

HUMUS IN SUGAR CANE AGRICULTURE

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The continuous stimulation of vegetable crops by artificial fertilisers is symbolic of our synthetic civilisation, the age of quick returns, and leaving any consequences for the next generation to worry about.

That the consequences of such legacies are being recognised is patent from the world-wide interest, and developments, in the production and use of Humus in tropical agriculture.

Professor Henry E. Armstrong opened the lecture on the Indore Process by Sir Albert Howard at the Royal Society of Arts (1), by saying:—

“Beyond question we are at the beginning of a new and rational epoch in agriculture. We have too long wandered in the unimaginative wilderness of mineral fertilisers.”

I do not propose to more than refer to artificial or mineral fertilisers. Their history began in the time of Liebig, 1843, and developed through the famous Rothamsted experiments with ammonium salts, to the great industry they constitute to-day.

From that history has grown an enormous literature, revolutions in soil science, bio-chemistry, statistical methods of measurements, and the lust of increased crops on the yardstick of present profit, while on the other side of the balance sheet have grown the accumulating uneasy feelings of decreasing fertility, and the increasing susceptibility of plants and animals to diseases, through a reduction in those nebulous conditions, which may be termed stamina, and quality.

It is true, that these subtleties refer in particular to such foodstuffs as flesh, milk and eggs; and that the agricultural methods employed in such an adaptable material as sugar cane, and its almost chemically pure final product sugar, are not likely to be influenced at present by the researches and fears of the bio-chemists.

That decision will eventually be based on costs, and all the considerations embracing permanent, as opposed to squatter, agriculture.

Our knowledge of the intricate processes of chlorophyll construction, together with its destructive complement by fungi and bacteria in Nature's life cycle, is singularly small, whereas our interference in Nature's workhouse is typically great, and particularly Western.

In Nature, the products of decay and their re-assembling into a basic bed for future plant life, is called Humus.

Sir Albert Howard says of Humus:—

“It consists of a mass of heterogeneous substances, the remains of plants and animals, substances like lignified cellulose, and a number of valuable materials synthesised by the micro-organisms of the soil, and undergoing oxidation to a point, when the mass becomes sufficiently homogeneous to be incorporated into the soil.”

Professor Armstrong added:—

“At present we know nothing of Humus, beyond that it is a good food for plants—the best they can have. Unfortunately this fact has long been treated with considered disregard by academic workers, who are obsessed by the worship of mineral fertilisers.”

Such criticisms, from men of high standing, at least warrant a little stock-taking, and consideration as to whether the sugar grower is also not obsessed by the worship of artificials, and if so, why?

The January number of the International Sugar Journal remarks on the production and use of humus in tropical agriculture, with the exception of sugar cane, where the general trend seems away from Humus towards an extended use of artificials. The answer is again economic, though one wonders whether serious attempts are being made to study the new methods of composting, and checking the costs against the results.

Fourteen years ago, in a paper entitled “Cane By-Products and their Manurial Value,” the writer of this paper stated:—

“The principle of returning plant residues to the soil is one of the oldest principles of agriculture. To its observance is to be attributed the long continued fertility of the soils of the older civilisations, while to its neglect is to be assigned the gradual exhaustion of our older cane lands.”

In the sugar industry we have as residues, cane trash and tops, bagasse ash, filter cake, and sometimes molasses or dunder. The age-old Chinese agriculture is based upon the principle, that only the crop itself should be grown upon the land. All other refuse, such as crop residues, weeds etc., is carefully removed, and composted for eventual return to the land.

Cane Trash.

The dead leaves of sugar cane constitute an appreciable portion of the crop. In the paper on Cane By-Products (4), the writer calculated that a

25 ton cane crop yielded 7,070 lbs. of trash, or 14 per cent. Tambe and Wad (2) showed that the average percentage of trash from five cane varieties was 21.8 per cent, or that for every 100 tons of stripped cane, about 22 tons of trash become available. In itself, trash is a refractory material, difficult and costly to handle, without some mechanical device, such as the Hosier Hay Sweep (6), and of a small manurial value. The writer has estimated that it contains 0.27 per cent of nitrogen, and 7.3 per cent of ash, consisting chiefly of silica, 62 per cent (4).

