CO-OPERATIVE FIELD EXPERIMENTS WITH FERTILIZERS FOR SUGAR CANE ON THE ANDREWS ESTATE, EMPANGENI.

PART I.

By H. H. DODDS and P. FOWLIE.

Mr. H. H. DODDS read the following paper on the above subject:—

As with almost all other agricultural experiment stations, co-operative field experiments form an important part of the work of the Natal Sugar Experiment Station.

The types of soil at the experiment station, as would be the case at any one site, form only a small proportion of the very variable types and conditions to be found growing considerable areas of cane in the sugar belt.

Experiments have therefore been established on private estates in co-operation with the occupiers where certain typical soils were well represented, and where other circumstances appeared favourable for the carrying on of such experiments.

This co-operative work requires special keenness and intelligence on the part of the planter providing the land, as well as thoroughness and perseverance to carry out the experiments properly to their conclusion. The land as well as being thoroughly representative of an important type of soil should be as uniform as possible in order that adjacent blocks of cane under different treatments should be comparable; it should also be reasonably convenient of access for the periodical visits from the experiment station staff or from interested fellow planters.

It is also necessary that the cane should be transportable to the mill in small tramway units and not direct by S.A.R. (Government railways), so that the cane from small plots can be weighed separately and accurately. This implies also the effective co-operation of the factory both in the weighing and if possible in the analysis of the different cane lots.

These conditions are not easy to fulfil simultaneously and several series of co-operative field experiments have been begun only to be abandoned for one reason or another.

Furthermore, not nearly as many of these experiments have been established as the local industry needs owing to the general lack of financial resources at the disposal of the experiment station; so that many of our important soils and special agricultural conditions are still entirely without experiments to study their particular problems, and the experiment station staff are able to supply only the most general information regarding them.

Thus we have no field experiments as yet in those wind-blown sandy soils characteristic of many estates close to the sea, or the richer sandstone soils represented in the Umhlali district and elsewhere.

We have no experiments under irrigation, although this very important and increasing practice brings its own separate problems. There are also very few green manure or fallowing experiments, or experiments on methods of ratoon cultivation, and there are as yet no systematic comparative field trials of variety canes apart from those at the experiment station. There are, it is true, a number of very small quarantine plots in various districts, but none of these are large enough to give us reliable estimates of yields of other varieties of cane compared with Uba.

Those sugar producing countries which are among the most successful to-day, such as Java and Hawaii, have attained their pre-eminent position largely as a result of their scientific experimental work; and in these countries co-operative field experiments are numbered literally by the hundred. In fact, nearly all the larger estates in these countries maintain elaborate field experiments in close collaboration with the staff of their general experiment station.

We have obtained some specially interesting and instructive results in this country from our co-operative experiments on the Andrews Estate at Empangeni. Here we have very favourable conditions for experimental work in a uniform rich red loamy soil typical of a large area of sugar cane lands in Zululand.

It is centrally situated within two miles of Empangeni and easily accessible by road except in very wet weather; and in the genial person of the manager, Mr. F. V. Ebsworth, we have a very keen and capable curator of our experiments. Also one can count on the willing and efficient co-operation of the local factory of Zululand Sugar Millers & Planters, Ltd., and their field and laboratory staff, especially that of Mr. F. Hayes, chemist to the S.A. Cane Growers' Association, stationed at Empangeni. Unfortunately, the recent extension of the railway to pass near the Andrews Estate means that in future all cane will be transported in this way, so that this estate will no longer be suited for field experiment work.

Nitrogen Series of Experiments:

Our first experiment laid down here showed the remarkable response of this soil to fertilizer, even to the relatively unavailable raw rock phosphate, a response that was greatly enhanced by the application also of nitrogen whether in the inorganic form of ammonium sulphate or the organic form of blood meal. This response was shown not only to the plant cane crop, but also in large measure to the first and second ratoons without further applications of the fertilizer, the total profit from the fertilizer over the three crops being truly remarkable, as shown below.

Although this fertile soil will yield good crops without fertilizer at all, one of its principal assets is that it will show such a remarkable response to a moderate investment in fertilizer.

Composition of red loamy soil represented in experiments:—

Reaction to litmus	Very slightly acid.
Hydrogen ion concentration (pH)	6.0
Moisture in air dried soil	3.48%
(a) Loss on ignition	9.44%
(b) Total lime (CaO)	0.23%
(c) Total potash (K_2O)	0.13%
(d) Total phosphate (P_2O_5)	0.07%
Sulphate (SO_3)	0.039% (surface)
"	0.035% (subsoil)
Chloride (Cl.)	0.019% (surface)
"	0.018% (subsoil)
Including:—	
(a) Nitrogen	0.15%
(b) Free lime (as carbonate)	0.006%
(c) Available potash (K_2O) soluble in 1% citric acid	0.024%
(d) Available phosphate (P_2O_5) soluble in 1% citric acid	0.001%
Water capacity	37.6%
Capillarity (rise in 24 hours)	300 mm.

The field was divided into 16 small areas of 40 feet x 50 feet each, every alternate one being maintained as a control without fertilizer and the others treated with Egyptian raw rock phosphate at the rate of 350 lbs. per acre at the time of planting with cane. In the light of further experience it seems probable that this dressing of phosphatic fertilizer could be materially increased with advantage in this highly phosphorus deficient soil. Two sections were also treated with ammonium sulphate at the rate of 250 lbs. per acre and two with blood meal at 500 lbs. per acre at the time of planting of cane. Another two sections were treated with a like quantity of ammonium sulphate but as a top dressing three months after planting. Each dressing of nitrogenous fertilizer corresponds to 50 lbs. of nitrogen per acre.

The field was planted with Uba cane in December, 1924, and harvested thereafter every two years.

There were abundant and well distributed rains for some months after the original planting, a most important factor in the light of further experiments.

PLANT CANE RESULTS—HARVESTED DECEMBER, 1926.

Treatment.	Yield in tons cane per acre.	Standard deviation from mean.	Standard experimental error.	Gain per acre over control in tons.	Gain per cent.	Cost of fertilizer per acre.	Value of increase per acre at 15/- per ton of cane.
Control, no fertilizer	19.54	2.24	0.79	—	—	—	—
Rock phosphate only	28.28	0.04	0.03	8.74	44.6	15/-	£6/11/1
Rock phosphate with ammonium sulphate as top dressing	30.64	1.36	0.96	11.10	56.8	45/-	£10/1/4
Rock phosphate with ammonium sulphate at time of planting	32.96	1.22	0.86	13.42	68.6	45/-	£8/6/6
Rock phosphate and blood meal	33.34	2.04	1.44	13.80	70.6	62/6	£10/7/-

CHEMICAL ANALYSIS.

	Brix.	Pol.	Purity.	Glucose.	Fibre.	Sucrose % cane.
Control	19.6	18.05	92.09	0.20	14.88	14.13
Rock phosphate only	19.8	18.34	92.62	0.17	—	14.36
Rock phosphate and ammonium sulphate	19.8	18.28	92.32	0.18	14.74	14.31
Rock phosphate and blood meal	19.6	18.05	92.09	0.17	—	14.13

FIRST RATOONS—HARVESTED AUGUST, 1928.

