THE RECOVERY OF WASTE PRODUCTS

By G. C. DYMOND.

Various experts have again and recently drawn our attention to the progressively increasing birth-rate; the diminishing fertility of our lands, and the colossal wastage of organic residues from our towns and cities.

Julian Huxley, in his book "Human Fertility, or the Modern Dilemma," stresses the fact that, in some parts, the world is rapidly filling up by the addition of 60,000 new mouths to feed each day.

Nearer home, Dr. T. D. Hall, agricultural adviser to African Explosives and Chemical Industries, said that if everyone on earth were to have an adequate diet by 1960, there would have to be 27 per cent more cereals, 27 per cent. more roots and tubers, 34 per cent. more fats and oils, 80 per cent. more legumes and nuts, 163 per cent. more fruits and vegetables, 12 per cent. more sugar, 46 per cent. more meat, and 100 per cent. more milk.

P. R. Krige, in his address to the Chemical Institute at Port Elizabeth, stated that 65 tons of nitrogen were lost in the sewers of South Africa every day.

In the tips and garbage dumps of our towns and villages; in the sewage works and down the pipe lines to the sea, go the embryo golden harvests of some day. That some day, it would appear, will not come by reason, but by education and Act of Parliament. Some day we shall be forced to conserve not only our land, but the life-blood of fertility; for in humus and its allies, the salts and trace elements, lie the complex matrix from whence the plants and trees and all the glory of the earth's covering, come to fruition.

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1. Fertility and Productivity. By fertility is meant that condition of soil wherein all the elements of healthy growth exist. Mother Earth has been a long time writing on her bosom the intricate story of life and death.

Thus in the virgin lands unspoiled by erosion, overcropping and monoculture, she writes the story of fertility. The Amazon Basin is an outstanding example of natural fecundity. There, sun and rain and alluvial soils enriched by constantly rotting vegetation, give the conditions necessary for a phenomenal vegetative growth.

At other extremes lie the deserts.

By producitivity is meant the application of human intelligence and accumulated knowledge to increase crop yields in fertile soils. With man's rapacious nature, the danger is obvious. The tedious maintenance of fertility is forgotten, the lands gradually die and semi-deserts scar the earth, marking man's passing.

2. **Recovery. What are we wasting?** To raise steam and power we burn coal, the dead carboniferous remnants of age-old forests.

To raise and maintain the energy of life, to grow and use our brains, we stoke our bodies with the living fruits of the earth—and throw the dross away.

That dross—the excreta of our bodies, the garbage of our civilisation, the abattoir wastes, the paper from trees, rags from cotton, the skins and leaves and industrial wastes—is the link between the living and all the lives of to-morrow, for in the balance of Nature lie the unseen hosts of micro-organisms, whose natural office it is to reduce all dead organic things to the simple Gold of Life—humus, leaf-mould, muck or compost, call it what you will, for by whatever name it be called it is the sweet-smelling forest bed, the loam of roses, the Seed-bed of Eternity.

3. **What is it worth?** In our civilisation we have come to reduce all values to £.s.d. The farmer takes no heed of "Seed-beds of Eternity," but he can understand the lines of James Grainger:—

> "Then, Planter, wouldst thou double thine estate ?
> Never, ah : never be ashamed to tread thy dungheaps."
> —(*Poem to Sugarcane*, 1721, *St Kitts, by James Grainger.*)

In truth, there's nothing new in modern admonitions of waste recovery, only in the race for productivity must we look back and say with Hamlet—

> "Confess yourself to heaven, repent what's past, avoid what is to come,
> And do not spread the compost on the weeds, to make them ranker."
> —*Hamlet, Act 3, Scene iv.*

Values ? In the complexities of our modern life, facts must be stated and figures checked. Thus we express in calories the food requirements of the

ever mounting 60,000 human furnaces each day. Cyphers and indices that foretell the balance of ruin or wealth, starvation or surfeit, war or peace.

4. **What are we worth?** On the average a human being excretes 0.31 lb. of fæces and 3.0 lbs. of urine every day. He also causes the accumulation of 2 lb. of litter or garbage.