Disposal of Trash.

In the Proceedings of the Hawaiian Technologists it is stated that the effects of the alternative practice of leaving the trash on the field are not, according to records uniform, due probably to a diversity of conditions. A further report shewed that no difference in yield resulted from leaving trash as a blanket (6).

The manurial value of trash is small, and considering the length of time it takes to rot on the fields, it may even have a harmful effect, in that the agents of its decomposition may compete with the cane plants for the available nitrogen.

In Australia the disposal of trash gathering into alternate rows or leaving it as a blanket, is complicated by the question of disease, as the layered trash affords a breeding place for pests. In consequence, the trash is usually burnt in the fields after harvesting.

This practice has little to commend it, as not only are the organic matter and nitrogen destroyed, but also those beneficial insects, which form the natural control of pests. In Natal and Zululand, where pests are comparatively unknown, the spreading of trash has the advantage of forming a surface mulch in times of drought, and this eventually leads to better tilth, and a saving in weeding costs.

Method of Trash Treatment by Composting.

The development of new methods of composting are to be found in the literature, references to which are appended.

In Mauritius and the West Indies composting with pen manure was a long standing practice and persisted until the advent of cheap artificials, and mechanical cultivation, rendered the keeping of cattle merely as a source of manure, uneconomical.

Since those days the Indore process, first worked out in 1931 by the Institute of Plant Industry, Indore, Central India, has received world-wide attention and interest.

Growers of Tea and Coffee in India and Ceylon in particular have become Humus-minded, the re-

sults shewing great improvements in yield and quality.

Nearer home, Majors Belcher and Grogan of the Kingatori Coffee Estate, near Kyambu, Kenya, have through their keen interest and results, caused the rapid spread of the method in East Africa. So far nothing has been done about it in our local tea industry.

Modifications of the original Indore process to suit sugar conditions are appearing from time to time, their object being to evolve a quick and cheap method of turning trash into Humus.

Actually there is not, and never can be, any one cut and dried method applicable to all the varied geographical conditions of cane farming, for trash may be composted with dung, filter cake, dunder, any green materials from sun-hemp to water hyacinths, or a combination of these, according to the materials available.

The economics of composting resolves itself into the following basic factors: The trash is on one field; the dung (if any) is at the stables; the filter cake or dunder is at the Sugar Factory or Distillery; green material somewhere else, and the water anywhere or nowhere; while the result may be required somewhere else.

Before considering these practical aspects, I propose commencing with the result—Compost, and finally discussing the possibilities of its practical manufacture.

Analysis of Composts.

A sample of compost made in Travancore during the South West Monsoon (kindly sent to the writer by Sir Albert Howard shewed the following analysis:—

	per cent
Moisture	65.0
Loss on ignition (dry)	46.5
Earth, ashes, etc.	53.5
Carbon (wet)	6.20
Nitrogen (wet)	0.43
C/N	14.4/1
Nitrogen (dry)	1.23

Experiments were thereupon carried out at Darnall, and it was found that excellent composts may easily be made from a variety of activators, provided the beds are kept moist from the start. One bed now composted with layers of filter cake and kraal manure has now been lying for a year, and except for rains has received no extra water, the result being that only slight crumbling has taken place.

