UTILIZATION OF URBAN WASTES

By J. P. J. VAN VUREN, M.Sc.(Agric.), Professional Officer (Extension) Department of Agriculture and Forestry.

"Man is the most extravagant accelerator of waste the world has ever endured," wrote the late Professor King in "Farmers of Forty Centuries." "His withering blight has fallen upon every living thing within his reach, himself not excepted; and his besom of destruction in the uncontrolled hands of a generation has swept into the sea soil-fertility which only centuries of life could accumulate—fertility which is the substratum of all that is living. It must be recognised that the phosphate deposits which we are beginning to return to our fields are but measures of fertility lost from older soils, and indices of processes still in progress. The rivers of North America are estimated to carry to the sea more than 500 tons of phosphorus with each cubic mile of water. To such loss modern civilization is adding that of hydraulic sewage disposal, through which the waste of 500 millions of people might be more than 194,300 tons of phosphorus annually, a waste which could not be replaced by 1,295,000 tons of rock phosphate, 75 per cent. pure . . . and this waste we esteem one of the achievements of our civilisation."

"The more we produce, the more numerous our millions, the faster must present practices speed the waste to the sea from whence neither money nor prayer can call them back."

At the time of the first world-war, Sir John Russell valued the excreta of the population of the United Kingdom at 7 shillings and 9 pence per person per year—that is to say, £17,500,000 annually for a population of 45.2 millions—the greater part of which was wasted.

Nobody would be able to deny the fact that in practically all the Western countries the valuable surface soil, as well as its fertility, is decreasing at an alarming rate in spite of the extensive use of chemicals. With the speeding-up of production to feed our ever-increasing population we are driving the soil to bankruptcy, physically, chemically and biologically.

Baron von Liebig in 1840 wrote of the Romans that "the sewers of the immense metropolis of the ancient world engulfed in the course of centuries the prosperity of the Roman peasants. The Roman Campagna would no longer yield the means of feeding her population; these same sewers devoured the wealth of Sicily, Sardinia and the fertile lands of the coast of Africa." This is not the only civilization that came to an end on account of soil exploitation and depletion; the one-time flourishing Egyptian Empire was eventually engulfed and driven practically to extinction by the encroachment of the Sahara desert.

On the other hand, the Mongolian civilizations have withstood the test of centuries. They waste nothing. It is in regard to them that Professor King wrote: "Not even in great cities like Canton, built in the meshes of tide-swept rivers and canals; like Hankow, on the banks of one of the largest rivers in the world; nor yet in modern Shanghai, Yokohama or Tokio, is such waste permitted. To them such a practice would have meant race suicide, and they have resisted the temptation so long that it has ceased to exist."

Dr. Arthur Stanley, health officer of the city of Shanghai, in his annual report, considering the subject as a municipal problem, wrote: "Regarding the bearing on the sanitation of Shanghai of the relationship of Eastern and Western hygiene, it may be said, that if prolonged national life is indicative of sound sanitation, the Chinese are a race worthy of study by all who concern themselves with public health." He continues by stating that "even without the returns of a Registrar-General, it is evident that in China, the birth-rate must very considerably exceed the death-rate, and have done so in an average way during the three or four thousand years that the Chinese nation has existed. Chinese hygiene, when compared to mediaeval English, appears to advantage. The main problem of sanitation," he continues, "is to cleanse the dwelling day by day, and if this can be done at a profit so much the better. While the ultra-civilized Western elaborates destructors for burning garbage at a financial loss and turns sewage into the sea, the Chinaman uses both for manure. He wastes nothing while the sacred duty of Agriculture is uppermost in his mind. And in reality, recent bacteriological work has shown that fæcal matter and house refuse are best destroyed by returning them to clean soil, where natural purification takes place . . . while to adopt the water carriage system for sewage and turn it into the river, would be an act of sanitary suicide. It is best, therefore, to make use of what is good in Chinese hygiene, which demands respect, being, as it is, the product of an evolution extending from more than a thousand years before the Christian era."

A story is told of an agent sent to China to sell chemical fertilizers. After a period of inactivity, he received a cable from his firm asking him when they could expect orders to be coming forth. He replied ironically: "Trade impossible, with 400 million competitors!"

It would, of course, be folly to condemn all Western sanitation practices and at the same time suggest that we should revert to the methods of the East. Our practices are undoubtedly most hygienic, but they are decidedly wasteful.

South Africa is fortunate in that it is one of the first Western civilized countries to grasp the idea and importance of returning urban wastes to the soil by adopting a municipal compost scheme on a national basis. This scheme was inaugurated almost two years ago, and so far almost a hundred municipalities throughout the country are actively engaged in carrying out a composting process. Although the scheme is still very far from being adopted by the majority of centres in the Union, it is nevertheless gratifying to know that at least a considerable portion of the accumulating fertility is already finding its way back to our soils.