Treatment.	Yield of cane in tons per acre.	Standard deviation from mean.	Standard experimental error.	Gain per acre over control in tons.	Gain per cent.
Control, no fertilizer	33.46	1.95	0.69	—	—
Rock phosphate only	40.04	1.56	1.10	6.58	19.67
Rock phosphate with ammonium sulphate as top dressing	40.06	2.37	1.68	6.60	19.73
Rock phosphate with ammonium sulphate at time of planting	43.98	0.48	0.34	10.52	31.44
Rock phosphate and blood meal	41.22	0.45	0.32	7.76	23.19

	Pol. (sucrose) per cent. cane.	Purity.	Sucrose in tons per acre adjusted for purity bonus.	Increase per acre over control.	Value of increase at £6/3/6 per ton of sucrose.
Control, no fertilizer	15.08	92.8	5.247	—	—
Rock phosphate only	15.20	92.6	6.358	1.111	£6/17/2
Rock phosphate with ammonium sulphate as top dressing	15.20	92.8	6.362	1.115	6/17/8
Rock phosphate with ammonium sulphate at time of planting	15.18	92.0	6.896	1.649	10/3/8
Rock phosphate and blood meal	15.40	92.6	6.595	1.348	8/6/8

SECOND RATOONS—HARVESTED AUGUST, 1930.

Treatment.	Yield of cane in tons per acre.	Pol. (sucrose) per cent. cane.	Purity.	Sucrose per cent. cane adjusted for purity bonus.	Tons sucrose per acre adjusted for purity bonus.	Increase over controls in tons adjusted sucrose per acre.	Value of increase at £5.2122 per ton of sucrose.
Control, no fertilizer	32.01	14.4	91.7	14.87	4.76	—	—
Rock phosphate only	33.56	15.2	91.9	15.69	5.27	0.51	£2/13/2
Rock phosphate with ammonium sulphate as top dressing	35.62	14.9	92.4	15.44	5.50	0.74	£3/17/2
Rock phosphate with ammonium sulphate at time of planting	37.94	14.6	89.9	14.78	5.61	0.85	£4/8/7
Rock phosphate and blood meal	37.25	15.0	91.6	15.46	5.76	1.00	£5/4/3

Note.—Owing to the exigencies of the harvesting on a commercial estate it was found impracticable to weigh the cane from each plot individually, but only to group them for weighing according to treatment. Consequently it is impossible to work out the experimental error in the second ratoon crop, but this has always been found to be relatively low in other instances in experiments on this estate.

VALUE OF YIELD INCREASE OVER THREE CROPS.

	Rock phosphate only.	Rock phosphate and ammonium sulphate as top dressing.	Rock phosphate and ammonium sulphate at time of planting.	Rock phosphate and bloodmeal.
Plant cane	£6 11 1	£8 6 6	£10 1 4	£10 7 0
First ratoons	6 17 2	6 17 8	10 3 8	8 6 8
Second ratoons	2 13 2	3 17 2	4 8 7	5 4 3
Total	£16 1 5	19 1 4	24 13 7	23 17 9
Less cost of Fertilizer	0 15 0	2 5 0	2 5 0	3 2 6
	£15 6 5	£16 16 4	£22 8 7	£20 15 3

It is certainly remarkable that at the second ratoon cutting there should still be a marked benefit from the fertilizer applied six years previously, after two heavy crops have each with considerable increase due to the fertilizer already been attained.

This fertile soil, rich in organic matter and of high moisture holding capacity, can evidently rapidly assimilate an insoluble material like raw rock phosphate in a way that is impossible in the light sandy soils or in the far less fertile clay loams of the experiment station. It can also utilise ammonium sulphate apparently without the toxic effects that may take place in more acid soils.

The profit on the small outlay in fertilizer is remarkable. As one of us remarked at a field day at the experiment station when these results were discussed, we can only suggest one more profitable kind of investment for the sugar planter, and that is money spent on experiment station work.

Phosphate Series of Experiments:

Although the results from a very moderate dressing of raw rock phosphate were sufficiently remarkable, it was decided to investigate whether some other form of phosphatic fertilizer would not prove even more profitable.

In a field adjoining the first one, in what appeared to be exactly similar soil, we planted therefore in March, 1927, a series of experiments in which we compared the effects of 500 lbs. of superphosphate, 300 lbs. of raw Egyptian rock phosphate, 410 lbs. of bone dust, 470 lbs. basic slag, 375 lbs. of equal portions of superphosphate and rock phosphate, and 450 lbs. of equal portions of superphosphate and bone dust. The quantity of each was calculated to supply the same ration, 90 lbs. of phosphorus as P_2O_5, but in different forms. Each series was in triplicate planted with Uba cane in equal similar plots of 1/10th acre each.

The cane was harvested in November, 1929. The results of the plant cane cutting were announced at a planters' field day held at the Experiment Station at Mount Edgecombe in January, 1930, and published in the "South African Sugar Journal" for that month, so that we do not propose to give details here, except an outline of the final results.

Fertilizer treatment.	Lbs. per acre applied.	Yield of cane in tons per acre.	Profit from increased yield per acre over controls with sucrose at £5.385 per ton.
Nil—control	—	30.78	——
Superphosphate only ..	500	43.94	£8 14 5
Basic slag only ..	470	43.78	8 4 1
Bone dust and superphosphate	450	43.42	7 19 5
Bone dust only ..	410	44.92	7 12 9
Rock phosphate and superphosphate ..	375	41.46	6 8 9
Rock phosphate only ..	300	37.50	4 18 5

It will be seen that although bone dust gives the biggest yield, it is not sufficient to pay for the extra cost of the fertilizer when compared with the results from the cheaper superphosphate. This is in accordance with all our experiments to date whether plant cane or first ratoons. So that even in this soil where the insoluble forms of phosphate have their best chance, superphosphate takes the lead in the plant cane crop at least.

They will be due for harvesting again as first ratoons during the coming season, and it is hoped that suitable transport arrangements can be made to continue the experiment, notwithstanding the change in method of cane transport on this estate to which we have already referred.

This experiment dealt with phosphates only, no other fertilizer element being added, except of course the nitrogen included in the bone dust, which was allowed as a "bonsella" to those plots over and above their standard ration of phosphorus.

The question naturally arises, having shown that that superphosphate is the best form of phosphatic fertilizer to apply, under the conditions of this experiment at least, what is the most economical quantity to apply?

We have taken in our experiments hitherto 500 lbs. of superphosphate, a sort of medium dressing that has been sanctioned by custom, but not necessarily justified by fact.

In a series of experiments planted in February of 1930, therefore, we have varied the dressing of superphosphate from nil up to 1,000 lbs. per acre through 250 lbs., 500 lbs. and 750 lbs., while maintaining a basic dressing throughout of 200 lbs. of ammonium sulphate and 100 lbs. of potassium chloride per acre.

We will thus be able to test the claim made recently by Sir Frederick Keeble that the quantities of phosphatic fertilizer in particular usually applied were far too small in our phosphorus deficient soil.

Nitrate Nitrogen v. Ammoniacal Nitrogen:

Having shown that, in favourable seasons at least, there is an excellent response to nitrogen in a soil of the Andrews' Estate, whether as ammonium sulphate or blood meal, unto the first and second ratoon crops, it was next considered advisable to compare the results from nitrate nitrogen in the form of sodium nitrate, or nitrate of soda, as it is commonly and incorrectly called, with those from ammoniacal nitrogen in the form of ammonium sulphate or sulphate of ammonia, as it is commonly and incorrectly called.

