

# RANDOM BLOCK AND QUASI-LATIN SQUARE DESIGNS USED TO DETERMINE FERTILIZER REQUIREMENTS OF SUGARCANE

By JOHN LINTNER

## INTRODUCTION

Only too often one hears it said that an experiment is too complicated; that it is too big and that a demonstration plot would have sufficed.

It is astonishing that many people still appear not to appreciate the value of comprehensive techniques which not only save time but are capable of elucidating the problem at a high confidence level, thus permitting the results to be applied on a practical basis much sooner than would be possible otherwise.

There has been a great step forward in the production of sugarcane and sugar per acre in this country in recent years and it is due entirely to careful and efficient research carried out and the adoption in practice of the findings by this industry.

<sup>1</sup>At the 21st Annual Congress of the South African Sugar Technologists' Association, J. L. du Toit recorded—

- (1) That the 1922-28 average yield on the North Coast was less than 19 tons per acre, whereas between 1939-44 the yield was 29.7 tons per acre—an increase of 56 per cent. In this same area the increase due to new varieties has been shown to be 23 per cent so that one must ascribe the 33 per cent difference to soil improvement.
- (2) The whole industry has shown an increase in yield of 50 per cent, of which it has been calculated that 29 per cent can be attributed to new varieties and 21 per cent to soil. The sucrose per acre rose 32 per cent from 2.77 to 3.6 from 1925 to 1944 and sugar per acre rose 59 per cent from 2.17 tons per acre to 3.45 tons per acre.

A guess at the consumption of N,  $P_2O_5$  and  $K_2O$  on the sugar belt in about 1930 could yield 3-400 tons of N, 2-3,000 tons of  $P_2O_5$  and 100 tons of  $K_2O$ .

In recent years, up to date, according to an article contributed to the *South African Sugar Journal* (March 1958) by J. L. du Toit—

	1951	1954	1956	1957
Tons mixed fertilizer ...	25,277	34,431	27,079	23,412
Tons nitrogenous fertilizer...	5,280	13,370	19,016	19,381
Tons phosphatic fertilizer...	15,297	12,210	11,109	8,099
Tons potassic fertilizer ...	125	2,214	5,802	8,746
Tons N... ..	2,135	4,516	7,397	6,875
Tons $P_2O_5$ ... ..	6,526	6,004	4,505	3,415
Tons $K_2O$ ... ..	842	2,813	5,786	7,389

This paper is a part summary of some work done and part exposition of work in progress, being a small contribution to the elucidation of fertilizer effects on sugarcane in Natal, with particular reference to the use of the Quasi Latin Square design for this purpose.

## FERTILIZER TRIALS ON UBA CANE AT HAZARA ESTATES, KEARSNEY, NATAL<sup>3</sup>

In October 1932, a fertilizer trial was laid down at Hazara Estate, Kearsney, the property of Major J. Woollam on the North Coast of Natal.

It is on record that the field in which the experiment was situated was 30 acres in extent and 1,550 ft above sea level. There is a slight incline towards the South although it is so small as to be practically unnoticeable. The aspect is open.

The soil is a red clay which at that time had been under cultivation for 15 years or more and prior to the planting of cane was under wattles.

Just prior to the establishment of the experiment the field was under a green crop of *Vigna Sinensis* (Cowpeas) sown in January 1932 and ploughed under in June 1932.

An examination of the horizons showed:

"A" *Horizon*— 9-12 inches of reddish brown clay loam containing a large amount of cane leaf refuse and pieces of old cane and root stumps.

"B" *Horizon*— 12-29 inches of yellowish brown clay with very little physical evidence of organic material especially towards the bottom of this horizon.

"C" *Horizon*— 28-48 inches bright brick red clay with no visible organic material.

Subsequent examination of root development whilst the cane was growing revealed the main area of distribution to extend down to  $\pm$  20 inches below the surface.

The soil analysis done through the kind co-operation of Dr. E. P. Hedley at the South African Sugar Association Experiment Station was:

	"A" Horizon	"B" Horizon	"C" Horizon
	%	%	%
Carbon ... ..	4.363	3.362	0.641
Nitrogen ... ..	0.273	0.168	0.054
C : N ratio... ..	16.000	20.100	11.600
Available Potash K <sub>2</sub> O ... ..	0.012	0.009	0.005
Available Phosphate P <sub>2</sub> O <sub>5</sub> ... ..	0.002	0.001	0.0002
Total Potash K <sub>2</sub> O ... ..	0.090	0.063	0.055
Total Phosphate P <sub>2</sub> O <sub>5</sub> ... ..	0.082	0.052	0.059
Loss on ignition ... ..	19.840	18.790	14.530
Hygroscopic moisture ... ..	6.610	6.310	4.310
Hydrogen ion concentration (pH) ... ..	4.750	4.640	5.270
Nitrate Nitrogen (parts per million) ... ..	1.640	2.410	2.340
Silica (SiO <sub>2</sub> ) ... ..	39.150	36.800	40.260
Iron (Fe <sub>2</sub> O <sub>3</sub> ) ... ..	14.200	15.800	16.920
Calcium (CaO) ... ..	0.350	0.275	0.251
Magnesia (MgO) ... ..	0.121	0.060	0.069
Alumina etc. (Al <sub>2</sub> O <sub>3</sub> TiO <sub>2</sub> Mn <sub>2</sub> O <sub>4</sub> )	26.930	27.090	28.640

Samples of this soil submitted to the Pretoria University for bacterial counts revealed no azotobacter by the Crumb method in any of the samples.

Bacterial numbers were—

"A" Horizon—	11,781,250	per gram dry weight.
"B" Horizon—	843,750	" " " "
"C" Horizon—	406,250	" " " "

Actinomyces—

"A" Horizon—	2,625,000	per gram dry weight.
"B" Horizon—	125,000	" " " "
"C" Horizon—	62,500	" " " "

In the comments on this paper, S. A. Waksman in *Principles of Soil Microbiology* was quoted where he says that study of the distribution of bacteria in different soil horizons reveals that numbers do not decrease gradually but by a series of drops from one sub-horizon to another.

The absence of azotobacter can be ascribed to the low pH of 4.7.

The experiment was laid down on 3rd October 1932 and the variety of cane used was Uba.

In the report on the experiment it is noted that "three lots of leaf samples were taken and analysed at the Mount Edgecombe Experiment Station". The leaves were taken from sticks chosen at random in each plot grouped together to form a thirty-leaf sample from each treatment.

The leaves collected were fully mature green leaves and the subsequent analyses were done in duplicate.

The following chart on page 122 gives the average leaf analyses for the three sections of the experiment, together with the N/K and Ca/Mg ratio.

An examination of the leaf analyses reveals an overall N/K ratio of 1:1.48. There being three

sections in this experiment the breakdown of the general average N/K ratio was—

	Without "K"	With "K"
A ... ..	1:1.42	1:1.99
B ... ..	1:1.27	1:1.58
C ... ..	1:1.27	1:1.71
Overall ... ..	1:1.32	1:1.76

N was ostensibly the same throughout, dropping back in February. When K was added the K content of the leaf was constantly higher. The Ca/Mg ratio was at its lowest for all treatments in April, higher in July and highest in February, the ratio being 1:1.84, 1:2.06 and 1:2.60.

The fertilizer applied was calculated from Stubbs' figures taken from the *Cedara Memoirs* (1912) for the theoretical removal of N, P and K by a 40-ton crop of cane and reduced to 30 tons with a  $\pm$  margin for various reasons. The nitrogen was reduced for fear of the effect of N on cane in droughty weather, the P<sub>2</sub>O<sub>5</sub> was increased because of possible reversion and fixation and the K<sub>2</sub>O was likewise increased because of the high clay content of the soil and the possibility of fixation.

The actual amounts applied per acre were:

O = Control.

N = 26.375 lb. N from 125 lb. amm.sulphate  
21.1% N.

N<sub>2</sub> = 52.750 lb. N from 250 lb. amm. sulphate  
21.1% N.

P = 68.400 lb. P<sub>2</sub>O<sub>5</sub> from 400 lb. superphosphate  
17.1% P<sub>2</sub>O<sub>5</sub> w.s.

K = 109.125 lb. K<sub>2</sub>O from 225 lb. potassium sulphate  
48.5% K<sub>2</sub>O.

K<sub>2</sub> = 218.250 lb. K<sub>2</sub>O from 450 lb. potassium sulphate  
48.5% K<sub>2</sub>O.

For the A section the whole lot of fertilizer was applied in the bottom of the furrow and the cane planted in full lengths double in the row and cut into setts.

The treatment combinations resolved into the following together with the yield of cane—

	Yield in tons cane per acre
O Control ... ..	40.8
P 68.4 lb. P <sub>2</sub> O <sub>5</sub> ... ..	45.5
NP 26.375 lb. N+68.4 lb. P <sub>2</sub> O <sub>5</sub> ... ..	45.4
NPK 26.375 lb. N+68.4 lb. P <sub>2</sub> O <sub>5</sub> +109.125 lb. K <sub>2</sub> O... ..	49.3
NPK <sub>2</sub> 26.375 lb. N+68.4 lb. P <sub>2</sub> O <sub>5</sub> +218.250 lb. K <sub>2</sub> O... ..	53.7
N <sub>2</sub> PK <sub>2</sub> 52.750 lb. N+68.4 lb. P <sub>2</sub> O <sub>5</sub> +218.250 lb. K <sub>2</sub> O... ..	53.4

	O			P			NP			NPK			NPK <sub>2</sub>			N <sub>2</sub> PK <sub>2</sub>		
	Apr.	July	Feb.	Apr.	July	Feb.	Apr.	July	Feb.	Apr.	July	Feb.	Apr.	July	Feb.	Apr.	July	Feb.
N ... ..	1.55	1.35	1.20	1.42	1.48	1.34	1.57	1.38	1.35	1.48	1.45	1.33	1.48	1.37	1.35	1.53	1.40	1.33
K ... ..	2.07	1.84	1.78	2.04	1.89	1.83	2.02	1.78	1.71	2.45	2.02	2.23	2.58	2.09	2.27	2.69	2.32	2.24
NK Ratio ... ..	1.33	1.35	1.48	1.43	1.27	1.36	1.28	1.28	1.26	1.65	1.39	1.67	1.74	1.52	1.68	1.75	1.65	1.68
Ca ... ..	.31	.41	.23	.32	.43	.26	.31	.48	.23	.29	.42	.22	.29	.43	.21	.29	.41	.22
Mg ... ..	.51	.82	.57	.57	.95	.66	.67	.97	.67	.55	.85	.59	.52	.83	.53	.52	.82	.54
CaMg ... ..	1.64	2.20	2.47	1.78	2.20	2.53	2.16	2.02	2.91	1.89	2.02	2.68	1.79	1.93	2.52	1.79	2.00	2.45

Section B was the same as Section A with the exception that the fertilizer was halved at the time of planting. The first half was put into the furrow under the setts and the remaining quantity halved

again and applied finally as two separate top dressings.

This procedure gave—

	IN FURROW	January 1933 1st Top Dressing lb.	April 1933 2nd Top Dressing lb.	Total lb.	Yield in tons cane per acre
O ... ..	Control (Nil)	—	—	—	—
P ... ..	34.2 P	17.2 P	17.200 P	68.4 P	34.9
NP ... ..	13.187 N	6.593 N	6.593 N	26.375 N	} 44.6
	34.200 P	17.200 P	17.200 P	68.400 P	
NPK ... ..	13.187 N	6.593 N	6.593 N	26.375 N	} 39.8
	34.200 P	17.200 P	17.200 P	68.400 P	
	54.560 K	27.280 K	27.280 K	109.120 K	
NPK <sub>2</sub> ... ..	13.187 N	6.593 N	6.593 N	26.375 N	} 43.6
	34.200 P	17.200 P	17.200 P	68.400 P	
	109.125 K	54.562 K	54.562 K	218.249 K	
N <sub>2</sub> PK <sub>2</sub> ... ..	26.375 N	13.187 N	13.187 N	52.750 N	} 46.5
	34.200 P	17.200 P	17.200 P	68.400 P	
	109.125 K	54.562 K	54.562 K	218.249 K	

Section C received an additional amount of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, 85.5 lb. P<sub>2</sub>O<sub>5</sub> instead of 68.4 lb. P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub> was raised from 218.25 lb. K<sub>2</sub>O to 388.0 lb. K<sub>2</sub>O. Half the amount of N was given in the form of ammonium sulphate and the balance in the form of sodium

nitrate. The dressings were split as in B but for the super, which was also split and was applied at the rate of 250 lb. per acre in the furrow with two top dressings—one of 150 lb. and the other of 100 lb. per acre.