Although a young country, South Africa has nevertheless taken a lead in this important direction and is being followed by much older countries. An all-India composting scheme is at present being inaugurated on similar lines to that in South Africa. As South Africans who carry the welfare of our soil and nation uppermost in our minds, this is indeed something to be proud and thankful for.

The fertility of its soil and the welfare and prosperity of a nation are inseparable considerations, and let us sincerely hope that the well-meant efforts of the National Veld Trust, which at the moment is trying its utmost to bring this truth home to everybody in this country, will not be in vain. Nothing is more important, in peace or war, than that the general public be brought to realize that our soil, the source of what we live on, is common heritage and concerns more than merely its individual owner. To utilize urban wastes is but another stepping-stone in this direction of mutual interest and consideration, and as far as this is concerned we need local agitation throughout the country to force the local authorities into action. If we want good food, it is useless to treat nature as though she were a chocolate machine that can be cheated with a dud penny.

VALUE OF URBAN WASTES IN SOUTH AFRICA.

"From the analysis made by Wolff in Europe and by Kellner in Japan, it appears that, on an average, mixed human excreta carry in every 2,000 pounds, 12.7 pounds of nitrogen, 4 pounds of potassium and 1.7 pounds of phosphorus. On this basis and that of Carpenter, who estimates the amount of excreta per day per adult at 40 ounces, the average annual production per million of adult population is 5,794,300 pounds of nitrogen, 1,825,000 pounds of potassium and 775,600 pounds of phosphorus, carried in 456,250 tons of excreta. The figures which Hall cites in 'Fertilizers and Manure' would make these amounts 7,940,000 pounds of nitrogen, 3,070,500 pounds of potassium and 1,965,600 pounds of phosphorus, but the figures he takes and calls high averages give 12,000,000 pounds of nitrogen, 4,151,000 pounds of potassium and 3,057,600 pounds of phosphorus."—(King.)

Based on these figures, we find that in the Union of South Africa, with a total population of almost 10.5 millions, of which 3.3 millions are urban, and taking half of this to represent adults, we arrive at the following rather conservative figures:—

In urban areas in the Union, therefore, we are annually accumulating from 9,560,000 to 20,000,000 pounds of nitrogen, 3,011,000 to 6,849,000 pounds of potassium and 1,279,000 to

5,045,000 pounds of phosphorus, in the form of human excreta alone.

According to calculations by Jackson and Wad, the average quantity of organic matter contained in human excrement is 23.20 pounds per capita per annum, which means that, apart from the above elements, an additional 76,500,000 pounds organic matter is annually available in urban areas, taking the population as 3.3 millions.

According to the same two investigators, the manurial constituents contained in the average sample of town refuse will yield the following results for urban areas in the Union :—

Constituent.	Percentage composition.	Quantity in pounds per capita per annum.	Pounds total for urban population (adults).
Organic matter	22.62	122.70	202,450,000
Nitrogen	0.70	3.80	6,270,000
Potassium	0.27	1.46	2,459,000
Phosphorus	0.43	2.33	3,844,000

Glancing at these figures carefully, and at the same time realizing that they represent merely a fraction of the total quantity of plant-food removed by the entire population, over a period of a few score years, only then do we grasp the significance and understand why the Mongolian races have managed to maintain themselves as well as the fertility of their soils for over forty centuries.

These figures, in addition, issue a note of warning to our European civilization in this corner of the world. We already recognise, in more ways than one, the dwindling fertility of our soils—in the physique and general health of especially our younger generation, degeneration in our livestock and plants, droughts, floods, erosion, crop failures, and numerous other danger signals. If we were only to realize this in time, townsmen and country folk alike, that nature has to be obeyed by the rule of return, only then will we safeguard our own future and the future of our civilization.

PRINCIPLE AND METHODS OF COMPOSTING.

Although the particular methods of composting differ from one place to another, the principle governing this procedure is universally the same. It consists mainly of creating certain optimum conditions inside a stack of suitable material of vegetable origin in order that certain micro-organisms are allowed, not only to multiply but at the same time to carry out their important duty of breaking down and balancing an unbalanced complex mixture of materials, into simpler and more useful forms, giving rise eventually to a more or less stable and uniform product that can be used as a fertilizer.

The success or otherwise of any composting process is dependent on the degree of fulfilment of such requirements. These conditions are, briefly, the following :—

1. Suitable types of organic wastes.
2. Suitable supply of soluble nitrogen compounds.
3. Correct moisture conditions.
4. Proper aeration; and
5. Suitable reaction.