The experiment was laid down in a deep red loam that had been broken up from typical thornbush veld about a year previously. The soil was apparently very similar in character to that in which the experiments already mentioned were carried out and was to all appearances uniform. There has not been as yet opportunity to carry out a chemical or mechanical analysis of this soil.

The plots each consist of five cane lines, 5 feet apart and 178 feet long, that is 1/10th acre each in area. There is an unfertilized dividing line between every two plots which is not included in the experiment.

The treatments were as follow:—

C.—Control—no fertilizer.
P.—Superphosphate only, 500 lbs. per acre.
PN1—Superphosphate 500 lbs., ammonium sulphate 245 lbs. per acre.
PN2—Superphosphate 500 lbs., sodium nitrate 320 lbs. per acre.

Each plot was in quadruplicate and was planted with Uba cane in December, 1928.

The soil at time of planting and for some weeks afterwards was noticed to be unusually dry for the season of the year.

All the fertilizers were placed in the furrow at the time of planting.

The cane was harvested in December, 1930, with the following results:—

AMMONIUM SULPHATE V. SODIUM NITRATE EXPERIMENT—PLANT CANE RESULT.

Treatment.	Yield in tons cane per acre.	Pol (sucrose) per cent. cane.	Purity.	Tons Pol (sucrose) per acre.	Increase in tons sucrose over control.
Control	49.08	13.4	89.6	6.64*	—
Superphosphate only	59.02	13.1	88.1	7.73	1.09
Superphosphate & ammonium sulphate	60.21	12.5	88.0	7.53	0.89
Superphosphate & sodium nitrate	61.35	12.7	87.5	7.79	1.15

*Adjusted for purity bonus according to Fahey scale.

Value of sucrose increase per acre at £4.936 per ton of Sucrose.

	P.	PN_1.	PN_2.
Value of increase ..	£5 7 7	£4 7 10	£5 13 6
Less cost of fertilizer	1 0 0	3 1 0	2 8 0
	£4 7 7	£1 6 10	£2 15 6

Unfortunately it was not found practicable to weigh the cane from each plot separately, so that the four plots of each treatment had to be pooled for weighing and analysis; consequently it is impossible to calculate the experimental error of the series.

It is manifest, however, that we get the usual great benefit from the application of the superphosphate alone, but in this case the slight extra advantage in yield of cane from the addition of nitrogenous fertilizer can hardly be considered to be beyond the probable experimental error of the series. In any case, there is found a considerable fall in sucrose content where the nitrogen has been applied, more than sufficient to wipe out any indicated advantage in cane yield.

This result, a falling off in sucrose content of cane is frequently found in Louisiana and other cane-growing countries as a consequence of applying nitrogenous fertilizer in somewhat heavy dressings such as these. It is in Louisiana usually attributed to a delay in maturity, but this is hardly very likely to be the case here with cane that has been in the ground two years and cut as late as December.

Nevertheless, it may have been so, and that this cane in view of its incompleted maturity began to grow again earlier in the season than the more matured cane, might account for its lower sucrose content at the time of the test.

Unfortunately there is not sufficient analytical evidence available to clear up this point.

At all events, there was evidently no decided increase in yield from the application of the nitrogenous fertilizer, such as there was in the first series of experiments.

This may be attributed perhaps to the fact that the soil in this case was virgin soil containing an immediate sufficiency of nitrogen in available form, whereas in the first series the land had already carried one cycle of plant cane crop and four ratoons so that the immediately available original nitrogen might possibly have been consumed and insufficiently replenished in the soil.

Or it may be, as seems most probable in the light of further experiments, that the unusually dry weather during the planting of this experiment prejudiced in some way the possible benefit from the nitrogenous fertilizer. All the fertilizer was applied at the time of planting which we have shown is the best practice for ammonium sulphate at least in this type of soil; but it may be that the sodium nitrate would have had better effect if applied as a top dressing some weeks later.

The upshot of this is that one can hardly go wrong in applying superphosphate, or in fact almost any kind of phosphatic fertilizer in this kind of soil, but that the results from nitrogen are not so assured which requires to be applied with discrimination, and that further experiments are required to establish the best methods of application under local conditions. It seems probable that abundant moisture must be present in the soil in the early period of growth to get a response from nitrogenous fertilizer.

It should be pointed out that the cost of fertilizer materials is based on the current retail price during the season in which it was applied, and that prices of many fertilizer materials have come down considerably within the last year or two.

Potash Series:

We have shown that there is apparently always a response to phosphatic fertilizer of any ordinary commercial kind, but particularly to superphosphate, in this soil, and evidently to nitrogen under certain conditions whether in inorganic or organic form, but not under all conditions, supply of moisture being probably the critical factor in the assimilation of nitrogenous fertilizer.

There remains to be discussed the effect of the other principal fertilizer element, potassium.

A field was selected within 800 yards of the first two series of experiments in the same type of soil, a red loam of great depth and very uniform in texture.

It should be remembered that the analysis of this soil taken at the first site showed a considerable proportion of potash present in an available form (0.024 per cent. K_2O soluble in 1 per cent. citric acid) so that no deficiency of potash was indicated.

The following fertilizer treatments were decided upon:—

C.—Control—no fertilizer.

P.—Basic mixture of 200 lbs. per acre of superphosphate and 200 lbs. of raw Egyptian rock phosphate, used as source of phosphorus in this series.

PN.—400 lbs. of phosphates as above and 200 lbs. per acre of ammonium sulphate.

PNK1.—400 lbs. phosphates, and 200 lbs. ammonium sulphate as above, plus 60 lbs. per acre of potassium sulphate.

PN2K1.—400 lbs. phosphates, 200 lbs. ammonium sulphate and 120 lbs. per acre of potassium sulphate.

PNK2.—400 lbs. phosphates, 200 lbs. ammonium sulphate and 50 lbs. per acre of potassium chloride (muriate).

PN2K2.—400 lbs. phosphates, 200 lbs. ammonium sulphate and 100 lbs. per acre of potassium chloride (muriate).

Each treatment was in quadruplicate, except for PN, which was replicated eight times.

The plots were of 1/15th acre, each consisting of five lines 5 feet apart and 116 feet in length.

There was one division line between every two plots not included in the experiment and treated with fertilizer according to the PN formula, except those adjoining control plots which were left without fertilizer.

The field was planted with Uba cane in January, 1928, and harvested in June, 1930.

Following are the harvesting results:—

Treatment.	Tons cane per acre.	Pol (sucrose) per cent. cane.	Purity of Juice.	Tons sucrose per acre.	Standard deviation from mean.	Standard experimental error.	Increase in tons sucrose over controls.
C	44.14	13.3	88.6	5.89	0.595	0.298	—
P	52.67	13.4	88.5	7.04	0.051	0.026	1.15
PN	50.34	13.3	88.6	6.68	0.328	0.115	0.79
PNK_1	51.19	13.1	88.4	6.72	0.303	0.152	0.83
PN_2K_1	51.01	13.1	88.4	6.69	0.563	0.282	0.80
PNK_2	51.69	13.2	88.1	6.85	0.767	0.384	0.96
PN_2K_2	51.00	13.2	88.4	6.80	0.375	0.188	0.91

Value of Increase over Controls at £5.1907 per ton for Sucrose—Plant Cane only.