	IN FURROW	January 1933 1st Top Dressing lb.	April 1933 2nd Top Dressing lb.	Total lb.	Yield in tons cane per acre
O Control (Nil) ...	—	—	—	—	21.5
P ... ..	42.750 P	21.375 P	21.375 P	85.500 P	33.6
NP ... ..	13.187 N	6.200 N	6.200 N	25.587 N	} 37.5
	42.750 P	21.375 P	21.375 P	85.500 P	
NPK ... ..	13.187 N	6.200 N	6.200 N	25.587 N	} 45.3
	42.750 P	21.375 P	21.375 P	85.500 P	
	54.562 K	81.722 K	81.722 K	218.250 K	
NPK <sub>2</sub> ... ..	13.187 N	6.200 N	6.200 N	25.587 N	} 50.2
	42.750 P	21.375 P	21.375 P	85.500 P	
	109.125 K	92.974 K	92.974 K	388.000 K	
N <sub>2</sub> PK <sub>2</sub> ... ..	26.375 N	12.400 N	12.400 N	51.175 N	} 46.4
	42.750 P	21.375 P	21.375 P	85.500 P	
	109.125 K	92.974 K	92.974 K	388.000 K	

Unfortunately, sucrose tests were not available due to circumstances beyond the control of the investigator.

In the comments it was pointed out that it was regretted that no PK treatments had been included and also attention was drawn to the possibility that some of the beneficial effect might have been due to the N/K ratios involved.

For the rest it is interesting to quote the explanations given at the time for some of the phenomena which occurred—

"It is possible that the amounts of superphosphate and potash applied as top dressings were absorbed in the topmost few centimetres of soil and were not within reach of the feeding points of the root system which were attained by the nitrogen salt which leached down to lower levels. From the total yield obtained in this section it seems to be indicated that the method of application adopted in Section A was more beneficial and created a better balance of plant food material at the disposal of the root system than was the case when the dressings were split and top dressings applied."

In connection with Section C—

"... but it is interesting to notice that the application of 500 lb. superphosphate did not increase the yield over the 400 lb. applied in the other two sections, and also the very high dressings of potash in  $K_2$  did not assist in counteracting the depressing effect caused by the  $N_2$ . It is difficult in this case to fall back on the view that the potash was absorbed in the first few centimetres of soil. The dressing was sufficiently heavy to justify the assumption that a portion should have leached down to the root system to counteract the detrimental effect of the double dressing of nitrogen since an increase was obtained between K and  $K_2$ . The heavy dressings of potash in this section were not applied with the view to obtain necessarily economic returns, but to refute the popular belief that heavy dressings of this ingredient are liable to have toxic effects on cane."

It is relevant in view of what was said at that time, to quote from a recent paper in which the penetration of P and K in a French apple orchard soil is discussed.

The soil analysed 0.14 per cent available  $P_2O_5$  and 0.20 exchangeable  $K_2O$ .

<sup>4</sup>An experiment was conducted in which N=100kgs. per Ha,  $P_2O_5$ =125 kgs. per Ha, and  $K_2O$  was 150 kgs. per Ha.

Between 1935 and 1950 there were thirteen applications so that the total amounts given per Ha were:

1300 kgs. of N from ammonium sulphate.  
1625 " "  $P_2O_5$  " superphosphate  
1950 " "  $K_2O$  " potassium sulphate

The fertilizers were broadcast at the end of winter and incorporated with the soil by cultivating them in to a depth of 10 cms. (4").

A year after the last application of fertilizer, soil samples were taken at different depths from the plots. The depths sampled were from 0 to 10 cms. and each successive 10 cms. down to 40 cms.

The following table gives the results—

Depth of Samples in cms.	% <sub>100</sub> on dry basis				
	TREATMENT				
	Control	NPK	NP	NK	PK
	Available $P_2O_5$ (cit. acid)				
0-10	0.22	0.60	0.58	0.15	0.57
11-20	0.14	0.13	0.11	0.09	0.16
21-30	0.11	0.11	0.14	0.12	0.12
31-40	0.11	0.13	0.15	0.15	0.13
	Exchangeable $K_2O$				
0-10	0.29	0.67	0.29	0.66	0.85
11-20	0.16	0.57	0.19	0.71	0.62
21-30	0.15	0.38	0.17	0.48	0.23
31-40	0.15	0.32	0.17	0.32	0.19

To quote the author—

"The table reveals that successive applications of superphosphate have only enriched the first 10 cms. of soil. The  $P_2O_5$  content of the area beyond 10 cms. has remained the same after 15 years of intensive manuring, in fact the same as the plots with no application of phosphate, the control and NK. As for potash the concentration is greatest in the upper layer and it declines progressively with increased depth. In the soil under observation with a Toulouse climate, one can estimate three to four years as the necessary time required for potash applied to the surface to penetrate 10 cms. The quasi immobility of  $P_2O_5$  and the slow movement of potash constitute a pretty generalised phenomenon encountered to the same extent in sweet or sour soils with or without irrigation under channel or Mediterranean climatic conditions."

These comments were made on the basis of results of investigations carried out on Norman grassed apple orchards, roses in the Antibes and on apples in the Blois area.

The explanations given for the Kearsney experiment still stand with the exception that one must now add that the  $K_2O$  in the 800 lb. of potassium sulphate was probably fixed just as much as the smaller amounts for the duration of this experiment. Moreover, the author of the French research just quoted, draws attention to the fact that the accumulation of  $P_2O_5$  cannot be overlooked because of the risk of provoking a deficiency of other elements, particularly Mg and Mn.

<sup>5</sup>In 1937 the experiment was harvested again and the results were summarised.

The increase due to treatments over controls for the two years separately and together was as follows:

	O	P	NP	NPK	NPK <sub>2</sub>	N <sub>2</sub> PK <sub>2</sub>
	Tons Cane per Acre 1934					
	37.14	+ 7.14	+4.73	+ 8.52	+12.19	+ 8.84
	Tons Cane per Acre 1936					
	22.37	+ 6.19	+3.69	+ 7.21	+ 8.80	+ 4.49
<b>Total</b>	59.51	+13.33	+8.42	+15.73	+20.99	+13.33

ALL SIGNIFICANT AT P = 0.05

This means that the top yield averaged 40.25 tons of cane per acre. This was grown with one application of 26.375 lb. N, 68.400 lb.  $P_2O_5$  and 218 lb.  $K_2O$ .

Major J. Woollam on whose estate the above trial was conducted has been kind enough to give the following information about yields from the same field from 1953 to 1957.

Year	Variety	FERTILIZER			Yield in Tons Cane
		N	P	K	
1953	Plant N:Co.310... ..	8	104	24	42.00
1955	First Ratoon ... ..	76	245	159	57.60
1957	Second Ratoon... ..	127	164	414	67.60

When varieties other than Uba were released naturally they came to be tested in experiments dealing with fertilizer problems.

Observing the difference in appearance of the different canes it was thought that it might be possible that there might be a significant difference between them regarding their mineral requirements.

#### FERTILIZER × VARIETY TRIAL AT UMBOGINTWINI

In 1933 three random blocks were put down to test N, P and K on three varieties of cane; Uba, Co.290 and P.O.J. 2725.

Quite apart from the general fertilizer effects on red sand it was very interesting to note that there was a difference in response between the varieties.

P had its biggest effect on Uba, increasing it by 11.76 tons of cane. The PK plot gave a further increment of 3.2 tons. For Co.290 P depressed the yield—0.75 tons whilst PK gave an increment of 8.45 tons and for P.O.J. 2725 P increased the yield by 2.47 tons of cane and PK by 5.11 of cane.

Attention was drawn to the  $P_2O_5$  content of the juice which was much higher for Uba than the other varieties, giving an average of 33.07 with a minimum of 28 and a maximum of 36.0 mg. per 100 ml. Co.290 gave 24.13 average with a minimum of 18.4 and a maximum of 32.0 which, incidentally, was the control. For P.O.J. 2725 the average was 18 with the minimum at 16 and the maximum at 20.

In the discussion of the paper read on this subject the Chairman of this Association at the time drew attention<sup>5</sup> to a paper written by R. J. Borden, in which great stress was laid on the importance of phosphate and potash in the crusher juice saying that the basic phosphate treatment for a field which produces canes of which the crusher juice gives a  $P_2O_5$  value of 0.01 or less is stated to be 300 lb.  $P_2O_5$  acre per crop.

The sucrose tonnages were affected similarly for Uba; O to P + 1.19 tons, P to PK + 0.26 tons, NPK to NPK2 + 0.75 tons.

For Co.290, O to P was -0.45 tons, P to PK was +1.07 tons, NPK to NPK2 + 0.96 tons.

P.O.J. 2725 gave O to P + 0.38 tons, P to PK 0.00 tons, NPK to  $N_2PK$  + 0.37, NPK to NPK<sub>2</sub> - 0.59 tons.

All these figures were significant at  $P=0.05$  with the exception of +0.38 and +0.37.

#### FURTHER RESEARCH

After many discussions with many research workers it was decided to adopt a new technique which in addition to affording the possibility to investigate the fertilizer requirements of sugarcane on different soils, also would give the opportunity for more accurate study of the reactions of different varieties to fertilizer treatments.

The result was, that amongst other experiments planned, two Quasi Latin Square designs were used at Reunion, then the property of the Illovo Sugar Company.

#### THE ILLOVO SUGAR CO. EXPERIMENT —REUNION

The results of these experiments which were adjacent to one another were published in 1944<sup>6</sup>.

There was a remarkable degree of similarity between the two experiments A and B, so that the work involved in conducting two similar trials next to each other produced data which gave proof of the value of this design for comprehensive exploratory work.

Unfortunately, these magnificent experiments established on a long-term basis in November 1938 were destined to be short-lived due to the war. Nevertheless, they provided some very useful information.

The treatments given were as under—

		0	1	2
Lb. N/acre as ammonium sulphate ... ..	N	Nil	100	200
Lb. cit. acid sol. $P_2O_5$ /acre as super/rock 1 : 1.86 ... ..	P	Nil	100	200
Lb. $K_2O$ /acre as $K_2SO_4$ (48.5% $K_2O$ ) ... ..	K	Nil	125	150

N applications were given as a basal dressing of 50 lb. N to all N plots at planting in November 1938, followed by a top dressing of 50 lb. N for  $N^1$ , and 75 lb. N for  $N^2$  in February 1939 and a further 75 lb. N in April 1939 on the  $N^2$  plots. Three varieties were used—Co.281, Co.301 and Co.290.

The cane was harvested at 21 months with the following results—

Treatment	0 T/Ac.	1 T/Ac.	2 T/Ac.	G.M. T/Ac.	S.E. T/Ac.	Sig. Diff. T/Ac.
N ... ..	58.1	63.6	64.8	62.2	5.0	$\left\{ \begin{array}{l} 2.8 (P=.05) \\ 3.7 (P=.01) \\ 4.9 (P=.001) \end{array} \right.$
P ... ..	61.0	62.9	62.6			
K ... ..	58.4	63.7	64.4			
Variety... Co.281 Co.301 Co.290	58.4	63.7	64.4			
Yield ... ..	61.4	62.7	62.5			

From this table it can be seen that for N,  $N_2$  and  $N_1 > N_0$  at  $P = 0.001$  and  $K_2$  and  $K_1 > K_0$  at  $P = 0.001$ .

The first level of nitrogen  $N_1$  and the first level of potash gave 5.5 and 5.3 T/Ac. respectively and it was noted with astonishment that no significant NK interaction was recorded.

During the early growth of the plant cane, seven months after planting, the following observations were made on all plots—

- (a) Number of shoots per stool.
- (b) Total shoot length per stool.

For number of shoots per stool, N and variety effects were significant at  $P = 0.01$  and  $P = 0.001$  respectively.

For N,  $N_2$  was greater than  $N_0$  at  $P = 0.01$ .

For Variety,  $Co.301 > Co.281 > Co.290$  at  $P = 0.05$  and  $Co.301 > Co.290$  at  $P = 0.001$ .

In the case of total shoot length per stool N and K effects were significant at  $P = 0.001$ , the variety effect and an NV interaction were significant at  $P = 0.01$ .

In the discussion these effects were recorded saying: "Nitrogen increased the number of shoots per stool, and this effect was more than maintained in the figures for total shoot length per stool, since individual shoots also grew taller as a result of nitrogen applications.

Potash, although not increasing the number of shoots, made them grow considerably taller.

Potash and nitrogen effects were identical to all intents and purposes when considering total shoot length per stool.

For total shoot length there was also a significant interaction between nitrogen and variety in that, for Co.281 and Co.290 the lower nitrogen dressing  $N_1$  already exerted the maximum effect whereas for Co.301 only the highest nitrogen application was effective."

Unfortunately, due to the war, these plots were not fertilized after cutting the plant cane and the first ratoon harvested after 15 months growth showed no residual fertilizer effects.

Varieties, however, which had shown no differences in the plant cane showed highly significant differences in the first ratoon. Co.301 outyielded Co.290 by 5 tons per acre and Co.281 by 6.5 tons per acre. It was unfortunate also that owing to insufficient analyses of plant material no further very searching investigation of these differences could be made.

The Quasi Latin Square B confirmed the N and K effects obtained from experiment A, and in addition the NV interaction which was only significant in A for total shoot length very nearly became significant in the yield of the plant cane crop in B.

The interaction was recorded as follows—

For Co.281  $N_1 > N_2$  and  $N_0$  at  $P = 0.05$  and  $N_1 > N_2$  at  $P = 0.01$ .