The following are the analysis of the various experiments:—

Composted with	Moisture	Loss on Ignition	N	Total P ₂ O ₅	Avail. P ₂ O ₅	Total K ₂ O	Avail. K ₂ O
1. Kraal Manure	60.5	30.6	0.74	0.28	0.14	S.T.	—
2. Filter Cake	74.2	44.0	0.67	0.68	0.52	S.T.	—
3. Kraal Manure and Filter Cake	61.0	33.3	0.71	0.40	0.28	S.T.	—
4. Kraal Manure, Filter Cane and Molasses ..	64.8	34.6	0.70	0.40	0.20	T.	S.T.
5. Dunder	28.5	20.0	0.72	0.40	0.21	0.52	0.30
6. Kraal Manure, Filter Cake, Ammonium Sulphate and Pot. Sulphate	59.2	27.8	1.00	0.42	0.29	0.72	0.49
7. F a r m composts with available materials ..	55.5	27.6	0.78	0.32	0.24	S.T.	—
8. F a r m composts with available materials ..	52.2	29.6	0.67	0.89	0.56	S.T.	—
9. F a r m composts with available materials ..	57.8	33.1	0.91	0.56	0.44	S.T.	—
10. F a r m composts with available materials ..	41.0	30.0	0.84	0.44	0.36	S.T.	—
11. F a r m composts with available materials ..	29.2	9.9	0.67	0.27	0.20	S.T.	—

These results are in the main similar to those obtained by Tambe and Wad (2), so that on an average it can be estimated that 100 tons of stripped cane, or 4 acres at 25 tons per acre, will yield approximately 40 tons of compost, containing about 280 lbs. of nitrogen, and 160 lbs. of phosphoric acid.

These amounts can be raised by increasing the quantity of the activators, as in analysis 2 and 8, or by enrichment with mineral fertilisers, as in analysis 6.

Disposal of Dunder.

The disposal of this troublesome product of a distillery has always been a serious problem facing distillery owners. The use of this waste material in the manufacture of Humus, not only effectively disposes of it, but the product becomes a valuable manure.

The absorptive quality of trash is immense. A heap of fairly old, normally packed trash, 9 yards in circumference and 2½ feet high, estimated to contain 400 lbs. of trash (purposely high estimate) absorbed 600 gallons of dunder in two months. During this period 20.8 ins. of rain fell.

A distillery producing 4,000 gallons of alcohol per diem, would also produce 60,000 gallons of dunder, or 3,600,000 gallons in 60 days. The quantity of trash required to absorb this would be 1,200 tons, or 6,000 tons of cane, representing 240 acres of cane, or 1,440 acres for a whole year.

These figures are probably largely in excess of actuality, owing to the heavy rain which was experienced throughout the course of the experiment.

Analysis 5 shews the analysis of the product, so that a year's output would contain, apart from its humus value, over 50 tons of nitrogen, 30 tons of phosphoric acid and 36 tons of potash.

In practice, the dunder could be run in ditches, or pumped with or without filter cake to any number of selected sites near conveniently situated cane fields, depending upon local conditions.

On account of its high carbon: nitrogen ratio, the effective composting of trash requires close contact with activators of a high nitrogen content.

Observations made during the course of the experiments, shew that trash should be a few months old before being composted. This causes a certain weathering, and consequent easier crumbling when composting.

It is further essential, that the trash be well layered, or mixed up as much as possible with the activating medium or mediums, and that the heaps be kept wet from the start.

After one month the heaps are turned, and a green manure crop, such as Sun hemp, can be planted on the heaps. When this has reached maturity, the whole is once more turned and then left for a total period of about 90 days, when the process should be completed.

Practical Considerations.

The economics and practical considerations of Humus manufacture from trash will be considered under the following divisions:—

1. Trash.
2. Kraal Manure.
3. Filter Cake.
4. Dunder.
5. Green materials.
6. Water.

Handling of the Trash.

The first cost is the conveyance of the trash off the field to the composting site. If the cane is stripped on the fields, this will necessitate extra labour, or some mechanical rake, such as the Hosier previously referred to.

The obvious solution to this problem is, where cane is loaded on the fields in wagons, and conveyed to a siding for reloading, the cane should not be stripped on the fields, but at the sidings, where it can be stacked for composting at the end of the crushing season.

Where no such reloading takes place, then provision must be made for removing the trash from the field to any convenient spot, where it is stacked for future composting "in situ," or conveyance to a suitable place after the cutting season.

These convenient sites will be as a rule adjacent to the tramline, or at sidings, or near a natural water supply.