	P.	PN.	PNK_1.	PN_2K_1.	PNK_2.	PN_2K_2.
Value of increase	£6 15 10	£4 13 4	£4 6 2	£4 3 6	£4 19 8	£4 14 6
Less cost of fertilizer ..	0 15 6	2 9 0	2 17 3	3 5 6	2 15 4	3 1 8
..	£6 0 4	£2 4 4	£1 8 11	£0 18 0	£2 4 4	£1 12 10

It will be seen that in this series also we get a marked benefit from the phosphatic fertilizer, but for the rest the yield is depressed rather than increased by the use of ammonium sulphate, and not appreciably increased again by the application of potassic fertilizer, whether a light or a heavy dressing, or the chloride or sulphate.

In fact according to this evidence the application of ammonium sulphate and the chloride or sulphate of potash may go far towards wiping out the profit shown by the phosphate.

Further, there is no evidence of any increase in sucrose content of the cane as a result of the application of the fertilizer, but simply a substantial increase in tons of sugar per acre from the increase in yield of cane from a phosphatic fertilizer.

Here again the cane was planted very late in the season and followed by an unusually dry period, which no doubt helps to account for the lack of response to the nitrogenous fertilizer.

One may say, therefore, that in the soil represented in these experiments at the Andrews Estate, Empangeni, that the application of superphosphate in dressings of 500 lbs. per acre or more will be very beneficial; and that the application of ammonium sulphate should only be made when planting in a moist soil during rainy weather. Apparently potassic fertilizer is not required in this soil, though there may be a sufficient response to potash when planting in rainy weather.

When we began to write up this paper, it was intended to include all the co-operative field experiments we had in progress. But after describing those of our most northerly co-operative field station, at Empangeni, we found we had already compiled a paper as long as the most patient hearer could be expected to sit out, as well as having taken up as much of our own time as could well be spared at present in writing it up.

Consequently we propose to give no detailed account in the present paper of the work of our other co-operative field stations.

We have, however, experiments on similar lines to those described in progress at Umhlatuzi (F. Piccione), Chaka's Kraal (C. J. Rapson), and Umzinto (E. J. Smith). Besides these, instructive experiments have been completed at Inyoni (Perks & Morris) and Tongaat (Egolomi Sugar Co.).

These experiments serve to illustrate the wide diversity of our sugar cane soils and their different fertilizer requirements. We have found a phenomenal response to suitable fertilizer treatment in a light sandy soil at Chaka's Kraal where the yield of cane per acre was increased from 12 tons to 35½ tons solely by the use of fertilizer. We find that while some soils appear to require phosphatic fertilizer only, others require a complete mixture including both nitrogen and potash, and very much more experimental work requires to be done before anything like systematic conclusions may be drawn for the varied conditions existing in our sugar cane agriculture.

Agricultural experiment in our South African sugar industry is as yet virtually a virgin field, with almost unlimited scope for useful work.

Natal Sugar Experiment Station,
South African Sugar Association,
Mount Edgecombe,
Natal.

March, 1931.

CO-OPERATIVE FIELD EXPERIMENTS WITH FERTILIZERS FOR SUGAR CANE AT UMZINTO, CHAKA'S KRAAL AND UMHLATUZI

PART II.

By H. H. DODDS and P. FOWLIE.

1. Fertilizer Experiments on the Estate of E. J. Smith, Umzinto:

This experiment was planted in a deep black loam representative of the good soils of the Umzinto area; it had been recently cleared of East Coast bush and was on a gentle slope near the foot of a small valley.

No analysis of the soil has yet been made, but it would appear to be characteristic of those derived from the granitic and metamorphic rocks of the lower South Coast.

The plots were 1/16th acre each, consisting of six lines of 5ft. 6in. apart and 27 yards long. There are no division lines between the plots but drains two feet wide bound the ends of each plot.

They were planted with Uba cane on January 9th, 1929, the following fertilizer treatments being compared; there were four replications of each separate treatment, or 20 plots in all.

C.—Controls—no fertilizer.

S.—Superphosphate only, 500 lbs. per acre.

SB.—Superphosphate and bone meal, 225 lbs. of each per acre.

SK.—Superphosphate, 500 lbs., and potassium chloride (muriate of potash), 75 lbs. per acre.

SA.—Superphosphate, 500 lbs., and ammonium sulphate, 250 lbs. per acre.

Almost as soon as the cane appeared above the ground there were very striking differences between the controls without fertilizer and all of the fertilized plots, the superiority of the latter being very evident at all stages of growth.

The field was harvested in September, 1930, with the following results:—

	Average yield of cane per acre in tons.	Standard deviation from mean.	Standard experimental error.	Gain per acre over control in tons.	Gain per cent.
Control—no fertilizer	33.30	5.94	2.97	—	—
S.—Superphosphate only	43.00	6.30	3.15	9.70	29.1
SB.—Superphosphate and bonemeal	44.16	4.22	2.11	10.86	32.6
SK.—Superphosphate and potash	42.12	3.96	1.98	8.82	26.5
SA.—Superphosphate and sulphate of ammonia	42.47	5.68	2.84	9.17	27.5

Unfortunately under the conditions of the harvesting it was not possible to do more than take the weights of cane from each separate plot, and not a separate analysis of the cane. The average sucrose of the whole, however, was 13.20 per cent. of cane and the value of sucrose for that month was £4.936 per ton.

If we assume the same composition of cane from each plot, and it is only in exceptional cases that we have found any material difference in sucrose content as a result of the fertilizer, we find the following:—

	Control.	Superphosphate only.	Super and bone.	Super and potash.	Super and ammonium sulphate.
Tons pol (sucrose) per acre	4.395	5.676	5.829	5.560	5.606
Value of £4.936 per ton for sucrose	£21 13 10	£28 0 4	£28 15 5	£27 8 11	£27 13 5
Increase over control	—	6 6 6	7 1 7	5 15 1	5 19 7
Less cost of fertilizer	—	1 0 0	1 8 8	1 9 7	3 2 0
Gross profit	—	£5 6 6	£5 12 11	£4 5 6	£2 17 7

This gross profit does not take into account the extra cost of harvesting the increased cane, the cost of transport and handling of the fertilizer, the interest on the investment in the fertilizer, or the like.

These factors vary enormously in different plantations and it is very difficult to say about what the average should be.

The gross results are sufficient, however, to show the great benefit from the applications of superphosphate in this soil, as is found to be the case almost everywhere in this country.

It is of special interest to note that there is apparently an increased yield and increased profit from replacing the superphosphate by an equivalent mixture of bone dust and superphosphate in equal proportions.

This is the first time we have found this in any experiment either at Mount Edgecombe or anywhere else, and even here the difference in favour of the admixture of bone cannot be regarded as significant in view of the considerable experimental error calculated from the variation in yield of the four plots of each treatment. In any case, after deducting the cost of harvesting the increased cane any difference would be inconsiderable.

However, in view of the fact that these are the results from the plant cane crop only, it will be of special interest to see whether the bone and superphosphate mixture can show an undeniable superiority in the ratoon crops.

