

BUILDING AND MAINTENANCE OF SOIL FERTILITY IN THE HIGHLAND SOURVELD OF NATAL

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One of the biggest problems in high rainfall areas, potentially suited to intensive farming, is the building and maintenance of soil fertility. This problem is common right through the highland sourveld area of Natal and is being investigated at the Tabamhlope Pasture Research Station, which was established to serve this region. Some interesting facts have come to light and, though it is early yet to draw definite conclusions from all the work done, it might be worth while to record some of the findings which have indicated the lines on which further work should be done.

When work was first started in this area, it was observed that a large proportion of the country consisted of worn-out, abandoned agricultural land. It had been regarded as excellent potato country, but after five or six years cropping with only one or two potato crops in that period, the lands had been abandoned, despite the fact that heavy applications of fertilizer had been used throughout. After a few years' cropping these soils would produce no crops, and were so sandy that they were prone to erode with the wind. Their whole structure had changed.

The details of the treatment of one such land were obtained from a farm adjoining the Research Station. Virgin veld had been broken up and the fertilizers, crops and yields had been as follows:—

Year.	Fertilizer per acre.	Crop.	Yield per acre.
1.	300 lbs. super	Maize	8 bags per acre.
2.	1,300 lbs. potato fertilizer	Potatoes	100 bags per acre.
3.	300 lbs. super	Maize	18 bags per acre.
4.	400 lbs. mixed fertilizer	Beans	6 bags per acre.
5.	300 lbs. super	Maize	6 bags per acre.
6.	300 lbs. super	Maize	4 bags per acre.
7.	—	Pasture	Failure.

In the seventh year, as the production had been so low the previous year, an attempt was made to lay down a pasture, but a very poor stand with most disappointing growth was obtained. The assistance of the departmental officers was then invited and trials were made to improve the pasture by cultivation and different fertilizers, but without success. All the farm stock were then fed for a whole winter on a 5-acre block, which was ploughed, fertilized with 1,300 lbs. potato fertilizer per acre and yielded 80 bags of potatoes per acre. This indicated that something more than mineral fertilizers was necessary, and that animal and vegetable wastes would probably be of the utmost importance in restoring and building fertility in these soils.

As preliminary green manure experiments, on the Research Station, had given disappointing results, attention was focussed on the production of compost (farmyard manure or "muck," as some people maintain it should be called), on as large and cheap a scale as possible, and its utilization for building-up of old lands.

It was found possible to make compost very cheaply on a big scale by working it in with the farming system applied. It had been discovered that veld, mown off at the end of the winter, produced earlier growth and higher hay yields than veld that had been burned off. The old, frosted grass so mown off was stacked and used for bedding for the stock in the kraals during the following winter feeding period, and, when the stock went back to the veld in the spring, compost was made from the trampled grass, dung and urine.

Pilot experiments were carried out with compost on a very badly worn-out, sheet eroded land. An 8-acre block was treated with 600 lbs. super per acre. Two strips through the land of an acre each were dressed with 12½ tons and 25 tons of compost respectively. The whole land was planted with maize. The land with super only produced no maize worth making ensilage from, the maize flowering at knee-height. A good yield of maize ensilage was obtained from the two composted strips, the maize being a good stand of 6 feet to 7 feet high.

Rye grass was sown as soon as the maize was taken off for ensilage. There was an excellent germination over the whole field, but, on most of the area which had received super alone, it did not develop and died off by mid-winter. The composted areas gave an excellent stand which lasted for four years. When these results were discussed with certain chemists, it was maintained by them that this result was due to the nitrogen in the compost, despite the fact that the effect had lasted for four years. A further experiment was then laid down with different fertilizer and compost mixtures, with five replications of each treatment. The first year soya beans were sown, followed by maize the next season, and the two seasons' results are rather interesting. For the purpose of this paper only three of the treatments will be taken, and as the results have not yet been statistically analysed the average of five plots will be given. These treatments were:—

- A.—Control.
- B.—7 tons compost plus 300 lbs. D mixture annually.
- C.—300 lbs. D mixture plus equivalent in nitrogen of 7 tons of compost = 500 lbs. sodium nitrate.

The soya beans were reaped as hay and the maize as ensilage. A most interesting feature with the maize was the poor stand that was obtained, quite apart from the growth of the plants. The results, average per small plot, were as follows:—

	A.	B.	C.
Soya bean hay (lbs. per plot)	69	117	85
Maize (plants per plot)	112	176	78
Maize (green stalks for ensilage, lbs. per plot)	51	134	24

It is evident that the effect here cannot be due to nitrogen, as was maintained. The organic matter in the compost must play a big part, and the use of compost for building-up such worn-out lands is a most important aspect of farming in these areas.

Certain people have stated that a sound crop rotation with short leys of pastures in the rotation is all that is needed to build up the organic matter and maintain fertility in these soils. This may be the case where virgin veld is broken up and the rotation is followed from the beginning; but in worn-out lands there is not the fertility to produce the pasture which will aid in building that soil.

