another ash-pit built under the third tayche, topped by a narrow grating, no bigger than a little gridiron, might have the effect of promoting the consumption of smoke; or, as it is now a custom with us to turn outer arches leading to each tayche, for the purpose of free communication, the said arches being hermetically closed by a slight partition of masonry, it might be worth the trial to leave an opening greater or less, in some or in all of these partitions,—so as to ascertain whether we can get at the great secret. I commend this simple experiment to your consideration.

A FEW LAST WORDS.

In all the advice which I have addressed to you, as young men, I have been actuated by a single-minded regard for your welfare, and inspired by a belief in your teachableness. It is only to those who are desirous of gaining information, and who are persuaded that there is yet something more to learn, that a Manual of this sort is likely to be of any service.

"There is more hope of a fool," says King Solomon, "than of a man wise in his own conceit." A desire to go on adding knowledge to knowledge, is the characteristic of superior intellects: the Judge, the Bishop, the Physician, never mind how great the man, or what may be the amount of previous attainments in his profession, neither is content to stand still, for, to stand still is to be left behind: but all are labouring and straining after additional knowledge, to keep pace with the onward progress of the universal mind of man. Onwards, still onwards. "Perséverance," says Shakespeare, "keeps honour bright:"

> "To have done, is to hang
> Quite out of fashion, like a rusty mail
> In monumental mockery. Take the instant way:
> For honour travels in a strait so narrow,
> Where one but goes abreast: keep then the path;
> For Emulation hath a thousand sons,
> That one by one pursue: If you give way,
> Or hedge aside from the direct forthright,
> Like to an entered tide, they all rush by,
> And leave you hindmost:"

The more a man knows the more he is desirous of knowing, and yet the farther he advances in knowledge the better he understands how little he has attained.* Take as an illustration such a man as Sir Isaac Newton, whose genius was so piercing and comprehensive that he was enabled to discover the mysterious principle of gravitation, by which the sun, moon, and stars, and this earth, are sustained in their courses. To him were revealed the hidden secrets of nature; the operations of light and heat, and all the manifold wonders of the heavens above, and of the earth beneath. And now, hear his own lowly estimate of himself, his long labours, and his marvellous revelations of science: "I am but as a child picking up shells on the brink of the great ocean of truth."

The most obvious mode of acquiring knowledge is by reading; a taste which, like every other, is susceptible of cultivation. There is a healthy taste, and a perverse taste, in all things: the first is gratified by that which is pure, and sound, and elevating: the other exhibits all the attributes of diseased appetite, craving only that which is seasoned with all that ministers to depravity in morals. A taste for reading is a blessing to every man. In this resource he may find comfort, even when care and misfortune press heaviest upon him. It is the rainbow in the midst of the storm: a bright and glorious thing where all around is dark and threatening. Happily for us, we live in an age when, by a cheap process of printing, the writings of the ablest and best men are multiplied to such an extent as to be within the reach of almost every man who

* Nil actum credens, dum quid superesset agendum.—LUCAN. PH., lib. ii, l. 657.

desires to possess them. I would, therefore, earnestly advise you to try to acquire the habit of reading. Whatever may be the nature of your duties, you will always have some leisure time, which unless employed profitably, and in the way I have pointed out, will most assuredly become a snare to you. Of old, the Roman Censor said: "*Nihil agendo homines male agere discunt,*" —By the habit of doing nothing, men learn to do evil; a sentiment which has resolved itself into the familiar proverb: Idleness is the root of all evil.

The principal points on which man should strive to gain information are, first, Religion; next, his Business in life. Upon this foundation, if it be permitted to him, he may build up a noble superstructure of literature and science. "The wisdom of a learned man cometh by opportunity of leisure." Now, in degree, you have your allotment of leisure, and, therefore, your opportunity. Moments go to make up days: —days make up a man's life.

Dr. Southey tells us of a humorous calculation by the late poet Campbell, in which he shows that the few minutes spent daily in the act of shaving, multiplied by fifty years, would suffice for learning seven languages. "See, then, what the value of time is, when put out at simple interest. But in knowledge there is no simple interest. Whatever funds you have in that bank, go on increasing by a compound ratio,—interest upon interest,—until the Bank closes, and all is over."

CALENDAR OF OPERATIONS

FOR A

NON-RATTOONING ESTATE.

CALENDAR OF OPERATIONS

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NON-RATTOONING ESTATE.

JANUARY.

Begin the year by laying the foundation for manure. Marl the stables thoroughly: and put a thick layer of marl, or mould, at the bottom of the cattle-sheds and pens. Take this opportunity to repair any little damage done to the walls. Stop any leak at the bottom; so that your dung-heap may not suffer loss from washing. White-wash, and in all respects, make clean the buildings appropriated to the Stock.

Inspect every arrangement for the approaching crop, —as regards the Mill, Boiling-house, and Distillery; and keep at hand every article likely to be required.

About the middle of this month you may venture to top as many of your ripest canes as will suffice to complete the planting of the new crop. You must diligently superintend this operation, for if it be carefully accomplished, there will be little or no cause for the extra trouble of supplying dead holes.

Pitch an ample hurdle-pen for the cattle, as near the mill as convenient; and give it a solid foundation of mould.

Give strict directions to the Coopers to ask for staves and nails at an early hour of the morning: for your time is valuable, and you cannot afford to be called off during the day by these workmen. But to provide against all contingencies, count out, at your leisure, a full allotment of nails for so many hogsheads,—tie each by itself in a separate parcel,—and keep them in a box, under lock and key, in some odd corner of the boiling-house.

Cut your topped canes, and make your first lot of sugar.

