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THE CIRCULATION OF ORGANIC MATTER IN NATURE

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THAT malnutrition both of animals and man is widely prevalent in the African Continent is common knowledge. In the investigations on this problem stress has been laid on the mineral deficiencies in the soil, such as phosphates in South Africa. Mineral deficiency no doubt exists, but why? A complete explanation is hardly yet to be expected, but a reasonable suggestion is that such mineral deficiency is an old evil arising out of faulty systems of native agriculture. Over large tracts of Africa what is known as shifting cultivation has been practised for many generations by the native peoples: the forest is cut or burnt, the resulting fertility is cashed into crops of some sort, and the tribe then moves on to destroy another area of natural wealth. The cumulative result of these depredations, as they can truly be called, has been the destruction of the forest canopy over large portions of the Continent, and indeed the evil is now so far advanced that the provision of an adequate supply of ordinary timber for native settlements can represent considerable problems for the administrator in some districts. This is an immediate result, but the ultimate effect of the large-scale destruction of trees is much more profound, seeing that trees are the natural agents which collect and pull up the minerals from below the soil and redistribute them in the shape of leaf, bark and twig fall on to the surface of the ground. Without the deep root thrust of a tree system this natural rotation cannot continue; the surface minerals are rapidly used up and the land becomes mineral-starved.

This function of the forest is seldom, if ever, mentioned by scientists. But should it not be one of the most important items in the basic structure laid down by Nature which the cultivator must recognise and on which he must proceed to

build? If the explanation is true for Africa—and *prima facie* it will require some very definite argument to disprove it—the lesson to be drawn is obvious. Any serious interference with the course of Nature, any real infringement of her arrangements, brings down on the cultivator, be he black, brown or white man, a condign punishment.

But mineral deficiency is only the fringe of a larger problem, which embraces many wide aspects. The thesis advocated by the present writer, in which every day his faith is confirmed by correspondence reaching him from all over the world, is that there is a health chain running through Nature. This health chain starts with the soil: it then runs through the crop, through the animal that eats the crop, and finally reaches man. Disease in a form which inflicts serious loss or disability anywhere means that the health chain has been broken. If serious diseases are rife among human populations we must try to trace where the break in Nature's round has occurred, and as often as not we have to go right back to the soil before we find it.

The first link in the health chain which Nature has created for our benefit is the one which connects a fertile soil and a healthy crop. Here the evidence may be regarded as overwhelming. This portion of the subject is discussed in detail in Chapter XI of [1]*An Agricultural Testament*, which was reviewed by Captain Moubray in the last issue of this journal. As this chapter was itself a résumé of the case, it will not be easy to summarise it still further; the reader interested must study the original. Briefly stated, it was established that insects, fungi, and viruses are not the cause of plant diseases, but are the consequences of improper methods of agriculture, resulting either from the growth of unsuitable varieties or from improper methods of cultivation, or from both. Generally speaking plant diseases are the consequence of infertility, so that the rational method of dealing with such problems is not to destroy the agent by means of insecticides or fungicides, but to bring the soil back into a condition of real fertility in the first instance and

[1]Howard, Sir Albert. *An Agricultural Testament*, Oxford University Press, 1940, 253 pp.

then to devise methods of farming suitable for the local conditions. In nine cases out of ten such a proceeding will automatically dispose of the problem. A few cases will remain, which will require further study in the direction of tuning up our agricultural methods.

A few examples of the conquest of plant diseases by the principles advocated may be quoted. The first relates to the flowering parasite (*Striga lutea*) known as witch-weed, which attacks the roots of maize in Rhodesia. It was discovered by the merest accident that the use of freshly prepared Indore Compost is a certain cure for this disease. One of the Rhodesian farmers when applying compost to his maize land ran out of material and left a portion of the field unmanured. He was astonished to find that on the manured portion of the land there was practically no witch-weed, while the unmanured land looked like a red carpet. This fortunate observation naturally led to further work. It was discovered that the effect of a dressing of compost in preventing witch-weed lasts at least two years, in addition to bringing a notable increase in the yield of maize. The ploughing in of a green manure by itself does not prevent the trouble. It can only be avoided by freshly prepared humus made from vegetable and animal wastes. This opens up a new and exceedingly promising field of research on the general question of parasitism, which will no doubt be eagerly taken up by the research workers in Africa. It seems probable that the matter will be further elucidated by the study of the mycorrhizal association, which connects a fertile soil and the roots of the maize crop. Evidence has already been obtained which points to the conclusion that this mycorrhizal association is only really effective when the humus in the soil is partly derived from the waste products of the animal.

