SELECTED ARTICLES,

COMPOSTING

THE SAFE CONVERSION OF VILLAGE REFUSE AND NIGHTSOIL INTO A VALUABLE MANURE

THE Chinese from time immemorial have used human excrement as an important and never failing source of manure in their agricultural pursuits.

Indeed one cannot help being struck, almost everywhere, in Malaya by the success and hardihood of the so-called Chinese squatter in rearing vegetables. He succeeds in cultivating luscious crops on almost any kind of land, however wretched or inhospitable the conditions may appear to be.

The faculty of the Chinese market gardener in making infertile soil fertile, and in maintaining that fertility, is largely due to his clever use of freshly fermented nightsoil and urine.

Though vegetables thrive, the practice of putting human wastes directly on the soil is dangerous to health. The heavy toll of sickness and death from various bowel diseases in China is well known.

The Chinese living on the land in China, are an easy prey to a swarm of filthy parasites, and yet, in spite of this grave handicap, no one can deny the virility of the race and their ability to maintain themselves under conditions which would be fatal to those less inured to such devastating infections.

Health Officers in this country, and elsewhere, have been brought up, quite rightly, to regard the safe disposal of human excrement as an essential requisite for safeguarding public health. We could justify our action in preventing the use of nightsoil in agriculture, because of the serious risks to health which its use involved.

Health Officers and Sanitary Inspectors have been very active in stopping the supplies of manure so eagerly desired by the Chinese cultivator.

We have sought the co-operation of all educated men and women to insist upon the use of properly constructed latrines by everyone and we have been inclined to regard the installation of a water-carriage system as one of the final aims of civilization.

Though there has been little drama or reward for the Sanitarian in struggling against " the filth diseases " one has, at least, the satisfaction of knowing that, as a result of these latrine campaigns, a large number of persons have been saved from a miserable and untimely death and the constant drain on the vitality of our people from worm infection is lessening in this country.

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* Read at the Annual Meeting of the Malaya Branch, British Medical Association, Kuala Lumpur, March 23, 1940, by Dr. J. W. Scharff, M.D., D.P.H., Chief Health Officer, Singapore.

What I shall have to say later about "composting" should not be taken as a recommendation to relax those sanitary standards, which are slowly but surely being built up, with such good effect, throughout Malaya.

PROGRESS IN RURAL SANITATION

In 1925 the International Health Division of the Rockefeller Foundation, in association with the Government of the Straits Settlements, undertook a "Rural Sanitation Campaign" lasting three years. At the conclusion of this campaign, the health authorities concerned had visited every part of the territories of Singapore, Malacca and Penang. They investigated the incidence of worm infections throughout these areas and undertook the treatment of many thousand persons found to be infected. During this time they organized the construction of sanitary latrines in every village and Government School throughout the land. Doctors Russell and Yaeger, who were the local representatives of the Rockefeller Foundation, also introduced the bore-hole latrine. This has since proved a valuable instrument for securing improvement in rural sanitation. Its value is so much the greater, because it removes all temptation of the illicit use of the contents of the latrine.

At the conclusion of the Rural Sanitation Campaign, I happened to be stationed in Penang and it fell to me to follow up the work there to its logical conclusion. In the administration of Rural Sanitation, it was sometimes necessary to institute proceedings against cultivators who continued to use their own, and other people's faeces in their gardens. Magistrates were not averse to inflicting heavy fines upon persons proved guilty of using human ordure as manure. The knowledge that there would be a heavy penalty, coupled with the gradual elimination of supplies, sufficed to stop the practice in two country places in Penang. This would have had a disastrous effect on local agriculture had it not been for the fact that the gardeners lived mostly near the seashore, and the alternative of fish manure was available in plenty (though at some extra expense) to make up for this loss. The Chinese are adaptable and thanks to the efforts of the Agricultural Department they were amenable to persuasion. It then became the established practice, wherever possible, to use the sea for dumping refuse, in the hope that fish might thereby thrive and fatten. Surplus fish, not required for human food, would thus in turn provide a safe source of nourishment for the soil. This plan of using fish manure sufficed, for a time, to ease my feeling that there must be something wrong in deliberately throwing away a substance which by proper manipulation might safely serve to enrich the land.

It had long been deemed beyond the wit of man to prevent this wastage. The priceless loss of this valuable material has been dramatically likened by Victor Hugo, the novelist, to a stream of gold flowing to waste along a sewer.

In the Tropics, the dangers of using crude sewage direct upon the land, are far more intense and deadly than is the case in a temperate climate where the risk of worm infection is relatively slight.

An editorial in the Indian Medical Gazette of February, 1934, drew attention to the fact that a method had been found in India to convert village refuse and nightsoil directly into humus. The composting method described in articles

by Mielazis, Jackson and Wad, was the Indore system. It was claimed that this method was simple, safe, economical and free from nuisance and that even fly-breeding was abolished.