If it is your practice to reserve a few acres of the earliest cut canes to give plants at the end of the year, I would strongly advise you to employ a trustworthy person to go over the field from which these first canes have been reaped, taking care to cut with a knife, evenly and level to the earth each and every stool. This plan, I am aware, is not usually insisted upon; but be assured that the uniform and very superior spring of the second crop will amply repay the extra cost and trouble. It makes a material difference whether the shoots spring up *from out the ground,* or whether they spring from the eyes of the stump of the cane left *above ground.*

The old Planters had this fact before them when they *moulded* young second-crop canes.

Take in yams, if you have any in the land; and break what Guinea or Indian corn you may have.

The light mule-grubber, or plough, must be kept in action throughout this month.

FEBRUARY.

Set up, in rather rich proportion, your first vats of wash. You will thus obtain "returns" of a better quality, which will enable you to carry on the operations of the Distillery with a good prospect of success.

Top canes again, and supply the first-planted fields.

Cut these canes; and, if the weather permits, set fairly to work upon the business of the crop.

In order to obtain the utmost amount of sugar, make it a rule to return into the racking copper, for re-clarification, all the tayche-skimmings; it being more profitable to make sugar than rum. In fact, unless you have a most abundant supply of water, you will find it better to make no more rum than you can possibly avoid.

Keep a jealous eye over the cane-tops in the field, and stack them as you proceed.

On each Saturday, examine with care the work of the farmers during the past week.

At the close of the month, you must lay a slight coating of mould, or any rubbish, upon the great pen near the mill.

Look to the close feeding of the Stock.

MARCH.

It is supposed that you are engaged day by day in cutting canes and making sugar. On every point relating to this process, I refer you to the second division of this book. Try to keep in your mind the counsels I have there given; and remember that it is a very serious business.

Test the molasses cistern, every two or three days, with the inch rod, that you may be able to form a correct estimate of your stock of that article; in the disposal of which you will be guided by the instructions of the Owner or Attorney. There is, I am sorry to say, a lamentable waste of profit on molasses, every year,—owing to a variety of circumstances which I am not called upon to discuss.

About the middle to the end of this month, make arrangements for trashing the first-planted canes, and proceed steadily with this operation—taking field after field—until the whole are covered.

I earnestly bid you to complete the work of supplying the young crop during this month. It is better to assign this very responsible duty to some one particular person, in whom you can place confidence.

Examine narrowly, as before, the work of weeding.

Look to your cane-tops.

See that the cattle and mules are highly fed and foddered. On each Saturday, cause the herdsmen to give the beasts a thorough cleaning and scraping.

APRIL.

Continue to practise during this month all the directions given for the preceding.

Bring the whole power of the Estate to bear upon the reaping of the crop;—which, if you are favoured with strong and steady winds and sunny days, will be brought nearly to a close at the end of the month.

Add another layer of mould to the cattle-pens, and remember, whenever you clean out the stable and mule-pen, to lay down generally a thick foundation of marl.

If you have the opportunity, make all ready for planting guinea-corn in those fields which have been relieved of canes: and this advice will apply with equal force to the preparations for potatoes, yams, and Indian corn.

Stock up the cane-stumps, rake as much loose trash into each hole as will fill it; bedding over all with soil. Let this mode of culture be always adopted for potatoes and yams. It is a little more expensive and troublesome than any other, but it will surely repay you, for it is a kind of half-manuring. This must be done in time for the first showers, which may be expected in all the next month.

MAY.

The crop now draws to a close, and you will be free to give all your attention to the nursing of the young canes, the planting of provisions, and every department of out-door duty on the Estate.

Take out the mill-sails, and hang them carefully on the beams of the boiling-house, with a cord wrapped round each. Lower the points at the earliest time. Clean the entire machinery of the mill and white-wash the cases.

Finish stacking the megass-ricks; and do the same to the cane-tops in the fields.

Sweep the yard thoroughly, and rake up every particle of broken mill-trash, which you will cause to be thrown on the great pen.

Complete the trashing of the young canes; and apply the ashes of the stoke-hole, as far as they will go, particularly to those young plants which need them most.

Be in readiness to take advantage of the first rains now to be expected, for planting such provisions as you may think proper.

It is a good plan to have a nursery, from which you may draw plants in December. If you are permitted to set apart two or three acres for this purpose, now is your opportunity for planting them.

Allusion has been already made to this important point, in our schedule of operations for January. One thing is clear: that you must contrive to have within the Estate the means of planting twenty acres of canes, at the very least, in December.

JUNE.

The young crop now demands your vigilant attention. You must inspect every cane-field, one by one, going carefully through the whole.

If it is proposed to give artificial manures to the growing crop, your arrangements must now be made for this purpose: and these manures will be best applied in moist weather.

About this time there will be a little work to do in regard to the molasses:—whether it is to be delivered summarily and irrespective of its real value, or whether it is to be put away in vats and casks, to be sold on some more favourable occasion.

Having emptied the molasses-cistern of its contents, you must take care to re-boil the residuum of doughy matter, by adding a little lime-water to it, and bringing it to the proper consistence in the skipping-tayche. When it is thoroughly cold, put it into barrels: and you will obtain a very passable sugar.

You will finish in the Distillery about this time. White-wash the outside of the vats, and leave them half-filled with returns and water. Clean the cisterns, and the building generally, and throw all the rubbish into the reservoir.

Crown the great yard pen with a top covering of mould, trim and square the edges of it.

Clean out the stables and spread the dung over the cattle-shed and pen attached to it. Then cover the

whole with a light layer of mould. Litter the pen with any green stuff you may be able to procure, such as sour grass and bushes; not only to help your field-trash, but because there will be ample time for them to rot.

The cattle are now thoroughly rested and recovered, and as they are about to be called upon to perform hard work, you must settle all the arrangements in regard to their daily food. Cut sour-grass throughout the month,—cart it home,—and apply it liberally to the cattle-pen. It will serve the double purpose of food and litter. Sour-grass takes a long time to be decomposed.

If you propose to make a heap of compost manure, now is the time to begin, by burning a kiln of lime, and laying down the foundation-layers according to my recommendation.