As the organisms responsible for breaking down the organic complex derive their energy principally from the softer tissues of cell walls, the celluloses and hemi-celluloses, the incorporation of this type of material in a compost heap is apparent. No organism has yet been found that will rapidly break down lignified or woody tissues. The decomposibility of various forms of plant matter appears to depend largely on their lignin content. Lignified materials are found to inhibit satisfactory and quick decomposition, and there is no doubt that soft unlignified tissues are most suitable. Rather than spend time in an endeavour to ferment lignified tissues, it may be more economical to screen out such resistant material from the finished heap and burn them, adding the ashes.

The presence of a suitable concentration of soluble nitrogen is essential, as this constitutes the food for micro-organisms. A shortage of such nitrogen will slow down the process, as the organisms die when their food is exhausted. The coarser and more mature therefore the material the more nitrogen must be added, as the organisms will be employed over a much longer period. On the other hand, the quantity of nitrogen should not exceed a definite amount. If the concentration of ammonium carbonate produced from the decomposition of urine or urea exceeds a definite limit, not only are break-down changes definitely held up, but they continue to be inoperative until by volatilisation the concentration has been reduced to the upper limit of growth of micro-organisms, and thus resulting, in addition, to a loss of valuable nitrogen into the air.

Apart from the fact that such forms of soluble nitrogen provide food for the organisms, some contain such organisms themselves and may act as a bacterial inoculant, thus fulfilling a dual purpose of supplying the labourer as well as his nourishment.

This particular constituent, being a most important ingredient in a compost heap, can be added in various forms, e.g. in the form of nightsoil, cowdung, cattle urine, activated sludge, and various other animal manure. The first two types are generally applied in the form of a thin decoction, so that every portion of the plant material be uniformly injected with the organisms and their food. Mixing of lumps of half-dry cowdung with vegetable refuse is most unsatisfactory and results in loss of nitrogen and time before the manure is ready. Experiments have shown that nightsoil produces quicker fermentation than cowdung, on account of the fact that the nitrogen compounds in the former lend themselves more readily to the changes which take place in the production of organic manure. Activated sludge, on the other hand, is, however, a manure of such value in itself that it is undesirable to use it in this way if it can be avoided. Nightsoil mixed with vegetable refuse rapidly loses its offensiveness and becomes virtually activated sludge. Admixture of nightsoil with refuse and systematic exposure to air is indeed a means of producing activated sludge, without tanks or machinery. Urine, both human and animal urine, when suitably diluted, are excellent sources of nitrogen for the production of organic manure.

In the absence of the above substances, i.e. the natural forms of soluble nitrogen compounds, a source of nitrogen must be found in synthetic products, but in no case is the fermentation as satisfactory. Such products are urea, ammonium carbonate, sulphate of ammonia, cyanamide, or else the "Adco" mixture of Hutchinson and Richards. The latter consists of a mixture of ammonium phosphate, cyanamide and urea.

The third essential is optimum moisture. Like all living things, micro-organisms require moisture for their existence. At the same time hard tissues are softened, rendering them more ideal for the organisms to penetrate and break down. If too little moisture is present the process is retarded. If too wet, there is a tendency for the material to cool down, as well as prevent suitable aeration. As a guide to optimum moisture, the material inside a compost heap should possess the consistency of a squeezed sponge. Excessive dessication due to either active fermentation or climatic conditions may necessitate the addition of moisture at such periods, as the process is otherwise slowed down.

The fourth essential is proper aeration. Composting is an aerobic process and therefore necessitates an almost continuous supply of fresh air, especially in the early stages. When air is excluded, either by intense consolidation or by the presence of excessive quantities of moisture, as would be experienced during continuous rain, the characteristic breakdown changes remain suspended. Heaps should therefore be made loose, so that enough air can diffuse into them from the atmosphere. Lack of enough air results in putrefaction rather than decay, and the odours produced may be enough to attract flies and encourage them to breed under such circumstances.

Finally we come to suitable reaction. The micro-organisms in a compost heap work best under slightly alkaline conditions (pH 7 to 8). During the first few days after a heap has been charged the medium is definitely on the acid side, and should therefore be sweetened or neurtalized by the addition of some or other base, such as ground limestone, chalk, wood-ash or ordinary soil. When the acidity of the heap is too high the materials will tend to become preserved, like silage, and a characteristic sour smell will be produced.

A suitable guide to find out whether one has successfully conformed to the above requirements, is to note the temperature.

If the temperature fails to rise to the required level, it is a definite indication that some or other of the above requirements have not been met properly. During the first week of the process intense fermentation should set in and temperatures of from 140 to 160 degrees Fahrenheit should be observed, while the material on the inside should be covered with a whitish fungous growth. For purpose of destroying harmful ingredients such as pathogenic organisms, weed seeds, etc., the aim should naturally be to encourage continuous high temperatures.

At certain intervals, or under circumstances when temperatures fail to rise or indicate a steady drop, heaps should be turned. During this procedure care should be taken that the different layers of material are properly mixed and surface layers worked into the centre. Such turning, furthermore, distributes moisture and ensures aeration.