For Co.301 there were no significant differences and for Co.290  $N_0 > N_1$  at  $P = 0.05$ . Alternatively—

- (a) For  $N_0$   $Co.301 > Co.290 > Co.281$
- (b) For  $N_1$   $Co.301 > Co.281 > Co.290$
- (c) For  $N_2$   $Co.301 > Co.290 > Co.281$

As will be seen later, these experiments provided the original data which illustrated the necessity to probe further into quantities of fertilizer—N, P, K., etc to be applied as well as their interactions with one another, as well as their interactions with different varieties.

## CO-OPERATIVE EXPERIMENTS AT

### GINGINDHLOVU

#### MR. W. KRAMER — "MINE OWN"

On a soil which was ploughed up for the first time in July 1924, a fertilizer experiment was established in October 1924. At ploughing the soil was dressed with 1,000 lb. per acre carbonate of lime.<sup>6</sup>

The following fertilizers were applied—

$N_0 = 0$

$N_1 = 14$  lb. N of which 5 lb. N was applied at planting in the form of 6 lb.  $NaNO_3$  plus 20 lb.  $SO_4(NH_4)_2$  and a top dressing of 9 lb. N in the form of 25 lb.  $NaNO_3$  plus 25 lb.  $SO_4(NH_4)_2$

$N_2 = 28$  lb. N of which 10 lb. was put in the furrow in the form of 12 lb.  $NaNO_3$  plus 40 lb.  $SO_4(NH_4)_2$  plus a top dressing of 18 lb. N in the form of 50 lb.  $NaNO_3$  and 50 lb.  $SO_4(NH_4)_2$

$P_0 = 0$

$P_1 = 60$  lb.  $P_2O_5$  from  $\left. \begin{array}{l} 100 \text{ lb. bone flour.} \\ 200 \text{ lb. superphosphate.} \end{array} \right\}$

$P_2 = 90$  lb. " "  $\left. \begin{array}{l} 150 \text{ lb. bone flour.} \\ 300 \text{ lb. superphosphate.} \end{array} \right\}$

$K_0 = 0$

$K_1 = 48$  lb.  $K_2O$  from  $K_2SO_4$  48.5%  $K_2O$

$K_2 = 72$  lb. " " " " "

The overall average from 7 controls was 23.98 tons of Uba cane per acre and the overall average of 18 fertilized plots was 32.95 tons per acre—a difference of 8.97 tons.

The  $N_0$  plots gave 32.93 tons, and N plots gave 33.17 tons.

A further breakdown showed in tons of cane per acre—



	Tons cane per acre	Tons sucrose per acre
N:Co.310... ..	55.12	9.19
Co.331 ... ..	43.74	6.23
Co.290 ... ..	32.81	4.86

On account of no effect from fertilizer in the plant cane the applications were not split for the first ratoon but the whole lot was applied in between the cane rows on top of the trash blanket. The fertilizer was applied on the 19th September, 1953, and the first ratoon was harvested in February 1955 after 19 months growth.

The results from the first ratoon gave the following figures for the varieties.

	Tons cane per acre	Tons sucrose per acre
Co.331 ... ..	37.94	4.51
N:Co.310 ... ..	36.81	5.29
Co.290 ... ..	27.75	3.41

Co.331 and N:Co.310 > Co.290 at  $P = 0.001$  for tons cane per acre and for sucrose N:Co.310 > Co.331 > Co.290 at  $P = 0.01$  and for—

	Sucrose per cent Cane	Sig. Diff.	In % Sucrose
Co.331 ... ..	11.99	.05	0.33
N:Co.310 ... ..	14.46	.01	0.44
Co.290 ... ..	12.37	.001	0.57

For sucrose Co.290 > Co.331 at  $P = 0.05$ , N:Co.310 > Co.290 and Co.331 at  $P = 0.001$  and in terms of sucrose per cent Co.290 > Co.331 by 0.38. N:Co.310 > Co.290 by 2.09, N:Co.310 > Co.331 by 2.47.

On examination a very strong effect from the nitrogen application is observed at the  $N_2$  level, which gave an increase for  $N_2 > N_0$  by 11.67 tons and  $> N_1$  by 7.8 tons of cane at  $P = 0.01$ .

In this ratoon crop the NP interaction is significant at .01.

An examination of the figures reveals that although P reduced the yield both at 100 and 200 lb. per acre when used alone, when used in combination with 100 and 200 lb. N there were considerable increases.  $N_2P_1$  gave nearly 7 tons increment over  $N_1, P_1$ .

The interactions can be seen in the following table:

	$N_0$	$N_1$	$N_2$
$P_0$ ... ..	33.77	28.60	37.98
$P_1$ ... ..	23.62	36.27	43.39
$P_2$ ... ..	29.62	33.68	40.60

$N_1P_1 > N_1$  and  $P_1$ .  $N_1P_2 > N_1$  and  $P_2$ .  $N_2P_1 > N_2$  and  $P_1$ .  $N_2P_2 > N_2$  and  $P_2$ .  $N_2P_1$  heads the list being higher than  $N_1P_1$  by 6.96 tons significant at  $P = .05$  and just misses significance over  $N_2P_2$ . P alone depressed the yield at the  $P_1$  level.

The sucrose yields show a significant increase effect and a significant depressive effect from K, amounting to a decrease of 0.62 tons at nearly  $P = 0.001$  but the decrease between  $K_0$  and  $K_1$  is not significant.

There was an NP interaction as there was in the cane yields which produced the following results—

$P_1 < P_0$  at  $P = 0.01$

$N_1 < N_0$  at almost  $P = 0.05$

$N_1P_1 > N_1$  at  $P = 0.01$  by 1.07 tons sucrose and  $> P_1$  at  $P = 0.001$  by 1.56 tons sucrose.

The total yield was 4.74 tons sucrose for  $N_1P_1$ .

$N_2P_1$  gave a total of 5.59 tons sucrose which was just short of significant over  $N_2$ .

And significant by 0.84 tons of sucrose over  $N_1P_1$  at  $P = 0.05$ .

$N_2P_2$  was just short of significant over  $N_1P_2$  and  $N_1P_1$  not significant over  $N_2P_2$ .

An examination of the effect of variety and treatment on sucrose per cent cane gave a significant value for variety and nitrogen but nothing for either P or K—the sucrose per cent has been recorded in the table of results of this first ratoon so that it can be seen that whilst Co.290 had a high sucrose per cent nevertheless it was outyielded by canes of much greater growth capacity.

For nitrogen there is a depression at  $P = 0.01$  for  $N_2$  over  $N_0$  and depression at  $P = 0.05$  from  $N_1$  to  $N_2$ .

For purity there were two significant interactions NP and NK at the 0.05 level.  $P_2$  just touched a significant increase used alone but in the presence of increasing amounts of N caused a decrease. N depressed the yield at  $P = 0.05$  and for  $N_2$  at  $P = 0.01$ .

$K_1$  increased the purity at  $P = 0.05$  by 3.61, and  $N_2$  in the presence of  $K_1$  decreased the purity by 3.59.

Thus it can be seen that whereas in the plant cane with the fertilizer split up with the exception of the phosphate, there were no significant responses. In the first ratoon, however, there was some interesting data. Unfortunately this experiment could not be carried on due to the whole field being ploughed out.

Therefore, due to the fact that the co-operator was very keen to have a sandy soil studied particularly with a view to the ratooning capacity following a comprehensive fertilizing programme, a new experiment was established on the same farm. This time, the field in which this experiment is located is exactly the same one as carried the first experiment in 1924.

The soil is a grey brown sand of Ecce origin, the examination of which revealed—

- 0 to 24" grey brown sand.
- 25 to 36" sandy—tendency towards deeper red colour.
- 37 to 40" reddish clay with yellow patches.
- 40" plus mixture of coarse grit and clay occurring in the water table which has risen considerably of recent years, following heavy rains and is at 37" at the present moment.

In the grit area, varying-sized lumps of coarse sand bound together with clay were encountered. These lumps sometimes had grown round a grain of coarse sand or a small ferruginous nodule or merely a streak of highly oxidised fine silty material. This was taken as being an indication of the beginning of a hard pan and will provide material for some very interesting study on the formation of hard pans on soils of this description.

The amounts of fertilizer given were calculated according to analyses done by Hedley and Beater<sup>8</sup>. An average was struck between the amount of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O as removed by—

- (a) a 30-ton crop of Uba cane including roots, etc. and a 40-ton crop of Co.290 and Co.281, and;
- (b) the amounts of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O removed by the stems of similar crops. The figures then obtained were rounded off for the fertilizer to be applied per acre.

The quantities given were—

N <sub>0</sub> 0	N <sub>1</sub> 210	N <sub>2</sub> 420	from ammonium sulphate.
P <sub>0</sub> 0	P <sub>1</sub> 76	P <sub>2</sub> 152	from superphosphate.
K <sub>0</sub> 0	K <sub>1</sub> 540	K <sub>2</sub> 1080	from potassium chloride.

The canes being used are N:Co.310, N:Co.376 and N:Co.382. The experiment was planted in May 1955 with 52.5 lb. N for N<sub>1</sub>, and 105.00 lb. N for N<sub>2</sub>; 76 lb. P<sub>2</sub>O<sub>5</sub> for P, and 152.00 lb. P<sub>2</sub>O<sub>5</sub> for P<sub>2</sub>; 135 lb. K<sub>2</sub>O for K<sub>1</sub> and 270.00 lb. K<sub>2</sub>O for K<sub>2</sub>. Or in terms of fertilizer at the time of planting—

N <sub>0</sub> 0	N <sub>1</sub> 250	N <sub>2</sub> 500	(ammonium sulphate 21.1 per cent N)
P <sub>0</sub> 0	P <sub>1</sub> 400	P <sub>2</sub> 800	(superphosphate 19.1 per cent P <sub>2</sub> O <sub>5</sub> )
K <sub>0</sub> 0	K <sub>1</sub> 225	K <sub>2</sub> 450	(potassium chloride 60 per cent K <sub>2</sub> O)

Unfortunately, the weather was such that due to drought the cane did not grow at all so it was ploughed out and the whole experiment was replanted on the 15th February 1956. No more fertilizer was given in the furrows but the first top dressing was applied as arranged.

The experiment was harvested in September 1957 and the results showed varieties significant at 0.001, nitrogen significant at 0.001 and potash significant at 0.001.

The varieties gave the following yields—

	Cane tons per acre	Sucrose T/acsres	Sucrose per cent cane	Purity
N:Co.310 ...	45.96	7.54	16.55	90.94
N:Co.376 ...	64.85	9.78	15.24	88.54
N:Co.382 ...	60.71	8.66	14.33	86.74

N:Co.376 leads the way for cane yield giving 18.89 tons more than N:Co.310 and 4.14 tons more than the next best N:Co.382, which yielded 14.75 tons more than N:Co.310. All these differences are significant at P = 0.001.

The following table shows the N and K main effects on the yield of cane—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>
40.02	62.24	69.26
K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>
51.12	59.53	60.88

from which it can be seen that N<sub>1</sub> at 210 lb. N per acre from ammonium sulphate increased the yield by 22.22 tons of cane per acre over N<sub>0</sub>, and that N<sub>2</sub> at 420 lb. N per acre from ammonium sulphate increased the yield by 7.02 tons of cane over N<sub>1</sub>, and 29.24 tons over N<sub>0</sub>. All at P = 0.001.

Potash at the K<sub>1</sub> level gave 8.42 more than K<sub>0</sub>, and K<sub>2</sub> gave 9.77 tons over K<sub>0</sub> both at P = 0.001. K<sub>2</sub> was not significantly higher than K<sub>1</sub>.

Moreover, there is a significant NV interaction which on examination reveals the following increments for the varieties at each level of N.

For N:Co.310, N<sub>1</sub> gave 17.77 tons increase over N<sub>0</sub> and N<sub>2</sub> gave 4.81 increase over N<sub>1</sub> which is not significant.

N:Co.376 gave a 28.88-ton increase for N<sub>1</sub> and 7.77 tons for N<sub>2</sub> over N<sub>1</sub>.

For N<sub>1</sub>, N:Co.382 gave an increase of 20.02 tons over N<sub>0</sub> and N<sub>2</sub> gave 19.62 tons over N<sub>1</sub>. N<sub>2</sub> gave an increase over N<sub>0</sub> of 39.64 tons of cane—both highly significant increases.

For sucrose yields all significant at 0.001, N:Co.376 gave 2.24 tons more than N:Co.310 and 1.12 tons more than N:Co.382 which gave 1.12 tons more than N:Co.310.

The N and K effects on the yields of sucrose were as follows—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>
6.36	9.48	10.13
K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>
7.76	9.14	9.07

The increment was therefore 3.12 for N<sub>1</sub>, and N<sub>2</sub> gave 0.64 over N<sub>1</sub>. N<sub>2</sub> over N<sub>0</sub> gave an increase of 4 tons all significant at P = 0.001.

$K_1$  increased the yield by 1.38 tons sucrose at  $P = 0.001$ .