Attend to the weeding of the young yams, potatoes, guinea and Indian corn; and be sure to plant a field or so of wolly-pira.

JULY.

Ploughing begins. Read the chapter on Tillage, p. 24.

Examine carefully the agricultural implements, and see for yourself that they are in a perfect state of efficiency. Turn to page 16.

In those fields which you do not propose to close-plough, I advise you to have the old cane-stumps stocked up.

As to those which are intended to be close-ploughed, you had better lose no time in commencing the work.

You have now done with the young crop in all except Weeding: an operation which, at this particular stage of the cane, must be performed with an almost tender care: for the plant begins to send forth white thread-like roots, which it would be fatal to injure. As this and the ensuing month may be regarded as critical to the young crop, you must not fail to give any extra help to those parts of the fields that seem to require it. Your object is to make every bunch of canes, throughout the Estate, productive.

Marl the cattle-pen.

Be pleased to turn again to page 16, and read the paragraph relating to the ploughman and his work.

You will burn another kiln of lime, and build up the second portion of your compost heap. Page 85.

AUGUST.

The plough being now fairly set a-going, it will have no rest. Plough—plough—plough.

The main object of your care, at this time, is to provide food for the cattle, and to attend in every way to their comfort. If it be practicable, have the best part of the cane-tops sliced, and moistened with a little molasses and water, and set in troughs under cover of the shed for the use of the working beasts, which, I need scarcely remind you, must be fed by themselves.

If you are taking up potatoes, be sure to bring home the slips for the pen. Top the Indian corn, also.

Clean out the horse and mule stables, and spread the contents over the cattle-pen, which you must cover again thoroughly with marl or mould, or both.

Never let the cattle-shed be without lumps of block-salt.

About the second week of this month, you will begin to cut guinea-corn meat for the stock. To be safe, cut it one day, to allow it to be acted upon by the sun and air, and serve it out the next.

Cause the 'sucks' in the fields, now in course of being cultivated, to be cleaned, and clean out all trenches leading to the same. This work depends upon the nature of the weather; and you must use discretion in the performance of it.

At the end of this month, you will apply the third and last kiln of lime to the compost-heap, which you

will now bring to completion, by covering the whole over with mould or marl.

You will consult with the owner or attorney about the supply of staves for the crop to come: and, if you are permitted to purchase any, bring them up on Saturdays, and be sure to give a full team to that work. So, also, with regard to boards.

SEPTEMBER.

SPEED THE PLOUGH.

You are now about to gather in your Indian corn. As fast as you do so, pull out the stalks and send them all home for the use of the cattle.

Continue to cut your guinea-corn meat: and give great attention to the management of the cattle-pen.

Stock up the old cane-stumps in the land as it is cleared. Rake into each cavity all the old trash and rubbish within reach: and lightly cover the whole with fine soil. Work your heavy plough, first along the distances from north to south, and again at right angles through the cross bank, from east to west. Line the land, and in one or other of the tracks of the plough, dig the new cane-hole, deep and wide, and remember to do the same in every field which is not subject to the operation of close-ploughing. For the third time I call your attention to this mode of preparing land: at page 30, and again under the month of April. I distinctly tell you that it is unquestionably the best mode of dealing with the land, whether it is to be prepared for provision or canes: FOR IT IS A KIND OF HALF-MANURING.

Repeat the work of cleaning out the stables and spreading the dung over the cattle shed and pen attached to it. Then cover the whole with a light layer

of mould. Litter the pen with green bushes and field-trash.

The light American plough, or three-toothed grubber, to be drawn by mules will act very advantageously on the less tenacious soils, and will be found a wonderful help to you.

OCTOBER.

Give notice to the Coopers to hold themselves in readiness to begin their work as soon as possible.

If there is work to be done to the Mill or Boiling-house, the necessary arrangements must be made accordingly.

Apply a substantial coating of marl to the cattle-pen and shed.

Your ploughing ought to be completed by the middle of this month, and the heavy grubber is to take its place.

And now you will commence to throw out dung, commencing with the great yard pen, which as it was first completed, is more ripe and fit for the land. Get out the whole of this pen during the month, and apply it to the fields which are to be earliest planted.

If you have any oil-meal for the cattle, give it during this work: and you must take up for their use whatever wolly-pira may have been planted. By the end of the month, everything, except yams, must be cleared off the lands to be planted in canes.

I am strongly against a second planting of Indian corn, or any other late crop in the preparations. The cane is our staple, and requires the whole force of the native fertility of our lands to bring it to perfection.

If you have any spare fields you may plant what you please.

NOVEMBER.

You must now attack the still-pond or reservoir; the contents of which you will apply to the fields, to be planted second in order. In addition to this stuff, and to counteract any latent sourness inherent in it, I advise you to put along with it a quart of slaked, or unslaked lime, to each hole, according to your means.

Having taken out all the mass, your care is immediately to fill again the reservoir or tank to the top with mould, bushes, and marl, ready for the next occasion to be acted upon by the dunder or still-refuse.

Apply the last layer of marl to the cattle-pen :—only marl.

The grubber and light American plough are still to be worked when the cattle and mules are not employed in carting the manure into the fields.

The compost-heap is now to be turned by the hoe, in order that its ingredients may be thoroughly mixed, and you will cause it to be applied to the land according to your own discretion.

Do not lose sight of my remarks about the work of repairs, if required, in the Mill, Boiling-house, and other Buildings of the Estate. You will find ample memoranda at page 127.

DECEMBER.

You are now to look for cane-plants for the first fifteen or twenty acres: and these are usually purchased from the labourers, or small land-renters, who choose to cut their canes at this time, in order to be first in the market with syrup: but if you have a nursery of your own, as I recommended, you will have a supply of plants within yourself. Refer to my remarks under January and May.

Cane-plants are money's worth, and if cut and planted with care, there is no reason why they should not every one grow. Nine inches is about the length of the plant, and this I consider to be a very proper average proportion.

