SOUTH AFRICAN SUGAR INDUSTRY AGRONOMISTS' ASSOCIATION

NOTICE OF ANNUAL MEETING

The Annual meeting of the Association will be held at the Experiment Station at 10 a.m. on Friday, 18th October, 1968. The following programme has been prepared:

10:00 a.m.	Tea.
10:15 a.m.	Committee report for 1967/68 - Mr. R. Wyatt. Discussion.
10:30 a.m.	Choosing an in-field loader - Mr. G.S. Bartlett.
11:10 a.m.	Hot water treatment 1. Mr. L. Allsopp 2. Mr. M. de Robillard 3. Mr. E. Gilfillan
12:20 p.m.	Minor element nutrition of sugarcane - Mr. P. Coignet.
1:00 p.m.	Lunch
2:00 p.m.	Coffee production - Mr. M. Stewart.
2:40 p.m.	Pre- and post-release varieties - Dr. P. Brett.
3:20 p.m.	Method study for the sugar industry - Mr. K. Morrow
4:00 p.m.	General discussion.

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

MINUTES OF ANNUAL MEETING HELD AT THE GOODWILL HOTEL ON TUESDAY, 26TH SEPTEMBER AT 10 A.M.

PRESENT: G. Shuker (Chairman), J. Abel, L. Allsopp, G. Bartlett, T. Bishop, W. Black, J. Boyce, J. Burton, R. Campbell, P. Coignet, J. du Plessis, E. Gilfillan, J. Hill, H. Kellerman, J. Landsberg, D. MacLeod, P. Moberly, M. Murdoch, K. Nathanson, D. Routledge, M. Stewart, G. Thompson, D. Truen, G. Turck, J. Wilson, R. Wood, R. Wyatt.

1. Mr. MacLeod welcomed members to the meeting which was sponsored by Illovo Sugar Estates Ltd.

2. Mr. R. Wyatt presented the Executive Committee's report for the year 1966/67.

3. Mr. J. Burton presented a paper on cotton production. Mr. Wilson recommended cotton as a "break" crop for the cane belt. The variety Deltapine was mentioned as a possible variety for the cane belt, and as a particular prospect for the Pongola area. Mr. Burton said that cotton in Rhodesia cost R110/acre to produce, and that a profit of R40 - R50 was expected. Mr. Stewart mentioned the limitations which local soils imposed on cotton production due to the wide gradients within soil series. Dr. Nathanson discussed ratooning of cotton which was feasible with modern pest control methods. Ratoon yields can be profitable, particularly in furrow irrigated lands where establishment costs may be high. Mr. Wardle referred to the use of defoliants and mechanical harvesting.

4. Mr. Bartlett talked on mechanization in the sugar industry. He emphasized the importance of labour training, labour availability, and the problems which local terrain constituted. Mr. Gilfillan discussed the relative costs of herbicides and cultivation for weed control. Mr. Wilson mentioned the potential that might lie in mechanical planting of single-eyed setts "on the square". Mr. Moberly raised the subject of mechanical row weeders for sugarcane fields. Mr. Stewart emphasized the necessity for work to be done on the integration of mechanization with general field planning. Mr. Bartlett referred to a project on the Mtunzini Propagation farm where this is being done. Mr. Campbell said that the discussion showed how necessary it was for the estates to employ qualified Agricultural Engineers, whilst Mr. du Plessis spoke of the necessity for co-operation between Engineering and Agronomy.

5. Mr. Wardle presented a paper on herbicides. The discussion dealt mainly with the subject of 2,4-D damage to sugarcane and the conditions under which this seemed to have occurred. No clear picture developed to show the effects of pre- compared with post-emergent treatments. It was also not clear whether particular varieties were more susceptible than others, nor whether different formulations had different effects. The experiments being and to be conducted by the Experiment Station were described.

6. Mr. Browne presented a paper on the effects of frost on sugarcane and showed colour slides to illustrate the subject. Varietal susceptibility was discussed. Mr. Wyatt felt that there was reason for optimism regarding much of the cane being grown in so-called frost areas.

7. Mr. Moberly spoke on recent results of nutritional experiments at the Experiment Station. Regarding iron chlorosis, Mr. Wood reported that green and chlorotic leaves may sometimes be found to contain similar amounts of Fe, but the chlorotic leaves have larger amounts of P. Chlorosis therefore seems to be associated with the P/Fe ratio. Mr. Wood also referred to the results of the phosphate placement experiment, where radioactive P in supers had also been included in the treatments. The better uptake of P from a broadcast application on trash was probably due to a high concentration of P in a very thin layer of moist soil directly beneath the trash. Banded applications presented a smaller volume of P enriched soil. As far as nitrogen timing was concerned, split applications had been shown in Hawaii to leave a greater residual amount of N in the soil than single applications. Mr. Allsopp had noticed that early applications of N gave visibly improved cane growth in a wet season, but the effect gradually disappeared. In a dry season, no response to early N compared with N applied at a later stage could be observed.

8. Messrs. Bishop, Stewart and Hill contributed to a symposium on fertilizer advisory methods. It became apparent that there was a decided trend on some estates away from the use of straight fertilizers, and towards the use of a limited number of chosen mixtures. The principle appeared to be satisfactory from the point of view that 10 years or more of scientific fertilization had eliminated most of the wide variations that previously existed between soils in different fields. Mr. Wyatt spoke in favour of the continued use of straight fertilizers, pointing out that a 20% saving was effected at Doornkop by using individual N, P & K carriers instead of the nearest equivalent mixtures. Mr. Wardle also emphasized that the cost of mixtures sometimes exceeded that of the equivalent straight fertilizers by an appreciable amount.