$K_2$  was not significant over  $K_1$ ; only significant over  $K_0$  by 1.31 tons of sucrose.

The NV interaction showed up in the sucrose yields as well as in the cane yields. The following table shows the relative effects for each variety—

	Increment in yield of Sucrose in tons per acre for $N_1$ and $N_2$		
	N:Co.310	N:Co.376	N:Co.382
$N_1$ —210 lb. N ... ..	2.96	3.85	2.54
$N_2$ —420 lb. N ... ..	3.08	4.66	3.54
Difference between $N_1$ and $N_2$ ... ..	0.12	0.81	1.00

*All significant at  $P = 0.001$*

Furthermore, it is worthy of comment to note that the KV interaction borders on significance at  $P = 0.05$  so in passing the following effects are recorded—

	Increment in yield of Sucrose in tons per acre for $K_1$ and $K_2$		
	N:Co.310	N:Co.376	N:Co.382
$K_1$ — 540 lb. $K_2O$ ...	0.63	1.83	1.66
$K_2$ —1080 lb. $K_2O$ ...	1.02	1.32	1.60
Difference between $K_1$ and $K_2$ ... ..	0.39	-0.51	-0.06

This table is shown for observation only and it will be very interesting to see what happens in the ratoons.

For sucrose per cent cane in this experiment nitrogen, potash, variety, NV and KV were significant.

The varieties gave the following values for sucrose per cent.

N:Co.310	N:Co.376	N:Co.382
16.55	15.24	14.33

*The differences are significant at  $P = 0.001$*

For sucrose per cent cane, N:Co.310 was significantly better than N:Co.376, giving 1.31 per cent more than N:Co.376 and 22.22 per cent over N:Co.382.

$N_1$  depressed the sucrose per cent cane by 0.63 and  $N_2$  by 1.59 at  $P = 0.001$ .  $K_2$  depressed the sucrose per cent cane by 0.40 at  $P = 0.01$ .

The NV interaction is expressed as follows—

	N:Co.310	N:Co.376	N:Co.382
$N_0$ ... ..	16.98	16.14	14.89
$N_1$ 210 lb. N ... ..	16.89	15.01	14.20
$N_2$ 420 lb. N ... ..	15.77	14.57	13.90

from which it is quite clear that  $N_2$  reduced the sucrose by 1.21 for N:Co.310. For N:Co.376,  $N_1$  reduced the sucrose by 1.13 and  $N_2$  by 1.57. N:Co.382 showed a decrease of 0.69 for  $N_1$  and 0.99 for  $N_2$ ; all figures being significant at  $P = 0.001$ .

For the KV interaction for sucrose per cent cane the table is given below—

	N:Co.310	N:Co.376	N:Co.382	Sig. Diff.
$K_0$ ... ..	17.18	14.94	14.40	} 0.42 .05 0.56 .01 0.72 .001
$K_1$ 540 lb. $K_2O$ ... ..	16.40	15.63	14.62	
$K_2$ 1080 lb. $K_2O$ ... ..	16.06	15.16	14.09	

An examination of the figures reveals the interesting phenomenon that where for N:Co.310  $K_1$  depressed the sucrose per cent at 0.001 as did  $K_2$ , in the case of N:Co.376  $K_1$  increased the sucrose per cent cane at  $P = 0.01$ .

The purity values N, K, V, and KV are all significant at  $P = 0.01$ .

The figures for variety were—

N:Co.310	N:Co.376	N:Co.382	Sig. Difference
90.94	88.54	86.74	$\pm 1.49$ at $P = 0.001$

from which it will be seen that for purity N:Co.310 is better than N:Co.376 by 2.40 and 4.20 better than N:Co.382. N:Co.376 was better than N:Co.382 by 1.80.

The N effect was depressive—

$N_0$	$N_1$	$N_2$	Sig. Difference
90.14	88.47	87.62	$\pm 1.49$ at $P = 0.001$

  

$K_0$	Potash with $K_1$	$K_2$	Sig. Difference
89.08	89.01	88.14	$\pm 0.87$ at $P = 0.05$

shows a significant depressive effect for  $K_1$  and  $K_2$ .

For fibre per cent there are three significant figures; nitrogen, potash and variety all at the 0.01 level. There are no interactions although PK is not very far off; therefore it will be of interest to follow at later stages of development in this experiment.

$N_1$  decreased the fibre per cent over  $N_0$  by 1.26 at  $P = 0.01$  and  $N_2$  over  $N_0$  by 1.57 at  $P = 0.001$ ; the significant differences being 0.70 for  $P = 0.05$ ; 0.93 at  $P = 0.01$ ; and 1.21 for  $P = 0.001$ . The drop between  $N_1$  and  $N_2$  is not significant.

K likewise decreased the fibre per cent.  $K_1$  at  $P = 0.05$  decreased it by 0.72 and  $K_2$  at  $P = 0.01$  over  $N_0$  by 0.99—the difference between  $K_1$  and  $K_2$  is not significant.

Varieties fibre per cent gave—

N:Co.310	N:Co.376	N:Co.382
13.77	12.96	15.89

with a difference of 0.81. N:Co.376 was significantly less than N:Co.310 at  $P = 0.05$  and with a difference

of 2.93. N:Co.376 is very highly significantly lower than N:Co.382 as is N:Co.310 with 2.12 less fibre per cent. Both figures qualify at well over  $P = 0.001$ .

Thus, having run through this experiment in detail it is very interesting after observing the significant effects to dwell for a moment on the actual achievements from the original angle of approach.

It will be remembered that the fertilizer applied was calculated from Hedley and Beater's figures for the removal of N, P and K by a given crop and that their figures were averaged and calculated to fit an 80-ton crop.

Also, it will be remembered that in 1924 the yields of Uba cane were, for the controls, 23.98 tons of cane and for the fertilized plots 32.95 tons. An examination of the three-way table of the present experiment reveals that the controls gave an average tonnage equivalent to 30.62 tons of cane per acre, and  $N_2P_2K_2$  an average of 76.20 tons of cane per acre.

The general average for the whole experiment was 57.78 tons of cane per acre. The highest yields were for  $N_2K_2$  with N:Co.376 which gave 84.14 tons per acre and  $N_2P_2$  on N:Co.376 which gave 86.83 tons of cane per acre.

The S.E. for tons cane was 4.62 which was 8.08 per cent of the General Mean.

Although after this experiment was replanted, the most favourable climatic conditions were experienced, nevertheless the effects and yields are very indicative of possible developments.

### CO-OPERATIVE EXPERIMENT WITH MR. BECHARD AT RICHENEAU—GINGINDHLOVU

In 1951 a Quasi Latin Square design experiment was laid down on this farm on a sandy soil with a high water table as indeed is indicated by the name.

The soil type is of the same geological order as that at "Mine Own" which is in point of fact not far distant.

The total amounts of fertilizer given were—

$N_0$	— 0
$N_1$	— 40 lb. N from ammonium sulphate 21% N
$N_2$	— 80 lb. N " " " " N
$P_0$	— 0
$P_1$	— 60 lb. $P_2O_5$ from superphosphate 19.1% $P_2O_5$
$P_2$	— 120 lb. $P_2O_5$ from superphosphate 19.1% $P_2O_5$
$K_0$	— 0
$K_1$	— 150 lb. $K_2O$ from KCl. 60% $K_2O$
$K_2$	— 300 lb. " " " " "

The setts were dipped before planting and planting was done under very wet conditions. Half the N applications and half the K applications were given as basal dressings. The balance was split into two top dressings.

Planting date ... ..	21.11.51
1st Top dressing ... ..	12. 1.52
2nd Top dressing ... ..	23. 9.52
The cane was harvested on the	6.10.53

The fertilizer effects which were significant in the experiment were very visible throughout the growth period.

For the yields of cane, N is significant at 0.05. K and V were significant at the .01 level and an NK interaction at .05.

The three varieties used were N:Co.331, N:Co.290 and N:Co.310.

Average yields in tons cane per acre			Sig. Difference	Tons/cane
Co.331	Co.290	N:Co.310		
40.38	45.76	47.18	$\left\{ \begin{array}{l} P = 0.05 \\ P = 0.01 \\ P = 0.001 \end{array} \right.$	=4.29
				=5.70
				=7.40

from which it will be seen that N:Co.310 was very nearly superior to Co.331 at  $P = 0.001$  with 6.80 tons greater yield per acre, and Co.290 was nearly superior to Co.331 at  $P = 0.01$  with 5.38 tons of cane.

The difference between Co.290 and N:Co.310 was not significant in tons cane per acre.

N effects in tons cane per acre—

$N_0$	$N_1$	$N_2$	Sig. Difference	Tons/cane
41.49	44.85	49.75		
			=5.70	
			=7.40	

$N_2 > N_0$  at  $P = 0.001$  with 8.26 tons of cane,  $> N_1$  at  $P = 0.05$  with 4.90 tons of cane.

The K effects in tons cane per acre—

$K_0$	$K_1$	$K_2$	Sig. Difference	Tons/cane
33.11	49.78	50.40		
			=5.70	
			=7.40	

$K_1$  and  $K_2 > K_0$  at  $P = 0.001$  with 16.67 tons and 17.29 tons cane respectively.  $K_2$  was not significantly better than  $K_1$  in this main effect but the NK interaction was significant which modifies drawing conclusions of this effect entirely at this stage.

In the absence of potash,  $N_1$  had no effect on the yield at all.  $K_1$  on the other hand increased the yield by 8.28 tons at  $P = 0.05$  in the absence of  $N_1$ , and in the presence of  $N_1$  the added increase over  $K_1$  was 8.05 tons at  $P = 0.05$  and  $N_1$  17.90 tons at  $P = 0.001$

Thus,  $N_0K_0$  gave 35.16 tons cane per acre  
 $N_1K_0$  gave 33.59 tons " " "  
 $N_0K_1$  gave 43.44 tons " " "  
 and  $N_1K_1$  gave 51.50 tons " " "

Passing on to an examination of the effects of fertilizer treatments on the yields of sucrose per acre, N is significant at .05, K and V at .01, and NK at .05.

For varieties the position was as follows—

Co.331	Co.290	N:Co.310
6.04	6.93	7.97

For the N effect in tons sucrose—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference	Tons	
6.49	7.12	7.33	P = 0.05	=0.68	
and the K effect in tons sucrose:				P = 0.01	=0.91
K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>			
4.95	7.89	8.09	P = 0.001	=1.19	

from which it is evident that N<sub>2</sub> > N<sub>0</sub> at P = 0.01 with 0.84 tons of sucrose and K<sub>1</sub> and K<sub>2</sub> > K<sub>0</sub> at P = 0.001 with 2.84 and 3.14 tons of sucrose respectively. The difference between K<sub>1</sub> and K<sub>2</sub> of course is not significant as can be observed.

For varieties it can be seen that Co.290 was superior to Co.331 at P = 0.05 with 0.89 tons sucrose, and that N:Co.310 was superior to Co.290 at above the P = 0.01 level with 1.04 tons of sucrose and above Co.331 at the P = 0.001 level with 1.93 tons of sucrose.

For the NK interaction in tons sucrose—

N <sub>0</sub> K <sub>0</sub>	K <sub>1</sub>	N <sub>1</sub>	N <sub>1</sub> K <sub>1</sub>
5.34	6.70	5.04	8.29

K<sub>1</sub> > K<sub>0</sub> at P = 0.001 with 1.36 tons sucrose, N<sub>1</sub>K<sub>1</sub> significant over K<sub>1</sub> at P = 0.001 with 1.59 tons sucrose.

For the sucrose per cent cane, P was significant at .01, K at .01 and variety at .01.

For variety sucrose per cent cane—

K <sub>0</sub> Co.331	K <sub>1</sub> Co.290	K <sub>2</sub> N:Co.310	Sig. Difference	Sucrose %
14.85	15.03	16.96	{ P = 0.05 P = 0.01 P = 0.001	=0.34
				=0.45
				=0.58

N:Co.310 > Co.290 at P = 0.001 with 1.93 per cent and > Co.331 with 2.11 per cent. The S.E. of this section of the experiment was 1.27 and 18.18 per cent of the General Mean.

The P effects were—

P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	Sig. Difference	Sucrose %	
14.46	15.88	15.50	P = 0.05	=0.34	
and the K effects were:				P = 0.01	=0.45
K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>			
14.90	15.83	16.11	P = 0.001	=0.58	

Thus P<sub>1</sub> and P<sub>2</sub> > P<sub>0</sub> at P = 0.001 with 1.42 per cent and P<sub>2</sub> > P<sub>1</sub> at P = 0.05 with 0.38 per cent sucrose. K<sub>1</sub> and K<sub>2</sub> > K<sub>0</sub> at P = 0.001 with 0.93 per cent sucrose and 1.21 per cent sucrose respectively.

The General Mean of this experiment for tons cane was 44.43 tons of cane per acre. N<sub>0</sub>P<sub>0</sub>K<sub>0</sub> gave an average of 42.54 tons of cane and N<sub>2</sub>P<sub>1</sub>K<sub>2</sub> gave 60.03 tons of cane per acre.

