THE PRESENT FERTILIZER POSITION.

By H. H. DODDS.

The last general paper on commercial fertilizers and fertilizer experiments in Natal given to you is that by J. E. Colepeper and the writer two years ago.8

Many profound and far-reaching world changes have taken place since then, that have had important repercussions on fertilizer supply, especially in those countries, such as South Africa, which depended largely on imported fertilizers and raw materials for fertilizer manufacture.

Of phosphatic fertilizers, before the war, nearly two-thirds of the phosphate used in South Africa were manufactured locally from imported rock phosphates and sulphuric acid made partly from imported sulphur and partly from South African pyrites.

Thus in 1937-38 (the last year for which figures are obtainable) there were manufactured in South Africa 172,130 tons of superphosphate8 and 92,244 tons of mixed fertilizers, while in 1938 there were imported 95,724 tons of superphosphate and 109,427 tons of rock phosphates, the latter being used mainly for the manufacture of superphosphate.

Compared with these figures for superphosphate, the import and consumption of other phosphatic fertilizers such as basic slag, 4,937 tons, and bone manures, 10,841 tons imported and 9,053 tons produced locally, are of relatively little importance.

In the same year (1938) 17,649 tons of ammonium sulphate (sulphate of ammonia) were imported with a negligible amount of other nitrogenous fertilizers, while no more than 1,160 tons of ammonium sulphate were manufactured locally, together with 5,442 tons of blood meal and meat meal, and 6,216 tons of so-called Government guano, obtained from certain coastal islands frequented by sea-birds.

7,923 tons of potassic fertilizer were imported in 1938; there is no appreciable production of potassic fertilizer from mineral sources within the Union.

The position now is that only very limited supplies of low-grade rock phosphate and no superphosphates can be imported; the importation of ammonium sulphate has practically ceased, and only small quantities of sodium nitrate (nitrate of soda) are obtainable, at a present price of £16 a ton, or £1 per unit of nitrogen.

The importation of potassic fertilizer has also ceased.

This, then, brings about very serious shortages of all mineral fertilizers.

The fairly extensive deposits of rock phosphate in South Africa are not adaptable to superphosphate manufacture, and appear to have very limited applicability as fertilizers in other ways, while the other sources of phosphatic fertilizer such as bone, or meat meals are still produced in very limited quantities and are in increased demand in animal industry because of the general deficiency of stock feeds, especially of proteins and minerals.

The production of ammonium sulphate in this country cannot be appreciated at present, for reasons that I need not enter upon here, so that we are largely limited to what local organic sources of nitrogen can be developed.

Let us now examine these possible sources.

LEGUMINOUS PLANTS (GREEN MANURES).

These appear to offer most promise of supplying nitrogen. If our industrial resources are not adequate to fixing atmospheric nitrogen by chemical engineering means, let us enlist the less spectacular nitrogen-fixing bacteria in our aid. There are several species of which we can use but beneficial creatures, but the only one which seems to be of much help to us at present is Bacterium radicicola, which under certain conditions inhabits the root system of leguminous plants and fixes nitrogen from the atmosphere.

The legumes which we know can be very useful to us in this way are sunn hemp, Crotalaria juncea, velvet bean, Stizolobium derrinum, soya bean, Glycine soja, cowpea, Vigna cajafang, and ground-nut, Arachis hypogaea. There are others in the experimental stage, as far as we in this country are concerned, of which Sesbania macrocarpa, and pigeon pea, Cajanus indicus, are of most promise at present.

Sunn hemp and velvet bean are the best of those in common use because of their rapid growth, adaptability to our special soil conditions, freedom from disease or insect pests, etc. They are also excellent for clearing the ground of weeds.

Incidentally, velvet bean is of special value because of its possible alternative use as food for livestock and may be fed green, or preserved as hay or silage. Seed is easily raised locally.

The amount of nitrogen contributed to the soil by a good leguminous green manure crop is substantial. H. Campbell at the 1940 Conference9 reported an increase of organic matter in a wind-blown sandy soil, six weeks after ploughing-in a good crop of sunn hemp, from 3.93 to 4.14 per cent., or a contribution of 8,000 lbs. per acre of organic matter.