YOU MUST DILIGENTLY SUPERINTEND, IN PERSON, THE OPERATION OF PLANTING, FOR IF IT BE CAREFULLY ACCOMPLISHED, THERE WILL BE LITTLE OR NO CAUSE FOR THE EXTRA TROUBLE OF SUPPLYING DEAD HOLES.

If it is your practice to use guano, or artificial manures, it will be of great advantage to make the first application of them a few days before the plants are put in the earth.

The earliest fields being planted, you will now commence to cart out the dung from the cattle-pen, shed and stables. This is the sheet anchor of the next crop, and the work is likely to stretch over the balance of the month, even to the last day.

Be pleased to refer to my remarks on the proper mode of applying dung to the land. See page 61.

As soon after Christmas day as convenient, have the mill-points hoisted, and it is expected that every arrangement, to the most minute item, for the crop now to be reaped, will be completed, in accordance with the instructions given in the second department of this Manual.

GLOSSARY

OF

CHEMICAL AND OTHER TERMS.

GLOSSARY

OF

CHEMICAL AND OTHER TERMS.

Agent. That which is capable of producing action: Latin, '*agere*,' to act.

Albumen. All those substances, whether animal or vegetable, which partake of the nature of white of egg: Latin, '*albus*,' white.

Alkali. From the Arabic particle '*al*,' the, and '*kali*,' vegetable ash; from which this substance is obtained in a pure form.

Alumina. The term used in science to express the principle of 'clay,' from which 'alum' is obtained. Latin, '*alumen*.' Greek, '*als*,' salt.

Ammonia. So called from the fact that it was first discovered, in a crude form, near the Temple of Jupiter Ammon, in the '*sandy*' desert of Upper Egypt. It is of a saline nature, and very volatile. Greek, '*ammos*,' or '*psammos*' sand.

Ammoniacal. Possessing the properties of ammonia.

Analogous. The resemblance, in part, of one thing to another,—a kind of proportion. Greek, '*ana*,' back again, and '*logos*,' ratio, or proportion.

Analysis. The separation of any compound into its original elements. Greek, '*ana*,' and '*luo*,' to dissolve.

Approximate. To bring near to, Latin, '*ad*,' to, and '*proximus*,' near.

Arable. That which may be ploughed—land fit for cultivation, Latin, '*arare*,' to plough.

Aroma. An odour. Greek, '*aroma*.'

Base. A term used to denote the earth, alkali, or metal which is combined with an acid to form a salt. Greek, '*basis*, foundation.

Calcareous. Chalky—relating to Chalk. Latin, '*Calx*,' chalk.

Capillary Attraction. A term applied to the rise of the sap in plants,—or the ascent of any fluid in small tnbes,—a drawing by means of *hair*-like tnbes. Latin, '*capillus*,' a hair: attraction is from '*ad*,' to, and '*trahere*,' to draw.

Carbon. Pnre Charcoal. Latin, '*Carbo*,' a coal.

Carbonaceous. Relating to carbon.

Carbonic Acid. A componnd of carbon and oxygen.

Carbonate. A componnd formed by the union of carbonic acid, with a base—as carbonate of lime.

Caustic. Bnrning, corroding. Greek, "*kaio-kauso*," I bnrn.

Cereal. Relating to corn. Latin, '*Ceres*,' the goddess presiding over corn.

Chemistry.—The science which ascertains the component elements and properties of all substances, and the resnlts of their action on each other. It is taken from the latter syllables of the word 'alchemy'—Arabic, '*al*,' the, and '*chemia*,' hidden art.

Chlorine. A gas of a *greenish* hue obtained from spirit of sea-salt: Greek, '*chloros*,' green.

Clarification. The act of making clear and bright. Latin '*clarus*,' clear, and '*facere*' to make.

Combustion. A burning away. Latin, '*con*' together, and '*urere*,' to bnrn.

Complexity. A folding together,—a binding-up. Latin, '*con*,' and '*plicare*,' to fold.

Composite. The nniting or pntting together of snbstances. Latin, '*con*,' and '*ponere*,' to place.

Constituent. That which goes to '*constitute*,' or make up anything. Latin, '*con*,' and '*statuere*,' to set np.

Crucible. A melting-pot. From the Dntch, '*kroes*:' any small cup or phial: onr words '*cruet*' and '*cruise*,' are derived from this sonrce. In the Bible, yon remember the widows' '*cruise*' of oil.

Débris. A French word, signifying the '*remains*' of anything.

Decomposition. The disnnion or separation of the elements of substances. Latin, '*de*,' and '*con*,' and '*ponere*,'—to disunite that which had been pnt together.

Defecation. Pnrifying from dregs. Latin, '*de*,' and '*fæx*,' dregs.

Deliquescence. A melting away, as by the absorption of moisture from the atmosphere. Latin, '*de*,' and '*liquescere*,' to melt.

Disengage. To act upon, so as to bring about separation. Latin '*dis*' and '*agere.*' '*De,*' and '*Dis,*' always negative the sense of the word with which they are combined.

Disintegrate. To destroy the wholeness of a body by breaking it up into particles or atoms. Latin '*dis,*' and '*integer,*' whole or entire.

Dissipation. A scattering—a wasting. Latin, '*dis,*' and an old word '*sipo,*' I throw.

Effervescence. A term applied to that sudden escape of air from the combination of certain substances chemically opposed to each other. Latin, '*Effervescere,*' to generate warmth.

Effete. Not capable of bringing forth—barren. Latin, '*Ex,*' out of, and '*fœtus,*' young.

Elastic. Having the power of returning to the form from which a thing has been bent or pressed,—springy. Greek, '*elao,*' I repel.

Electricity. A property which certain bodies possess when rubbed or excited—whereby they attract or draw other and remote bodies—as first observed in '*electron,*' amber, Greek.