The evaluation of these waste products determines our individual contribution to the earth's fund of fertility and, in the mass, our value to the land we live on and the country we call our own.

In agricultural terms or unit values of N.P.K.—nitrogen, phosphorus and potassium—we are worth £1.634 per person per annum.

To this may well be added the physical and biochemical values of organic matter and the essential benefits of trace elements. Add to these the abattoir and trade wastes, and we can accept the simple minimum value of £2 per person per annum. After three score years and ten, we should have given back to Mother Earth in gratitude £140 worth of potential fertility.

Not much, but when we consider our white population in South Africa of 2½ millions, the figure mounts to £5,000,000 per annum. Add to this the somewhat lower value for our natives, and then speculate in terms of world populations, and the figures become astronomical.

The world produces and largely destroys some five thousand million pounds worth of human wastes every year.

5. **What are we doing about it?** Recovery is not a matter of ethics, though the commonsense duty to the 9 inches of soil on which we all live is obvious, but a matter of simple economics in which the returns by recovery give a profit, as against the dead loss by destruction or disposal.

The principles and practice of recovering wastes by orthodox composting are definite, whether they are applied to the smallest or largest communities; only the layout and degree of mechanisation vary. Correct procedure is essential.

Throughout the world various systems are on trial. The Beccari, Boggiano-Pico, Earp-Thomas, Fraser-Eweson, Hyganic, Selvi, and others. These embody fermentation by controlled aeration and inoculation with selected bacteria and fungi. Claims range from complete breakdown in from 2 days to 35 days.

The well-known Indore process of the late Sir Albert Howards takes from 2½ to 3 months, but can be reduced by continuous inoculation with the semi-finished product. It is simple and effective, for as Selman A. Wakesman* and his colleagues state:"No single organisms, no matter how active, can compare in the rapidity of decomposition of the manure, with a mixed population."

The following descriptive procedures are based on the orthodox methods originated by Sir Albert Howard.

6. **Principles and practice.** The first essential factor in correct composting, particularly when nightsoil, sewage, sludge and abattoir wastes are used, is the correct ratio between absorbent organic wastes, such as prepared garbage, grass, straw, sawdust, etc., and the activating media.

Too often schemes have been initiated which have not conformed to this fundamental and imperative rule, with the result that such schemes have not conformed to rigid health standards and have become suspect, condemned or abandoned.

This correct ratio lies between fairly wide limits, being dependent on the porosity or fineness of the absorbent medium and its original moisture content.

Usually there is not enough of these materials, and when this occurs anærobic conditions prevail with ensuing smell, fly-breeding and general nuisance. To avoid these conditions all available absorbent materials should be collected and allowed to weather and dry out.

Porosity, fineness or coarseness of such materials is important. Coarse garbage, unshredded mealie stalks, etc., give low surface absorption, together with too much air porosity, causing low temperature and high run-off.

On the other hand, sawdust has great absorption rates, but low porosity and aeration. Experience with the materials available will soon determine the correct ratio, which usually ranges from 2 to 3 : 1.

7. **Quantities.** If all materials are used, then there is a maximum of 140 to 200 cubic yards of coarse materials (1,100 lbs. per cubic yard) per 100 population per month. This will yield from 110 to 150 cubic yards of finished product per month (1,500 lbs. per cubic yard). Layout and size of cells must allow for a filling time of about 5 to 10 days and cycle of 30 days.

In normal practice the above figures can usually be halved, and in areas where vegetation is scarce, or where no attempt is made to collect grass cuttings weeds, etc., the amount may be only one-fifth of the possible, resulting in the ill effects of too low a ratio between absorbent media and activator.

In every town and village a true estimate of potential organic wastes must be made before the capacity and number of cells required are calculated.

8. **Practice.** In small villages and towns using the bucket system the following points are important.

