TRIANGLE SUGAR ESTATES

THE GROWING OF SUGARCANE UNDER IRRIGATION IN S. RHODESIA

By K. B. SINCLAIR.

Before dealing with the technical side of Triangle, I think an insight into the conditions prevailing is essential. Therefore I shall commence this paper with a resume of the history and general conditions.

For all practical purposes, Triangle came into being in 1932, when Mr. T. M. McDougall first introduced sugar into this area by planting a few setts of cane from Mount Edgecombe Experiment Station. The estate was subsequently purchased by the Government in 1945, and a Sugar Industry Board was formed, consisting of six members. The estate is situated some 120 miles south-east of Fort Victoria, in the Sabi Valley area, at an approximate elevation of 1,300 feet. It comprises some 91,000 acres of fertile land, being excellent cattle country. The many species of the Acacia family, knobby thorn, mopani, mahogany and marula are found in this area, as is also the famous Baobab tree. The weather is hot and dry for the greater part of the year, with temperatures rising as high as 111 degrees in the shade during November and December, and dropping as low as 26 degrees in June and July. The average rainfall is 18 to 20 inches, but can hardly be taken into account as it falls over a period of five months, either in falls of less than an inch or in torrential downpours, and much too far apart to be of any real value to such a crop as sugarcane. However, it does serve to keep the grass green and sweet for the cattle, and of course encourages weeds, much to the annoyance of the field staff.

Game is very prevalent, as are also hippo in the rivers, and, to add to our worries, snakes are also quite numerous.

The estate runs approximately 1,000 head of cattle, mainly for slaughtering for native food, but good use is made of the kraal manure as fertilizer. A dairy herd is also maintained, which supplies the staff with its essential fresh milk and cream. Vegetable gardens are also kept under cultivation to enable the staff to have fresh greens. As we are 120 miles from our nearest town, Fort Victoria, of which 60 miles have to be traversed over bush roads, the essentiality of the dairy herd and gardens will be appreciated.

Citrus, in the form of grape fruit, is also cultivated to quite a large extent, there being 1,200 trees, which yield a very high-class product. On a much smaller scale, we also cultivate mangoes, lemons, paw-paws and oranges.

A club, a nine-hole golf course and two tennis courts are provided for staff recreational purposes, and the disciples of Izaak Walton are amply catered for by the numerous bream and barbel to be found in the local rivers.

Malaria, although present, is not so prevalent as reports would have it, there having been only two European cases during the past year, out of a community of thirty-one. Although bilharzia is present in all the rivers and streams, the incidence of this disease amongst the staff is not really high. In general, the health all round is exceedingly good.

With these few remarks on the general conditions prevailing, I shall now pass on to the more particular conditions in regard to the growing and production of sugar.

Irrigation.

It will be obvious from my previous remarks in regard to rainfall, that great importance had to be attached to irrigation, and I therefore propose to deal more fully with this problem.

We are fortunate in this respect, that the Mtilikwe River, which traverses the estate on its western boundary, runs all the year round, under normal rainfalls. In the rainy season a vast volume of water is carried by the river and emptied into the Sabi River, thence to the sea. The flow during the dry season drops to below 50 cusecs, and during the 1946 drought practically ceased. It is from this river that we draw the water for our irrigation scheme. A storage dam, constructed up-stream, holds back 700 million gallons, the equivalent of 2,900 acre feet, which, allowing for seepage, can carry us over for three months. The water is fed through sluice gates down to a diversion weir thrown across the river at the entrance to a tunnel, five feet in diameter. From the outlet of this tunnel, which is 1,400 feet in length, starts the main canal, which is approximately 17 miles in length. This has an average bed width of 10 feet and side slopes of 1 to 1, and a grade of 1 in 4,000.

The country traversed by the canal in its early stages is cut by many spruits and two large river beds. The crossing of these, and other depressions, is made possible by reinforced concrete inverted syphons 4 feet 6 inches in diameter, the longest being 1,450 feet.