Although we have shown that the benefits from superphosphate are much more prolonged than is sometimes supposed, there is no doubt that an insoluble substance like bone even when finely ground is only slowly available in the soil and may consequently be expected to confer, relatively to the plant cane crop, greater residual benefits to the ratoon crops than superphosphate.

As the matter stands therefore this is an instance, the only one we have hitherto found, where the extra cost of the bone admixture may be justified.

The experiments further appear to indicate that the addition of potash as the chloride, or of nitrogen as ammonium sulphate, in this particular soil, actually depresses the increased yield from the superphosphate as well as materially reducing the profit.

Although the latter is no doubt the case however, and the addition of potassium chloride or ammonium sulphate to superphosphate does not pay under the conditions of this experiment, a word of warning is necessary against accepting the apparent decrease in yield in these cases as a proved fact.

The relatively large experimental error involved is greater than the difference between the plots having superphosphate only and those with superphosphate and other fertilizer. We are therefore only justified in deducing that the addition of the other fertilizer ingredients to the superphosphate does not apparently result in a further increase in yield; but not in saying that they would on the average diminish the increase due to the superphosphate, as they appear to do in this particular instance.

These are the first results we have had from an experiment in this district and type of soil, and need to be repeated in different seasons. We have shown at Empangeni, for example, that the response to ammonium sulphate at least may vary considerably, showing a good profit in wet seasons but not in a dry one.

Experiments will need to be continued over many years, both with plant and ratoon crops, and probably soon with other varieties than Uba, to arrive at anything like a comprehensive knowledge of fertilizer requirements for sugar cane in this area.

Summary and Conclusions:

A fertilizer trial with Uba cane in a deep loam near Umzinto showed a substantial increase in yield on the plant cane crop from the application of 500 lbs. per acre of superphosphate or 450 lbs. per acre of a phosphate equivalent mixture of superphosphate and bone dust in equal proportions. This increase was not enhanced by the addition of 75 lbs. per acre of potassium chloride, or of 250 lbs. per acre of ammonium sulphate.

Thanks are due to Mr. E. J. Smith, of Umzinto, for kindly supplying the site for this experiment, taking full charge of it after planting, and harvesting and weighing the cane yields without further assistance from us.

2. Fertilizer Experiment on Hillhead Estate (C. J. Rapson), Chaka's Kraal.

This series is in a very light sandy soil typical of a considerable area under cane. It was virgin veld, having been ploughed for the first time a few months before planting.

It was planted with Uba cane on December 4th, 1928, and divided into plots of 1/10th acre each consisting of eight lines 4ft. 6in. apart and 40 yards in length.

The following fertilizer treatments were made, there being four replications of each treatment, all the fertilizer being applied at time of planting:—

C.—Control—no fertilizer.
P.—Superphosphate only 500 lbs. per acre.

PK.—Superphosphate 500 lbs., potassium chloride (muriate of potash) 75 lbs. per acre.

PKN1.—Superphosphate 500 lbs., potassium chloride 75 lbs., ammonium sulphate 200 lbs. per acre.

PKN2.—Superphosphate 500 lbs., potassium chloride 75 lbs., sodium nitrate 250 lbs. per acre.

PKN3.—Superphosphate 500 lbs., potassium chloride 75 lbs., whale guano 330 lbs. per acre.

The dressings of nitrogenous fertilizer were calculated to give the same quantity, 40 lbs. of nitrogen in each case.

The cane was harvested on December 1st, 1930, with the following results:—

	Tons cane per acre.	Standard deviation from mean.	Standard experimental error.	Increase over control in tons of cane.	Gain per cent.
Control—no fertilizer	12.075	3.530	1.765	—	—
Superphosphate only	28.00	2.938	1.469	15.925	131.9
Superphosphate and potassium chloride ...	31.40	1.930	0.965	19.325	160.0
Superphosphate and potassium chloride and ammonium sulphate	25.94	5.995	2.998	13.865	114.8
Superphosphate, potassium chloride and sodium nitrate	32.725	5.685	2.842	20.650	171.0
Superphosphate, potassium chloride and whale guano	35.49	1.902	0.951	23.415	193.9

The results show a phenomenal response to the phosphatic fertilizer which is increased by the addition of potash.

Apparently there is a depression of yield from the addition of ammonium sulphate and a slight further increase from sodium nitrate. Having regard, however, to the large experimental error associated with this type of soil and exhibited particularly in the ammonium sulphate plots, we are not justified in attaching any significance to these fluctuations, but only to infer that there is no evident response to either of the two forms of inorganic nitrogen.

We have, however, a further material advance in yield where organic nitrogen has been supplied in the form of whale guano in which series the yield is nearly three times that of the controls.

Unfortunately the sucrose contents of the canes are not available, but the mean sucrose content for the November/December period of the cane received at the factory to which the cane was sent was 13.46 per cent.

If we take this as a standard and £4.935 as the value of sucrose per ton the gross profit is as follows:—

Value of Increased Yield over Controls.

Plant Cane Crop Only.

	Superphosphate only.	Superphosphate and potash.	Super, potash and ammonium sulphate.	Super, potash and sodium nitrate.	Super, potash and whale guano.
Value of increase...	£10 11 7	£12 16 9	£9 4 2	£13 14 4	£15 11 7
Less cost of fertilizer	1 0 0	1 9 7	3 4 2	3 7 1	3 15 9
Gross profit ...	£9 11 7	£11 7 2	£6 0 0	£10 7 3	£11 15 10

Even without taking into account the cost of harvesting the increased yield of cane and the cost of application, etc., of the fertilizer, it is evident that there is a very substantial profit from the use of superphosphate in this soil which is considerably enhanced by the addition of potash in the form of the chloride, and still further by the addition also of organic nitrogen as whale guano.

These results are for the plant cane crop only, and to judge by general experience elsewhere there will be further residual benefits from the fertilizers; these will be determined in due course.

The costs of the fertilizer are those calculated from the retail prices prevailing when these experiments were planted, since then most fertilizer materials have come down considerably in price.

Summary and Conclusions:

A fertilizer trial with Uba cane in a very light sandy virgin soil at Chaka's Kraal showed a very substantial increase in yield on the plant cane crop from the application of 500 lbs. per acre of superphosphate.

This increase was considerably increased by the addition of 75 lbs. per acre of potassium chloride and still further increased by the addition of 300 lbs. per acre of whale guano.

The application of 200 lbs. per acre of ammonium sulphate or of 250 lbs. per acre of sodium nitrate instead of the organic nitrogenous fertilizer did not appear to increase the yield materially or profitably.

Thanks are due to Mr. C. J. Rapson, of Chaka's Kraal, for kindly taking charge of this experiment on his property and showing the keenest interest in it.

3. Fertilizer Experiment at Umhlatuzi (F. Piccione).

This experiment is in a typical Zululand alluvial soil of the more sandy type. It is probably of mixed origin, the Umhlatuzi River draining many varied formations both sandstone and granites as well as Ecca shales and conglomerates. The presence of small micaceous particles is very characteristic of this soil.

This alluvial sand is of considerable depth as the following analyses carried out at the Experiment Station show:—

A.—Surface soil, down to 12ins.
B.—Subsoil, between 12 and 24ins. from surface.
C.—Subsoil, between 24 and 36ins. from surface.

1.—Mechanical Analysis.