A second example of the rôle of a fertile soil in preventing disease also comes from Rhodesia. Here the potato crop like that in Great Britain and other parts of the world is frequently attacked by eelworm, a parasite which destroys the root system of the crop. Observations by the writer in the plains of India established the important fact that an area of rice land

in Bengal and a portion of the wheat growing area in N. West India are regularly attacked by eelworm. The disease is always limited to a definite area and does not spread to the rice and wheat alongside, which in both cases continue for at least 1,500 miles in vast unbroken stretches. From both these afflicted centres there is every opportunity for the spread of the parasite by such agencies as the feet of animals and men and a continuous stream of wheel traffic. In both centres the aeration of the soil is poor. In the great potato area of South Lincolnshire the continuous cropping of the land for potatoes has been followed by the loss of the crumb structure and the appearance of eelworm disease. The same thing has happened in Rhodesia.

Captain Moubray at Chipoli decided to revise his methods of potato growing by the use of Indore Compost. The restoration of the fertility of his soil by this means is leading to the rapid disappearance of eelworm. It should be observed at this point that large sums of money are being spent all over the Empire in trying to devise methods of direct control of eelworm by means of soil poisons of various kinds. If the trouble is due to the destruction of the porosity of the soil which follows the oxydation of the soil organic matter, it would follow that these attempts are certain to fail. No success has been obtained up to the present. The eelworm has eluded all frontal attacks of this description. The moment indirect methods have been employed success has been immediate.

In various parts of Africa an important industry has arisen in the form of high quality tobacco. All went well for a time, but the industry is now threatened by what is known as virus disease. This trouble is not due to insects or fungi but is associated with the imperfect functioning of the leaf. The proteins which are manufactured there appear to be incompletely synthesised. The writer has had some personal experience of this trouble in the case of tobacco when he grew large areas of this crop for nearly twenty years in India. At first virus disease appeared, but when all due care was devoted to the growing of seed, the raising of nursery plants, and the maintenance of soil fertility, all traces of virus disease disappeared,

and for more than fifteen years not a single case of virus was observed in his tobacco fields. This experience is being repeated by a number of tobacco growers in Rhodesia.

In all probability it will be duplicated in the vineyards of South Africa when the vines there are manured solely by means of freshly prepared humus. That this forecast is likely to be realised in practice is indicated by the experience of the great growers in Central Asia, where neither spraying machines, insect nor fungoid pests are to be found in the best vineyards: the only manure used is farmyard manure. In countries like Germany, France, and Italy the balance between the areas under vine and those which support livestock has been destroyed: there are far too many vines and far too few animals; the supply of farmyard manure is totally inadequate. The resulting infertility has led to insect and fungoid diseases which have to be kept in check by regular applications of poison sprays. Side by side with the use of insecticides, etc., there has been a steady fall in the quality of the wine. Already the vine growers in South Africa are learning this lesson. The use of Indore Compost is spreading: the yield, quality, and disease resistance of their grape harvest are improving.

The second link in Nature's health chain is that between the crop and the animal. Here again decisive evidence has been obtained, but in this case the work was mostly done in Asia, not in Africa. At three centres in India, Pusa in the Indo-Gangetic plain, Quetta on the Western frontier, and Indore in Central India, the writer carried out an experiment with four of the important breeds of work cattle in India with the object of discovering to what extent well chosen, well managed, and well fed oxen would resist the diseases of livestock without any help from vaccines or serums. None of his animals was inoculated, none was segregated; they frequently came in contact with the common diseases of the countryside such as foot and mouth disease, septicæmia, rinder-pest, Johne's disease and so forth. Over a period of nearly twenty years not a single case of infection occurred although the oxen were sometimes seen rubbing noses with foot and mouth cases. The

recognition of the second link in Nature's health chain was rewarded by immunity.