A rough idea of the amount of water required to irrigate cane under semi-tropical conditions was known, but much had to be learned on how this water was to be applied, and at what grade the cane

furrow should be drawn to ensure the maximum use of water. Experimental applications proved that it was impracticable to feed the water for a greater distance down the cane rows than 210 feet. I would suggest, however, if anyone here is contemplating the laying out of an irrigation scheme of similar capacity, that they seriously consider running the water for only 100 feet in spite of the extra initial capital outlay, as marginal effect is quite noticeable in the 210-feet run as standardised on our estate.

Our main canal is constructed to pass 75 cusecs at a depth of 3 feet. This is sufficient to irrigate 2,500 acres, allowing 1 cusec for every 33 acres.

At points suitable to the lie of the land, the canal is tapped into storage dams of 2 acre feet capacity, this allowing for a constant flow of 2 cusecs for 24 hours, thus giving 4 cusecs for daylight application. The reason for choosing this unit is that we have found, for good control of irrigation, fields should be standardised in area, so far as the available ground will allow, and that for our purposes 30-acre blocks are most suitable.

From the aforementioned storage dams, permanent field distributary canals are set out, to supply 120 acres. These distributaries are graded at 1 in 1000 and have a bed width of 3 feet with 1 to 1 slope sides, and a capacity of 4.7 cusecs at a depth of one foot. Measuring weirs are installed at the head of each distributary. These distributaries are then tapped on both sides every 1,260 feet, by a main feeder graded at 1 in 100 to suit the cane furrows, and protected by drops to obviate erosion. Care must be taken on the first application, not to allow too much water to run down the furrows, as the grade of 1 in 100 is a little on the fast side, until the cane has become established. From these main feeders, water is drawn off every 210 feet and fed down the cane rows by secondary feeders, which are drawn by ridges, and are seldom longer than 630 feet. This cuts the field up into approximately 3-acre blocks, being the area we allocate to each labourer.

The cost of water delivered to the fields is 14s. 5d. per acre foot, this figure including the depreciation on all irrigation works, maintenance and repair cost of canals. The cost of applying the water to the field is £1 per acre month, giving an overall cost of £1 14s. 5d. per acre foot.

A sketch of the general lay-out of a field is available for inspection, if my description needs clarification.

Yields.

Under normal field conditions, but with only 7 acre feet of water applied, the following results were obtained from plant cane up to 14 months old :—

Co.281	40 tons per acre
Co.290	44 tons per acre
P.O.J.	60 tons per acre

The system has not been long enough in operation to give average ratoon tonnages, but an individual field of third ratoon, Co.281, gave 32.4 tons per acre.

Whilst on the subject of yields, I would mention that I have read many requests for results obtained from green manuring. Though I am not in the position to give detailed results, a few remarks on the system adopted by us may be of some value. For the past two years we have green-cropped all lands with Saunders upright cow-peas, and in some cases followed this with sunn-hemp. The cane in the green-cropped fields has shown a much more even stand than that on virgin soil. Our soils are mainly dark chocolate loam, and are deficient in humus. Though the cost of green-manuring works out at approximately 30s. per acre, we feel it pays, as it also assists in improving the texture of the soil. We are at present laying out experimental areas, to enable us to ascertain what increase in yield, if any, is obtained from green-cropping.

Field Operations.

Planting at Triangle is similar to that adopted in most cane-growing countries, the main difference being that we do not mould up the cane, but leave the original furrow for irrigation purposes, the capillary action of the soil, due to the excessive heat, not allowing for irrigation between the rows.

The cane rows are spaced 4 feet 6 inches apart for Indian varieties, and 5 feet 6 inches apart for P.O.J.'s. Planting is continuous single line for Indian canes, and staggered in P.O.J.'s, with about 6-inch gaps.

With the irrigation scheme that we have installed, planting is not such a gamble as that experienced in cane-growing areas lacking irrigation, and our eye germination is appreciably higher, giving as much as 90 per cent.

Prior to planting, sets of four eyes are immersed for three minutes in a 0.5 per cent. Aretan solution. They are then planted in the furrows, which have been previously treated with 400 lbs. of 18.5 per cent. superphosphate and 200 lbs. of 33⅓ per cent. raw rock phosphate per acre.