At the same time the nitrogen content of the soil had increased from 0.216 to 0.231 per cent., corresponding to 375 lbs. of nitrogen per acre.

Recent unpublished analyses by B. E. Beater of sunn hemp grown in Mount Edgecombe showed a content of 0.71 per cent. of nitrogen in the tops and 0.36 per cent. of nitrogen in the roots. This corresponds to 15 lbs. of nitrogen from a ton of sunn hemp tops and roots.

Since a good crop of sunn hemp can yield 10 or 12 tons or more of material per acre, it follows that 150 to 180 lbs. or more, of nitrogen per acre would be contributed.

The nitrogen requirements of an average cane crop are about 80 lbs. per acre.

One serious limitation at present to the cultivation of sunn hemp is the restricted local supply of seed. This is a matter that is being investigated.

Unfortunately, it cannot be said that the whole of the nitrogen accumulated by the nitrogen-fixing organisms comes from the atmosphere, since a varying proportion is taken from the soil, especially if the soil is already rich in nitrogen.10 This is true, of course, of the legume itself, which may take nitrogen from the soil like any plant, as well as of the nitrogen-accumulating bacteria in the root nodules, which may find it easier to take some at least of the nitrogen from the soil rather than from the air.

Nevertheless there is, as stated, a valuable net gain of nitrogen to the soil from a vigorous leguminous green manure crop, especially in soils rather poor in nitrogen.

Thus the nitrogen requirements of the plant cane crop can be met by a previous course of leguminous green manuring, while at the same time the organic material of the soil is being replenished to some extent, a matter which may be at least equally important with the fertilizer supply in light or depleted soils.

The nitrogen supplied in this way does not necessarily last longer than the period of the plant cane crop, however, and can hardly be counted on to supply any of the ratoon crop requirements.

Weather conditions in this country are such that it is seldom warm and wet enough after harvesting the cane crop to grow a good green manure crop between the cane lines to fertilize the ratoons without injury to the cane.

Consequently other ways than direct green manuring must be found to supply nitrogen to ratoons, of which composting is one possible way.

COMPOST.

It should be realised that composting does not contribute nitrogen or any fertilizer element, but may help to conserve such elements, especially nitrogen, in such a way as to facilitate their eventual application to the cane, while at the same time converting waste vegetable matter into valuable moisture-retaining humus.
By this means a legume green manure crop can be harvested and so treated as for example by composting with cane trash and tops, as to yield a valuable product for the fertilizing of cane crops, whether ratoon, or plant cane crops which have not had a green manure crop ploughed in.

I will not now go further into this matter, which has been ably dealt with by our Vice-President in a paper given at a recent general meeting of this Association, and which I understand will be included in the Annual Proceedings.

FARMYARD MANURES.

These are very valuable sources of nitrogen and other fertilizer elements and of organic matter, but on the average sugar plantation in this country the supplies of such manures are far below the demand, though there is a tendency for them to increase with the increasing development of cattle and pig farming on sugar plantations.

Like green manures, they may be used either directly or after first using them to make a compost.

The composition of such manures varies enormously, not only with the content of moisture, which is constantly fluctuating, but with the kind of animal from which the dung was derived, and the sort of food it had, the nature and relative quantity of bedding material, the age and conditions of storage, etc.

However, the average analysis of a considerable number of samples from various sources tested at Cedara College of Agriculture was:

<table>
<thead>
<tr>
<th>Element</th>
<th>Calculated on dry sample (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>60.0</td>
</tr>
<tr>
<td>Phosphate (P₂O₅)</td>
<td>0.2</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.6</td>
</tr>
<tr>
<td>Potash (K₂O)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

It would thus take 6½ tons per acre of this farmyard manure to supply the 80 lbs. of nitrogen required by the cane crop, assuming, that all the nitrogen in the manure is available to the sugarcane and will be taken up by it, an assumption that is very far from the truth, as we shall see.