In areas where the climate tends to be dry, a well-sheltered and protected site should be chosen. Under such circumstances the process is best carried out in specially constructed pits; whereas under humid conditions or during the rainy season, when trenches or pits are liable to become flooded, the heap or stack method is recommended.

A.—METHOD WHEREBY NIGHTSOIL IS EMPLOYED.

It is not my intention to describe this method in detail, as a full description is contained in a pamphlet which was sent to all municipalities in the country, and which can be obtained on request from the author or any of the responsible compost officers in each Province. This is briefly the method perfected at the Institute of Plant Industry, Indore, between the years 1924 and 1931 and is described by Howard and Wad (1931), Jackson and Wad (1934), Howard (1935), and Watson (1936). In these publications a detailed account will be found of the bio-chemical principles underlying the Indore process and the practical working of the method.

The original composting scheme, based on the above data, was started in Ficksburg in the Orange Free State, by the author in collaboration with the urban authorities in May, 1939. With a few modifications it was adapted to South African conditions, and all the schemes started since were based on the findings at Ficksburg, where the author is still busy on a part-time basis to carry out further scientific investigations in this connection.

As a consequence of the unobtainability of sufficient mineral fertilizers from overseas during the present war, due to a lack of shipping facilities, as well as the success obtained with the "pilot" composting plant at Ficksburg, the Secretary for Agriculture and Forestry decided to institute a composting scheme on a national basis in September, 1942. For the duration of the war the author was appointed co-ordinating officer, and with him six other officials, stationed in each of the four provinces. In Natal the officer concerned is Mr. J. G. Brevis, of the Cedara College of Agriculture.

Within a year of the scheme being inaugurated, practically every municipality in the country was contacted by one or more of the officers concerned, and a summary of the position at the end of August, 1943, was as follows :—

Province.	Schemes in course of construction.	Schemes already in operation.	Monthly production in bags.	Already produced in bags.
Northern Transvaal ...	2	5	2,000	10,000
Southern Transvaal ...	4	8	6,000	45,000
Orange Free State ...	6	7	4,000	32,000
Natal	3	6	2,000	11,500
Western Province ...	3	14	7,000	14,000
Eastern Province	4	10	2,000	10,000
Total	22	50	23,000	122,000

Based on the average composition of municipal compost (moisture 40 per cent.; loss on ignition 40 per cent.; nitrogen 1.5 per cent.; potassium (K_2O) 1.0 per cent., and phosphorus (P_2O_5) 1.0 per cent., and assuming that a bag of compost weighs 180 lbs.), the position up to that date, as far as salvaging plant-food material in urban areas is concerned, the balance sheet reveals the following :—

Constituent.	Total quantity in lbs. returnable from urban areas.	Annual quantity in lbs. returned at present rate.
Organic matter... ...	205.0 million	11,900,000
Nitrogen	15.8 to 26.2 million	447,000
Potassium	5.5 to 9.2 million	298,000
Phosphorus	5.1 to 8.8 million	298,000

This was the position, as stated, at the end of August, 1943, and the figures may at present be considerably higher, as many more municipalities have joined the producers' ranks since. These figures, however, do not include the production of dried sludge, which is quite considerable in Reef cities and towns and Pretoria, nor the product resulting from the plant of Organo Fertilizers Ltd., Durban.

We may perhaps get a clearer picture of the situation if these figures are expressed in percentages.

Constituent.	Approximate percentage returned per annum.
Organic matter	5.8
Nitrogen	1.7 — 2.9
Potassium	3.2 — 5.4
Phosphorus	3.3 — 5.8

A very important consideration in the production of municipal compost is the question of possible dissemination of disease organisms. This question has been raised on various occasions and a considerable amount of doubt and prejudice is still prevailing, although the Department of Public Health has expressed itself quite definitely that "there is no likelihood of the matured compost, used as a fertilizer, acting as a medium for the dissemination of infective material of amoebic dysentery and parasitic worms, provided the process of composting has been carried out in accordance with instructions issued by the Department of Agriculture and Forestry, where temperatures of 150°—160°F. are attained in the pits for two to three weeks."

According to carefully controlled experiments carried out at Ficksburg during the past twelve months, the following results were obtained with regard to temperatures in an average pit :—

Temperature range Degrees F.	Time expressed as percentage of total (30 days) that material was subject to
51—60	1.78
61—70	1.11
71—80	2.89
81—90	2.00
91—100	1.77
101—110	2.22
111—120	2.67
121—130	9.55
131—140	24.67
141—150	33.33
151—160	18.00
	100.00

This experiment was carried out during winter, when minimum temperatures fell to 18°F.

If 125°F. could be regarded as the minimum safety limit (cysts of amoebic dysentery, for example, get destroyed at 122°F. in two minutes if exposed to such temperature), then one can quite definitely conclude that as the material in a pit is exposed to temperatures above this limit for 80 per cent. of the time, the possibility is exceedingly small that pathogenes will be able to survive and disseminate.