Though we can plant in most months during the year, our March to June planting gives the best results, as the cane is in its early stages of growth when we get our cold weather, with the possibility of frost. Low temperatures and frost only affect the leaves of the young plants, which die back, and are soon replaced with new growth. Established cane, however, is more seriously affected, the main shoot dying and the top eyes throwing out shoots in a fan-like manner. A heavy loss in sucrose content

results, giving gummy juices which have to be dealt with in the factory.

Cutting takes place between June and December, plant cane being 14 months old and ratoons 11 to 12 months. No mechanical apparatus has been installed for cutting or loading, but an experiment with portable cranes, with grabs, is being instituted.

Transport of cane to the factory is accomplished by the use of diesel lorries with trailers attached, each unit carrying 10 tons. The average cost of transport is 3d. per ton mile or 3s. per ton delivered.

The cane is removed from the transport vehicle by winch, and fed to the cane carrier by rakes, thence through revolving cane knives into the milling train. The train is comprised of 12 rollers, each 24 by 48 inches, and a 22- by 46-inch Krajewski crusher.

The factory has been built up with units obtained from Natal factories which have been closed down through centralisation. It can therefore be imagined what an unbalanced state of affairs resulted. Our greatest drawback has been the impossibility of obtaining new or suitable plant, either from South Africa or overseas, but with the installation of a new vacuum pan, now on its way, our main bottle-neck will be overcome, and every effort is now being made to get the factory up to a 25-ton per hour capacity.

Complete chemical control has not been possible, as juice scales have been unprocurable. Therefore, I shall not give results from purely estimated weights. We were able to get some guide, however, from crusher and bagasse samples. The average crusher juice samples were: brix 20.6, sucrose 17.9 per cent., purity 86.9.

The highest monthly averages were obtained in September with brix 21.02, sucrose 18.9 per cent. and purity 90.0, these being from Co.281 and Co.290. Thirteen-month-old P.O.J.'s gave brix 22.36, sucrose 20.23 per cent. and purity 90.4.

The average sucrose in bagasse was 3.5 per cent. and moisture 54.0 per cent.

Experiments.

In conclusion, I would like to draw your attention to the experiments we have been carrying out to combat smut and to find varieties least susceptible to the disease, and which at the same time will give the necessary tons of sucrose per acre.

The three main varieties being cultivated at this time were Co.281, Co.290 and Co.301, until the disastrous smut infection in the Co.301. Every effort was made, though perhaps a little too late, to save this variety, as its growing qualities seemed to suit our particular conditions. However, the disease had obtained so firm a grip, that we had to discard 422 acres, a rather heavy blow with only 689 acres of standing cane.