Emanation. That which proceeds or issues forth from another. Latin, '*e,*' out of, and '*mano,*' to flow.

Exotic. That which is foreign or brought from abroad. Greek, '*exo,*' from without, or outside.

Feculence. Dregs—impurity. Latin '*fœx,*' dregs.

Fermentation. Latin '*fermentum,*' leaven—a word which contains the idea of warmth, and signifies that peculiar action which takes place in dough which has been *leavened.*

Fetid. Filthy, stinking. Latin, '*fœtidus,*' having an ill-scent.

Friable. That which may be crumbled or reduced to powder. Latin, '*friabilis.*'

Gas. A word used to signify the most subtle and volatile emanations obtained by heat from various substances: supposed to be derived from the Saxon '*gast,*' air.

Gaseous. Appertaining to gas.

Germination. The act of sprouting. Latin, '*Germen,*' a sprout or bud.

Granitic. Latin, '*granatus,*' that which has several grains, because the rocks called '*granite*' are marked with variegations like *grains.* The word 'pomegranate,' is nothing more than '*a fruit with grains.*'

Gypsum.—A substance containing lime. Latin, '*gypsum.*' Greek,

'*Gupsos*,' plaster, or baked earth. Plaster of Paris is made from it.

Humus. A Latin word, signifying earth; used in science to denote the principle of decayed vegetable matter, as it exists in *mould* or *soil*.

Humic Acid. The acid contained in '*humus*.'

Hydrogen. A term derived from the Greek, '*udor*,' water, and '*gennao*,' to generate. The chief element of water. Hydrogen and oxygen, in due proportions, compose water.

Hydrochloric Acid. A compound of Hydrogen and Chlorine.

Incipient. Beginning—commencing. Latin, '*incipiens*.'

Incorporate. To mix or unite in one body. Latin, '*in*,' and '*corpus*,' body.

Inert. Incapable of motion or action. Latin, '*iners*,' inactive, dull.

Infinitesimal. Small to the last degree. Latin, '*infinitas*,' that which is without limit or end.

Inorganic. A term applied to substances which have no organs of action in themselves. Latin, '*inorganicus*,' that which is devoid of organs.

Liberated. Set free. Latin, '*liber*,' free.

Magnesia. An earth; the name of which is supposed to be derived from '*Magnesia*,' a district of ancient Thessaly, where it was first found.

Manure. A word derived from the Latin, '*manus*,' the hand, and '*operari*,' to exercise—or the French, '*manœuvrier*,' to cultivate by the hand. Both these meanings prove that *tillage* tends to enrich the soil: equally with those substances to which term *manure* is now applied.

Manurial. Relating to manure.

Minerals. Substances destitute of organization which exists naturally in the earth. Derived from Latin of the lower age '*minera*,' a vein of metal.

Monopoly. The exclusive privilege of selling any commodity. Greek, '*monos*,' alone or single—and '*poleo*,' I sell.

Murexid. Latin, '*murex*,' a peculiar sort of shell-fish from which the ancients obtained the colour purple-red.*

Muriatic Acid. Spirits of sea-salt: composed of hydrogen and chlorine—also called hydrochloric acid. Latin, '*muria*,' brine, salt water. Greek, '*almuris*,' salt liquor.

* Tyrioque ardebat murice læna.—VIRG: ÆN: Lib. iv, l. 262.

Muriate. The union of mnriatic acid with any base.

Neutralize. To render inert, to combine two or more substances so that the known qualities of each shall be destroyed. Latin, '*neuter*,' neither.

Nitre. Commonly call saltpetre, and existing natnrally in the earth. Greek, '*nitron*,' nitre.

Nitric Acid. A mixtnre of snlphuric acid and nitre.

Nitrification. The process of making nitre. Latin, '*nitrum*,' and '*facere*,' to make.

Nitrate. The union of nitric acid with any base—as, *nitrate of Soda, &c., &c.*

Nitrogen. Greek '*nitron*,' and '*gennao*,' I prodnce. That element which forms the principal ingredient of the atmosphere in the proportion of three parts in fonr. This explains the mannring properties of the air and rain. See page 27.

Nitrogenize. To impregnate with nitrogen.

Organic. Applied to snbstances which have organs of action within themselves. Greek '*organon*,' an organ.

Oxygen. Greek '*oxus*,' acid, and '*gennao*,' I generate. So called from its property of generating acid. It is that important constitnent of the atmosphere which snpport life and fire. It is also one of the component parts of water.

Oxalate. A salt formed by the union of oxalic acid with any base—as oxalate of lime.

Oxide. Any snbstance combined with oxygen.

Pabulum. A Latin word signifying 'food.'

Pearlash. A kind of refined potash.

Peat. The accnmulation of vegetable matter on the snrface of the earth ; a sort of tnrf nsed as fnel on acconnt of the grass and other fibrons roots contained in it.

Permeable. Latin '*per*,' throngh, and '*meo*,' to pass. That which may be *passed through*—as glass—which is permeable to light, earth permeable to water.

Phase. An appearance. Greek, '*phasis*,' which is taken from '*phaino*,' I show.

Phosphorus. Greek '*phos*,' light, and '*phero*,' I bring—the light-bringer, applied to the morning star. It is in Latin '*Lucifer*.' Yon remember in the Bible "How art thon fallen, O, Lncifer, son of the morning." Used by chemists to signify a snbstance lnminons in the dark. It is obtained from bones.

Phosphoric Acid. Phosphorus combined with oxygen.

Phosphate. A salt formed by the union of phosphoric acid with a base—as phosphate of lime the chief principle of bones.

Phosphuretted. Combined with phosphorus.

Potash. A substance obtained by steeping the *ashes* of plants in water.

Process. Latin, '*processus*,' a going onward, progressive action.

Putrescent. Becoming putrid. Latin, '*putrescere*,' to become rotten.

Residuum. A Latin word signifying that which remains or is left of anything, residue.