## CO-OPERATIVE EXPERIMENT AT ILLOVO SUGAR COMPANY—POWERS COURT

In September 1953 a co-operative experiment was put down at Powers Court.

The soil is a product of decomposing mist belt Table Mountain sandstone.

The varieties used were N:Co.331, Co.310 and Co.301.

The fertilizers used were—

N <sub>0</sub> = 0	N <sub>1</sub> = 100	N <sub>2</sub> = 200	from ammonium sulphate
P <sub>0</sub> = 0	P <sub>1</sub> = 100	P <sub>2</sub> = 200	„ superphosphate
K <sub>0</sub> = 0	K <sub>1</sub> = 100	K <sub>2</sub> = 200	„ potassium sulphate

All the phosphate was applied as a basal dressing in the furrow, half the nitrogen at the time of planting, and half as a top dressing. The potash was also applied in two dressings.

The cane was planted on the 3rd September, 1953.

The plant cane crop in terms of tons of cane per acre gave a significance for N at 0.05, K at 0.01, and PK interaction was not far distant from being significant at 0.05.

Co.331	N:Co.310	Co.301	Sig. Difference	T/Acre
49.15	58.21	37.18	P = 0.05	=3.73
N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>		
42.23	45.53	47.77	P = 0.01	=4.95
K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>		
40.62	45.42	49.47	P = 0.001	=6.45

An examination of the table reveals that Co.331 was better than Co.301 by 11.97 tons of cane per acre and that N:Co.310 was better than Co.301 by 21.03 tons of cane per acre and better than Co.331 by 9.06 tons of cane per acre. All these increments are well over the P = 0.001 level.

N<sub>2</sub> was significantly higher than N<sub>0</sub> with 5.54 tons of cane.

K<sub>1</sub> was higher than K<sub>0</sub> by 4.80 tons just short of 0.01 and N<sub>2</sub> was higher than N<sub>1</sub> by 2.24 tons which is not significantly better than N<sub>1</sub>. N<sub>2</sub>, however, is greater than N<sub>0</sub> by 5.54 tons of cane per acre at P = 0.01.

The PV interaction is quoted for reference only where P<sub>1</sub> and P<sub>2</sub> increased the yield of Co.331 and depressed the yield of N:Co.310 and increased the yield of Co.301.

For the yield of sucrose per acre, P and K and variety were significant; P = 0.05, K and V = 0.001. An NV interaction is not so very far from being significant.

V <sub>0</sub>	V <sub>1</sub>	V <sub>2</sub>	Sig. Difference	T/Ac
5.46	8.36	4.49	P = 0.05	=0.40
P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>		
5.83	6.06	6.41	P = 0.01	=0.53
K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>		
5.28	6.27	6.75	P = 0.001	=0.69

From this table one can see that in this experiment: Co.331 > Co.301 by 0.97 tons, N:Co.310 > Co.331 by 2.90 tons and N:Co.310 > Co.301 by 3.87 tons of sucrose per acre.

For the P effect P<sub>1</sub> is not significantly higher than P<sub>0</sub> but P<sub>2</sub> with 0.58 tons sucrose per acre is significant at P = 0.01.

The K effects are that K<sub>1</sub> > K<sub>0</sub> by 0.99 tons and K<sub>2</sub> > K<sub>1</sub> at P = 0.05 and K<sub>2</sub> > K<sub>0</sub> by 1.47 tons per acre at P = 0.001.

For reference only the NV figures show an increase of tonnage from N<sub>1</sub> for Co.331, a tendency to decrease for N:Co.310 and a general tendency to increase for Co.301.

For the sucrose per cent there are significant figures for the main effects of N at .05, K at .05, V at .001 and NV interaction at .01, a PV interaction at .05, and a KV interaction at .01.

For varieties the sucrose per cent cane was recorded as follows—

Co.331	N:Co.310	Co.301	Significant Difference
13.57	14.80	12.08	$\left\{ \begin{array}{l} 0.22\% = P = 0.05 \\ 0.28\% = P = 0.01 \\ 0.37\% = P = 0.001 \end{array} \right.$

It can be seen from this that N:Co.310 > Co.331 by 1.23 per cent and > Co.301 by 2.72 per cent at P = 0.001.

For N effects—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Significant Difference
13.62	13.53	13.30	$\left\{ \begin{array}{l} 0.22\% = P = 0.05 \\ 0.28\% = P = 0.01 \\ 0.37\% = P = 0.001 \end{array} \right.$

N<sub>0</sub> > N<sub>2</sub> by 0.32 per cent at P = 0.05, N<sub>1</sub> > N<sub>2</sub> by 0.23 per cent at P = 0.05.

For K effects—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>
13.34	13.62	13.49

where K<sub>1</sub> > K<sub>0</sub> by 0.28 at P = 0.05.

For the NV interaction N<sub>1</sub> and N<sub>2</sub> depressed the sucrose per cent by 0.45 per cent at P = 0.05 and by 0.78 per cent at P = 0.01 on N:Co.310 there were no other significant interaction effects.

For the PV interaction P<sub>2</sub> increased the sucrose per cent cane by 0.62 per cent at P = 0.01 on Co.331, P<sub>1</sub> depressed the sucrose per cent by 0.57 on N:Co.310 and there was no change for Co.301.

The KV interaction showed an increase of sucrose per cent by 0.58 per cent for K<sub>2</sub> on Co.331 a nearly significant increase for K<sub>1</sub> on N:Co.310 and a significant increase on Co.301 for K<sub>1</sub> by 0.39 per cent.

For purity in the plant cane crop only variety at 0.001 and PV at .01 were significant.

Co.331	N:Co.310	Co.301	Significant Differences
89.88	91.26	88.83	$\left\{ \begin{array}{l} 0.67\% = P = 0.05 \\ 0.89\% = P = 0.01 \\ 1.15\% = P = 0.001 \end{array} \right.$

N:Co.310 > Co.331 by 1.38 and > Co.301 by 2.43 at P = 0.001.

The PV interaction shows that P<sub>2</sub> increased the purity by 1.27 for Co.331 and P<sub>1</sub> decreased the purity by 1.7 at P = .05 and .01 respectively.

### 1st Ratoon

The fertilizer was applied in the rows before the cane was cut. For this purpose the cane was pre-trashed. The idea was to have fertilizer available for the 1st ratoon from the very outset of growth instead of cutting the cane first and top-dressing only when the cane became visible again.

The first ratoon was cut in July 1957; N and K were significant at .05 and varietal effect at .01.

In tons of cane per acre varieties gave the following:

Co.331	N:Co.310	Co.301	Sig. Difference	T/Ac
29.62	46.47	39.97	$\left\{ \begin{array}{l} .05 \\ .01 \\ .001 \end{array} \right.$	$\left\{ \begin{array}{l} 3.43 \\ 4.57 \\ 5.94 \end{array} \right.$

Thus N:Co.310 > Co.301 by 6.50 tons and > Co.331 by 16.85 tons of cane, Co.301 > Co.331 by 10.35 tons of cane.

The N effect for tons cane per acre was—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference	T/Ac
35.59	40.53	39.96	$\left\{ \begin{array}{l} .05 \\ .01 \\ .001 \end{array} \right.$	$\left\{ \begin{array}{l} 3.43 \\ 4.57 \\ 5.94 \end{array} \right.$

N<sub>1</sub> > N<sub>0</sub> by 4.94 tons cane and N<sub>2</sub> > N<sub>0</sub> by 4.37 tons cane. The difference between N<sub>1</sub> and N<sub>2</sub> is not significant.

The K effect was—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Sig. Difference	T/Ac
35.99	39.16	40.93	$\left\{ \begin{array}{l} .05 \\ .01 \\ .001 \end{array} \right.$	$\left\{ \begin{array}{l} 3.43 \\ 4.57 \\ 5.94 \end{array} \right.$

K<sub>1</sub> > K<sub>0</sub> by 3.17 tons of cane which just misses significance at .05, K<sub>2</sub> > K<sub>0</sub> by 4.94 tons cane at a significant level.

For tons sucrose there were significant effects from variety at .01, N and K at .05.

Co.331	In tons sucrose per acre N:Co.310	Co.301	Sig. Difference	T/Ac
3.95	6.97	5.11	$\left\{ \begin{array}{l} .05 \\ .01 \\ .001 \end{array} \right.$	$\left\{ \begin{array}{l} 0.52 \\ 0.70 \\ 0.91 \end{array} \right.$

N:Co.310 > Co.301 by 1.86 tons sucrose and > Co.331 by 3.02 tons sucrose per acre. Co.301 > Co.331 by 1.16 tons sucrose. All these figures being at the .001 level of significance.

The N effect was—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference	T/Ac
4.89	5.61	5.52	$\left\{ \begin{array}{l} .05 \\ .01 \\ .001 \end{array} \right.$	$\left\{ \begin{array}{l} 0.52 \\ 0.70 \\ 0.91 \end{array} \right.$

N<sub>1</sub> > N<sub>0</sub> by 0.72 tons sucrose, N<sub>2</sub> > N<sub>0</sub> by 0.63 tons sucrose; the difference between N<sub>1</sub> and N<sub>2</sub> was not significant.

K showed the following—

$K_0$	$K_1$	$K_2$	Sig. Difference	T/Ac
4.89	5.04	5.47	.05	0.52
			.01	0.70
			.001	0.91

$K_2 > K_0$  by 0.58 tons sucrose per acre; the difference between  $K_1$  and  $K_2$  is not significant.

In the case of sucrose per cent cane, P is significant at .05 and variety at .01; there were no other effects.

For variety—

Co.331	N:Co.310	Co.301	Sig. Difference	% Cane
13.36	14.95	12.79	.05	0.46
			.01	0.61
			.001	0.79

N:Co.310 > Co.331 by 0.59 per cent > Co.301 by 2.16 per cent, Co.331 > Co.301 by 0.57 per cent.

P gave the following—

$P_0$	$P_1$	$P_2$	Sig. Difference	% Cane
13.92	13.83	13.36	.05	0.46
			.01	0.61
			.001	0.79

$P_2 < P_0$  by 0.56 per cent,  $P_2 < P_1$  by 0.47 per cent.

For purity two effects were significant—variety at 0.01 and potash at 0.05.

Co.331	N:Co.310	Co.301	Significant Differences	
88.94	90.42	88.95	.05	1.08
			.01	1.43
			.001	1.86

N:Co.310 > Co.331 and Co.301 by 1.48 and 1.47 respectively.

## CO-OPERATIVE EXPERIMENT

### —NATAL ESTATES BURNSIDE SECTION

At Natal Estates Burnside Section a Quasi Latin square design experiment was put down in 1951 on 3rd April.

The soil is a sand of recent origin and an examination of the profile gave—

0-9" Reddish Sand  
10-36" Red Sand  
37-48" Bright Red Sand with lumps of agglomerated material.

Region of main root development 4"-36". A crop of Sunn hemp was ploughed in just prior to planting.

Very heavy dressings of filter press cake high in lime are used on these soils and the experiment was primarily put down to study the effect of fertilizer on this soil type saturated with this high lime material.

It was thought that it would be unlikely to be able to record any response to potash unless the experiment could be run for many years on account of the antagonism between Ca and K.

Most unfortunately this experiment site was planted up again after ploughing out in the absence of the investigator and following the death of the

manager of the section on which it was situated. Nevertheless, some very interesting data were collected so that the effort was not wasted by any means and this experiment, as did the others, contributed to our knowledge of the problem.

The three varieties used were Co.331, Co.301 and N:Co.310. The fertilizer dressings were—

$N_0 = 0$   $N_1 = 20$   $N_2 = 40$  from ammonium sulphate 21% N.

$P_0 = 0$   $P_1 = 60$   $P_2 = 120$  from superphosphate 19.1%  $P_2O_5$ .

$K_0 = 0$   $K_1 = 75$   $K_2 = 150$  from  $(K_2SO_4)$  48%  $K_2O$ .

All the phosphate was applied at the time of planting in the furrow, together with the potash and half the nitrogen. The balance of the nitrogen was applied as a top dressing on 15th September, 1951.

The cane was harvested in December, 1952 and the statistical analysis revealed that N and P were significant at .05, variety at .001 and an NK interaction at .01. It would seem that one has to apply nitrogen on a far higher level than was used in this experiment to get an NV interaction.

The results were as follows in tons cane per acre—

Co.331	Co.301	N:Co.310	Sig. Difference	T/Ac
57.61	41.04	39.69	.05	3.42
$N_0$	$N_1$	$N_2$		
43.29	48.41	46.60	.01	4.55
$P_0$	$P_1$	$P_2$		
32.68	47.06	47.61	.001	5.92

Scrutiny of the table reveals that—

Co.331 > Co.301 and > N:Co.310 at  $P = 0.001$  with differences of 16.57 tons cane per acre and 17.92 tons cane per acre respectively. The difference between Co.301 and N:Co.310 is not significant.