It is indeed a moot point how far nitrogen contained in small proportions in bulky organic manures may be considered available to the crop in comparison with nitrogen in concentrated nitrogenous fertilizers such as ammonium sulphate and meat meal.

This has not yet been worked out systematically under our conditions, though some experiments with this end in view have been laid down recently. In the past, experiments have been done to compare inorganic versus organic nitrogen for sugar cane, but only with concentrated sources of organic nitrogen such as whale meal, blood meal, and the like. There was relatively little difference in normal seasons in their effect on yields per unit of nitrogen applied; but the tendency appeared to be for inorganic nitrogen to be more effectual per unit in seasons of adequate rainfall, but decidedly less so in dry seasons. This question is no doubt complicated by various factors when moisture supply tends to become more definitely a limiting factor.

In view of its much lower cost per unit of nitrogen, inorganic nitrogen showed much greater profits than organic nitrogen in normal seasons of rainfall and fertilizer prices and supplies.

LONG-CONTINUED EXPERIMENTS AT ROTHAMSTED AND ELSEWHERE.

Systematic experiments on fertilizers for wheat carried out continuously at Rothamsted since 1843 and recently summarized by Sir J. Russell and D. J. Watson showed that nitrogen from sodium nitrate was most fully utilized by the crop, approxi mately 35 per cent. of the nitrogen applied being recovered in the straw, but only about 15 per cent. of the nitrogen applied in farmyard manure.

This much greater relative efficiency of concentrated mineral fertilizer as a supplier of nitrogen compared with farmyard manure is reflected also in the yield figures.

Thus farmyard manure applied at the rate of 14 tons per acre (200 lbs. nitrogen) annually for 74 years produced an average gain in yield of grain approximately equal to that resulting from complete inorganic fertilization including 550 lbs. sodium nitrate (56 lbs. nitrogen); also applied annually for 74 years. Using ammonium sulphate, 412 lbs. per acre (68 lbs. nitrogen), in place of sodium nitrate the average yield was only slightly less.

Taking the nitrogen in sodium nitrate as 100, we find that the nitrogen in ammonium sulphate is worth 90, and that in farmyard manure only 44.

Further, it was shown that farmyard manure took four years to give most of its benefit to the crop, while the maximum benefit was obtained from the mineral nitrogenous fertilizers in the first year.

In England, however, there is a considerable annual loss of nitrogen from the soil by the leaching out of nitrates during the autumnal rain; and it is possible that in this country, where there is regular heavy loss of nitrogen does not occur, farmyard manure and similar bulky organic forms of nitrogen may be relatively more valuable.

It may be suggested that the above comparisons between farmyard manure and inorganic nitrogenous fertilizers is possibly not fair to the former, since it was always applied in much greater quantities of nitrogen per acre, in accordance with standard English practice.

However, in another series of experiments at Woburn two different quantities, 4 and 8 tons per acre, of farmyard manure supplying the moderate amounts of 83 lbs. and 105 lbs. of nitrogen per acre respectively, were applied annually to crops of barley and wheat over a period of ten years (1877-1886).

Results showed substantial increases in yield over control plots without added nitrogen, approximately proportional to the quantity of farmyard manure applied, the larger quantity showing slightly better gains per unit of nitrogen applied.

Here, also, over a period of 50 years of continuous experiment (1877-1928) the increments in yield of barley and wheat for unit of nitrogen supplied were much greater for sodium nitrate than for farmyard manure. While the effectiveness of the farmyard manure was only 25 per cent. of that of sodium nitrate in increasing the yield of barley grain over the first 15 years, this proportion had risen to 60 per cent. over the last 25 years. With wheat, on the other hand, the effectiveness of the farmyard manure compared with sodium nitrate averaged 28 per cent. throughout, showing very little increase with the passing of time.

In both crops, however, there was a tendency for the farmyard manure to be more efficient in promoting yields of straw. Evidently the soil tended to suffer somewhat after a time by the depletion of some factor that could be supplied by farmyard manure and not by artificials.