Such a simple solution for a difficult problem in rural sanitation, seemed too good to be true. It seemed to me to be beyond the realms of reasonable expectation that this new method of composting could readily be adapted to fit the special conditions of Malayan climate and environment. I know now that I was wrong.

At the London School of Hygiene in the Summer of 1937, I had the good fortune to listen to an eloquent talk by Sir Albert Howard on the subject of composting. This information helped to convert me to the view that the Indian methods of composting were scientifically sound and that they should receive an extended trial in Malaya.

On my return to Singapore, in the Autumn of 1937, experiments in the composting of village refuse and nightsoil were begun. These experiments have now gone forward sufficiently to convince me that in composting we possess a means of stimulating agriculture and perhaps even of making the people of Malaya self-supporting in vegetable food.

In bringing these investigations to the notice of this Association I wish, in particular, to invite discussion upon the safeguards which may be needed to ensure that the work of composting is so carried out in Malaya as to cause no danger to public health.

THE DEVELOPMENT OF COMPOSTING

Prior to the introduction of composting, by Sir Albert Howard and his co-workers in India in the year 1931, there had been many attempts to render human excrement, or its products, safe and fit for agriculture. All of these, so far as my experience goes, have failed in Malaya, because of the extreme resistance of intestinal worm eggs and amoebic cysts; in only one of these attempts has there been a certain measure of success. Since 1932, the sludge from the Municipal Sewage Works in Singapore has been subjected to the heat of 140°F for about half an hour. This heating has been proved by Dr. Gilmour, the Municipal Bacteriologist, to be sufficient to destroy all pathogenic organisms, which may be present in the sludge, including the eggs of intestinal worms. The source of the heat is derived from the gas evolved in the Imhoff tanks and the process is therefore comparatively inexpensive.

The heated sludge, though no longer dangerous, is, however, of poor manurial value, since it is lacking in adequate amounts in nitrogen and potash.

Sludge in Singapore is given away free of charge for those who choose to pay for cartage.

This serves to emphasize the difference in value between the sludge of septic tanks and the crude nightsoil, for which the Chinese gardener is always ready to pay a handsome price.

It also serves to bring into view the great potential value of compost in which every element needed by plants is properly preserved.

Composting as originally propounded by Howard and Wad is a process whereby the waste products of agriculture are converted into humus. In principle it corresponds to the natural process which goes on in the jungle,

whereby the residues of plant and animal life are converted into humus, through the agency of fungi and bacteria. Nature's method of dealing with forest wastes, is to convert them into an essential manure for trees, by means of continuous oxidation. The revolution of recent years in the technique of rubber cultivation, by the " forestry method ", has been due to modern understanding of this principle.

The Indore composting process, which is based upon the same principle, was first devised for the manufacture of humus from waste products of agriculture. It was later adapted, as I have already said, to serve as a simple solution for the sanitary disposal of the nightsoil and rubbish carted from towns and villages in India. Further modification of this process resulted in the creation of the Culcutta system of composting, in which the compost is made in brick-lined pits, instead of in mounds or trenches.

In following up this work in Malaya one has to guard against the penalty of allowing enthusiasm or haste to outstrip good sense. There is a painful feeling that one might endanger health by listening too freely to the clamour for manure ; added to this there is a natural disinclination to proclaim one's interest in articles so unsavoury as nightsoil and rubbish. Experience shows that these objections can be overcome and I am now satisfied that, with reasonable care, both the Indore process and the Culcutta system, with very slight and easy modifications, as briefly summarized at the conclusion of this article, can be safely used in Malaya.

I am prepared to prophesy that composting of refuse in our village kampongs and estates will cause a revolution in the sanitary organization of our rural areas no less dramatic and no less beneficial than has been the case in the change over from the clean weeding to forestry methods in rubber cultivation. It is clearly the duty of Health Officers, stimulated, not only by the crying need of improved nutrition amongst the masses, but also, by the special needs of war, to encourage this sanitary revolution and to see that the work is carried out safely and expeditiously.

THE AGRICULTURE ASPECT

The importance of composting is intensified by war conditions.

The war has had a profound effect in hastening the effort which is being made in Rural Singapore to alter sanitary organization in such a way as to produce the greatest possible amount of compost, as quickly as can be done. Composting is now being carried out in three large village centres drawing supplies from about 10,000 inhabitants, yielding approximately three tons of crude compost daily. Arrangements are being made to extend the system.

Meanwhile certain areas of waste land near Health Department Coolie lines have been occupied ; over fourteen acres of this land are already being cultivated for the production of vegetables and fruit.

At the beginning it required considerable persuasion to induce the labourers to carry out this work in their spare time, after working hours, without extra pay.