For nitrogen  $N_1 > N_0$  at  $P = 0.01$  giving an increment of 5.12 tons cane,  $N_2$  is not significantly better than  $N_0$ , nor is the depressing effect of  $N_2$  over  $N_1$  significant.

In the case of P the effect is that  $P_1 > P_0$  at  $P = 0.05$  with an increment of 4.38 tons of cane and  $P_2 > P_0$  at  $P = 0.01$  with 4.93 tons of cane per acre increment but there is no significance between  $P_1$  and  $P_2$ .

The NK interaction is of very great interest in that it draws one's attention to the value of factorial designs which are capable of avoiding the drawing of completely false impressions and conclusions.

NK Interaction Table—

	In tons Cane per acre			Sig. Difference	T/Ac
	$N_0$	$N_1$	$N_2$		
$K_0$	46.46	46.00	46.10	.05	5.92
$K_1$	37.66	50.15	48.64	.01	7.88
$K_2$	45.75	49.08	45.16	.001	10.25

Potash in the variance table is not significant as must have been observed since no mention was made of it at all.

The NK interaction being significant throws light on the effect of potash in this soil and this experiment. By itself nitrogen had no effect at these levels and potash by itself at the  $K_1$  level depressed the yield by 8.80 tons of cane at  $P = 0.01$ . The  $K_2$  depression was not significant. 20 lb. of the N and 75 lb.  $K_2O$  together in the  $(N_1K_1)$  treatment gave a yield of 50 tons of cane, which is 13.49 tons higher than  $K_1$  and 4.15 tons higher than  $N_1$ .

An examination of the tons sucrose per acre reveals N significant at 0.01, variety at 0.001 and an NK interaction at 0.01.

The following table gives the effect in tons sucrose per acre—

Co.331	Co.301	N:Co.310	Sig. Difference	T/Ac
7.99	6.25	6.49	.05	0.52
$N_0$	$N_1$	$N_2$	.01	0.68
6.44	7.32	6.97	.001	0.89

Co.331 > Co.301 and > N:Co.310 by 1.74 tons of sucrose per acre and 1.50 tons respectively at  $P = 0.001$ .

It will be noticed here that as against tons of cane per acre differences, N:Co.310 shows a reduced margin due to the high sucrose per cent cane value of this variety.

$N_1$  is not significantly better than  $N_2$  but now  $N_2$  is significantly better than  $N_0$  which it was not for tons cane per acre.  $N_1 > N_0$  by 0.88 tons of sucrose per acre at  $P = 0.01$ .

NK Interaction Table in tons sucrose—

	$N_0$	$N_1$	$N_2$	Sig. Difference	T/Ac
$K_0$	7.00	6.90	6.98	.05	0.8
$K_1$	5.56	7.64	7.28	.01	1.19
$K_2$	6.75	7.41	6.65	.001	1.55

The  $(N_1K_1)$  effect is highly significant over  $K_1$  which alone depressed the yield significantly but this yield just escapes significance over  $(N_0K_0)$ .

An examination of the sucrose per cent cane figures shows that only variety is significant in this experiment with an NV interaction at 0.05.

The varietal effect is shown as—

Co.331	Co.301	N:Co.310	Sig. Difference	% Sucrose
13.87	15.00	16.41	.05	0.33
			.01	0.44
			.001	0.57

where N:Co.310 > Co.301 > Co.331 by 1.41 per cent and 1.13 per cent respectively. N:Co.310 > Co.331 by 2.54 per cent.

The NV Interaction shows—

	Co.331	Co.301	N:Co.310	Sig. Difference	% Sucrose
$N_0$	14.02	14.84	16.27	.05	0.58
$N_1$	13.83	15.78	16.42	.01	0.77
$N_2$	13.77	14.98	16.53	.001	1.00

So that  $N_1$  increased the sucrose per cent for Co.301 by 0.94 per cent and  $N_2$  decreased it from 15.78 by 0.80 per cent.

For purity the only significant feature is the varietal effect—

Co.331	Co.301	N:Co.310	Sig. Difference	% Sucrose
90.36	92.67	93.24	.05	0.58
			.01	0.77
			.001	1.00

N:Co.310 > Co.331 by 2.88 and just missed significance over Co.301 which was > Co.331 by 2.31.

The whole lot of fertilizer was broadcast in the cane rows before cutting, the cane having been pre-trashed for the purpose.

Harvested on 14th October 1954, the first ratoon gave a significant value for variety only. None of the fertilizer effects being positive on the yield of cane per acre.

Co.331	Co.301	N:Co.310	Sig. Difference	T/Ac
63.19	51.01	41.56	.05	3.86
			.01	5.13
			.001	6.68

Co.331 > Co.301 by 12.18 tons of cane per acre and > N:Co.310 by 21.63 tons of cane per acre. Co.301 > by 9.45 tons of cane per acre.

For sucrose per acre the only significant value was for Variety—

Co.331	Co.301	N:Co.310	Sig. Difference	T/Ac
8.80	7.73	6.85	.05	0.86
			.01	1.14
			.001	1.49

Co.301 > Co.331 by 1.07 tons sucrose per acre. Co.301 > N:Co.310 by 0.88 tons sucrose per acre.

Sucrose per cent cane similarly showed only one significant figure and that was again for variety—

Co.331	Co.301	N:Co.310	Sig. Difference	% Cane
13.92	15.16	16.73	.05	0.41
			.01	0.53
			.001	0.71

N:Co.310 > Co.301 by 1.24 per cent and > Co.331 by 2.81 per cent, Co.301 > Co.331 by 1.24 per cent.

The treatment effect on purity was significant for variety at .001 and K at .05.

Co.331	Co.301	N:Co.310	Sig. Difference	% Cane
90.64	91.52	92.52	.05	0.73
			.01	0.97
			.001	1.27

N:Co.310 > Co.301 by 1.00 and > Co.331 by 1.88. Co.301 > Co.331 by 0.88.

For K the figures were—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Significant Difference	
91.62	92.00	91.05	.05	0.73
			.01	0.97
			.001	1.27

$K_1 > K_2$  by 0.95.

The fertilizer was augmented for N and K after these results had been observed and for—

N <sub>1</sub>	20 lb. N	} was applied in the spring 1956.
N <sub>2</sub>	40 ,, N	
K <sub>1</sub>	75 ,, K <sub>2</sub> O	
K <sub>2</sub>	150 ,, K <sub>2</sub> O	

Thus the totals applied to the second ratoon were in point of fact—

N <sub>1</sub>	60 lb. N
N <sub>2</sub>	120 ,, N
K <sub>1</sub>	150 ,, K <sub>2</sub> O
K <sub>2</sub>	300 ,, K <sub>2</sub> O

The second ratoon was harvested on 21st December 1955, and the results showed for cane weight a very significant main response for N at 0.01, the varietal effect was also significant at a high level of 0.001.

For varieties in tons cane—

Co.331	Co.301	N:Co.310	Sig. Difference		T/Ac
42.37	39.82	28.14	.05	4.98	4.98
			.01	6.63	6.63
			.001	8.63	8.63

where Co.331 > N:Co.310 by 14.23 tons of cane per acre, Co.301 > N:Co.310 by 11.68 tons of cane per acre.

The Nitrogen effect was—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference		T/Ac
32.01	39.27	39.06	.05	4.98	4.98
			.01	6.63	6.63
			.001	8.63	8.63

$N_1 > N_0$  by 7.26 tons of cane per acre and  $N_2 > N_0$  by 7.05 tons of cane per acre.

The figures recorded for tons sucrose per acre were interesting. N was significant at .01, variety at .01 and an NK interaction at .05.

Therefore, the tons sucrose for the varieties gave—

Co.331	Co.301	N:Co.310	Sig. Difference		T/Ac
5.42	5.66	4.38	.05	.67	.67
			.01	.87	.87
			.001	1.16	1.16

Co.301 > N:Co.310 by 1.28 tons of sucrose per acre and Co.331 > N:Co.310 by 1.04 tons of sucrose per acre.

For N effect—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference		T/Ac
4.54	5.53	5.38	.05	.67	.67
			.01	.87	.87
			.001	1.16	1.16

$N_1 > N_0$  by 0.99 tons sucrose per acre and  $N_2 > N_0$  by 0.84 tons of sucrose per acre. These differences were at the  $P = 0.01$  level and the difference between  $N_1$  and  $N_2$  was not significant.

The interaction followed the same pattern as in the plant cane in that  $K_1$  depressed the yield, N produced no effect alone, but in conjunction with  $K_1$  at the  $N_2$  level, gave an increase.

For sucrose per cent cane effects from varieties gave—

Co.331	Co.301	N:Co.310	Sig. Difference		% Cane
12.85	14.08	15.61	.05	0.36	0.36
			.01	0.47	0.47
			.001	0.62	0.62

N:Co.310 > Co.301 > Co.331 by 0.53 per cent sucrose and 1.23 per cent sucrose respectively. N:Co.310 > Co.331 by 2.76 per cent sucrose.

For N effects—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference		% Cane
14.32	14.30	13.92	.05	0.36	0.36
			.01	0.47	0.47
			.001	0.62	0.62

$N^2 < N_0$  by 0.40 per cent

In the case of purity the following figures were obtained—

Co.331	Co.301	N:Co.310	Significant Differences	
90.45	91.42	92.90	.05	0.64
			.01	0.85
			.001	1.10

N:Co.310 > Co.301 by 1.48 and > Co.331 by 2.45, N:Co.301 > Co.331 by 0.97.

### CO-OPERATIVE QUASI LATIN DESIGN AT NELTHORPE, GINGINDHLOVU MR. D. NIGHTINGALE

In 1951 a site was selected to test fertilizer effects on one of the most difficult soils of the sugar belt of Natal—a shallow Ecca Shale with a hard pan very close to the surface.

The fertilizer given was as follows—

N <sub>0</sub> = 0	N <sub>1</sub> = 100 lb. N	N <sub>2</sub> = 200 lb. N	N from ammonium sulphate
P <sub>0</sub> = 0	P <sub>1</sub> = 100 lb. P <sub>2</sub> O <sub>5</sub>	P <sub>2</sub> = 200 lb. P <sub>2</sub> O <sub>5</sub>	superphosphate
K <sub>0</sub> = 0	K <sub>1</sub> = 100 lb. K <sub>2</sub> O	K <sub>2</sub> = 200 lb. K <sub>2</sub> O	from potassium chloride

Only one quarter of the N = 25 lb. for  $N_1$  and 50 lb. N for  $N_2$  was applied at planting time, all the P<sub>2</sub>O<sub>5</sub>, and half the potash 50 lb. K<sub>2</sub>O for  $K_1$  and 100 lb. K<sub>2</sub>O for  $K_2$ .

The cane was planted on 29th November, 1951 and top dressed ten months later with—

25 lb. N	for $N_1$	and 50 lb. N	for $N_2$
50 lb. K <sub>2</sub> O	for $K_1$	and 100 lb. K <sub>2</sub> O	for $K_2$

Four months later the balance of nitrogen was applied; 50 lb. N for  $N_1$  and 100 lb. N for  $N_2$ .

The cane was harvested in September 1953. P was significant for tons of cane per acre at .01, K at .05 and variety at .001.

The varieties used were Co.301, N:Co.310 and Co.331 and the yields of plant cane were as follows—

In tons of Cane per Acre				
Co.301	N:Co.310	Co.331	Sig. Difference	T/Ac
50.26	56.21	45.16	{ .05 .01 .001	{ 0.80 1.07 1.38

N:Co.310 > Co.301 > Co.331 by 5.95 tons of cane per acre and 5.10 tons of cane respectively. N:Co.310 > Co.331 by 11.05 tons of cane.

P effects in tons of cane were—

P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	Sig. Difference	T/Ac
47.71	51.47	52.45	{ .05 .01 .001	{ 0.80 1.07 1.38

P<sub>2</sub> > P<sub>1</sub> > P<sub>0</sub> by 0.98 and 3.76 tons respectively and P<sub>2</sub> > P<sub>0</sub> by 4.74 tons of cane.

The K effects in tons of cane per acre were—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Sig. Difference	T/Ac
49.00	50.14	52.50	{ .05 .01 .001	{ 0.80 1.07 1.38

K<sub>2</sub> > K<sub>0</sub> by 3.5 tons of cane and > K<sub>1</sub> by 2.36 tons of cane whilst K<sub>1</sub> > K<sub>0</sub> by 1.14 tons of cane per acre.

It is interesting to note that for this experiment in the plant cane, the sucrose in tons per acre showed no fertilizer effect whereas for varieties the differences were marked.

Co.301	N:Co.310	Co.331	Sig. at 0.01
8.01	9.83	6.77	

N:Co.310 > Co.301 > Co.331 by 1.82 tons of sucrose and 1.34 tons respectively. N:Co.310 > Co.331 by 3.06 tons of sucrose.

For sucrose per cent cane significant figures were obtained for nitrogen and phosphates at .01, potash just on .05 and variety at .001.

The figures for variety in sucrose per cent cane—

Co.301	N:Co.310	Co.331	Sig. Difference	Sucrose % Cane
15.99	17.52	15.04	{ .05 .01 .001	{ 0.30 0.41 0.53

N:Co.310 > Co.301 by 1.53 per cent, Co.301 > Co.331 by 0.95 per cent and N:Co.310 > Co.331 by 2.48 per cent.