	A.	B.	C.
Stones	Nil	3	5
Gravel	Nil	11.8	10.0
Coarse sand	3.7	3.25	60.9
Fine sand	50.7	37.6	24.5
Silt	19.5	6.5	1.0
Fine silt	23.2	7.0	0.5
Clay	2.0	1.6	0.0

Results expressed as per cent. of total.

2.—Chemical Analysis.

	A. Per cent.	B. Per cent.	C. Per cent.
Hygroscopic moisture	3.2	1.2	0.29
Loss on ignition	6.4	2.9	0.63
Total phosphorus (as P_2O_5)	0.076	0.062	0.033
Total potash (as K_2O)			
Containing:—			
Nitrogen	0.13	0.078	0.025
Available phosphate (P_2O_5 soluble in 1% citric acid)	0.016	0.022	0,020
Available potash (K_2O soluble in 1% citric acid	0.020	0.010	0.010
Chloride	0.0044	0.0025	0.0016
Sulphate	0.047	0.030	0.019
Acidity (requirement of $CaCO_3$ to neutralize)	0.19	0.16	0.10
Hydrogen ion concentration (pH)	6.2	6.1	5.6

Although the total reserves of plant food are not very great, the proportion available is unusually high, showing that the soil is in a very fertile condition, both chemically and physically.

The above analysis is not from soil actually taken from the field where the experiment to be described was actually carried out, but may be considered as generally indicative of the soil of this area.

The particular soil under this experiment has not as yet been analysed, but in general it may be said to resemble the other except that it is a little darker in colour and presumably rather better supplied with organic matter.

The field is about 200 yards from the river and the water table is normally within three feet of the surface so that lack of moisture is not ordinarily a limiting factor. The land is also liable to occasional inundations from the river which usually leave a further deposit of rich silt thus replenishing the plant food in the surface soil.

The experiment was planted with Uba cane on February 4th, 1929, the fertilizer having been applied in the drills two days previously.

Each plot was 1/10th acre in area comprising 4 rows 6ft. apart and 60½ yards in length.

The following fertilizer treatments were applied, there being four replications of each treatment, excepting the controls of which there were five:—

Control—no fertilizer.
Superphosphate, 500 lbs. per acre.
Superphosphate, 500 lbs. and ammonium sulphate 250 lbs. per acre.
Superphosphate, 500 lbs. and sodium nitrate 320 lbs. per acre.

The cane was harvested on September 18th, 1930, with the following results:—

	Tons cane per acre.	Standard deviation from mean.	Standard experimental error.	Increase over control in tons of cane.	Per cent. increase.
Control—no fertilizer	38.89	6.855	3.066	—	—
Superphosphate only, 500 lbs. per acre ...	41.47	6.84	3.42	2.58	6.63
Superphosphate 500 lbs. + ammonium sulphate 250 lbs. per acre	43.50	3.88	1.94	4.61	11.85
Superphosphate 500 lbs. + 320 lbs. sodium nitrate per acre	44.22	4.44	2.22	5.33	13.70

	Pol (sucrose) per cane.	Purity of juice.	Tons sucrose per acre.	Increase of control in tons.	Per cent. increase.
Control—no fertilizer	12.14	88.6	4.721	—	—
Superphosphate only	12.00	88.5	4.976	0.255	5.40
Superphosphate and ammonium sulphate ...	11.83	87.3	5.146	0.425	9.00
Superphosphate and sodium nitrate	11.83	87.3	5.231	0.510	10.80

Value of Increased Yield over Controls at £4.936 per ton for Sucrose—Plant Cane only.

	Superphosphate only.	Superphosphate and ammonium sulphate.	Superphosphate and sodium nitrate.
Value of increase	£1 5 0	£2 2 0	£2 10 4
Less cost of fertilizer	1 0 0	3 2 0	3 8 0
Gross profit	£0 5 2	£1 0 0 loss	£0 17 8 loss

It is seen that although there is an apparent response to superphosphate it is much less than we usually find in our phosphorus deficient soils, and the gross profit shown over the cost of the fertilizer is so small that it would be wiped out by the cost of harvesting the increased yield of cane and the incidental costs of transporting and applying the fertilizer.

And although the increased yield appears to be enhanced by the addition of nitrogen whether in the form of ammonium sulphate or sodium nitrate, there is an actual loss when the cost of fertilizer is deducted owing to the relatively high price of nitrogenous fertilizer.

The costs taken for the fertilizer are the actual retail prices prevailing when the fertilizer was purchased in 1928, and fertilizer prices, especially that of ammonium sulphate, have come down considerably since then. But even if we use current prices as a basis there is still a substantial deficiency after deducting the net cost of the nitrogenous fertilizer.

However, these results apply only to the plant cane crop, and in view of the probable low reserves of total phosphorus in the soil, it may well be that the phosphatic fertilizer at least will show better results with later crops. Since the need for phosphatic fertilizer is not very immediate in view of the large proportion indicated as available, very possibly some cheaper and more slowly available source of phosphorus, such as powdered raw rock phosphate, may prove advantageous for later crops.

Further, only one quantity of each kind of fertilizer was put under trial, and it is possible that smaller or larger quantities would prove payable, or that the same quantities might in a different season.

The only valid conclusion we can draw from this experiment is the need for further experiments in this important class of soil, experiments to cover a wider scope of inquiry and embodying more than four replications of each treatment. It is evident in view of the large experimental error associated with experiments in this variable soil, and the relatively small effects that may be expected from ordinary fertilizer treatment, that eight or ten replications of each separate treatment are advisable to reduce the experimental error sufficiently below the mean differences obtained between various fertilizer treatments to give reliable results.

No tests were made with potassic fertilizer in this series, but it is not at all likely that potassium is a limiting factor in this class of soil in view of the relatively high content of available potash shown in chemical analyses and the indecisive results of earlier experiments in adjacent soils where potassic fertilizer was used.

The analyses of the cane in the above experiments show that there was a considerable fall in sucrose content of cane where nitrogenous fertilizer was applied. This was also found in some of our experiments at Empangeni and is a frequent result of the application of nitrogenous fertiliser generally in Louisiana and other places where conditions are not ordinarily conducive to the ripening of the cane. Under such circumstances maturing of the cane is likely to be further delayed by the general effect of the nitrogenous fertilizer. In the present instance, however, the depression of the sucrose content by the nitrogenous fertilizer is not very severe.

Summary and Conclusions:

Experiments in a recent sandy alluvial soil near the Umhlatuzi River showed a small response on the plant cane crop to superphosphate only, 500 lbs. per acre, a response that was somewhat increased by the addition of ammonium sulphate, 250 lbs., or sodium nitrate, 320 lbs. The results, however, cannot be regarded as significant in view of the relatively large experimental error, and in any case the increases were not profitable taking into account the cost of the fertilizer and working costs.

Further experiments are very desirable to determine the fertilizer requirements of this soil.

Thanks are due to Mr. F. Piccione for providing a site for this experiment and for his further co-operation in providing the necessary labour for the various field operations involved.

General Summary and Conclusions:

The three series of fertilizer experiments described herewith in three widely differing soils show the very varying soil requirements of these soils and the need for further experiment in all representative types of soil in the sugar belt.

In the rich heavy loam of the Umzinto experiments there is a very profitable response to phosphatic fertilizer but not apparently to potash or nitrogen in the plant cane crop from the particular forms applied.