Another very important consideration is the possibility of fly-breeding at a composting site. Apart from being a nuisance, they are a menace as well in spreading epidemics. After a careful study of this question, the conclusion was arrived at that wherever flies are encountered excessively at a composting site, it should in most cases be taken as an indication that the process is being carelessly handled and neglected. Experiments at Ficksburg have proved that 85 per cent. of the maggots present in a compost pit could be destroyed by giving the material a thorough turning. The generated heat will be sufficient to destroy them. We generally recommend that contents of pits should be turned three or four times during the fly-breeding season, so that the possibilities are slight that any actual breeding will take place. If poisoned bait is furthermore put out the few that are on the wing could be easily disposed of.

Various other experiments in connection with municipal compost in general are at present being conducted at Ficksburg, some of which are of considerable practical importance, as, for example, the most suitable depth of the compost pit. Preliminary results seem to indicate that the usual depth of 2 feet may be increased to 4 feet with advantage, as this will give rise to the generation and maintenance of even higher temperatures as compared to the shallower pits.

Experiments have been conducted with certain chemicals, harmless to the product or process but detrimental to the fly-maggots. Two easily available and relatively cheap by-products from Iscor Steel Works, viz., crude naphthaline and interstill residue in varying concentrations, were used, and with these very encouraging results were obtained. This can be used to control fly-breeding.

B.—METHOD WHEREBY SEWAGE AND REFUSE ARE EMPLOYED.

The object and aim of each municipality, as far as sanitation is concerned, is to adopt a water-borne sewage scheme sooner or later. As already stated, this is perhaps the most practical and hygienic way of handling such material, especially in congested areas, but it is nevertheless decidedly wasteful unless special arrangements are being made to return the end-products to the soil for the production of useful crops. Coastal towns and cities usually dump this valuable material recklessly into the sea and "solve" their problems this way.

Inland centres are less "fortunate" and in many instances find it exceedingly difficult to throw sewage away. Large deposits exist in certain areas, where they have accumulated over many years and are a curse rather than a blessing, as such authorities have either overlooked the fact that sludge is a valuable fertilizer or have not yet succeeded in overcoming the prejudice of farmers in their vicinity.

Lieut.-Colonel F. C. Temple, a leading British consulting engineer, recently stated that "engineers who had to deal with sewage or town refuse were not doing their job properly until they got products from both back on to the land." To hear such a statement from an authority on modern sanitation practices undoubtedly carries with it promising possibilities for the future of one of the most wasteful practices of our Western civilization. Refuse disposal, on the other hand, is another problem, long "solved" by those unsightly tips, announcing the presence of urban habitations, where scavengers, both human and animal, are continuously busy salvaging and scattering both filth and disease, apart from breeding vermin and infecting the air. Such, in fact, is the problem confronting many of our urban authorities in this country to-day. Many of them have resorted to incinerators, but have merely succeeded in reducing the bulk rather than solving the problem of disposal.

Composting gets over this difficulty and solves the problem of sludge and refuse disposal. At Leatherland and Maidenhead, dry refuse is at present composted with sewage sludge with excellent practical results. The traditional expensive, intricate and elaborate disposal works have been modified so advantageously as to make it commendable to any city or town, thereby making it possible that the maximum amount of urban waste will find its way to its proper destination, as nature intended it to be—the soil.

The separation of ash from the refuse is accomplished by rotary screens, and on a picking-belt bottles, rags, cardboard, paper and metals are extracted. The remaining refuse is afterwards pulverised in a crusher and laid out in bays, where it receives measured quantities of sewage sludge. Within two days these sewage-moistened bays are turned over for aeration (the latest development is mechanical turning). After it is turned for the second time the compost will be practically free from moisture, while temperatures of 150—160°F. will have destroyed pathogenic organisms. The ultimate result is a fine crumbling humus, without any smell or trace of its origin. It could be literally handled without the slighest distaste, as "the bio-chemical action that had taken place in the compost heap had completely changed its structure—you could no more call it refuse and sewage than you could call a slice of bacon pig-swill and acorns."

Reynolds, the author of the above rather cryptic remark, in *The New Statesman and Nation*, remarked that "there is, of course, a ridiculous prejudice against sewage fertilizers. For over fifty years, a fertilizer has been manufactured in the sewage works of Kingston-on-Thames. But in 1936 the Kingston surveyor reported that a very large quantity of this output was going to the Continent. Obviously the home market cannot have been very keen and the situation has its ironical humour. We will not pollute our own cabbages with sewage (though farmyard manure, if available, would not be objectionable); but we will cheerfully buy and eat cabbages grown abroad and fertilized by this sewage."