Nitrogen effects were—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference	Sucrose % Cane
16.47	16.19	15.89	{ .05 .01 .001	{ 0.30 0.41 0.53

N<sub>2</sub> < N<sub>0</sub> by 0.58 per cent.

P effects were—

P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	Sig. Difference	Sucrose % Cane
16.46	16.13	15.97	{ .05 .01 .001	{ 0.30 0.41 0.53

P<sub>2</sub> < P<sub>0</sub> by 0.49 per cent.

K effects were—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Sig. Difference	T/Ac
16.32	16.27	15.97	{ .05 .01 .001	{ 0.30 0.41 0.53

K<sub>2</sub> < K<sub>0</sub> by 0.35 per cent.

For the first ratoon all the fertilizer was applied in one lot as soon as the cane was visible. Unfortunately fire spread to the plots from an accidental fire and the plots had to be cut again in August 1954. The yields were very good considering.

For tons cane per acre, N, P and Variety were significant at 0.001 and K at 0.01. For Variety the following were the effects—

Co.301	N:Co.310	Co.331	Sig. Difference	T/Ac
36.60	34.11	28.65	{ .05 .01 .001	{ 2.29 3.05 3.97

Co.331 > N:Co.310 by 2.49 tons of cane and N:Co.310 > Co.331 by 5.46 tons of cane per acre and Co.301 > Co.331 by 7.95 tons of cane per acre.

The main effect of N in tons of cane per acre was as follows—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference	T/Ac
30.65	32.89	35.82	{ .05 .01 .001	{ 2.29 3.05 3.97

N<sub>1</sub> is just short of significance at .05, N<sub>2</sub> > N<sub>0</sub> by 5.17 tons of cane per acre and > N<sub>1</sub> by 2.93 tons of cane per acre.

Under these conditions P gave good response with the following main effects—

P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	Sig. Difference	T/Ac
28.84	33.92	36.60	{ .05 .01 .001	{ 2.29 3.05 3.97

P<sub>1</sub> > P<sub>0</sub> by 5.08 tons of cane per acre. P<sub>2</sub> > P<sub>1</sub> by 2.58 tons per acre and > P<sub>0</sub> by 7.77 tons of cane per acre.

The yields in tons sucrose per acre were significant for N at .01, P at .001, K at .05 and Variety at .001.

For Varieties—

Co.301	N:Co.310	Co.331	Sig. Difference	T/Ac
4.70	5.39	3.12	{ .05 .01 .001	{ 0.36 0.47 0.62

N:Co.310 > Co.301 by 0.69 tons of sucrose per acre. Co.301 > Co.331 by 1.58 tons of sucrose per acre and N:Co.310 > Co.331 by 2.27 tons of sucrose per acre.

Nitrogen gave the following effects—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference	T/Ac
4.06	4.37	4.81	{ .05 .01 .001	{ 0.36 0.47 0.62

N<sub>1</sub> > N<sub>0</sub> by very nearly .05 with 0.31 tons of sucrose per acre. N<sub>2</sub> > N<sub>1</sub> by 0.44 tons of sucrose per acre and N<sub>2</sub> > N<sub>0</sub> by 0.76 tons of sucrose per acre.

The P effect on the sucrose tonnage per acre was—

P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	Significant Difference	
3.87	4.58	4.78	.05	0.36
			.01	0.47
			.001	0.62

P<sub>1</sub> > P<sub>0</sub> by 0.71 tons of sucrose per acre. P<sub>2</sub> > P<sub>0</sub> by 0.91 tons of sucrose but not significantly better than P<sub>1</sub> with 0.20 tons of sucrose per acre.

For the potash effect—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Sig. Difference		T/Ac
4.16	4.41	4.66	.05	0.36	
			.01	0.47	
			.001	0.62	

K<sub>1</sub> is just not better than K<sub>0</sub> at .05 with 0.31 tons of sucrose per acre but K<sub>2</sub> > K<sub>0</sub> by 0.50 tons of sucrose per acre.

The only figure of any value in the sucrose per cent cane was expressed by the differences between varieties—

Co.301	N:Co.310	Co.331	Significant Differences	
12.96	15.76	11.03	.05	0.35
			.01	0.46
			.001	0.60

N:Co.310 > Co.301 > Co.331 by 2.80 per cent and 1.93 per cent respectively. N:Co.310 > Co.331 by 4.73 per cent.

The fertilizer was applied as before.

The second ratoon was cut in February 1956 and in results nitrogen is very highly significant and varieties lose their significant differences.

Phosphate loses significance and potash retains significance at .05.

An NP and KV interaction are significant at .05 and .01 respectively.

For the N effect in tons per acre—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference		T/Ac
34.77	38.75	40.60	.05	3.72	
			.01	4.95	
			.001	6.44	

N<sub>1</sub> > N<sub>0</sub> by 3.98 tons per acre and N<sub>2</sub> > N<sub>0</sub> by 5.83 tons of cane and > N<sub>1</sub> by 1.85 tons which is not significant.

For the NP interaction N<sub>2</sub> = 38.81 tons of cane and P<sub>1</sub> = 37.27 tons, N<sub>2</sub>P<sub>1</sub> gave 41.54 tons of cane per acre, an increase very nearly significant at the P = 0.01 level over N<sub>2</sub> and +.001 over P<sub>1</sub>.

For the KV interaction in tons cane per acre—

	Co.301	N:Co.310	Co.331	Sig. Difference		T/Ac
K <sub>0</sub>	39.81	37.56	35.57	.05	3.72	
K <sub>1</sub>	35.58	38.02	37.52	.01	4.95	
K <sub>2</sub>	36.88	42.54	38.89	.001	6.44	

Co.301 is depressed significantly at both levels of K, 4.23 tons of cane and 2.93 tons of cane per acre. K<sub>2</sub> > K<sub>0</sub> for N:Co.310 by 4.98 tons of cane and K<sub>2</sub> >

K<sub>0</sub> for Co.331 by 3.32 tons which just misses a significant increase at P = 0.05.

The yields in tons sucrose per acre revealed high significance for nitrogen and potash at .05 and variety highly significant in spite of the equalising of the cane yields to a point of no significant differences in cane tonnages per acre.

The KV interaction is very nearly significant at 0.05 to confirm the trends found in the tons cane per acre.

For varieties in tons sucrose—

Co.301	N:Co.310	Co.331	Sig. Difference		T/Ac
5.28	6.16	5.01	.05	0.36	
			.01	0.44	
			.001	0.57	

Co.310 > N:Co.301 by 0.88 tons sucrose. N:Co.310 > Co.331 by 1.15 tons of sucrose per acre.

The N effect was—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference		T/Ac
4.92	5.61	5.91	.05	0.36	
			.01	0.44	
			.001	0.57	

N<sub>1</sub> > N<sub>0</sub> by 0.69 tons sucrose and N<sub>2</sub> > N<sub>0</sub> by 0.99 tons sucrose per acre. The difference between N<sub>1</sub> and N<sub>2</sub> is not significant.

The K effect in tons sucrose is—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Sig. Difference		T/Ac
5.36	5.34	5.75	.05	0.36	
			.01	0.44	
			.001	0.57	

K<sub>2</sub> > K<sub>0</sub> by 0.39 tons sucrose per acre at P = 0.05.

For sucrose per cent cane in this second ratoon N, K and variety are significant.

For variety effects in sucrose per cent cane—

Co.301	N:Co.310	Co.331	Sig. Difference		Sucrose % Cane
14.10	15.63	13.43	.05	0.24	
			.01	0.33	
			.001	0.43	

N:Co.310 > Co.301 by 1.53 per cent, Co.301 > Co.331 by 0.67 per cent, N:Co.310 > Co.331 by 2.0 per cent.

The N effect in terms of sucrose per cent cane was:

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference		Sucrose % Cane
14.16	14.50	14.50	.05	0.24	
			.01	0.33	
			.001	0.43	

N<sub>1</sub> > N<sub>0</sub> by 0.46 per cent. There is no difference between N<sub>1</sub> and N<sub>2</sub>.

For the K effect—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Sig. Difference		Sucrose % Cane
14.22	14.41	14.53	.05	0.24	
			.01	0.33	
			.001	0.43	

K<sub>2</sub> > K<sub>0</sub> by 0.30 per cent.

It was not possible to distribute the fertilizer before cutting the third ratoon which in places had lodged very badly indeed.

The whole lot of fertilizer was applied on top of the trash as soon as the cane had been harvested.

In the interim the plots on this experiment had been sub-soiled soon after the second ratoon crop had been cut.

For the third ratoon crop of cane N, P, K and Variety were highly significant.

For Variety in tons of cane per acre—

Co.301	N:Co.310	Co.331	Sig. Difference	T/Ac
38.81	55.85	50.22	.05 .01 .001	3.08 4.10 5.34

N:Co.310 > Co.331 > Co.301 by 5.63 tons of cane and 11.41 tons of cane respectively. N:Co.310 > Co.301 by 16.94 tons of cane.

The P effect in tons of cane was—

P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	Sig. Difference	T/Ac
45.66	49.03	50.29	.05 .01 .001	3.08 4.10 5.34

P<sub>1</sub> > P<sub>0</sub> by 3.37 tons of cane per acre. P<sub>2</sub> > P<sub>0</sub> by 4.63 tons the difference between P<sub>1</sub> and P<sub>2</sub> not being significant.

For K the effect in tons was—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Sig. Difference	T/Ac
44.34	48.48	52.07	.05 .01 .001	3.08 4.10 5.34

K<sub>1</sub> > K<sub>0</sub> by 4.14 tons of cane per acre and K<sub>2</sub> > K<sub>1</sub> by 3.59 tons of cane per acre and K<sub>2</sub> > K<sub>0</sub> by 7.73 tons of cane per acre.

In tons of sucrose per acre the third ratoon gave N at .01, P not significant, K at .01 and Varieties at .001.

For varieties in tons sucrose per cent—

Co.301	N:Co.310	Co.331	Sig. Difference	T/Ac
4.29	7.47	5.53	.05 .01 .001	0.46 0.62 0.80

N:Co.310 > Co.331 by 1.94 tons of sucrose and > Co.301 by 3.18 tons sucrose per acre. Co.331 > Co.301 by 1.24 tons sucrose.

The N effect gave—

N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	Sig. Difference	T/Ac
5.32	5.93	6.03	.05 .01 .001	0.46 0.62 0.80

N<sub>1</sub> > N<sub>0</sub> by 0.61 tons sucrose per acre. N<sub>2</sub> > N<sub>0</sub> by 0.71 tons of sucrose per acre but not significantly better than N<sub>1</sub>.

The K effect was—

K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>	Sig. Difference	T/Ac
5.31	5.72	6.25	.05 .01 .001	0.46 0.62 0.80

K<sub>1</sub> > K<sub>0</sub> by 0.51 tons sucrose per acre and K<sub>2</sub> > K<sub>1</sub> by 0.53 tons sucrose per acre. K<sub>2</sub> > K<sub>0</sub> by 0.94 tons sucrose per acre.

For the third ratoon, sucrose per cent cane, the only significant effects shown were between Varieties:

Co.301	N:Co.310	Co.331	Sig. Difference	Sucrose % Cane
11.14	13.40	11.00	.05 .01 .001	0.62 0.83 1.08

N:Co.310 > Co.301 by 2.34 per cent and > Co.331 by 2.4 per cent. The difference between Co.301 and Co.331 is not significant.

## SUMMARY

Ten fertilizer trials of which five are fertilizer-cum-variety trials are examined.

The first experiment to be discussed is one which was written up fully previously, but recorded again so as to summarise. Leaf analyses are recorded and the N/K and Ca/Mg ratios set out as is the overall N/K ratio with and without K.

The most beneficial effects were from the section on which all the fertilizer was applied in the furrow at planting time. The other sections are discussed and reasons for differences put forward. Finally, the present-day yields of this 30-acre field are given so that the following table can be elaborated—

	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Yield in Tons/acre
No Fertilizer (Uba, 1932) ...	—	—	—	40.8
Fertilizer (Uba, 1932) ...	26.4	68.4	218.25	53.7
1957 (N:Co.310 2nd Ratoon)...	127	164	414	67.60

The first differences in response to fertilizer were recorded at Umbogintwini in an experiment testing Uba, Co.290 and P.O.J.2725. In this experiment it was recorded that P gave the biggest response on Uba cane, giving an increase of 11.76 tons. It depressed Co.290 but increased the yield of P.O.J.2725. The PK treatment yields are given as well. Sucrose yields followed the same trends as the cane effects.

Two Quasi Latin Square design experiments at Reunion are discussed. From measurements taken during growth nitrogen encouraged tillering as well as greater length of shoot. K increased the length of shoots. There was an NV interaction where it was shown that Co.281 and Co.290 gave their maximum response at the lower level of N, whereas for Co.301 only the highest dressing was effective. In experiment B of these two trials NV was very nearly significant in the yield of cane in tons per acre.