Kraal Manure.

Wherever cattle or mules are used, the kraal or stable should be bedded with trash from the nearest field, and periodically removed to an adjacent heap for use during the off season. It is surprising how much manure can be made in this manner, if sufficient quantities of trash are used.

Filter Cake.

This waste material of the Sugar Factory is a better medium for composting trash than cattle dung, while the resulting manurial value is greater.

The cost and difficulties of handling this material at the Sugar Factories are considerable, and there appears no reason why more rational methods for its disposal could not be evolved in conjunction with Humus manufacture.

For example, where trash has been collected along the tram route, tank cars loaded straight from the Presses and diluted in the form of a thick slurry, could be discharged on to trash heaps.

Another method would be to dilute the cake with all the effluent water from the Factory, and pump the whole material to convenient sites for

composting with trash. In this way, some of the costs and reloading difficulties of filter cake handling, and the problem of effluent water disposal, would, with benefit be solved.

Dunder.

The possibilities of the disposal of this material have already been considered, and its use together with filter cake and effluent waters would take the same lines as suggested under the previous heading.

Green Materials.

No fixed rules can be made under this heading. With other products of tropical agriculture, such as Tea, Coffee, Maize, etc., green materials are essential, as no such materials as Filter Cake or Dunder are available.

Nevertheless, the incorporation of any available materials, such as weeds, grasses, green manures, etc., into the compost heaps, will accelerate the action and result in a more valuable material.

Water.

Under the suggestions elaborated above, it will be seen, that the difficulties of water supply in areas favourably situated to the Sugar Factory or Distillery are not insurmountable.

All other cases constitute individual problems, and where watering is an impracticable proposition, composting only during the rainy months with suitable materials, can still give the results over a longer time, as has been demonstrated in India.

Conclusion.

In this paper the writer has attempted to review the practical problems connected with the manufacture of Humus from cane trash. The Sugar Planter has at his disposal a variety of canes immune to most diseases, from which he can select those most suitable to his conditions.

Artificial is easy of application, easily purchased in good times, or not bought at all when times are bad; they form a never-ending topic of conversation with one's neighbours, a source of argument with the vendors; they are a duty and a sop to one's conscience; whereas Humus means more labour, more attention, transport and trouble. Nevertheless Humus is the basis of permanent agriculture, artificial the policy of the here to-day and gone to-morrow.

There is in fact no reason why the Cane Farm should not fertilise itself, assisted maybe in a small way by artificial, for in the concluding words of Sir Albert Howard's address on the Indore Process he said:—

"Nature's round—the wheel of life—consists of two processes, the process of growth, and the process of decay. Both are integral to her activity, both are equally important, neither can be omitted."

References.

1. The Manufacture of Humus by the Indore Process. J. Roy. Soc. Arts, Nov. 22nd, 1935.
2. Humus Manufacture from Cane Trash. G. C. Tambe and Y. D. Wad. Int. Sug. J., 1935, 260; S.A. Sug. J., 1937, 161.
3. A Note on Composting Organic Matter by the Use of Chemical Starters. V. V. Gadgil and R. M. Hedgekatti. Agric. and Live-stock in India, 1937, 711.
4. Cane By-Products and their Manurial Value. G. C. Dymond. S.A. Sug. J. Exhibition Number, 1923.
5. Soil Organic Matter and Tropical Agriculture—A Discussion. D. W. Guthrie. Agric. J. British Guiana, 1937, 177.
6. Some Further Information on Humus. Int. Sug. J., 1938, 6.
7. Rep. Ass. Haw. Sug. Tech., 1936, 371.

Darnall.



The PRESIDENT: In opening the discussion said that Mr. Dymond had been one of the most consistent contributors to the Proceedings, and could always be relied upon for new and original ideas.

Mr. COIGNET: Congratulated the writer and emphasised the need for humus in sugar cane agriculture. He illustrated the benefits of humus in light soils and heavy clay soils, stating that a proper supply of organic matter might prove as beneficial as irrigation, considering the water-holding capacity of humus.