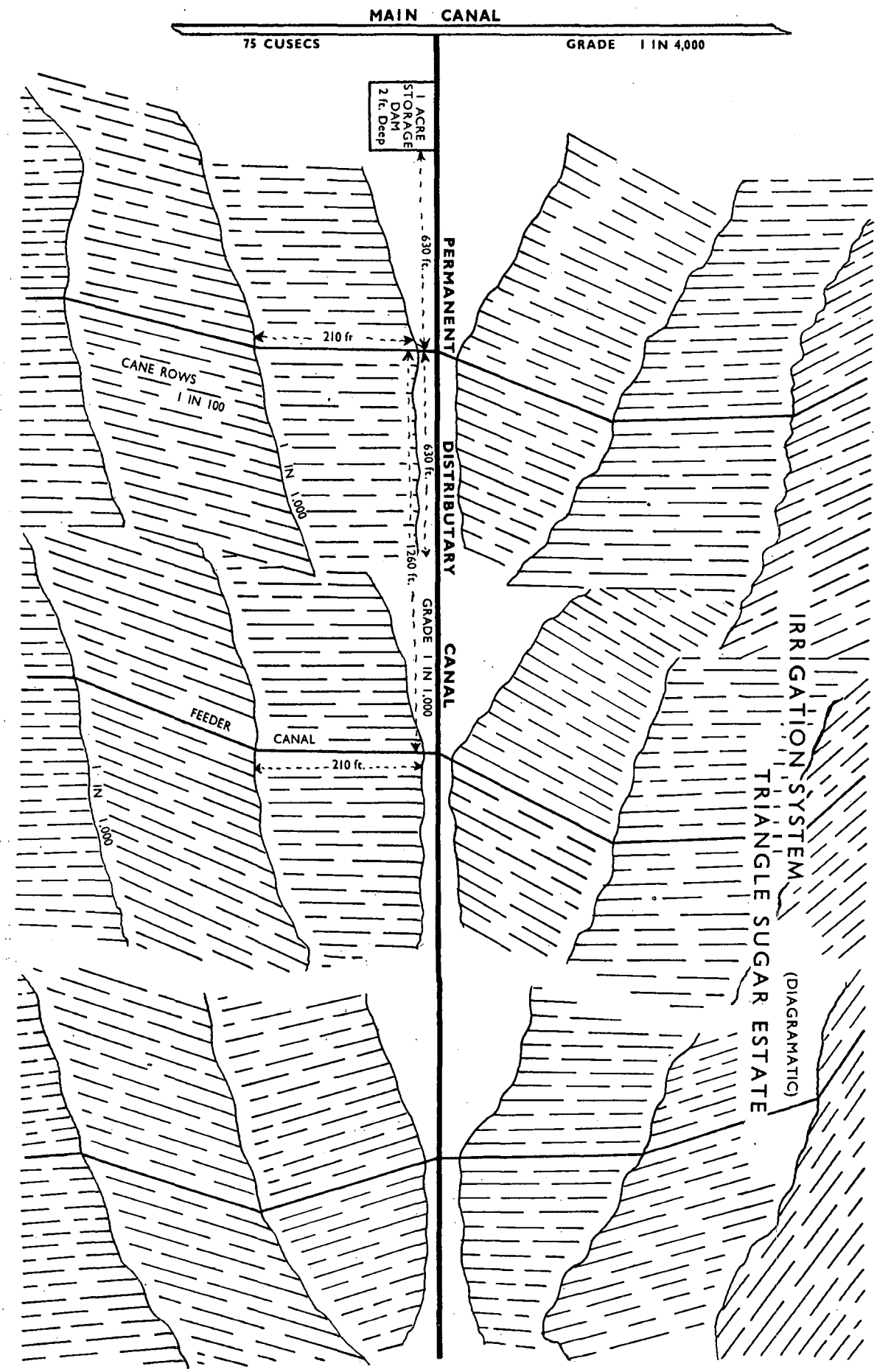
Experiments with P.O.J.'s had proved that they were highly resistant to smut, so from a small plot we started bulking up. By this time Co.281 and Co.290 had also succumbed to the disease. Fortunately we were able to cope with this outbreak by roguing the plant cane, and removing whips from ratoons. With these three main varieties now infected, it was essential for us to find other varieties more resistant to smut, and with this in view we communicated with Mount Edgecombe and, through the good services of Dr. Dodds, we obtained forty different varieties of cane from the Experiment Station. This enabled us to carry out a comprehensive experiment, in which these varieties were planted in two different sites, each planting being similar in all respects. The first site chosen was in close proximity to the smut area, whilst the second site was in an isolated area. These experiments were inspected by Dr. Dodds and Dr. McMartin during their visit to the estate last year, and their reports thereon were published in the South African Sugar Journal. Since their reports were published, further varieties have become infected, bringing the total number of infected varieties up to ten—namely, N:Co.79, 151, 291, 292, 313, 323 and 349, Co.453 and 464, and M.270.

Of these, Co.453, 464 and N:Co.291, have shown the greatest amount of infection. An interesting feature was that Co.349 produced a whip from the main shoot, some six feet above ground. This is entirely unprecedented in the history of our smut infections, as to date all our whips have appeared from tillers or from first or second buds. All the infected varieties were amongst those planted in the first experimental site, adjacent to the already infected area, none of the isolated plants succumbing to the disease. The location of the experiments tends to prove that wind-borne infection is as equally responsible as water-borne.