At Chaka's Kraal in a very light sandy loam there is an even more generous response to fertilizer, and the need for a complete fertilizer is here indicated, including superphosphate, potash and organic nitrogen.

The response to fertilizer is much less definite in a fertile sandy alluvial at Umhlatuzi and the results of further experiments especially with ratoon crops will need to be studied before very definite conclusions may be drawn in this class of soil.

Experiment Station,
South African Sugar Association,
MOUNT EDGECOMBE.

April, 1931.

CHAIRMAN: This paper you have just heard represents only one of the many lines the Experiment Station has been investigating during the last few years. It has been said on several occasions by Planters who have not been in touch with the work there that very little is forthcoming from the Experiment Station, but that is hardly the case, as a great deal of work is being done both at the Station itself and these co-operative field experiments, and a great deal has been published. As Mr. Palairet said at our meeting last year, the Experiment Station has been hurling information at us; they evidently continue to hurl this information and there is a great deal here which is of very great interest to you all.

Mr. PALAIRET said he had been very strong on the phosphate question. Many people did not realise that a planter who uses heavy phosphatic fertiliser is helping his payments out very much. It was evident that there had been a very great deal of study in connection with this paper, and he knew Mr. Dodds and Mr. Fowlie were very careful of their accuracy. There were many planters to-day who wished cane in the mill was worth 15/–, but this year cane was only worth about 13/– in the mill. Planters had to get it to the mill, and if 5/– was allowed for cutting and getting it to the mill, it meant that cane in the field was not worth more than 8/– per ton, which halved the value of the increases mentioned in the paper. He thought it was rather a pity it has been put in this way as it was rather an important point, and while they had to watch every farthing they did not want to over-value the increases.

Mr. O. J. ASKEW said a point was: What was the particular value of a particular fertiliser, whether they got 8/– or 15/–? Practical farmers knew that they had to study their soils, and the kind of fertiliser to be used depended on the kind of soil. On one of the farms in which he was interested they had seven different kinds of fertiliser in an area of about 500 acres, and records were kept of every field. After considerable experiments they were now using on the bulk of that farm superphosphates or basic slag alone or with a little mixture of potash in it. The soil was a heavy chocolate, and he considered that in that type of soil the best fertiliser was basic slag and it was cheaper than others. He was very interested to hear what Mr. Dodds had said about superphosphates. He knew that on one field on the Umhlatuzi flats he put in 300 lbs. superphosphates to the acre and obtained very fine results in sucrose and increased weights. He was now using 500 to 600 lbs. of basic slag at Umhlali and watching the results very carefully.

Mr. DODDS replying to the point raised by Mr. Palairet stated that the value of the cane crop was based on the price actually received for it at the time of cutting, which he thought was the fairest way of expressing it. Where they showed the balance over the three crops it would be seen that the plant cane was valued at 15/– per ton, as that was the price actually received, and the second cutting in August, 1928, was £6/3/6 per ton of sucrose which also was actually obtained. The same applied to the other instances. As pointed out in the paper the cost of fertilisers had gone down materially during the course of these experiments, as well as the price of cane.

Mr. JOHNSON stated that Mr. Dodds had given them a report on the Empangeni experiments, but they knew that the experiments there were on some of the richest land in Zululand. He would have liked to have heard something more about the poorer lands, what experiments had been carried out on such soils. He was interested in three estates at different parts of the country, the land in each case being different. Each individual farm needed separate consideration. He did not think that at Amatikulu superphosphates would be suitable at all. He had tried experiments at Amatikulu with sulphate of ammonia. They had to use their knowledge to apply it to the needs of the individual farms. He would be very sorry to see the experiments at Empangeni discontinued; Mr. Dodds had stated that there would be difficulty in getting the cane away, but he did not see that; there would still be the siding there to get it away with, and it would be a pity to drop the experiments on account of transport difficulties to the mill. He hoped that next year Mr. Dodds would be able to give them results of experiments on a different type of soil.

Mr. DODDS pointed out that as mentioned in the paper they had set out with the intention of giving the results of all the co-operative experiments in progress at the present time, but they found that after describing the Empangeni experiments they had a long enough paper and could not fully describe the others. Reference had been made, however, to experiments in a very light sandy soil at Chakas Kraal where they had obtained an increase from 12 tons wwithout fertiliser to 35½ tons with a complete fertiliser. Reports on these and other experiments would follow long before the next Conference. Referring to the Empangeni experiments, although it was one of the richest soils in Zululand, it was evident it paid to fertilise it with phosphates at least, and during a rainy season there was a marked response to nitrogen also. It was surely useful to have this information even though it was possible to get excellent crops in this soil without any fertiliser at all. There were cases where they found a complete fertiliser essential for the best results. That had been found necessary at the Experiment Station, for example, but it did not appear to be the case in the sandy loam at Empangeni.

Mr. PALAIRET said Mr. Dodds had given the figures for each season, but that was the value of the cane at the mill. Unfortunately the cost of getting the cane to the mill was in most cases as high as 40 per cent. of the value of that cane at the mill and the criterion of the value of fertiliser or some particular treatment was the value of the cane in the field. He hoped Mr. Dodds would give careful consideration to the question of making some allowance for getting it to the mill.

Mr. DODDS replied that certainly the cost of harvesting and transport had to be taken into account, but it was difficult to assess the extra cost of harvesting an increased yield. Some of the planters' overhead charges probably remained practically the same, while others no doubt showed progressive increases, but with these figures before them it was possible for each planter to come to some conclusions on his own case. There were also other things to be taken into consideration, as for example the transport charges on the fertiliser, the labour in applying it in the field, and the interest on the capital locked up in the fertiliser. All those strictly speaking should be taken into account, but those items were very small when compared with such enormous profits as were shown from the application of a very moderate and inexpensive dressing of fertiliser.

Mr. PATRICK asked if it was possible to put the fertiliser into the furrow at the time of planting or after planting?

Mr. DODDS replied that the usual practice was to put the fertiliser in the furrows at the time of planting; perhaps the day previously, or at all events practically at the same time. The only exception was where green manure was applied it was sometimes the practice to apply fertiliser to the green manure crop which of course became available also for the following cane crop. In the case of nitrate of soda the common practice now was to apply this as a later top dressing. All other fertilisers were applied with the plant cane in the furrow.

Mr. PATRICK stated that he had been under the impression that where a heavy dressing of fertiliser was placed with the plant cane it was apt to cause burning of the roots. He had understood that this had been found out at the Experiment Station and that the superphosphates had been put in a month to six weeks before planting.

Mr. DODDS replied that he did not think there was any fear of the superphosphates damaging the cane plants, especially if moist weather was selected for planting, as should be the case. In any case he thought there was little or no risk even in dry weather if the cane was placed in the row covered with trash without stripping it. On some occasions at the Experiment Station they had raked over a little soil just to cover the fertiliser with about half-an-inch of soil to avoid direct contact between the fertiliser and the plant, but he doubted whether that was really necessary. There had been occasions also in which they had placed the fertiliser in the furrow in dry weather and awaited a shower of rain before planting; but that had been mainly for their own convenience and not because it was considered really necessary to apply the fertilizer long before planting.