Mr. PALAIRET: Said he had experimented with humus. In preparing compost he had added artificial nitrogen which he had found necessary. In a second experiment he had prepared the compost without artificial nitrogen but had planted hemp on the heap, which seemed to produce the necessary nitrogen. He thought it a good scheme to trash cane at the siding and water it there, if possible. He said that heaps should be square with a flat top, or slightly concave, but not round. He thought the preparation of compost was most important, as he believed the new varieties were going to be rather exacting in their demands. A soil rich in humus, he said, did not wash away readily, and also it was capable of absorbing a great deal of moisture.

Mr. MOBERLY: Stated that if trash for making humus was required centrally at one point, then a machine which simply cut and loaded the cane was all that was required on the field. The removal of trash and tops could be attended to at the siding, and perhaps very much more efficiently than was the case in the field.

Mr. ARDINGTON: In expressing his appreciation of the paper pointed out that it was an old subject, and we had neglected it. He had made tenta-

tive experiments and got some satisfaction. He thought the question of cost should have been given more attention in the paper. That prevented planters, but he had no doubt that if someone could make a study of the subject and present a paper on his work, showing the actual costs of humus production, it would be of great value. He hoped Mr. Dymond or somebody else could do that for our next Congress.

Mr. DU TOIT: Referred to the question of burning trash which was harmful owing to the loss of nitrogen and humus. The danger of leaving trash on the field, on account of the agents of decomposition competing with the growing plant, had been emphasised by Mr. Dymond. The preparation of humus then seemed to be the ideal solution to the problem. The advantages claimed for this process were many, both physical and chemical. He went on to say that the cost of manufacture in other countries varied tremendously. At Travancore it worked out to from one or two rupees per ton, approximately 1/6 to 3/-. In Ceylon cost was as high as 12/-, while in Kenya it was 4/4 per ton and in Nairobi 14/-. Such variations showed the need for further examination. As so little experimental work had been done with cane, however, it would be interesting to obtain further information. Sir Albert Howard said that it took at least six years before definite results could be expected from such experimental work. Mr. du Toit then asked for information on the size of the heaps he used, the amount of water required, the frequency with which he turned the heaps, and the increases in temperature. Further had Mr. Dymond any information on the nitrogen content before and after composting? Had he found an increase? Lastly could Mr. Dymond refer him to any literature stating definitely how the quality of the product is effected by the addition of humus.

Dr. HEDLEY: Proposed the formation of a committee to investigate the application of dunder to soils. The Indore process was utilised at the Durban Country Club and at the Natal Estates golf course, but in neither case had the costs been worked out. The possibility of making humus from dunder would have to be worked out. The Sugar Association would no doubt vote the money, and he hoped that Mr. Campbell would be able to offer his co-operation.

Mr. CAMPBELL: Said he was prepared to carry out the experiments suggested. He would carry out the Indore process from a commercial point of view, and suggested that Dr. Hedley be allowed to co-operate with his staff. Regarding the transport of dunder, he said that this could be disposed of locally by each factory.

Dr. McMARTIN: Thought the Industry should be grateful to Mr. Dymond for bringing up this neglected subject. He spoke of the conflicting

knowledge about humus. Both humus and artificial fertilisers were necessary. He had read that nitrogen in either the organic or inorganic form gave similar results. Bulky organic matter was still nevertheless required, in order to give the soil its water-holding capacity which was a most important point.

Mr. BECHARD: Referred to the encouragement given by humus to the breeding of insect pests; for example he quoted the white worms brought with kraal manure. He wanted to know something more about the fixation of nitrogen by chemical means.

Mr. FOWLIE: Spoke on the actual improvement to be expected from farmyard manure. The transient nature of the improvement due to compost or farmyard manure had to be considered. Farmyard manure really only contained decaying organic matter, which was not the same as humus. Decay and humification were two different processes. In the former case nearly all the organic matter went to waste. The immediate results of compost, farmyard manure, etc. wore off as soon as the process of decay was completed. Hence he would caution against expecting improvements from the use of fertilisers of this class.