Rather interesting results on these lines were obtained at Tabamhlope. An old land which had lain fallow for years was ploughed up, fertilized with grass fertilizer and sown to pasture. There was a good germination, but the pasture did not last a season. Another old land which had had a small amount of compost was sown to pasture, after fertilizing with grass fertilizer. A poor pasture was obtained and this, thanks to the subterranean clover in it, is slowly improving. A third block was very heavily composted and put down to pasture and, after four years, is still excellent and vigorous.

There is no doubt here that though a pasture in a rotation may be of utmost value in maintaining soil fertility and stability, there must be enough fertility initially if a pasture is to be established, and the only way of ensuring this is by use of compost to build up the organic material in the soil.

The results obtained to date, on which a number of replicated experiments have been laid out, may be summarised as follows:—

- (1) The soil soon becomes deficient in organic matter with cropping, and heavy dressings of artificial fertilizers do not rectify this.
- (2) It is possible to rectify matters by the use of compost.
- (3) The effect of compost is far more than mere nitrogen effect.
- (4) Crop rotations with pastures in the rotation may maintain fertility in good soils, but will not solve the problem where fertility is too low for the establishment of a good pasture.

In areas of high rainfall such as this under discussion, the various conditions lead one to regard it as potentially an area for intensive farming, but the degree to which intensification can be carried out will depend on the fertility which it is possible to build and maintain in the soils. Compost will have to play a very large part in this building and maintenance of fertility, and, with this in view, a great deal of work is being done (a) to produce compost on as big a scale and as cheaply as possible by fitting in with the farming system practised and (b) to establish the balance between stock, veld, pastures and crops.

This balance has to be worked out on a basis of (1) the amount of compost required to build up the initial fertility per acre; (2) the number of stock which will make the compost; (3) the area of veld required to support the stock and provide waste material for compost; (4) the type of livestock to be carried on the veld, on pasture and on fodder crops; and (5) the proportion of veld to pastures to crops. Once this has been worked out initially, it should be possible to build up the fertility of more and more land and improve the standard of production both of crop and livestock.

Although one cannot generalise on the results obtained from one area, there is little doubt that, in this country, there has been much unbalanced farming; and if we are to have a stable agriculture, there must be a balance between stock, veld and crops, so that the fertility of the soils can be maintained in perpetuity.

The PRESIDENT, in opening the discussion on the two papers, "An Agro-Ecological Survey of Natal" and "Building and Maintenance of Soil Fertility in the Highland Sourveld of Natal," referred to a recent broadcast which he characterised as stupid and mischievous. In this broadcast the accusation was made that the sugar planters exploited the soil in an attempt to get rich quickly, thus ruining the land without thinking of the future. The assertion had also been made in the report of the Committee on Reconstruction of Agriculture that sugarcane was a plantation crop and not a farm product in the true sense. There was much misapplied, thoughtless criticism of our methods of agriculture as applied to sugarcane. He was therefore glad to see that Mr. Pentz, who was a Government pasture officer, gave us credit for not only trying to maintain, but also trying to improve the fertility of our soils.

Mr. DODDS said that Mr. Scott described some interesting experiments in which compost or farmyard manure gave enormous increases in yields which could not be attributed to the nitrogen content of the compost alone. It would be interesting, however, to know which other elements occurred in the compost and what the original organic matter content of the soils was, so as to get an idea to what extent the moisture-retaining power of the soils was increased.

It was of interest to note that Mr. Pentz recognised the possibility of different soils occurring under similar climatic conditions, as there was a tendency to classify soil types on a purely climatic basis. That, the speaker thought, was considered a mistake, as far as the coastal belt was concerned at any rate.

The region in which we were naturally most interested was the coastal evergreen bush. Here the author rather critically referred to the practice of monoculture, a term which was regarded as somewhat derogatory. At all events, he gave us credit for green manuring and like practices. Although the animal industry was still largely lacking on the Natal coast, it was now growing rapidly. Many sugar planters were now going in for dairy farming on a small scale in conjunction with pig farming and were thus making use of cane tops and the skimmed milk. This had not only been a profitable side-line in recent years, but had also helped to increase the rather scanty supply of animal manure.

The author referred to the adverse effects of the system of monoculture being noticeable. The speaker would like to know what particular districts were meant, and in how far this was the result of monoculture?

Reference was made to the quota system enabling farmers now to practice greater selectivity of soils. This, however, was

not the only reason. Production per unit area had gone up very considerably and the same crop could not be produced on much smaller areas.

Mr. DYMOND said that in these experiments the Government fertilizer "D" gave the same results on large areas as he had found in pot experiments. He thought our production of cane per acre had gone up largely because we had discarded our poorer soils and were only planting cane on the most fertile areas now.