The first of these vegetable and fruit garden allotments, to start cultivation, was begun in the third week of October, 1939 ; others followed in quick succession. The first crops were gathered in within two months ; these,

consisted mainly of kangkong, spinach and beans. Later, supplies of tomatoes, lettuce, cucumber, radishes, chillies, ground nuts, pumpkins, bringals, ragi, tapioca and sweet potato began to arrive; and now, within six months of planting a bumper crop of papaya is about to be gathered in.

The produce is shared amongst Health Department labourers. At the present rate of production it is estimated that over 200 of them are saving at the rate of 20 cents a week as a result of their daily ration of vegetables. Thus within six months, vegetable production is benefiting the labour force at a rate of over $ 2,000 a year. What the increase in health and vitality of the labourers is going to be remains still to be computed.

The cost of composting is no greater than cost of incineration and the capital cost of the compost pit is very considerably less than that of a village incinerator.

The local staff of the Agricultural Department have been closely associated with this work and, but for their cordial assistance, this fine achievement on the part of the coolies could not have been accomplished.

There is evidence on all sides that this development is being watched with growing interest by the villagers, many of whom are now getting busy on their own allotments. The slogan " For Health and Victory grow your own Vegetables and Fruit ", is finding practical expresssion in the clamour for more and more supplies of compost by the would-be Chinese and Tamil gardeners. The Eurasian village community, and even the Malays, are joining in this hubbub; there are signs that school teachers are awakening to the possibility of making the local schools gardens something more than mere show places. These developments are all of very recent date.

LOCAL EXPERIMENTS IN COMPOSTING

The period of two years, preceding the outbreak of war, was taken up with the study of the methods by which composting of village refuse and nightsoil might be well and safely done. This necessitated tests not only from the chemical, as well as the parasitological standpoint but also involved attention to the aesthetic aspect of the process.

There have been many doubts to overcome and many difficulties and disappointments to face; there are doubtless many more adversities and adversaries to face before one can hope to establish this practice of composting on a firm, self-supporting and healthy basis.

From the parasitological point of view it has been necessary to ascertain the degrees of safety in the various systems which are practicable in this country. Temperature records have been made throughout the testing period and temperature readings are now being taken regularly under practical field conditions. The highest temperature recorded was 168°F and the lowest 142°F; these temperatures are maintained in the compost heaps for at least three weeks, during which time the compost is being turned and all fly maggots living in the surface of the heap are thereby killed. Thus the margin of safety is considerably greater than that which has been proved sufficient in dealing with sludge in Singapore.

It has been determined that the nightsoil used in making compost is literally teeming with ascaris eggs; it is also heavily contaminated with hookworm eggs. By the end of the third week, the compost is free from intestinal worm eggs.

Smell is a factor to be reckoned with, but I find that with increasing experience of the method, this objectionable feature, which is common to all concerns where nightsoil is manipulated, can be reduced to a minimum.

Indeed, I believe that, by seeding the nightsoil pails and buckets with compost, it will be possible to reduce the smell nuisance almost completely. It may, moreover, be possible, by this means, to introduce a saving in the present extravagant use of antiseptic fluids. These are points which must remain for subsequent confirmation. It should be observed however that the presence of either flies or odour in any composting scheme is an indication of defective work. Composting depends for its success upon the elimination of flies and smell.

The chemical results of village composting in Singapore have so far been poor. Nitrogen is recorded at the rate of only 0·73 per cent. and Phosphates, in the experimental samples, occur only in negligible amounts. These figures were so disappointing, in comparison with the Indian results, that, in the latter stages of these preliminary experiments, I was in doubt as to whether it would be worth while continuing an apparently thankless task. I am glad to report that field tests are beginning to show that the purely laboratory approach to the problem was misleading. Either there was something wrong with the sampling or, as now appears more likely, small scale experiments did not suffice to establish the full effects of the chemical process involved in composting. The Agricultural Department in Singapore have now started a field test in their experimental agricultural station. It is confidently expected that these tests will bear out the view that the compost produced on a large scale from village refuse in Singapore is of great manurial value.

The following is a brief summary of two methods of composting village refuse and nightsoil which have so far proved to be practicable and safe under the local conditions prevailing in Malaya.

THE "CALCUTTA" METHOD OF COMPOSTING AS USED IN SINGAPORE

A battery of brick-lined trenches, twelve feet long, four feet wide and two feet deep, are constructed. Channels, formed of loose bricks, are so laid, beneath the trenches, as to provide amply for drainage and aeration. (For specification see Journal of Royal Sanitary Institute, Vol. LIX., No. 4, October, 1938.)

2. An appropriate amount of refuse is dumped daily into successive trenches. One trench may, if necessary, be used for two days' supply of refuse. The refuse is sorted; bottles, tins and other incombustible materials are taken out and put on one side for subsequent disposal.