On one of the large estates of Great Britain these results have been confirmed in a most interesting way. At Marden Park in Surrey the late Sir Bernard Greenwell compared the effect of animal food raised from fertile soil with that imported into the country. In six months very striking differences between the two sets of animals were observed. The use of produce from fertile soil was followed by the disappearance of infantile mortality and of many of the common ailments of live-stock in the case of poultry and pigs. Other livestock such as horses and cattle throve markedly better on the home-grown produce than on imported food; a reduction in the grain ration of about ten per cent. in favour of the grain from fertile soil also resulted—such produce appears to have a greater satisfying power than that obtained when the feeding stuffs are grown anywhere and anyhow. In Nigeria the use of farmyard manure on a cotton seed farm was followed by a marked diminution in the tsetse fly disease among the work cattle.

These results suggest that more work should be done in Africa to ascertain whether the introduction of mixed farming and the restoration of soil fertility in the areas afflicted with tsetse fly would not prove to be the real remedy for this trouble. Such well farmed areas should cover at least some square miles. In these experimental areas the varieties of crops which do so well in the Far East, such as pigeon pea and other legumes, as well as the buffalo—the milch cow of India—might also be tried out. It is more than likely that a first-hand study of the agricultural conditions in the best agricultural tracts of India would provide the investigators in Africa with many useful suggestions and general directives for any experiments contemplated.

The final link in Nature's health chain is that which connects the plant and the animal with mankind. Here again the evidence is strong enough to establish a case for further inquiry. Perhaps the best example of the connection between human health and an efficient system of agriculture, in which all the

wastes of the plant and the animal are returned to the soil, is provided by the Hunzas, an ancient tribe which inhabits one of the valleys in the Gilgit area of the Himalayas. Here the crops are raised by what has been described as staircase cultivation, a series of well made and well managed terraces irrigated from a glacier torrent. The remarkable physique, health and stamina of the Hunzas has been described by McCarrison and other writers. These hillmen think nothing of walking across the mountains to Gilgit sixty miles away, doing their business, and then returning. Africa presents in the Sahara desert similar cases of endurance. Here the shepherds are nourished by the produce of fertile oases, where mixed farming has been the rule since time immemorial. It is probable that in some of the areas administered by Great Britain examples will be found in which the standard of agriculture is above the average with a corresponding development in health and fitness. Should these exist in countries like Tanganyika they should be studied and described by competent officers.

Supporting evidence for the view that a fertile soil is the real basis both of rural sanitation and the public health system of the future is coming forward from the Malay Peninsula. Dr. Scharff, Chief Health Officer, Singapore, in a recent paper published by the Journal of the Malaya Branch of the British Medical Association (Vol. 4, No. 1, June, 1940) has described how in the neighbourhood of Singapore all the vegetable, animal, and human wastes are composted for growing the food required by local labour. In this work the important fact has been established that the composting of human excreta by the Indore process effectively destroys such parasites as those present in hookworm disease. Already results of the greatest promise have been obtained. It seems more than probable that the general health of the labourers will show a very definite improvement and that the first step on the road to the Hunza standard will be achieved.

In Africa some promising results have already been obtained on Colonel Grogan's estate at Taveta. The waste products of the sisal plant have been converted into compost, which with

the waste water from the decorticators has been largely employed to grow the vegetable crops needed by the labour force. The improvement in diet which has resulted has not only attracted labour to this estate, but has enabled the workers to complete their daily tasks in a much shorter time than hitherto and with fewer calls on their general endurance. The general advantages of feeding the native worker well, and the extraordinary decrease in sickness which can follow, has also just been notified by Mr. O. C. Dawson, of Darwendale Estates, Ltd., in Matabeleland. Here 2,000 to 3,000 "boys" are employed, and a yearly hospital bill of £300 was cut down to nil by good feeding, while a marked all-round increase of efficiency was observed (*Vuka*, official organ of the Matabeleland Farmers' Union, October, 1940).

Some of the large estates in Africa and some of the mining companies could easily contribute valuable evidence on the connection between a fertile soil and a healthy and contented labour force. It might easily pay such organisations to take up land, to establish mixed farming, and to supply the produce to their labourers. If, as the writer anticipates, they succeed in establishing the principle that a fertile soil means healthy crops, healthy animals, and last but not least healthy and contented human beings, they will have done much to consolidate their position in the scheme of things now and to-morrow. Their results would also stimulate the various administrations to go one better in carrying on another stage the work of statesmen like Lord Lugard. In such work the assistance of the local chiefs and their people would be readily granted. The political advantages of such co-operation need no argument.