Almost the same can be said of Natal, in particular. On various occasions have certain local and medical authorities in Natal expressed themselves rather critically about the possibility of disseminating amoebic dysentery through the advocated municipal composting process. But perhaps the very same most ardent objectors may cheerfully buy and eat, without any objection or discrimination, vegetables raised by Indians on soil fertilized with crude and most probably amoebic dysentery-infested nightsoil.

C.—THE INDORE METHOD OF COMPOSTING.

Park or Garden Refuse.

This is the typical Indore method of composting. The actual process is so easy to carry out and the general layout so inexpensive that no public park or private garden in any urban area should be without its own scheme. There is no danger whatsoever of causing a nuisance, as the process lends itself very well to being carried out in parks and gardens, where usually considerable quantities of vegetable material in the form of dead leaves, grass, weeds, lawn clippings, old plants, light prunings, hedge clippings, etc., are encountered, and which as a rule are so tempting to a match. In a public park or private garden the most intensive form of farming or crop production is practised, and no director of parks and gardens or private householders should make themselves guilty of permitting or allowing any such refuse to be either burnt or carted away. Let us hope the time is not very far distant, when refuse removals in urban areas will be limited to bottles and tins only, and that all forms of plant-food material will be composted *in situ* and returned to the soils that raised them. It is far too commonly found to-day that householders are burning their rubbish to save their rates.

Fortunately, many of our parks officials have already come to realize the necessity and advantages of "making their own manure." Whether or not certain claims for compost are justified, as far as the production of flowers is concerned there is no doubt that, if grown with organic manures, such flowers are known to possess intensity of colour and fragrance *par excellence*.

We need not go far afield. In this very city of Durban, hundreds of tons of compost are annually produced in the public parks and vacant lots under the very able supervision and enthusiasm of the Director of Parks and Gardens, Mr. P. Robertshaw. Durban is to be congratulated on the way this official has so far made use of "waste" in creating beauty.

This method is so well-known that only a brief description may be sufficient. Refuse of vegetable origin is stacked in alternate layers with fresh stable manure, or preferably mixed beforehand, in the proportion of 3 to 1. For neutralizing acidity a sprinkling of either lime or ordinary soil is given, after which the material is thoroughly watered. The stacks should be 4 to 5 feet high and of any convenient length. The material is turned over two or three times, and the process is generally completed in three months' time, when the product will be ready for immediate use.

Various other forms of waste exist somewhere within the boundaries of urban areas, just lying in wait to be unearthed and utilized. Without going further into detail, I should nevertheless like to draw the attention of urban authorities to such resources. These include materials such as old refuse tips—where nature has steadily carried out her own methods of composting by slow oxidation over perhaps many years. These are virtually "humus mines" and they sometimes contain hundreds of thousands of tons of finished humus, which urban authorities should try and make available to farmers in their vicinity. The valuable material could be screened out and the inorganic residues or refractory material used for filling up any low-lying areas. Another excellent source of valuable plant-food material is the contents of old nightsoil trenches. These may be dug up and marketed through a composting plant, as it may still contain harmful organisms which would be destroyed during composting.

Various other forms of industrial wastes, such as tannery waste (containing up to 3.5 per cent. of nitrogen), wastes from sugar mills (filter press cake, mill effluents, molasses, cane trash, etc.), dehydration plant wastes (leaves and peels), etc., could be composted without difficulty and in this way find their way back again to the soil.

One of the biggest drawbacks, however, in connection with composting such materials on a large scale is that too much hand labour is required, thereby rendering production costs too high for economical large scale use. Compost is bulky in nature, and if it could be manufactured and distributed mechanically its production and application would be decidedly enhanced. Various devices are, however, being tested out in England at present whereby compost could be turned over mechanically, the success of which should unquestionably stimulate the production and use of this type of manure.

FERTILITY AND HEALTH.

Various instances could be quoted to prove that it is essential to the well-being of man and beast that the rule of return be obeyed. Sir John Orr, in his treatise in "Minerals in Pastures," stated :—

"Munro reports that in the Falkland Islands sheep have been reared and exported for forty years without any return to the soil to replace the minerals removed. During the last twenty years it has become increasingly difficult to rear lambs. The other animals are also deteriorating."

"The process of depletion," he continues, "and the resulting deterioration which shows itself in decreased rate of growth and production, and in extreme cases by the appearance of disease, is proceeding on all pastures from which milk, carcases or other animals products are taken off without a corresponding replacement being made. Accompanying the visible movement of milk and beef, there is a slow invisible flow of fertility. Every cargo of beef, or milk products, every shipload of bones, leaves the exporting country so much the poorer. In many of the grazing grounds of the world this depletion has become a serious economic problem." Amongst others, he quoted the example of the Scotch hills, where the process of depletion "has been going on with increasing rapidity since the time when the produce of animals, instead of being consumed on the land and therefore returned to the soil, began to be driven off to be consumed in the industrial areas." A very true picture of what has and is still taking place in our own country, where there is a steady flow of fertility to our urban areas. with the inevitable result that, unless some efforts are made to return some of the vast quantities of plant-food that are locked up and daily accumulating somewhere within the boundaries of our cities and towns, we will be faced by the same problem eventually as in the Highlands, where, according to Orr, "there are now districts which could not support populations which once lived there, even though the people were willing to accept the same standard of living as their ancestors.