Mr. RAULT could not agree that the fertility of our sugarcane soils had deteriorated. On the contrary, he maintained that the fertility of the soils had been greatly improved. Natal Estates had been growing cane on the same soil for seventy years, and still their yields were on the increase. From 1920 to 1932 they averaged 18 to 20 tons of cane per acre, while during the latter years the yield had increased to 30 to 35 tons per acre, with a record average of 44 tons of cane per acre for this last season. This did not apply to a small area either; but to a total of 9,000 acres. A considerable area, at present about 2,000 acres, was under long fallows and green manure crops.

Dr. FISHER said that there was no doubt that the monoculture system as applied in grain crops led to the devastation of the soil. In this system the soil was cultivated in a most drastic manner. Ploughing, discing and harrowing were done at frequent intervals, and the rain would cause further disturbances of the bare soil, with the result that the soil had no rest and its physical characteristics were destroyed. This was most important because, immaterial of what plant-foods might be present in a soil, unless the correct physical structure was maintained the soil was of no value. In trying to go against nature and taking as much as possible out of the soil, man was defeating his own object. He was inclined to be concerned about the wear and tear upon his implements, whereas the wear and tear of the soil was of prime importance. Nature never yet planted crops in rows; it planted them broadcast and man might as well take a leaf out of nature's book and plant broadcast crops wherever possible, and also try and have the soil covered for the whole year.

The cultivation of sugarcane was, however, something entirely different from growing a monoculture grain crop. Here we were really dealing with a giant grass. The soil was only ploughed once in a number of years, and even then it was contour-ploughed. In the intervening years the soil was covered and this giant grass acted as an excellent shock-absorber, in that the rain never beat down with all its stinging force on the soil. In a grain crop a lot of concentrated plant-foods such as phosphates were removed. This was not the case with a sugarcane crop, and the cane grower had never hesitated to buy fertility in the form of artificial fertilizers. The fact also remained that sunn-hemp was used extensively as a green manure crop in the sugar industry and that it was one of the best means of enriching the soil with nitrogen. In these circumstances, Dr. Fisher could see no reason why sugarcane could not be grown almost indefinitely on the same soil.

We in this country were often led astray by the experience and examples in other countries. In cold climates it was possible to build up the organic matter in the soil and increase its nitrogen content. It was, however, a totally different problem to build up organic matter and to get a higher nitrogen content in tropical soils. With constant cultivation you could put as much as 15 tons per acre of kraal manure in a tropical soil, and all would just be burnt up and would not lead to any permanent benefit. Under these conditions it was necessary to build up organic matter content under pastures. The speaker knew of no other way that was cheaper or as efficient. Whilst rebuilding the soil the pastures were profitable. The Cedara farm was originally bought because it was cheap and was naturally a very poor farm; but during the course of thirty-five years that farm had been improved continually and the fertility of the soil built up day by day. Pastures played the great role in this process. It was, however, necessary to put down pastures properly. At first all attempts to establish clovers at Cedara failed. To-day, however, clovers were spreading through all the grass and they were going to oust kikuya grass.

The speaker was not in favour of big farms. He considered 500 acres quite a large enough area to look after. By selling fertility in the maize bags and not buying enough in the fer-

tilizer bags we defrauded the soil both of plant-food and physical character. Farming was indeed a most complex profession, and there were many things which remained unexplained and not understood.

One heard a lot about social security these days; but there could be no social security for anyone unless we first ensured soil security for our country.

Mr. SCOTT explained that their method of making compost was to collect the grass not eaten by the cattle the previous year, store it and use it as bedding for the stock the next winter. Every week or so, depending on the number of cattle, more grass was added, so that at the end of winter about a layer of three feet of mixed dung, grass and urine had accumulated. This was what he thought Dr. Fisher would call "muck." It was then removed and put into heaps and aerated, and the resulting processed product was "compost." He failed, however, to get as good results from "muck" as he had obtained from the application of compost.

In reply to Mr. Dodds, the speaker said that he did not have the analysis of the compost used, but he ascribed most of its

beneficial effects to the resulting improvement of the physical structure of the soil, and its consequent better water-holding capacity. The effects could be seen in rye-grass, for example, with its high moisture demand in winter. The structure of the soil was affected to such an extent that one would notice the difference by just walking over composted strips and areas not so treated.

He had seen areas of sugarcane land along the South Coast which had been thrown out of production and which were now dormant. This was probably what Mr. Pentz meant by having stated that adverse effects were beginning to be noticed. He admitted, however, that these lands did not become dormant while under sugarcane. To make a fair comparison on yields as to whether fertility had increased, it was necessary to know whether the same varieties were still cultivated, and whether fertilizer application had remained the same.

Mr. RAULT replied that although mostly new varieties were now being cultivated, Uba cane had been grown for about thirty years, and also in the case of Uba the yields were very good and had doubled themselves on the Natal Estates.