Mr. DU TOIT: Asked how the writer had arrived at two tons of compost from one ton of trash. Did he accept Tambe & Wad's figure?

Mr. DODDS: Complimented Mr. Dymond on his paper, and drew attention to the depletion of organic matter through sugar cane agriculture. Mr. Dymond had asked if we were not obsessed by the worship of artificials. Hawaiian technologists claimed that there was no need to be concerned directly about supplying organic matter to the soil; all that was necessary was to grow big crops by irrigation, suitable heavy fertilising, and so on. Root residues were quite sufficient to supply the necessary organic matter. That was all very well where the soil was originally stocked with organic matter, but would not do for this country. He said, in common with his usual practice, he would like to circulate this agricultural paper to farmers in the hope that they would take up the matter.

Mr. LINTNER: Said that it was unwise to pay too much attention to any one aspect of agriculture, and so belittle other factors contributing to soil fertility. We should preserve a balance, and examine carefully all factors governing soil fertility according to the latest methods of field technique.

Mr. DEENIK: Seconded Mr. Lintner's statements. The maintenance of organic matter in the soil at a high level was after all only sound agriculture and any practice which causes its depletion was to be condemned. It was obvious that the return of plant residues obtained from a mineral deficient soil to the same soil was not going to solve

this deficiency. Such a process could only gradually aggravate the position. Artificial fertilisers essential for plant growth were plant foods themselves and not mere stimulants as Mr. Dymond claimed.

Mr. DYMOND: Replying to the question of watering the heaps, said he had merely kept the beds sufficiently damp as indicated by the position six inches inside the heap. As regards the turning procedure, he turned them once a month, two turnings in all. That was sufficient to obtain a compost in just over 90 days. Alternatively the heaps could be aerated by other mechanical means such as compressed air, and so save much labour.

He would welcome the formation of a committee to go into the whole problem of humus manufacture. Some work of his using barrels had given remarkable results. Humus incorporated into the soil at about 15 tons per acre gave an increase in cane stool leaves and all of about 18%.

As regards composting, the beds were made above ground. Composting in pits was not necessary. His procedure was to lay trash about four inches, then layer with either filter cake, dung or green material, the first proving itself the best activator if added at the rate of at least 25% of the weight of the trash. Partial control was kept of temperatures, which should be 60°C. and over after two or three weeks. The only intermediate nitrogen analyses that were made on the compost, were after 3 months when the nitrogen content averaged 0.7%, and recently on a badly attended heap, which had been lying nine months and showed a nitrogen content of 1.0%. Regarding quality he could only say that Darjeeling tea planters produced tea of the highest quality where they had never used artificials.

He suggested either conducting an experiment with dunder in the neighbourhood of the Natal Cane By-Products; and so obviate the expense of riling the material, or preparing it in situ. Natal Estates filter cake was different to that of other factories and that fact must be borne in mind.

He said he had noticed that old compost heaps were infested with the large white grubs of the Rhinoceros Beetle. Regarding the fixation of nitrogen, he said humus had the double value of largely preventing leaching and providing the necessary bacteria for fixation.

The figure quoted by Mr. du Toit, namely 2 tons of compost had been based on 20% of trash per cent cane instead of Tambe and Wad's figure of 21.8%.

Referring to Mr. Dodds he said he would gladly consent to his paper being circulated.

Lastly in reply to Messrs. Lintner and Deenik's remarks regarding artificial fertilisers, he said arti-

officials had held the stage too long. Humus had been neglected, and he thought many results might have become significant had NPK and humus variations been brought in. This year he hoped to investigate the effect of compost on the solubility of phosphates in rock phosphate.

He concluded by thanking members for their in-

terest in his paper, and hoped that with the coming year the economic possibilities of humus manufacture from cane trash would be fully investigated.

The PRESIDENT: In moving a vote of thanks to the writer expressed his pleasure at the long and interesting discussion that had ensued.