"Richardson has recently called attention to the effects of depletion in Victoria. He has estimated that the soil of Victoria has been depleted to the extent of about 360,000 tons of phosphoric acid during the last sixty years, through the removal of phosphates in the exported meat, meal and other animal products, and that nearly 2,000,000 tons of superphosphate would need to be added to the pasture-lands to restore them to the condition they were in about 1860. He attributes malnutrition in stock to the resulting deficiency of phosphorus in the pastures."

The question inevitably arises, how much of the malnutrition encountered amongst our own population in this country can be attributed to such human beings consuming animal products like beef, milk, butter and cheese originating in phosphorus-deficient areas where this deficiency in pastures leads to the well-known "gal-lamsiekte" in cattle ? How many other "deficient areas" exist in South Africa to-day, where phosphorus deficiency is not revealed at all or at least to the same extent, but may nevertheless occur to such a degree as to cause malnutrition ? It is a well-known scientific fact that, on the whole, South African soils are deficient in phosphates, and still we are continuously busy removing it in the organic form and only partly substituting it inorganically.

If this be the picture of what happens in the case of one mineral alone in the pasture-land, how much more may it become necessary to be on our guard against products derived from cultivated land, where the soil is being depleted much more constantly and rapidly in relation to more than just phosphates alone.

We seem to be more and only concerned with the effect of certain deficiencies on the yield of crops and growth of animals, whilst omitting the most important consideration of all in our calculations, viz. the ultimate effect of such deficiencies on the health of human beings.

If mineral deficiencies in our soils could reveal such marked defects as far as general health and production is concerned, what do we know about the possible effects on health of a humus-deficiency in our soils ? All we know is that the "health of the soil" is upset and this particular deficiency reveals itself in the form of erosion. A picture of the extent of erosion gives merely an indication of the much greater incidence of loss of fertility and what would be the ultimate effect on the health of human beings.

These are all vital questions, to which, unfortunately, nobody as yet has attempted to offer any satisfactory reply. Sooner or later, however, such queries will have to be answered; and let us hope the day is not very far distant before such investigations are attempted.

Not until then shall we understand and realise what basic principles are included in the sound structure of health. Health is something more than just an absence of specific disease; that alone is just an indication of health. Neither is hygiene a substitute for health, but merely an intermediary stage to that final physical, moral and biological condition. Health is born and has its origin in the soil and is transmitted through the plant and the animal to the human being, and the sacred duty of the latter should be to complete the circle and pass it on until it eventually finds its way back into the soil again, where we call it fertility. Health is a state of balance between the individual and its environment. How can we ever hope to possess constant health, if the environment from which we draw our nourishment is exploited and continuously changing for the worse ?

Numerous rather mysterious characteristics are claimed for compost. I do not intend to elaborate upon them, apart from quoting just one example that rather struck me as being interesting and rather important.

It is a well-known fact that certain nematodes, of which eelworm (*Heterodera marioni*) is the best known, play a rather important role as far as the reduction of yield and quality is concerned in many of our agricultural and garden crops. Various research workers have not yet succeeded in finding a successful remedy, although time, money and energy were not spared, in attempts to eradicate this pest. Recently, however, some light was thrown on this important problem by researches in Ceylon.

The extract given below was taken from Peradeniya Manuals No. IV, "Diseases of Village Crops in Ceylon," by Malcolm Park, plant pathologist, and M. Fernando, assistant botanist, published by the Ceylon Government Press, 1941.

"The most promising method of ridding the soil of eelworm is one that has only been discovered recently. It has been found that if large quantities of organic material, *e.g.* green manure, cattle manure and compost, are added to the soil the population of eelworm in the soil is greatly reduced. This is due to the increase in the soil, as the result of adding organic matter, of organisms like fungi, insects and other nematodes, which prey on Heterodera so efficiently that the population is reduced. If, therefore, a garden or field is heavily infested with eelworm to the detriment of the crop, heavy dressings of compost, or green or cattle manure should be applied before the area is replanted."

The following from the same publication is also of interest :

"As research work on plant diseases progresses it is becoming increasingly evident that many of our soil-borne diseases in Ceylon would not be so severe, if more care were taken to increase the amount of humus or organic matter in the soil. Plants grown in well-cultivated soils, well supplied with organic matter, are not affected by many plant diseases to the same extent as those which are grown in the poorly-cultivated, unmanured soils which are so common in this country."