Where sodium nitrate was compared against ammonium sulphate the effects on yield per unit of nitrogen were remarkably similar with both barley and wheat for about the first 12 years; thereafter the yields from the ammonium sulphate plots began to fall-off, until after 25 years the yields were negligible, due to the increasing acidity of the soil brought about by the ammonium sulphate. Where this acidity was neutralised by the addition of lime, 1 ton per acre, ammonium sulphate maintained its equality with sodium nitrate.

Incidentally the experiments at Woburn, contrary to Rothamsted experience, indicated that both sodium nitrate and ammonium sulphate could exercise favourable residual effects by leaving something in the soil to benefit the succeeding crop. We have had recently some evidence of this in South Africa also. This "something" may be nitrogen, as it probably partly is at least with farmyard manure, but is hardly likely to be so with soluble inorganic nitrogen compounds, whose nitrogen soon becomes oxidised to nitrates which are not fixed in the soil and are highly soluble so that they cannot remain long.

The Woburn experiments clearly demonstrate also that, for some reason a crop supplied with an adequate complete fertilizer does not maintain its yield as well grown in the same soil, though the deterioration is slower when farmyard manure is applied. This phenomenon has been studied by A. F. Bell with sugarcane soils in Queensland. Whatever the cause of this deterioration is, it can be temporarily overcome by following, but not necessarily by crop rotation.
Another series of long-continued experiments are recorded from the New Jersey station. These experiments were done on a sandy loam in a highly acid Penn. loam soil. The crop was a five-year rotation of maize, oats, wheat, and timothy grass, and was followed continuously for 40 years.

Here also sodium nitrate (180 lbs. or 320 lbs. per acre) was the most effective carrier of nitrogen and gave rise to higher total yields of crops and higher recoveries of nitrogen in the crops, per unit of nitrogen applied than any other form of nitrogen. Ammonium sulphate (320 lbs. per acre) and blood meal were approximately equal, but only superior to farmyard (cattle) manure per unit of nitrogen applied if the acid soil was periodically limed.

The best results were obtained where both farmyard manure and sodium nitrate were used, the former supplying 60 per cent. of the nitrogen applied. The results from each of the 20 different fertilizer treatments were all greatly improved by a course of liming and green manuring (with vetches) twice in each crop rotation.

Although the mineral nitrogenous fertilizers and blood meal gave the most profitable results, it was noticeable that after 10 years the clay soil that had not been limed in fertility as shown by nitrogen and organic matter content and pH were those that had been systematically treated with 16 tons per acre of farmyard manure annually and periodically limed and green manured.

The beneficial effects of farmyard manure on the soil were measurable for 16 years after its application was discontinued.

It appears as though farmyard manure, possibly by initiating certain biochemical and physico-chemical changes in the soil, whether by the agency of its animate or inanimate components, or both, brings about in certain cases permanent beneficial changes in the soil.

It may form a source of some of the growth-stimulating substances for plants, distinct from plant nutrients as ordinarily understood. Amongst these are the auxins, or indole-substituted lower fatty acids, which are known to occur in urine and can have a profound effect in stimulating root growth of plants.

Farmyard manure may also benefit the soil by liberating large quantities of carbon dioxide, which when dissolved in the soil solution to form carbonic acid will attack insoluble mineral constituents of the soil to make them soluble and available to the plant; the carbon dioxide may also supply green plants with the most effective carrier of nitrogen and gave rise to higher recoveries of nitrogen in the crops, per unit of nitrogen applied if the acid soil was periodically limed. Thus the average nitrogen content of oven-dried samples of six different consignments analysed at the Experiment Station was 1.7 per cent., ranging from 1.40 to 1.97 per cent. This agrees fairly well with the average nitrogen analysis of a large number of samples at the College of Agriculture, Cederah, which was also 1.7 per cent. nitrogen, none being higher than 1.96 per cent. The average phosphorus content was 1.36 per cent. ranging from 1.02 to 2.35 per cent. The lime and potassium averaged 5.52 per cent. as K2O, the limits being 3.00 and 7.10 per cent. These tests are somewhat higher than those recorded at Cederah.