Rotation. The act of turning. Latin, '*rota*,' a wheel.

Salt. This is strictly a technical term used in chemistry to express the combination of an acid, with an alkali, an earth, or any metallic base. Our common salt seems to be an exception to this definition, as it does not contain either acid or alkaline matter in the *dry* state in which we use it.

Silica. Latin '*silex*,' flint. It exists in the earth and is the mineral constituent of all plants, especially in those which produce straw, as wheat, oats, barley, Guinea, and Indian corn. Our sugar-cane requires a full proportion of silica to help to make up its rind and trash.

Soda. An alkali—obtained from sea-water, the ashes of marine plants and other sources. The term is of uncertain derivation.

Soluble. That which can be dissolved. Latin, '*solvere*,' to melt.

Substratum. Latin, '*sub*,' under, and '*sternere*,' to lay along—an under layer, the *sub*-soil.

Sulphuric Acid. Commonly called 'oil of vitriol.' A compound of sulphur and oxygen. Latin '*sulphur*,' brimstone.

Sulphate. The union of sulphuric acid with any base.

Sulphuretted. Combined with sulphur.

Technical. Greek, '*techne*,' art, skill; applied to words used exclusively in a scientific sense.

Tenacious. Latin '*tenax*,' holding fast, applied to earths which adhere firmly—as *clay*, &c., &c.

Theoretical. Greek, '*theoreticos*,' speculative; and again from '*theoreo*,' I see, applied to speculation, as distinguished from practice, and to a plan or scheme as it subsists in the mind.

Trap. A term derived from the Swedish '*trappa*,' a stair, and applied to a class of rocks rising one above the other like

steps. These rocks are described to consist of black iron-clay.

Turf. The vegetable covering of grass and other small plants on the surface of the soil. Derived from the Saxon '*tyrf.*'

Unsanatory. Unhealthy. Latin, '*un*, or *in*,' not, and '*sanitas*,' health.

Volatile. Latin, '*volare*,' to fly away, that which readily escapes in the air.

APPENDICES.

RELATING TO GUANO

AND

MC'DOUGALL'S DISINFECTING POWDER.

APPENDIX I.

RELATING TO GUANO.

At the monthly gathering of the Highland Agricultural Society, on the 18th of February, in this year, Sir John Stewart Forbes read a letter from Mr. Finnie, some extracts from which I subjoin:—

"It has for some time occurred to me, that the treatment which agriculturists now experience at the hands of Messrs. Gibbs, is only what was to have been expected. The temptation to overcharge is too great for human nature to forego, and is quite consistent with the history of all monopolies. But the lessons of history also teach us that this is an exhaustive process, because by charging for an article far beyond what it is worth, the latent skill and energy which Necessity, the mother of Invention, has ever in reserve, is called forth into activity, and the result generally has been, that, on the one hand, the monopolist, if not driven out of the market, has been compelled to lower his prices to the fair value of the article, and, on the other, the public has reaped not only the advantage of the reduced prices, but also of the further discoveries which have been made. I confess, therefore, that although we may suffer a little temporary loss and inconvenience, the farmers will soon come round to see that these gentlemen, unintentionally, perhaps, have proved to be their very best friends. Far be it from me, nor is it necessary, to allege that guano does not stand deservedly high among our lists of portable manures. I would also be the last to maintain that we can effectually keep up

the fertility of the soil without supplementing farm-yard manure, and that to a considerable extent, with substances foreign to the farm. But I have as little hesitation in affirming that, to the abuse, and not to the use of guano, is the present crisis in some measure attributable, inasmuch as that substance has unjustly engrossed the attention of the farmer, to the exclusion of other portable manures equally as valuable and efficacious: nay, I would say, even to the exclusion of farm-yard dung itself. It is not so many years since guano was first introduced into this country, and then sold at 28*l.* per ton. By-and-bye, as the supply increased, it fell to 25*l.*, but at that price it was apparently to remain, when the late Professor Johnston (not forgetting the invaluable services, however, of eminent men of the same school, such as Liebig and others) entered the field as our analytic chemist. No sooner did he give forth to the agricultural community a list of substances which by due admixture might be used as a substitute for what was produced from natural sources, while it could be obtained at less than a third of the cost, than all at once the skill of an enlightened public, with all the resources at command, was made available. The refuse of every manufactory became an object of inquiry and importance, and very shortly we were inundated with endless varieties of portable manures.

"In this race of competition, coupled, no doubt, with the supplies of inferior guanoes, such as Ichaboe and Chili, the Peruvian guano, with all its vaunted superiority, had to submit to a downward movement, and ultimately succumb to a rate not exceeding 8*l.* per ton. Now, let me ask, are our prospects gloomier than when guano sold at 25*l.* per ton? I venture to reply, we have only to put the same machinery in motion, and results similar to those I have stated will follow; and, certainly, this can be done at present under circumstances much more likely to be attended with permanent and beneficial effects.

"In short, it would be tiresome to enumerate the inexhaustible resources patent to agriculture, which only require

the aid of science, to turn all to a profitable account, and fit us, without much loss or inconvenience, to dispense with even the Peruvian deposit. No doubt much has been presented to the farmer that has led to disappointment; and hence one of the principal reasons why agriculturists have so unreservedly adopted the use of guano, to the almost exclusion of any other portable manure. Our celebrated chemists, however, have not only served to expose, but are now better able, to prevent the reappearance of such trash. It is also true, that the reduced price of guano drove out of the market much that was valuable, as the respectable manufacturers and dealers could not successfully compete. It can, therefore, occasion no surprise (one of the conditions of the Messrs. Gibbs being, that no one who obtained a cargo from them should venture to sell any other than Peruvian guano) that, flushed with the idea that the ball was at their feet, and with the irresistible and fatal determination to be too soon rich, and relying too confidently on the passive resistance of farmers, they have, unfortunately for themselves, but luckily for agriculture and the interests of the general community, roused us from our dream of fancied security, and in a way none of us can mistake,—viz., by putting their hands into the very bottom of our pockets.