(a) *Garbage.* On delivery this should be sorted and tins, bottles, books and metal parts removed. A

* New Jersey Agricultural Experiment Station publication, July 29th, 1938.

sorting belt followed by a green garbage disintegrator are necessary for good control; coal ash should be collected in separate containers and discarded.

(b) *Buckets and Nightsoil.* After washing, 1 to 2 lbs. of sawdust should be placed in each bucket. No poisons such as D.D.T. should be used in the buckets.

(c) *Sewage Sludge.* Wet sludge can be used with pulverised refuse in the ratio of 4 pints of sludge to 1 part of refuse.

(d) *Grass Cuttings, etc.* These, together with pulverised refuse, should be left to partially weather, thereby providing a drier medium with greater absorptability.

(e) *Sawdust.* This can be used in limited amounts. It is of especial use in absorbing liquids and covering the filled cells.

Approximately 25 per cent. can be used, but care must be taken to see that the porosity of the materials is not unduly lowered.

(f) *Lime and Rock Phosphates.* Finely ground limestone should be sprinkled throughout the material Rock phosphate may also be used for enrichment. The availability of the phosphate is increased by this procedure.

(g) *Poison Sprays.* If these are in use, it is a sign that the correct procedure is not being carried out.

The composting cells should be fly-traps and not fly-breeders. Poison sprays not only kill maggots but the micro-organisms which break down the raw materials.

10. **The Cells.** These should be built on a sloping ground and made of concrete, cement blocks or brick with a cement bottom sloping to the off-loading end. Along each side a row of bricks are placed to support the aeration floor of poles or grid. These should provide an aeration area not more than 6 inches high in the centre.

This arrangement is the most important point in the construction, for not only does it provide sufficient aeration from the bottom, but it affords drainage, a trap for any fly maggots and a means of observation as to the condition of the cells on filling.

A satisfactory initial moisture content will be shown by a small flow of liquid which runs into a drain running the length of the cells, emptying into shallow wells, where it may be absorbed by sawdust and returned to the raw material.

The offloading end of the cells is closed on filling with a removable gate made of planks or poles, held by pipes or standards in concrete bases. These are easily removed on offloading.

The loading site should be a ramp on the level of the cells. Across the top of the cells T-shaped loose planks are placed for loading purposes. No walking should be allowed on the compost, in order to prevent packing of the particles.

When all the cells have been filled the contents of No. 1 are thrown out with forks and piled in a heap for maturing. On the second round these heaps can be removed or turned out for further storatge.

11. **Filling the Cells.** The following procedure *must* be followed. A mat of loose dry grass cuttings about 1 foot deep is distributed over the pole floor or grid. About 3 inches of prepared garbage is then added, with a further covering of grass. This forms an absorbing mat for the first layer of nightsoil or sludge. The efficiency of absorption will be noticed from the run-off. If this is excessive the ratio of mat to media must be increased, or the mat covered with a layer of sawdust.

Half the supply is evenly distributed, dusted with lime and then immediately covered with grass and garbage. The rest of the buckets are then distributed and the process repeated. As the cell is filled less care is needed and all the buckets may be distributed at once.

The drain will indicate whether there is too much or too little moisture. This must be corrected.

The physical structure of the raw material is important, as adequate porosity or size of particles enable the heap to breathe and absorb fresh air. Too much sawdust, on the one hand, causes clogging, while too coarse materials cause loss of heat and poor liquid absorption.

The cell should be filled in from 5 to 10 days, about 1 foot above the surface—since the mass sinks approximately 25 to 30 per cent. this procedure gives greater capacity.

When all the cells are full the first is turned out, as already explained.

The size of the cell is determined by the quantity of raw materials handled each day.

Thus 1,000 people require 170 cubic yards per month, or 5.7 cubic yards per day (see section 7).

Five cells 20 feet long, 10 feet wide and 6 feet deep are necessary. Increasing amounts can be handled by more cells or greater individual capacity.

12. **General.** The foregoing is a brief description of the procedure necessary to ensure good results in villages and towns. In the larger towns and cities mechanisation becomes imperative. Screens, removal of iron by electro-magnets, picking and sorting belts, disintegrators and crushers prepare the raw material. An increasing number of plants operate on these lines.