A large proportion of the phosphorus and potassium contents is available, that is to say, soluble in 2 per cent. citric acid.

The manure contains about 90 per cent. of organic matter and may contain from 10 to 90 per cent. of free moisture.

If purchased in bulk it is a very cheap manure, the present price being about nine shillings per ton delivered in railway truck loads. There is then no guarantee concerning moisture content or freedom from large lumps, etc., but the limited experience of the writer is that the material is nevertheless usually satisfactory in composition and texture, although the moisture content is somewhat higher than in the processed material.

It is more frequently advertised for sale in bags, after being dried, milled and sifted, but the price then may be from 25s. to 36s. per ton. Even taking the present value of bags into account, it is much cheaper and probably satisfactory as a rule to buy it unmilled in bulk.

Sometimes it is burned and the ash offered for sale. The burning, however, destroys the principal value of the manure, its nitrogen content and organic matter. The ash also is strongly alkaline from the presence of lime and carbonates of potassium and sodium, and also contains chlorides, sometimes in high proportions. It is therefore undesirable for use as a fertilizer.

Even the unburnt manure may have a pH of over 10, and a chloride content of 1 per cent., corresponding to 1.6 per cent. of common salt, which makes it unsuitable to apply to dry soils and to certain crops.

Fortunately, however, sugarcane (more especially Co.881) is fairly tolerant of brak, our soils are mostly slightly acid and are not usually dry for long at times of the year when the manure would normally be applied.

Experiments are in progress with Karroo manure as a source of nitrogen, but results are not likely to be available for some time.

Some planters have reported very good apparent results from its use, and it seems to be a possible source of fertilizer for the sugar industry.

Whether Karroo manure will show similar residual values to fresh farmyard manure remains to be seen, but it seems quite possible that it will be so.

An application of 3 tons per acre of Karroo manure containing 20 per cent. moisture would, according to our average analyses, contribute to the soil 80 lbs. of nitrogen corresponding to 400 lbs. of ammonium sulphate, and 65 lbs. of Phosphoric acid, being to 400 lbs. of superphosphate, 16 per cent., and 265 lbs. of
K\(_2\)O corresponding to 440 lbs. of potassium chloride. The lime content of 5 per cent. as CaO implies that the 3 tons of Karroo manure would contribute lime equivalent to 430 lbs. of calcium carbonate (agricultural lime).

According to the Cedara average analyses, compiled from a much larger number of samples than ours, the nitrogen from 3 tons of Karroo manure would be about the same, but the phosphorus and potassium would be considerably less, equivalent to about 370 lbs. per acre of superphosphate, 16 per cent., and 300 lbs. of potassium chloride. In this case the Karroo manure would need to be fortified by the addition of superphosphate, about 150 lbs. to the 3 tons application, to balance the nitrogen so as to make a suitable mixture for ratoon canes.

**FILTER CAKE.**

Another waste product of value as a fertilizer is filter cake, sometimes (less accurately) termed filter press mud, scum cake, press cake, molo, or less flattering names.

This is a valuable manure that should be fully exploited at the present time.

It consists of precipitated or suspended solid matter filtered from the cane juice and, like many waste products, is very variable in composition, depending on the method of filtration, the juice clarification system in use, the nature of the cane and the soil from which it was derived and its fertilizer treatment, etc.

A large number of filter cake composite samples from different South African factories have recently been analysed at the Experiment Station, with the following results:—

|---------------------------------------------------------------|-------------|---------------|---------------|
| Nitrogen, total ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 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The phosphates are no longer recorded on water-soluble contents, but on citric acid-soluble phosphate, calculated as \( P_2O_5 \).

Another innovation, which I think is also to be welcomed, is that the NPK sequence replaces PNK, thus coming into line with overseas practice and allocating to nitrogen its rightful primary rank.

Such mixtures might be compounded as follows, using superphosphate, 16 per cent., ammonium sulphate, 20 per cent. nitrogen, potassium chloride (muriate) containing 60 per cent. potash as \( K_2O \). These are probably still the cheapest and most suitable ingredients with which to make a so-called "complete" fertilizer.