It would certainly be premature to draw any definite conclusions about the role of organic matter or humus in the soil and its corresponding effect on the health of the individual, be it plant, animal or human being, but recent observations and researches, nevertheless, point to interesting and perhaps far-reaching scientific developments. At a recent meeting of the compost committee, a body consisting of representatives of the different divisions of the Department of Agriculture and Forestry, it was decided, after discussing this subject of fertility and health, that this question was considered to be important enough to warrant special investigation. Such investigations are to be commenced in the near future.

Under our present economic system, we are unfortunately forced to look upon crop production from the point of view of quantity alone, with very little regard for quality, and we got into the habit of regarding price as the index of quality. Quality, unfortunately, is an unmeasurable entity, and not before it can be proved that true fertility imparts quality, and quality in its turn imparts health, will our outlook on crop production in general be reconstructed along these lines.

In our everyday life, each of us toils independently on his own particular problem, not realising that all the minute fragments which occupy our separate researches, whether it be soil, crops, animals or human beings, constitute the integral components of one whole—the creation of a better environment for the individual. The sooner, therefore, we realise the need for co-ordination of research, nutritional, medical, veterinary and agricultural, the sooner will this ideal and vital balance be established.

The contents of our dust-bins should not be regarded as a nuisance or something that should be got rid of as quickly, unobtrusively and cheaply as possible, but as an essential link in the process called *life* and in the condition known as *health*. If the urban authorities could be brought to realise the significant role which they have to fulfil in preventing the formation of a C3 nation, I am convinced that in future they will be more willing to assist by way of providing farmers with fundamental ingredients for the production of high quality, nutritious food, thereby stemming the tide of chronic malnutrition at present existing among large sections of the community.

The following quotation from Professor King may serve as an apt conclusion to this paper :—

"If the United States is to endure, if we are to project our history through four or five thousand years, as the Mongolian nations have done, and if that history is to be written in continuous peace, free from periods of widespread famine, or pestilence, this nation must reorient itself; it must square its practices with a conservation of resources, which can make endurance possible."

BIBLIOGRAPHY.

[1] Wrench, G. T. (1938) : "The Wheel of Health." Cambridge.

[2] King, F. H. (1926) : "Farmers of Forty Centuries."

[3] Northbourne, Lord (1940) : "Look to the Land." London.

[4] "Manures and Farming (1937). Bull. 36 of the Ministry of Agriculture and Fisheries.H .M. Stationery Office. 1937.

[5] Fowler, G. J. : "Recent Experiments on the Preparation of Organic Manures." A Review. The Agric. Journ. of India, vol. xxv., part v., p. 363.

[6] Timson, S. D. (1939) : "Compost." The Rhodesia Agric. Journ., vol. xxxvi., No. 4, p. 285.

[7] Hutchinson, H. B., and Richards, E. H. (1921) : "Artificial Farmyard Manure." The Journ. of the Ministry of Agriculture, vol. xxviii., p. 398.

[8] Jenkins, S. H. (1935) : "Organic Manures." Imp. Bur. Soil Sci. Tech. Comm. No. 33.

[9] Douglas, F. C. R. (1941) : "Economic Aspects of Soil Fertility and Nutrition." Journ. Roy. Soc. Arts, vol. lxxxix., No. 4593, p. 572.

[10] Howard, Sir A. (1940) : "An Agricultural Testament." London.

[11] — (1939) : "Experiments with Pulverised Refuse as a Humus-forming Agent." The Institute of Public Cleansing Annual Conference, Scarborough.

[12] Howard, A., and Wad, Y. D. (1931) : "The Waste Products of Agriculture: their Utilization as Humus." London.

[13] Howard, Sir A. (1939) : "The Preservation of Domestic Wastes for use on the Land." The Institution of Sanitary Engineers. Paper read at sessional meeting. Caxton Hall.

[14] Jackson and Wad (1934) : "The Sanitary Disposal and Agricultural Utilization of Habitation Wastes by the Indore Method." Indian Medical Gazette, Feb. 1934.

[15] Howard, A. (1935): "The Manufacture of Humus by the Indore Method." Journ. Roy. Soc. Arts, Nov. 1935.

[16] Watson, (1936): "A Boon to smaller Municipalities: the Disposal of HouseRefues and Nightsoil by the Indore Method." The Commercial and Tech. Journ., Calcutta, Oct. 1936.

[17] van Vuren, J. P. J. : "The Manufacture of Municipal Compost." Bull. Union Dept. Agric. and Forestry.

[18] Van Vuuren J. P. J. (1943): "Compost Making." Paper read 7th Conference Assoc. Sup. Public Parks and Gardens, Salisbury, Sept. 1943.

(For discussion see end of paper—"Note on the Cure of Streak Disease in Uba Cane.")