"In various respects, guano may be said to be abused, such as (1) in trusting to its agency alone for keeping up the fertility of the weaker description of soils in the country; (2), in supposing the best character of land can be profitably cultivated by reducing much the proportion of farm-yard manure, and substituting guano instead; and the last and not least important instance of its abuse consists in applying guano alone, to the exclusion of every other portable manure, whereas a mixture would not only have given as good results at first, but have proved more permanent in its beneficial effects. It is a curious fact in practice that the guanoes of an inferior class, when applied weight for weight with the Peruvian, have, upon the most reliable evidence, produced equal results.

"I draw these observations to a close by simply expressing the conclusions at which I have arrived as to the mode of extricating ourselves from the apparent difficulty of the guano question. And first I would take leave to say that we, as agriculturists, are certainly bound to approach the legislature, and ask for what we are reasonably entitled to, viz., that Government render available all possible means of investigating every source from which a supply of guano can be obtained, even although it should be of second-class quality. But, secondly, as past experience gives us but slight encouragement to place much dependence upon the assistance to be obtained from government or the legislature, we should exhaust for ourselves every other available source of supply, or, in other words, encourage importers and manufacturers, by making fair trial of such other portable manures as may be brought into market, provided these are certified by the analysis of some well-known chemist. At the same time, we should not forget to turn our attention more than ever to the dung-heap at home, which, I am convinced, by judicious management, may in every case be very much augmented, and which cannot be dispensed with, whether guano be high or low in price. And, lastly, instead of employing guano by itself as formerly on the lighter and weaker description of soils, let farmers use along with it an admixture of some other portable manure, highly charged with phosphates, such as bone meal, dissolved bones, or even guano of a secondary class, if unadulterated, and on the heavier character of soils, employ along with guano some other nitrogenous manure, such as rape-dust, blood-manure, &c., and while this course will be more profitable, it will tend materially to lessen the demand on the Messrs. Gibbs, and compel them soon to lower their colours and send in a flag of truce."

APPENDIX II.

SOME ACCOUNT OF

MC'DOUGALL'S DISINFECTING POWDER.

It would be ungracious towards Mr. McDougall if I were to omit to mention his Disinfecting Powder,—one of the most valuable chemical discoveries of the age. The late Professor Johnston, a short time before his death, had referred to the thing as a desideratum yet to be supplied, in these words :—

"*An effective disinfectant must be able either to decompose or combine with both the alkaline and acid products of decomposition. And, economically, its value will be further increased if, while it effects these chemical purposes, it at the same time produces a new substance which is not offensive in any way, and still more if it produces one that is positively useful.*"

Mr. McDougall then proceeds :—

"The fact is that this department of agricultural improvement has been retarded for the want of a suitable agent to effect the purpose; neither *salt*, nor *sugar*, nor *nitre*, nor any of the substances which are ordinarily used to preserve flesh would be effective for the disinfection of animal offal and excrements, and the preservation of those elements in them which give to these substances their agricultural value. An advanced state of scientific knowledge was necessary

even rightly to state the problem, and much thought and investigation to effect its solution.

The problem, stated in as few words as possible, was, to find a substance which should effect the following things:—

1. Remove offensive smells.
2. Prevent putrefactive fermentation, so that the offensive smell, being once removed, should not set in again from the same substance.
3. Combine with and preserve, in fœcal and other matters, the elements which form the food of plants.
4. The substance should be cheap and easily procurable.

If we take any of the ordinary deodorizers or disinfectants, and test them individually by the requirements of the case as I have just stated it, we shall be able at once to form a correct judgment of their utter and entire unfitness for the purpose. Those most commonly known are, *chloride of zinc*, *nitrate of lead*, *chloride of lime*, *gypsum*, *copperas*, and *charcoal*. There are a few others, but none better, or in any degree more suitable than these, are in general use. But even these substances are open to objection on the ground that they introduce pernicious substances into the manures to which they are applied. Thus, chloride of zinc and nitrate of lead are strongly acid and corrosive, both costly and both highly poisonous. Chloride of lime is also expensive, unpleasant to use, and 'acts most detrimentally upon manures by decomposing the ammonia they contain.' Other substances, such as charcoal and copperas, are also pernicious in their action upon organic manures. The noxious emanations from these manures, which it is desirable to remove, are sulphuretted hydrogen, and the fertilising elements, which it is necessary to preserve, are phosphoric acid and ammonia.

The justness of the remark previously made will now be clearly perceived,—that the want of a suitable agent has hindered the progress which might otherwise have been made in the 'preservation of the natural manures.'

In order to a correct understanding of the subject, it is necessary to recollect that the gaseous emanations from fœcal and other organic matters used as manures are sulphuretted hydrogen and phosphuretted hydrogen, either free or in combination with ammonia, and that the fertilizing elements to be preserved are phosphoric acid and ammonia.

The agent by means of which we propose to remove these noxious bodies, and preserve the valuable ones, is a compound of two acids and two bases. The acids are *sulphurous acid* and *carbolic acid*, and the bases, magnesia and lime. These four exist in it as two salts, viz., *sulphite of magnesia and lime* and *carbolate of lime*. The action peculiar to each of these constituents of the disinfector I shall now explain.

The only agent we know which will decompose the noxious emanations from putrescent excreta, or other animal offal, without exerting any detrimental action upon those elements which we wish to preserve, is sulphurous acid.

Let us take two atoms of sulphuretted hydrogen, and one of sulphurous acid; when they are brought iuto contact, they are mutually decomposed, and form three of sulphur and two of water, both of which are entirely odourless.

A similar reaction will ensue, if we put phosphuretted hydrogen in the place of sulphuretted hydrogen, only the products would be, two of phosphorus, one of sulphur, and two of water, as before, both of which are also entirely odourless.