Of the remaining thirty varieties, the following seven appear to be best suited to our conditions: C.P.29/116 and 29/291, Co.331, 419 and 421, N:Co. 332, and N.M.168. In addition, N:Co.310 was also not affected in this experimental planting, but proved susceptible in a previous introduction. Nevertheless, its outstanding qualities must make it one of the favoured varieties in this area.

Experiments carried out at the suggestion of Dr. Bates, the Government Senior Plant Pathologist, have proved that infection by way of the bud is the most rapid and fatal method of contamination. Therefore, by systematic roguing and the removal of smut whips, infection this way is greatly reduced. Our experiments in this direction are far from complete, so results obtained cannot be regarded as final.

In addition to smut experiments, we are also running trials on the important question of fertilization, using nitrogen, phosphates, potash, magnesium and calcium, in different levels; but as these experiments are still in their infancy, no comparisons can as yet be drawn.


MAIN CANAL
75 CUSECS
GRADE 1 IN 4,000
1 ACRE STORAGE DAM 2 ft. Deep
630 ft.
PERMANENT
210 ft
CANE ROWS 1 IN 100
630 ft.
DISTRIBUTARY
1 IN 1,000
1260 ft.
GRADE 1 IN 1,000
CANAL
FEEDER
CANAL
210 ft.
1 IN 1,000
IRRIGATION SYSTEM
TRIANGLE SUGAR ESTATE
(DIAGRAMATIC)

The PRESIDENT expressed the Association's gratitude to Mr. Sinclair, who had come to this country as a visitor, but who had nevertheless found time to present the paper at very short notice.

It would appear that irrigation in Rhodesia cost about ten to twelve shillings per ton of cane, which was very much cheaper than the cost at a big estate in Natal. Crusher juice purity was rather low at Triangle, and, probably because the factory was not yet in full operation, sucrose and moisture figures for bagasse were rather high. One of our new released varieties, N:Co.291, it was disconcerting to learn, had not stood up well against smut. The Rhodesian fertilizer experiments would be interesting when the results were available.

Mr. CARTER asked whether irrigation was stopped some time prior to harvesting, and what tests had been done to find when the cane was fully mature.

Mr. SINCLAIR replied that no such experiments had been done, as they had not as yet had full chemical control. The land had to be kept irrigated for twelve months in any case, and as they had such a small tonnage to crush, they endeavoured to make as much sugar as possible as soon as they could.

The PRESIDENT enquired if the purity and sucrose figures referred to smut-attacked cane, as smut reduced sucrose content and purity and increased reducing sugars very much indeed.

Mr. SINCLAIR stated that, except for P.O.J. canes, all the cane was smut-infected, but not much smut was obvious on the sticks, most being visible on the young tillers.

Mr. WALSH said that he had seen very similar irrigation schemes in East Africa under almost identical conditions, that is, very little rainfall and long periods of high sun temperatures. Under these conditions considerable difficulty had been found through salts leaching out and coming to the surface. This was particularly noticeable in the early stages of growth before the cane covers up. The growth of cane is, of course, adversely affected.

An enpensive drainage system had to be installed to enable the salts to be washed out, otherwise the soil became useless. This, of course, made irrigation enpensive.

Mr. SINCLAIR thought that such leaching was a danger, but they had an experienced soil chemist to watch out for this. So far, the land had been under intensive irrigation for five years without showing any detrimental effect, and this period was as long as they would allow their fields to bear before fallowing and green manuring.

Dr. BATES stated that he appreciated very much the invitation to himself and Mr. Sinclair to attend the Congress. The whole of Triangle Estate might be looked upon as an experiment, as it was the first development on the Rhodesian low-veld on a large scale. Irrigation on this estate, therefore, was being carefully watched. It would be a guide to the large undertaking of cultivating what was called the Sabi Valley.

Smut developed in Rhodesia very quickly—Natal had not experienced anything like that—and consequently they were forced to eradicate Co.301, the most susceptible variety. Co.381 and Co.290 also were affected, but to a much lesser extent, and with a certain amount of rogueing the disease had been kept under control to a certain degree. The new varieties kindly sent from Mount Edgecombe were serving a double purpose, in that they were being tested in the search for more suitable varieties for Rhodesia and, at the same time, acting as a "guinea pig" for Natal.