Recovery of wastes is a duty to the land we live on; a duty to the ratepayers in lessening the costs of living and a duty to the health of plants and animals and men.

Mr. du Toit observed that the President, a man of many parts, had now come forward with an entirely different sort of paper. It reminded Mr. du Toit in part of Mr. Dymond's presidential address, and he felt that this paper afforded an opportunity of discussing Mr. Dymond's presidential address within the context of the present paper. He wished, however, to raise one point, and asked whether the 100 municipal schemes in the Union being conducted along the lines advocated by Mr. van Vuuren were still in operation.

Mr. Dymond replied that many of these schemes had either closed down or were operating inefficiently. The reason for this was the faulty layout, together with incorrect ratios between organic materials and activators. The cells were shallow and provided insufficient aeration, thereby necessitating continuous turning and high labour costs.

Dr. Dick brought up the point of parasitic worms and harmful bacteria in the compost heap, and remarked that DDT had no harmful effect on fungi. He asked how it would be possible to recover useful waste material from water-borne sewerage, which was generally necessary in large cities.

Mr. Dymond replied that it had been proved that efficient composting destroyed pathogenic organisms without odour and that no pathogenic bacteria could survive in the intense heat applied. With regard to the use of DDT, Mr. Dymond replied that this was generally used for the destruction of maggots, but some centres where composting was applied were not particular what kind of spray was employed, many sprays having an adverse effect on the composting process. Mr. Dymond remarked that he had been in correspondence with an interested person in New Zealand on the subject of recovering waste from water-borne sewerage by means of the water hyacinth, and that tests conducted there had proved that it was possible to recover sludge from the sewage for use in composting, while solids in suspension were drained off for processing. The system was not yet applied in any part of the world, but had its possibilities. Experiments were being conducted on these lines at Germiston.

Mr. Pearce asked whether non-pathogenic fungi would be killed, since pathogens were killed by the high temperature applied.

Mr. Dymond replied that he thought that these bacteria would survive, and asked whether Dr. Dick had more information on the subject.

Dr. Gilbert, replying to Mr. Pearce's query, stated that most thermophilic organisms live in compost longer than the pathogenic bacteria, which are destroyed at a temperature of about 60°F., and enquired at what temperature the material was usually composted.

Mr. Dymond said that the temperature averaged from 130° to 175° F. for the first three weeks, after which it gradually dropped.

Dr. Gilbert observed that such a temperature should destroy all pathogenic bacteria.

Mr. Pearce stated that the temperature attained was concentrated in the middle of the compost heap and seldom reached the outside edges, which made it seem probable that the pathogens were destroyed by some agent other than temperature, *e.g.* antibiotics. He also asked how non-spore-forming organisms would be re-introduced once they had been destroyed.

Dr. Gilbert replied that he could not guarantee that all bacteria would be destroyed and further did not think that antibiotics played any part. He mentioned that the pH of the compost heap might have some bearing on the matter.

Mr. Johnstone remarked that the maggots present in the heap would make their way to the outside edges of the compost since the temperature there would be cooler, and observed that if pathogens were also present in the outside edges there was a possibility that when the maggots matured they would take disease away with them.

Mr. Dymond replied that this could be obviated by covering the final layer of the compost with fresh stable manure, urine-impregnated sawdust, filter cake or partly-matured compost.

Any maggot emerging through the false bottom of the cells could be easily washed into the well and returned to the cell in the process of construction. A light spray of DDT could be used when absolutely necessary. With regard to pathogenic organisms when the cell is first turned after four to five weeks, if ordinary care is taken that the top and bottom portions now become the centre of the new heap, there can be little, if any, danger of such organisms surviving. He said that there was an increasing amount of evidence to prove this.

Mr. Duchenne enquired whether bacteria of an anærobic type would not possibly occur in the compost.

Mr. Dymond replied that in this case odour would be noticeable from the heap, which it would not if composting was properly executed. He stated that if no air was able to get to the heap ærobic decomposition could not take place and a faulty compost would result.