**Lbs. required to make 1,000 lbs. of mixed fertilizer.**

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Ammonium Sulphate</th>
<th>Superphosphate</th>
<th>Phosphate Chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Nil</td>
<td>800</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>100</td>
<td>600</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
<td>800</td>
<td>40</td>
</tr>
<tr>
<td>D</td>
<td>150</td>
<td>800</td>
<td>50</td>
</tr>
<tr>
<td>E</td>
<td>200</td>
<td>750</td>
<td>Nil</td>
</tr>
<tr>
<td>F</td>
<td>200</td>
<td>650</td>
<td>100</td>
</tr>
<tr>
<td>G</td>
<td>300</td>
<td>650</td>
<td>50</td>
</tr>
<tr>
<td>H</td>
<td>400</td>
<td>600</td>
<td>Nil</td>
</tr>
</tbody>
</table>

It will be seen that mixtures C, E and F do not require 100 per cent. of these ingredients, and give the manufacturer an opportunity to use less concentrated ingredients if he desires.

Mixture "A" may be used by the sugar planter in place of superphosphate where a response to potassic fertilizer is known to exist, and where the nitrogen requirements of the sugarcane crop have been met by leguminous green manuring, or will be met by top-dressings of mineral nitrogenous fertilizer when the cane is established. It would be a good mixture also for fertilizing leguminous green manure crops in poor soils, and for sweet potatoes where the maximum amount of tuber development and not too much top is required.

"E" is a mixture that would be of much value for ratoon fertilizing in quantities of about 500 lbs. or 400 lbs. per acre where it is intended to apply a later application of nitrogenous fertilizer. It would be useful also to balance farmyard manure where a mixture of organic and inorganic nitrogen is desired.

"F" could be used for a similar purpose in soils known to be deficient in potassium.

"H" would be useful for ratoons in cases where it was desired to apply larger initial quantities of nitrogen, whether followed by still further applications of nitrogen or not.

These fertilizers form a far more rational and useful range of mixtures than the hundreds of registered mixtures, most of them differing from each other only slightly if at all, that resulted from private enterprise, and the Department is to be congratulated on the steps they have taken.

I think we are fortunate at the present critical time to have a government who are keenly alive to the requirements and to the importance of agricultural industry, and to have also in the Union an enterprising superphosphate manufacturing industry associated with one of the greatest firms of chemical manufacturers in the world.
acre, and the highest yield was obtained from the 800 lb. plots of 39.19 tons of cane per acre of 15.93 per cent. sucrose, or 6.24 tons of sucrose per acre. The most profitable treatment was the superphosphate ranging from 300 lb. to 450 lb. of ammonium sulphate per acre of 15.92 per cent. sucrose, or 6.22 tons of sucrose per acre. This showed a profit of £4 15s. 9d. per acre over the cost of the fertilizer, with ammonium sulphate at £16 a ton, and the driest season on record.

In the plant cane crop, similarly fertilized and harvested in September, 1939, all the applications of ammonium sulphate were highly profitable; the 800 lb. plots gave the best and most profitable results, yielding 52.93 tons of cane per acre (compared with 39.30 tons from the controls) of 15.54 per cent. sucrose, or 8.78 tons of sucrose per acre. This represented a net gain over the controls without ammonium sulphate of £11 11s. 11d. per acre, the ammonium sulphate then costing £8 a ton. The percentage increases in yield for each quantity of fertilizer in the two crops corresponded remarkably closely throughout, reaching a maximum of 38 per cent. in the first ratoon 800 lb. series.

Another remarkable example of the benefit obtained from ammonium sulphate is given in an experiment harvested last June at Kulu (C. F. M. Hibberd) as second ratoons of Co.200 cane.

The soil is a windblown light sand, and both the plant cane and first ratoon gave highly significant increases to 30 lbs. or 45 lbs. of nitrogen per acre, whether applied in the form of ammonium sulphate, sodium nitrate, or whale meal.