Rhodesia was the baby of the cane sugar industry, although Mr. Sinclair had had a lot of experience, but the information and assistance so freely given from Natal, and particularly from the Experiment Station, was much appreciated.

Mr. LEWIS said that, ordinarily, with irrigation between the rows, soil hardened up. This might point to a deficiency in humus. He also enquired if anything was known of how smut originated.

Mr. SINCLAIR considered that irrigating in the row was preferable, as the shade from the cane would prevent excessive evaporation.

Dr. BATES thought that it was possible that smut had been acquired from other countries. He could not vouch for that, but as far as he knew this smut was peculiar to sugar cane.

Mr. DUCHENNE enquired if the disease was carried by irrigation water.

Mr. SINCLAIR replied that he had mentioned that, if blown on to the irrigation system, the spores might infect freshly-cut cane. Experiments were now being carried out to test that possibility. Dr. Bates had proved that the spores could live for a long time in water.

Dr. DODDS congratulated Mr. Sinclair, and said that he had told us very little of the troubles that he had had, through the isolation and various adverse conditions he had to put up with at Triangle Estate.

Among the various points of special interest in the paper, he noticed that in irrigation they allowed one cusec for every 33 acres. That, compared with Natal Estates, who, he believed, said that one cusec was adequate for 100 acres, showed a very different position. But, of course, the rainfall was very much less—probably about half of that at Mount Edgecombe—and the great heat also would result in very much drier conditions, which, with the higher water requirements, showed the importance of irrigation to

the Triangle Estate. The question naturally arose, what reserve of water they have, and whether the Mtilikwe River would be able to give an adequate water supply ? What was the prospect of getting other supplies of water, or of making major storage accommodation ? He was very pleased to read what Mr. Sinclair said about green manure. He had had many questions on green manure lately, arising very largely out of a full-page advertisement in the Sugar Journal a month or two previously and published by African Explosives and Industries, who said that, as far as they were aware, green manure had never been of any economic benefit in any part of South Africa. He thought they were entirely wrong, and that was a subject which would have to be taken up with them. In the meantime, it was alarming many of our planters who had been convinced by our assurance that the green manuring was worth doing.

A great deal of the paper was concerned with the replacing of varieties. They found that with P.O.J. it was possible to have a six-inch gap between the setts in the row. We were doing experiments on those lines which are not yet completed, but we had felt for some time that it was unnecessary in favourable planting conditions, to have a continuous single line or even more than that, as many planters have, and a good deal of economy could be made in the use of planting material by discriminating in the spacing of cane.

He saw that, like ourselves, they reached their peak of brix and sucrose, etc., in September. The figures were remarkably good and very promising for the future of the Estate. They certainly had very bad luck in having smut. Where the smut came from, he could not say, but he had an uncomfortable suspicion it came from Natal; not, he was sure, from the specimens they were supplied from the Experiment Station, but from the bulk supplies Triangle got from time to time. There seemed to be some evidence that smut has been more or less dormant in cane for the last forty years, since we previously had a very susceptible variety—China cane, grown by Mr. Townsend seventy years ago—and with the elimination of that variety, smut seems to have been hardly noticed until we got another variety, Co.301, highly suscpetible to this disease. He hoped that we were not quite so susceptible to smut in this country as they were in Rhodesia. He thought it had a good deal to do with the humidity of the atmosphere. At all events, it was shown that they had reduced the incidence of smut a good deal by eliminating Co.301. It must have been a formidable task to discard 422 acres out of an area of only 659 acres of cane—of course, it would be an impossible task here to discard all the Co.301 at short notice. It was rather alarming to find that so many of the varieties that were sent up there were susceptible, including, for example, N:Co.151, which we believed was resistant in Natal. One of the difficulties about smut was that often a long time elapsed before symptoms developed. It was rather alarming to read that they found a good deal in N:Co.291 and N:Co.349.

Dr. BATES thought it premature to express an opinion on the relative susceptibility of the new varieties mentioned. They had been planted only in November, 1947, but until developed on an extensive scale, it would be difficult to judge which was more likely to be seriously affected.