Mr. NUTMAN stated he had had a good deal of correspondence with Mr. Dodds from time to time, and he had to thank Mr. Dodds for the assistance he had given him. He agreed with Mr. Johnson that it would have been better if more results had been shown of experiments on poorer lands. With regard to the statement made by Mr. Dodds that he did not think there was any danger from superphosphates, he (the speaker) had planted many acres with superphosphate in the black soils round the hills at Empangeni, and he had had considerable correspondence with Rothamsted in respect of it. Acres and acres of cane had been burnt out entirely. The dressing had only been 300 lbs. to the acre. He had been informed that in England he would have a case against the Company supplying the fertiliser. He had also had an interview with Sir John Russell who had told him it should not cause any harm, but he had been informed by Mr. C. B. Hill to be careful what he was doing with superphosphates in the black soils as he had found it burnt the cane. Sir John Russell had asked him if the soil was sticky, stating that this was due to the presence of sodium in the soil. He (the speaker) had abandoned the use of superphosphates and applied basic slag at the time of planting—about 500 lbs. to the acre—and had obtained excellent results. After cutting, however, he had dressed the lines of ratoons with superphosphates. Where black soils had to be dealt with he differed from Mr. Dodds, as he had found that superphosphates decidedly burnt the cane; his experience had been that it was not confined to individual cases here and there, but whole fields of twenty to fifty acres had been burnt out, with the consequent loss of a whole season. He considered that they should have reports of the failures experienced by the Experiment Station also, and in this way they would learn more about the subject.

Mr. DODDS in reply stated that judging by the experience of Mr. Nutman it would appear that in certain circumstances superphosphates did have the effect of burning the cane, but they had not had this experience at the Experiment Station or in the course of their various experiments elsewhere. However, there was the evident alternative in such cases of using basic slag. From the results of their experiments recorded in the paper it would be seen that basic slag was second only to superphosphates and showed nearly the same profit. At the Experiment Station basic slag gave results on plant cane which were practically as good as the superphosphate, though not so good on the first ratoon crop. At all events where there was any doubt about the burning effect of superphosphate, or in acid soils where it would be a good thing to apply a little lime as well, there was always the alternative of using basic slag.

Mr. O. J. ASKEW asked Mr. Dodds if he could explain why superphosphates should burn and yet basic slag should not have the same effect. He would also like to know what Mr. Dodds' experience had been in fertilising ratoon cane?

Mr. DODDS in reply stated that he thought the reason for the different effects was that the superphosphate contained a larger proportion of water-soluble material, and in a dry soil this would result in a highly concentrated solution of superphosphates round the plant, which might conceivably do damage. Basic slag, on the other hand, was of course insoluble in water and only became soluble by degrees by chemical reaction in the soil or by action of the plant roots. He would not like to say that it lasted longer, and although superphosphate began to show its effect sooner, as far as he could see the effect of it was just as lasting as the less soluble forms of phosphate. That had been their experience so far at the Experiment Station, and had been so at Rothamsted over many years. Their results hitherto only dealt with plant cane and first ratoons, and in only one or two cases further than that. With regard to the fertilising of ratoons they had not yet very much definite information to give. One of the papers before the Congress gave the effect on the ratoons of fertiliser given to the plant cane; that was the residual effect over and above the effect on the plant cane. They could not say very much yet with regard to the separate application of fertiliser to ratoons, except that on general grounds one would expect the fertiliser needs of the ratoons to be approximately the same as those of the plant cane. It was only a different problem as regards the application of the fertiliser to get it down to the already established root system, which was probably more a matter of cultivation than anything else.

Mr. LEISEGANG stated that it was very nice to get these results from the experimental plots; they did not all live in Zululand, however, and did not all possess very rich soil on their farms. What would interest him particularly would be to get his sucrose yields per ton of cane higher. He understood that in Germany the sucrose content of beet in a very few years had been raised from 15 to 20 per cent. They would all like to get higher sucrose results, and he would like to ask Mr. Dodds if it would be possible to carry out experiments in that respect to try and obtain higher sucrose yields. He believed it was quite possible to increase the yield a good deal.

Mr. DODDS replied that naturally they would all like to get it both ways; they would like to see the yield of cane from fertiliser increased, and the composition of the cane improved as well, and they were always on the look-out for any indications of this. That was one reason why they maintained a chemical laboratory at the Experiment Station and analysed all the cane from the experimental plots so as to trace any possible evidence of any increase in sucrose as apart from increase in yield of cane. So far he could only say that their results in that direction had been negative. They had had no definite indication of any increase in the sucrose content of the cane as a result of the application of fertilisers; that he thought was the experience of most experimenters all over the world. Sometimes a heavy dressing of nitrogen decreased the sugar content of the cane when harvested because of the fact that it delayed the maturity of the cane; in other words the cane ought to have been kept longer. No doubt other fertilisers would hasten the maturing of cane, but he was not aware of any definite experiments where the sucrose content of the cane at its maximum maturity had been increased. The fact quoted of the increase in sucrose in beet in Europe had been brought about by breeding. There had been a big improvement in beet in the last few decades brought about by careful improvement in breeding and seed selection. That was a thing which was very difficult to do with sugar cane as it was not ordinarily planted from seed. Cane was planted vegetatively which meant practically the same plant over and over again. Cane breeding could only be done at Experiment Stations highly specialised for that particular purpose; consequently sugar planters had not the same scope as beet farmers for increasing the sucrose content of their product. Nevertheless, they had found that many of the new canes that had recently been developed in certain parts of the world were materially higher in sucrose content than the older ones, and they hoped for a good deal in this respect from the new canes that they had now under experiment at Mount Edgecombe and elsewhere.

The CHAIRMAN stated that in looking for increased sucrose content of cane he thought they had to look for it from other channels than fertilising. The two main points to look for were to make sure that the fields were cut at the right time; it was impossible to lay down any laws or rules as to when to cut, but it was possible by careful study of the conditionss of growth in the fields to decide when to cut, and the second point was the condition of the cane when cut—to eliminate all the external materials such as trash, tops, roots, etc., and send that part of the cane only which had the best sucrose. Those were the two main ways in which planters could improve their sucrose content. It was also done to a certain extent in the case of irrigated cane by controlling the irrigation, and in Hawaii where a good deal of cane irrigating was done the irrigation water was cut off suddenly shortly before it was intended to harvest the cane so as to check the growth and bring about maturity.

Mr. DODDS stated that it had been found that the cane from the central North Coast area round about Chaka's Kraal year after year showed a higher sucrose content than that from other parts, and he had often wondered why that should be so. He did not know if anyone could throw any light on this problem but it was obviously a very important one if they could learn to bring up the composition of the cane as a whole to the standard of the Chaka's Kraal and Umhlali districts.

Mr. LEISEGANG stated that he had always been led to believe that by giving a good application of potash to the cane they would get increased yields of sucrose, and he still believed that to be a fact. His question was whether it would not be possible to experiment to see if they could not increase the yield of sucrose.

Mr. DODDS replied that he would not like to say that it would be impossible to affect the sucrose content by the application of potash or some other element, but he could only say that up to the present they had not succeeded in doing so in any of the experiments. They had found that in certain soils in favourable conditions they obtained a marked increase in the yield of cane from the use of potash, but they had never been able to substantiate the claim that he knew had been made that the sucrose content of the cane was also influenced. When canes of equal maturity had been compared there seemed to be no difference in the sucrose content of the cane effected by the fertiliser, no matter how much the sucrose yield per acre had been improved.