Similar results were obtained with the second ratoons, ammonium sulphate, 225 lbs. per acre, increasing the yield of cane from 28.99 tons per acre without nitrogen to 38.96 tons, the value of the increased sucrose after deducting the cost of the ammonium sulphate at £16 a ton being as much as £6 3s. 7d. per acre.

In all last season’s experiments 200 lbs. to 300 lbs. per acre of ammonium sulphate yielded a profit in five experiments out of eight, the average gain being £5 4s. 6d. per acre. 400 lbs. to 600 lbs. gave an average net profit of £1 13s. 2d. per acre over four experiments out of seven; and 800 lbs. yielded £3 4s. 11d. profit per acre, positive results being obtained in three cases out of six. The three negative results were obtained in heavy dry soils.

**SUMMARY OF RESULTS WITH AMMONIUM SULPHATE.**

The jigsaw puzzle of the last fifteen years concerning the response of local sugarcane soils to inorganic nitrogenous fertilizers is therefore now largely solved.

Practically all types of soil show a profitable response to sulphate of ammonia in seasons of normal or excessive rainfall. If the soil has had a good leguminous green manure crop ploughed in before planting with sugarcane the nitrogen is already there in sufficient quantity and applications of nitrogenous fertilizer will have no effect. Apparently the same may be said of plant cane crops in certain rich soils where a very heavy crop of weeds has been ploughed in.

In such cases a response to nitrogenous fertilizer may be expected in the ratoon crops.

In seasons of abnormally low rainfall a response to ammonium sulphate and the like may be expected in open sandy or sandy loam soils.

Heavy soils well provided with moisture, either irrigated soils or alluvals with a high water table, will also respond, but not heavy drought-stricken soils. Even in the latter, however, there may be a response to organic nitrogenous fertilizer such as whale meal or blood meal; in such cases the nitrogen comes into the soil solution only slowly.

**SUMMARY OF RESULTS WITH SUPERPHOSPHATE.**

The results last season from superphosphate as a fertilizer were not so definite and are less easy to interpret.

Eight experiments were harvested in which various quantities of superphosphate ranging from 300 lbs. to 1,600 lbs. per acre (mainly 400 lbs.) were applied, and in four there were profitable results ranging from £1 to £2 2s. 9d. per acre, averaging £1 12s. 10d.

These positive results were obtained with first ratoons (no plant cane crops were cut) in heavy and medium soils at Verulam (Central Factory), Upper Tongaat, Braemar, and Esthove. The four negative results were in first and second ratoons in a heavy clay alluvial at Illovo, a heavy clay (D1) and a heavy loam (F2) (sixth ratoons) at the Experiment Station, Mount Edgecombe, and the windblown sand at Kulu.

As with ammonium sulphate, superphosphate suffered from the great increase in price, applications that would have shown a profit at normal prices now failing to do so.

All the experiments had received superphosphate to the plant cane and first ratoon crops, and in most cases had shown a satisfactory response. The history of the negative experiments seems to suggest that sufficient residual phosphates had accumulated in the soil, thus making further applications unnecessary for the present, the size of the crop being limited by time in the Illovo alluvial and by drought at the other places.

The average crop of sugarcane does not remove much phosphorus from the soil, say about the equivalent of 250 lbs. or 300 lbs. of superphosphate per acre; so that once the original phosphorus deficiency of the soil has been supplied heavy applications of superphosphate are probably not necessary in most soils to maintain the available phosphate contents at an adequate level.

There are certain soils which have the property of fixing phosphates, that is to say converting any phosphates added to them into relatively unavailable compounds such as iron or aluminium phosphates. To guard against this possibility and to give the plant cane cycle a good start-off, I believe it is advisable to give the plant cane crop a generous dressing of 500 lbs. to 700 lbs. of superphosphate or its equivalent in filter cake; but after that it may not be necessary to add much phosphates (say 200 lbs. to 300 lbs. per acre of superphosphate) to the ratoons. Until more experimental information about our soils is forthcoming, the planter must still depend largely on his own experience of his soils in this matter.