Here, then, we have the means of solving the first conditiou of the problem. By the agency of sulphurous acid, the offensive smell of putrescent substances may be removed. Further than this, sulphurous acid has a conservative action, which is highly favourable to our object. It has a strong affiuity for oxygen, and will not permit other substances in its presence to combine with oxygen, till its own affinity is satisfied. It thus exercises an influence highly antiputrescent, besides decomposing the offeusive compounds which have been already formed.

We have another guarantee, however, for the prevention

of putrefactive fermentation; this is the carbolic acid which has the property of coagulating albuminous substances, and generally of preventing putrescence. As it is a liquid, oily compound, we combine it with lime, and are thus enabled to dry it and reduce it to a powder, so rendering its application easy and simple.

It only remains now that I explain the reason why we use magnesia in combination with the sulphurous acid. The reason is, that the compounds to be preserved are ammonia and phosphoric acid, and magnesia is the only available element which combines with them both and forms a triple compound, perhaps of all other possible combinations the best for agricultural purposes, viz., the triple phosphate of magnesia and ammonia.

In the treatment of sewage or other similar matter in an advanced stage of decomposition, containing any considerable per centage of ammonia, we find it advantageous to add a soluble phosphate, as the quantity of phosphoric acid in the substance to be operated upon is not, in the circumstances, sufficient to permit the formation of the triple phosphate.

Thus, then, we use sulphurous acid to remove the offensive smell, carbolic acid to prevent putrefactive fermentation, a little lime to neutralise and dry this latter acid, and magnesia to combine with and preserve the phosphoric acid and ammonia; and in special cases, we add a soluble phosphate to prevent the loss of any of the ammonia.

Such is the theory of the Disinfecting Powder. Theoretically, it is perfect, leaving nothing to be desired, and in practice, it has not fallen short of the just expectations which were formed of its probable results in actual use.*

* It thoroughly removes the smell from DRAINS, CESSPOOLS, WATER-CLOSETS, URINALS, &c. It is intended for Domestic as well as Public use.

In STABLES, COW-HOUSES, &c., it preserves the air pure, and makes ventilation easy, so that its use is highly conducive to the health of the animals.

Manures treated with this Disinfector, will be found much improved,

There are certain relations established between the vegetable and the animal kingdoms with which all your arrangements ought to harmonise; for unless they do, the results will be neither economical nor sanitary. The plant gives off as excrementitious that upon which the animal subsists, while it vegetates luxuriantly upon that which the animal ejects. These two departments of nature are the complements of each other. If your animal refuse is carefully preserved in the condition in which it is best adapted to supply food to the plant, it will not only give healthfulness to your homestead, but clothe your fields with verdure and endue them with fertility."

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DR. SHERIDAN MUSPRATT, F.R.S.E., M.R.I.A., &c.,

Professor at the College of Chemistry, Liverpool; Fellow of the Royal Agricultural Society of England; and Author of various Works on Agricultural Chemistry.

This Company's Manures are prepared on the principle that they contain *all the ingredients* of the best Peruvian Guano, and in a better and more assimilative form, besides *other mineral matters* which are known to play *a most important part in the vegetable kingdom;* all the salts being in more *exact proportion* for the complete development of the crops for which they are suited, than is found in Guano; consequently, independently of price, they are far cheaper.

The British Patent Manure Company append the following Analysis and Report from DR. HEREPATH, the eminent Chemist.

Bristol, 21*st March*, 1857.

GENTLEMEN,

I have analyzed the sample of Patent Manure sent to me, and the results of which I now enclose:—

Moisture	15.40
Ammoniacal Salts (Nitrogen, 7.01)	22.30
Soluble Salts (Soluble Phosphates, 7.20)	17.54
Earthy Phosphates	30.86
Nitrogenous Organic Matter	13.99
	100.00

The soluble Salts consisting principally of the Chlorides of Potassium and Sodium; Super-Phosphate of Lime and Phosphate of Magnesia; Sulphates of Potassa, Lime, and Magnesia; and Nitrate of Soda; together with a Soluble Silicate of Potassa.

From this examination, I have no hesitation in stating that this Manure contains a very large proportion of the *two most important* ingredients of Peruvian Guano, viz.: Phosphate of Lime and Magnesia, and Ammoniacal Salts 22.30 per cent., yielding with the other Nitrogenous matter 7.01 *per cent. of Nitrogen*, a most indispensable constituent of any Manure for Cereal (Wheat, &c.) Crops. The other Salts of Potassa, Soda, Lime, Magnesia, and Silica, are in the best state and proportion to be assimilated by the growing plant, and will doubtless afford to the Agriculturist a most valuable Manure, and which will give him large Crops at once, as well as produce lasting effects upon his land; combining as it does the qualities of a good stimulating Manure, together with the more durable effects of Bone Manure.

I have also no hesitation in saying that the Artificial Manure manufactured by you from DR. MUSPRATT'S formula (whose name alone is a sufficient guarantee of its excellence) *must return to the soil all the inorganic constituents taken away by any Crop* however heavy it may be; and I, therefore, with the utmost confidence, recommend it to the attention of the public as a most excellent and durable Manure.

(Signed) W. BIRD HERAPATH, M.D., F.R.S.E.

To the BRITISH PATENT MANURE CO.

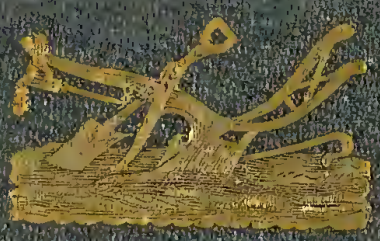
Price of the Manure.

No. 1.—Eight Guineas per Ton.

Quantity per acre, five cwt., to be applied like Guano.

Free to any Railway Station or Canal Wharf in Manchester.

OFFICE OF THE COMPANY.—7, Chapel Walks, Manchester.



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