Mr. Duchenne mentioned the case of hay decomposition where spontaneous combustion could occur due, he thought, to the presence of anærobic bacteria.

Mr. Dymond said that decay was the result of ærobic microbial activity and putrefaction of the energy of anærobic organisms. Both these processes might go on simultaneously; the outer surface which was exposed to the air decayed, while the interior putrefied.

With regard to Mr. Duchenne's point, he said that sour fodder or ensilage was an anærobic fermentation caused by a heat-resisting bacteria—*Bacillus subtilis*. The spores of this bacteria could resist the effect of boiling water for an hour.

Mr. Barton observed that if the development of insects such as flies was allowed to occur in the compost heap for longer periods before destruction, this might aid the decomposition process. He said also that, even with frequent turning of the heap, flies might still complete their development by making their way to the cooler parts of the heap, such as the outside edges.

Mr. Dymond maintained that commonsense methods could keep fly incidence at a minimum. After a little experience the cells became fly traps and not fly breeders.

Dr. Dick stated that turning of the heap should occur when the flies were in the pupæ stage and not the maggot stage, since maggots could crawl back to the cooler temperature areas to complete their development, which pupæ could not do.

Mr. Dymond asked what period it took a fly to emerge to full growth.

Dr. Dick replied that it depended on the temperature, but two to three weeks was an average figure.

Dr. Dodds mentioned that he was interested in the soil fertility aspect of the matter. He cited the instances of municipalities which attempted to conserve town garbage with indifferent results, owing to the small amount of fermentable waste which was obtainable. With regard to Mr. Dymond's complaint about sewerage being diverted into the sea, Dr. Dodds regarded this as a system which had its possibilities, since the sea was a potential source of food whose resources were at present practically untouched. He stressed the need of a marine research station to investigate this matter. Touching on Mr. Dymond's complaint against the use of DDT in compost heaps, Dr. Dodds observed that DDT was toxic only to insects and not to humans.

Mr. Dymond replied that there was increasing evidence of the toxicity of DDT to humans. Further, that flies acquired immunity which became inheritable. In an article appearing in the *British Medical Journal*, October 13th, 1951, p. 901, the following statement was made: "The practical future of fly control seems to lie in a return to sanitation, poison baits and pyrethrum sprays, methods on which we relied before the introduction of DDT."

Mr. Barton remarked that, in the case of municipalities, composting was expensive and the householders who had contributed the original raw material were not prepared to buy the compost back at the present high prices prevailing. He thought that the best solution to the problem was for municipalities to apply for a Government grant to finance the undertaking.

Mr. Dymond replied that the usual objection to large-scale composting was high transport charges for a low-grade fertilizing material. The Dutch Refuse Disposal Co. Ltd. in Holland were producing 120,000 tons of compost a year and the total cost delivered at a farm was 12s. per ton. He said that apart from its value as a soil conditioner compost could be enriched with any chemical fertiliser. The addition of rock phosphate finely ground caused increased availability of the P_2O_5.

With regard to private individuals, he said that the commonsense principles set out in his paper would cause no nuisance.

Mr. Johnstone stated that since the average householder was not an expert on the matter of composting, the results if everyone began composting in his backyard were likely to be offensive.

Mr. Dymond replied that composting was a simple process and only offensive if not properly executed.

Mr. Barnes remarked that Mr. Dymond had dealt with only one small aspect of the conservation of waste material—he had not touched, for instance, on industrial waste which had great potentialities. Farmers and industry alike did not sufficiently conserve nitrogen for use as fertiliser, and the whole subject should be most carefully considered in its broadest possible sense.

Mr. Dymond agreed with Mr. Barnes and said he had only touched on one aspect of a huge problem. The disposal of trade wastes such as dunder and abattoir wastes would naturally be incorporated in any well laid out scheme for waste recovery.

Mr. Dymond concluded by thanking the visitors from the Health Department for their interest in his paper and for the part which they had taken in the discussion.