**POTASSIC FERTILIZER RESULTS.**

In four of the experiments harvested last season at the Experiment Station (Mount Edgecombe), Verulam, Upper Tongaat and Kulu, in widely different types of soil, potassium chloride was tested in quantities ranging from 80 lbs. to 160 lbs. per acre (50 lbs. to 100 lbs. as K₂O), with negative results in every case. While we have found occasionally a response to potash, such cases have been relatively few, and satisfactory yields were first obtained in practically every case without potassic fertilizer. It would appear to be unnecessary under present conditions, therefore, to apply potash, which is fortunate in view of the position of the supply of such fertilizers.

**CONCLUSION.**

We are much better off for fertilizer supplies for the sugarcane crop than we would have thought possible in pre-war times if we had then imagined a total cessation of imports of ammonium sulphate and superphosphate and high-grade rock phosphates.

The extended practice of green manuring, the full utilization of waste products such as filter cake and kraal manure, a thorough trial of such materials of South African origin as Karroo manure and the like, will probably supplement sufficiently the scanty supplies of superphosphate and give us through the present difficult times and those still to come.

The production of the maximum sugar crop possible with our present limited resources of fertilizer, soil moisture, cane varieties, field equipment, labour, and transport, and the recovery of the greatest possible amount of sugar from the crop, is an urgent national duty that devolves upon each one of us.

**SUMMARY.**

The pre-war South African consumption of certain fertilizers is noted, especially ammonium sulphate and superphosphate, and possible local supplies of alternative fertilizer materials considered.
Those discussed in some detail are leguminous green manure crops, farmyard manure, Karroo manure, and filter cake. Long-term experiments with farmyard manure, in Britain and the U.S.A. are also examined.

Comment is made on the new fertilizer compositions laid down by the Union Department of Agriculture, and the need for "straight" fertilizers for sugarcane agriculture is stressed.

Fertilizer experiments harvested by the Experiment Station in 1941 are briefly summarised and the effects of drought on the results in various types of soil are pointed out.

The need for economy in fertilizer use and for maximum production of sugar at the present time is expressed.

Acknowledgments.
The writer acknowledges with thanks the help of Dr. A. McMartin in some of the subjects discussed, and thanks also those planters and estates whose co-operation has made possible a wide range of fertilizer experiments in representative soils.

References.

Mr. GARLAND stressed the fact that the price of sunn hemp seed had gone up and was now 41/- to 43/- per bag. Natal Estates had planted 3,000 acres of sunn hemp and it was planted at different times from July to February, yet nowhere was there sufficient seed to justify the collecting of it. He asked what the reason was for sunn hemp not seeding here, and requested the Experiment Station to investigate the problem.

Mr. DODDS said that a beginning along these lines had already been made. He had written to various quarters, but did not get much satisfaction. It was possible that the reason for sunn hemp not seeding here was due to insect pests or soil and climatic conditions.

The VICE-PRESIDENT said that very little seed had so far been collected at the Experiment Station. He had noticed, however, that sunn hemp planted in February, although not growing nearly so well as that planted in November, did form some seeds. It was also possible that better results might be obtained further inland.

Mr. FOWLIE said that some ten years ago he saw a plot of sunn hemp that set quite a lot of seed. It had been suggested that there were different strains of sunn hemp and that some strains seeded much more freely than others.

Mr. POUQUET wanted to know whether adding lime to a field before an application of fertilizer would not avoid fixation of plant-foods. He also wanted to know what fertilizer elements were to be found in bagasse ashes.

Mr. DODDS said that the fixation of phosphate was a difficult and obscure problem. Superphosphate was water soluble, but on application to the soil the phosphate soon became fixed and hardly any further movement took place. Ashes were poor in fertilizer elements and were not usually in available form. Ashes had been used for composting in certain countries, however.

Mr. Dodds stated, in reply to further questions, that generally the most profitable quantity of nitrogen to apply was about 80 lbs. per acre, i.e., 400 lbs. sulphate of ammonia or 500 lbs. nitrate of soda. Under present circumstances he would advise a little less, say 300 lbs. and 400 lbs. respectively.

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