3. The sorted refuse is spread loosely over the surface of the trench. A layer of about six to ten inches is required. The refuse is drawn up towards the side and sloping end of the trench, so as to form a hollow into which the nightsoil is to be dumped.

4. Crude nightsoil (undiluted with water) is poured direct from nightsoil pails on to the layer of refuse. About one gallon of nightsoil is required for each cubic foot of refuse.

5. Immediately after adding the nightsoil, the refuse is thoroughly mixed, using a long rake. The coolie stands on the edge of the trench. The mixture of refuse and nightsoil is then drawn into a heap to one end of the trench where it is left undisturbed for a week. No watering is done. In very wet weather a loose layer of attaps is used to protect the heap from excessive moisture.

6. At the end of a week (during which time seven other trenches will usually have been similarly filled) the rubbish is turned and is drawn over to the other end of the trench where it is left to mature for two weeks. It is then removed and stacked in a heap on an earth floor, preferably under cover, for a further two weeks, by which time it is ready for use.

Thus, at the end of the fifth week, a continuous daily supply of humus becomes available for agriculture. The whole process, when properly carried out, is free from fly-breeding. Maggots may occasionally be observed at the surface of the heap, but these are killed after the first turn. The trenches are so constructed as to prevent the escape of maggots. The average temperature recorded during the first two weeks is at 145°F. At the end of this period the temperature gradually falls to normal. The occurrence of smell, except at the time of dumping nightsoil, is not more than that which is normally associated with an efficient septic tank.

THE "INDORE" METHOD OF COMPOSTING AS USED IN SINGAPORE

Well drained land, free from flooding, is suitable for this method of composting. The area required is pegged and levelled. Plots of suitable size are marked out and defined with shallow earth drains.

2. Village refuse is stacked loosely in heaps. These heaps should not be less than six feet wide at the base, four feet high and four feet wide at the top. The volume of a heap 6 feet × 4 feet × 4 feet is reckoned as representing 96 cubic feet of refuse. Glass, tins, coconut husks, stones, and other incombustible material are sorted out and put on one side for subsequent disposal.

3. A trench, four feet long, two feet wide and two feet deep, having a cubic content of 16 cubic feet, is dug out in the centre of a heap of the standard size. This trench is filled with well-stirred crude nightsoil. The top of the trench is then covered over loosely with refuse drawn from the side of the heap.

The quantity of nightsoil filling the trench should equal about one-sixth (14 per cent.) of the volume of the heap. For ready reckoning each nightsoil pail full represents three gallons; approximately one gallon of nightsoil is added to each cubic foot of refuse.

4. The heap is left undisturbed for a week, except for a daily moistening with about six gallons of water in dry weather. No watering is done during wet weather.

5. At the end of the first week the heap is turned so that the outer portion of the heap becomes the inner and the rubbish inside the heap forms the outer covering. A trench three feet long, two feet wide and two feet deep is dug along the centre of the heap which is by this time reduced to about four-fifths of its original volume. Twelve cubic feet of crude nightsoil (twenty-five

nightsoil pails full), equal to about one-tenth of the volume of the standard heap, is added. The top of the trench is then again covered over with drawn refuse. Watering is continued, as before, daily in dry weather.

6. The turning of the compost heap, as described above, is done, again at the end of the second week and trenched along the centre. The same quantity of nightsoil is again added.

7. At the end of the third and fourth weeks the heap is again turned but no more nightsoil is added. Daily watering is discontinued. The heaps are now left to mature for one month. In the event of heavy rain a loose covering of grass (lallang) or coconut fronds is laid over the heaps.

Two months from the commencement of composting the heaps will have been reduced to almost one-third of its original size. The compost is then fully mature and can be used upon the land. The amount of compost to be used in vegetable cultivation depends upon the condition of the soil. In Singapore the proportion used successfully in cultivation plots has been a mixture of one part of soil to one of humus.

The Indore method requires no capital outlay on the construction of trenches, as in the case in the Calcutta method. The Indore method, however, necessitates the use of a much greater area of land and calls for much more manipulation. There is therefore a slightly greater recurring cost, though this is found to be no greater than is required for efficient incineration.

The Indore method is applicable only where the whole supply of nightsoil is available in villages or towns (*i.e.*, in villages or towns where the use of bucket latrines is universal) and where there is an ample supply of well water.

Temperature records in the Indore method are relatively higher and more prolonged than in the Calcutta system. The temperature reached in the first week averages 160°F and this heat is maintained at a high level (average 150°F) during the first three weeks.

Maggots, which may be seen at the surface of the heap, are destroyed at the first turn and do not reappear. The existence of fly breeding is evidence of inefficiency. Unpleasant odours, except at the time of applying nightsoil, are evidence of inefficient workmanship.

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