A series of experiments run at "Mine Own" at Gingindhlovu are then discussed. A rather primitive type of fertilizer trial put down in 1924 is recorded for comparison against others of later date and proper design. A  $3 \times 3 \times 3$  factorial and two Quasi Latin Square designs are then reviewed.

The 3<sup>rd</sup> was of short duration due to the war but the effects of N on Co.281, the variety involved, confirmed the finding at Reunion that it reduced the yield. There was a negative PK interaction as well.

A Quasi Latin Square is reviewed next using Co.331, Co.290 and N:Co.310. The fertilizer but for the phosphate was split and the result was no significant responses at all in the plant cane. The only significant differences in this experiment were between varieties, with N:Co.310 well in the lead for tons cane and sucrose per acre and Co.290 at the bottom of the list.

An interesting feature was the high significance of the effect of N in the first ratoon with  $N_2 > N_0$  by 11.67 tons and  $> N_1$  by 7.8 tons of cane. An NP interaction is recorded also where although P reduced the yield at both levels alone with  $N_1$  and  $N_2$  there were considerable increments.  $N_2P_1$  giving nearly 7 tons increment over  $N_1P_1$ . The interaction two-way table is given for reference. The same N and NP effect followed through to the tons sucrose per acre.

K depressed the yield of sucrose per acre. In the NP interaction  $N_2P_1$  gave a total of 5.59 tons of sucrose being just short of significance over  $N_2$ .

N depressed the sucrose per cent cane and N decreased the purity. K increased the purity significantly.  $N_2K_1$  decreased the purity.

The next experiment to be discussed is one in which very large amounts of N and K were used. The varieties were N:Co.310, N:Co.376 and N:Co.382. Although the differences between the varieties were quite considerable they were not as large as the effect of nitrogen.

There has been much discussion about the effects of nitrogen on plant cane and the general opinion seems to be that there is a sufficient N supply in freshly-planted cane soil to provide the first crop with a sufficiency. Experiments giving negative responses to N in the plant cane and positive responses only in the ratoons seem to be contradicted in no uncertain manner in this trial where the differences are very great and the NV interaction quite confirms the type of thing which was found at Reunion. It is rather strange that P had no effect but in this as well as other experiments there is a very strong indication of second order interaction which will have to be studied very closely.

The N main effect was impressive with  $N_1$  giving an increment of 22.22 tons of cane per acre and  $N_2$

another 7.02 tons giving a total of 29.24 tons of cane over  $N_0$ .

More impressive still was the increase of 28.88 tons of cane from  $N_1$  on N:Co.376 and another 7.77 for  $N_2$  giving a total of 36.65 tons per acre. N:Co.382 gave a much more balanced performance with a still higher total of 20.02 tons for  $N_1$  and 19.62 for  $N_2$  over  $N_0$  giving a total of 39.64 tons per acre, or some 188.7 lb. cane per lb. of N. Obviously this is as an average N effect and not a straight N effect.

The K effect was very marked, less marked perhaps in the actual yields than in the appearance of the growing cane. The impression gained from field observations was that there was going to be a very strong NK, NV and KV interaction. This was not to be, however.

We must pause here for a moment to consider the fact that at the moment of harvesting, although the cane was enormous and the time of the year was right, there were plots which were far from mature. Also generally speaking one could say that N:Co.310 looked the least mature. N:Co.376 the most and N:Co.382 in between the other two.

The N and K effects on sucrose yields were interesting and quite considerable. Four tons of sucrose is a big increase and was the effect of  $N_2$  over  $N_0$ .  $K_1$  increased the yield by 1.38 tons sucrose per acre.

The NV interaction carried through with the same pattern as for cane yields. The KV interaction bordered on significance.

For sucrose per cent cane N, K, variety, NV and KV were significant. The most interesting feature was the KV interaction where it reduced the per cent for N:Co.310 but increased it for N:Co.376. Purity was decreased significantly as a main effect of N, P and K. Fibre was decreased significantly by N, P and K.

The next experiment to be recorded was at "Richeneau" where very good main effects were obtained from N and K with a very positive NK interaction which followed through to the sucrose per acre.

At Powers Court K was highly significant and N significant with a PV interaction very nearly significant for the cane yields and for sucrose P and K were significant with an NV interaction nearly significant. K was the outstanding effect with 1.47 tons sucrose per acre at  $P = 0.001$ . K also increased the sucrose per cent cane and there was an NV, PV and KV effect.

$N_1$  and  $N_2$  depressed the sucrose per cent of N:Co.310. P depressed the sucrose per cent of N:Co.310, increased it for Co.331 and no change for Co.301. K increased the sucrose per cent for  $K_2$

on Co.331, gave a very nearly significant increase for  $K_1$  on N:Co.310 and a significant increase for  $K_1$  on Co.301. For purity values in this experiment there was a PV interaction.

In the first ratoon there were no interactions but the main effects were good and in the sucrose per cent cane it is interesting to note that  $P_2$  depressed the sucrose by 0.56 per cent. Potash improved the purity.

At Natal Estates the trial was carried out on a sand of recent origin similar to that at Umbogintwini where the differences in reaction to fertilizer treatment was observed between Uba, Co.290 and P.O.J.2725.

The three varieties used this time were Co.331, Co.301 and N:Co.310. The increment from N and P is almost the same and it is rather strange that there is no NP interaction. There is a good NV and KV interaction. The first ratoon gave significance for variety only for some obscure reason, therefore the fertilizer was augmented and for the second ratoon there was an excellent response to N and there was an NK interaction.

The experiment at Nelthorpe completed the series under the report. In the second ratoon there was an NP and KV interaction. The KV interaction was very nearly significant in the sucrose yield per acre. For the third ratoon main effects only were significant.

### CONCLUSION

It is evident that there is still much to be learned about the interaction of varieties under different conditions and it is interesting to note that the original suppositions which promoted this work have proved correct.

### ACKNOWLEDGMENTS

It is only because of very close and friendly co-operation on the part of many people that this work has been possible.

In the first instance grateful thanks must go to the planters whose generosity in supplying suitable sites and unlimited labour allows great accuracy to be achieved in the field.

Very special mention must be made of Messrs. W. & B. Kramer for, since 1924 practically speaking, there has been an experiment on their farm. Also Mr. D. Nightingale, since there have been experiments on Nelthorpe since the early thirties.

Great encouragement always has been received from members of the South African Sugar Association Experiment Station in co-operation with whom this work has been carried out. By transporting samples and analysing samples they have

contributed handsomely to the success of this research.

Furthermore, sincere thanks must go to Prof. D. Rainer and Mr. Muller for their kindness and assistance in the statistical field.

Very special thanks go also to Misses Strauss and Hilliar for the handling of all the statistical computation and checking of results at every stage.

### REFERENCES

- <sup>1</sup> du Toit, J. L., Trends in Cane and Sugar Yields in Natal. 21st Annual Congress, South African Sugar Technologists' Association.
- <sup>2</sup> du Toit, J. L., Fertilizer Responses, South African Sugar Technologists' Association, 1957.
- <sup>3</sup> Lintner, J. L., A few Preliminary Observations on a Fertilizer Experiment on Sugarcane.
- <sup>4</sup> Liwerant J., Influence du Mode d'Application des Engrais sur l'Efficacite en Culture Fruitiere. VI Congres International de la Science du Sol.
- <sup>5</sup> Lintner, J., Some Fertilizer Trials on Sugarcane. 11th Annual Congress of South African Sugar Technologists' Association (1937).
- <sup>6</sup> Lintner, J. L. and Officers of the Division of Chemical Services Pretoria, Results of Some Co-operative Field Experiments with Sugarcane in Natal.
- <sup>7</sup> Jerwitz, W. and Meynhardt, C. J., Fertilizer Experiments on Sugarcane in Natal. (Pamphlet).
- <sup>8</sup> Hedley, Dr. E. P. and Beater, B. E., The Absorption of Plant Foods by Sugar. 7th Annual Congress of the South African Sugar Technologists' Association, March 1933.

A summary of the paper was read by Mr. P. Brewer as the author was unavoidably absent.

**Mr. du Toit** (the chairman) wished to point out that the Quasi Latin Square experiments with three different types of fertilizer at three levels and three different varieties was supplementing the work of the Experiment Station. He wished to know more of the interaction effects between variety and fertilizer, and also of results obtained on Mr. Kramer's farm where the application of nitrogen and potash was very high.

**Mr. Brewer** said regarding the interaction of variety and fertilizer it was apparent that varieties differed in their response to applied nutrients, in that their demand or utilisation of any one nutrient might vary considerably. For example, in W. Kramer's 1956 experiment there was a NV interaction which in the yield of plant cane showed that N:Co.310 yields were not increased significantly by the highest nitrogen application, whereas, with N:Co.382 the highest nitrogen application (420 lb. N/acre) gave an increase of 19.62 tons/acre over the lower nitrogen application (210 lb. N/acre).

On Mr. Kramer's farm where the application of nitrogen and potash had been very high, the fertilizer applied had been calculated from Hedley and Beaters' figures for the removal of N, P and K by a given crop. In this instance the figures were averaged

and calculated to fit an 80-ton crop. The actual amounts applied were 0, 210 and 420 lb. N/acre as ammonium sulphate and, 0, 540 and 1080 lb.  $K_2O$ /acre as muriate of potash.

It is interesting to remember that in 1924 on the same site, the yields of Uba cane were, for the controls, 23.98 tons cane per acre, and for the fertilized plots 32.95 tons. In this case the amounts of N and K applied were 0, 14 and 28 lb. N/acre and 0, 48 and 72 lb.  $K_2O$ /acre.

In the present experiment with the high applications of nitrogen and potash, control yields have been 30.62 tons/acre, whilst  $N_2P_2K_2$  averaged 76.20 tons.

Although the most favourable climatic conditions were experienced, the effects and yields are, nevertheless, very indicative of possible future developments.

**Dr. McMartin** enquired relative to interaction between variety and fertilizer if it were possible to summarise and say that Nitrogen had an effect on one variety and not on the other.

**Mr. Brewer** said it appears that varieties have different capacities to respond to nitrogen, but at this stage it was impossible to state the optimal nitrogen requirements of any particular variety.

**Mr. Sexton** asked if there were any analyses of the soil in the plots before the experiments were laid out.

**Mr. Brewer** replied it was Mr. Lintner's practice to take soil samples on every site before the experiment was laid down, usually of the whole area and not plot by plot.

**Dr. Dodds** wished to know what was meant exactly by a Quasi Latin Square.

**Mr. Brewer** replied that it was fundamentally a Latin Square design in which certain treatments had been confounded within the rows or columns.

**Mr. Pearson** said that he understood from the summary of the paper that nitrogen at high levels gave a good response from the plant cane. Apparently the tendency in the industry was not to use much nitrogen for plant cane. He noticed that out of the six experiments quoted, four out of five responses came from interactions of NK in the relationship of 1:1. This confirmed some results obtained by the Experiment Station where the ratio of NK was at 1:1 proved the most profitable.

**Mr. du Toit** said that he was surprised to find that there was a response to phosphate on Burnside Estate, because this Estate had had very heavy dressings of phosphates and calcium carbonate in the form of filter cake.

**Mr. Brewer** said the results had shown that there had been a response to 60 lb.  $P_2O_5$ /acre though it was not a large response.

**Mr. du Toit** pointed out that the average yield in the industry was 31 tons of cane per acre. An increment of four tons per acre was economic for phosphate application. He said it was to be expected that a combination of N, P and K would give highly significant increases.

**Mr. Hastilow** said that the real criterion was tons of sucrose per acre and not tons of cane per acre, for an increased yield of cane does not necessarily mean an increased amount of sucrose.

**Mr. Brewer** said the calculation of tons sucrose/acre was detailed in Mr. Lintner's paper in seven out of ten experiments.

**Dr. Dick** said that in general the Experiment Station had found that the application of fertilizer had very slight effect on the sucrose per cent cane, with the possible exception of nitrogen which in some cases had a slight decreasing effect.

**Mr. du Toit** said that when one was dealing with very high yields and using very high quantities of fertilizer slight differences in sucrose per cent made an appreciable difference in yield of sucrose per acre. He pointed out that in the experiment where abnormally high quantities of nitrogen and potash had been applied, these quantities actually depressed the sucrose.

**Dr. Dodds** said that he understood that a square design for a fertilizer experiment did not have many special advantages. One disadvantage was that one could get an equal number of outside and inside plots, so they could not be equally distributed over the variants, the nearest approach being the  $7 \times 7$  square which had 24 outer and 25 inner plots. The only accurate solution to this is an  $8 \times 6$  lay-out which gives 24 outside and 24 inside plots. This he believed was the only size of perfect rectangle in which the outside and inside plots were equal in number. This factor was an important consideration in certain types of field experiment, where differences in results between inner and outer plots were liable to be very considerable.

**Dr. Dick** said fundamentally the Latin Square and Quasi Latin Square were designed to obtain balanced treatments in each row and in each column. In this way one could control the trends of natural fertility in two directions.