9. In a general discussion on the subject of heat treatment Mr. Browne requested that data be obtained on the relative merits of heat treating setts compared with whole sticks.

THE MEETING CLOSED AT 5.00 P.M.

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

CHOOSING AN INFIELD CANE LOADER

George S. Bartlett

The most significant development in mechanisation in the South African Sugar Industry during the past ten years has been the infield cane loader. While the labour saving advantages of this type of mechanisation were known from field trials conducted eight years ago, it has only been in the past two to three years that cane growers have started purchasing these machines in any numbers.

The reasons for this probably revolve mainly around the fact that it has taken a number of years for the local manufacturing industry to develop production made machines. The results of this development are very encouraging indeed, and an examination of some of the machines now available will reveal that South Africa will soon be among the world leaders in the design and manufacture of cane loaders.

During the 1967/68 harvest season, an estimated 5% of the 18.6 million ton cane crop was loaded mechanically infield. This figure is expected to double during the current season, while in five years time it is hoped that at least 30% of the crop will be handled mechanically.

It is perhaps opportune therefore at this time to consider a few of the factors affecting the choice of an infield cane loader, since in the next few years many cane growers will be faced with this problem. These factors can be broken into a number of broad categories, namely economic, terrain, type and harvesting systems.

Economic factors

The economic factor is probably the major consideration facing the cane grower when contemplating purchasing a cane loader. Ideally, the introduction of mechanisation should not only reduce labour but also reduce costs. Experience shows that this is possible providing the correct selection is made.

It will be appreciated that the utilisation factor is important when considering economics. The more a machine is used during a fixed period of time, the lower will be the "fixed" costs ie. depreciation, license, insurance etc., per unit of work done. Since it is desirable to "write off" a machine over a period of approximately five years due to the obsolescence factor, the more work which can be done during this period the better.

The other major factor affecting economics is the capacity of the machine to do the intended work per unit of time. The more efficient the machine, the lower the unit "operating" cost of work done.

These two factors, utilization and capacity, must be examined thoroughly by any grower contemplating purchasing an infield cane loader.

Taking utilisation and "fixed" costs first, the first question to ask is "What is the daily cane allocation?" The second factor, capacity, therefore immediately follows "How fast can I load this tonnage of cane?" As a general rule of thumb, it can be said that if a cane grower uses his prime movers, ie. tractors etc., for at least 1,000 clock hours per annum, then, all else being equal, the unit is an economic proposition.

If a cane grower therefore, is cutting 6,000 tons of cane per year over a 210 day cutting season, his daily allocation would be 29 tons of cane. The loading capacity of loaders vary from as low as 10 tons per hour for a front-mounted, fixed-boom loader, to as high as 60 tons per hour for a slewing boom loader.

It would therefore take a front-end loader 2.9 hours per day, and a slewing loader (at 60 tons per hour) 39 minutes per day to load the 29 tons daily allocation. Operating 210 days per year would mean that the two machines would work a total of 609 and 101 hours per annum respectively.

It becomes very clear from the foregoing that utilization is a critical factor in the selection of a cane loader. Following the rule of thumb guides given above, a grower using a front-end loader to load only, would have to load 10,000 tons per year at an average rate of 10 tons per hour, to achieve the desired 1,000 hours annual utilization, while the high capacity slewing loader would have to load 60,000 tons at an average rate of 60 tons per hour to also achieve this.

These are generalisations which will vary according to the make of loader, its price, rated loading capacity, operating costs and the acceptable economic cost of loading a ton of cane. This latter figure should be an average of 10 cents per ton, rising to as much as 25 cents under less efficient operations, but dropping to as low as 7 cents where high utilization is being achieved by the more efficient machines.

From the above, and information and experience gained over the past two years, it would appear that slewing loaders costing in excess of R6,000 with an average capacity of about 30 tons per hour, require an annual throughput of at least 20,000 tons. Cane growers producing crops less than this have three alternatives, viz., to combine into harvesting syndicates, employ a contractor, or to purchase a multi-purpose loader which can do work other than loading cane.

Syndicates are desirable under such circumstances, but they have one major problem affecting their success, viz., the human factor. Growers contemplating such a step must be quite sure in their own minds that they are prepared to accept the disciplines and responsibilities of a co-operative effort. These have succeeded in the past in transport schemes and transhipment crane syndicates, but on the other hand, the Sugar Industry's history also includes many failures, mainly due to disagreement on the part of the co-op's members. The second major problem is adequate management skills to ensure the success of the project.

Contractors can be hired, but under these circumstances the grower must be prepared to pay a higher rate since the contractor must ensure his profit.

Multi-purpose loaders offer an excellent alternative for the smaller grower cutting up to approximately 75 tons per day. By necessity, these machines must be of the front-end, tractor mounted, non-slewing type so as to allow for quick and easy switching to other work. Unfortunately, many cane growers, when first observing the fixed-boom, non-slewing loaders working alongside the slewing-boom machines, are inclined to dismiss the fixed-boom machine from their minds due to the constant forward and reversing of the tractor. This constant back and forth movement conjures up the compaction bogey and consequently, front-end loaders have not been readily accepted in South Africa.

This has not been the case in Australia, however, where their use reached a peak in 1964, before the advent of the "combine" cane harvester, when of the total of 3,125 loaders in use, the vast majority were front-mounted, fixed-boom machines. This is because the average Australian cane grower has a small daily allocation of less than 50 tons of cane, which can easily be loaded by a front-end loader.

The experience in Natal with these machines has been that a grower can easily load or stack, 40 tons of cane in 3 or 4 hours, and then by attaching a cultivator, trash rake or fertilizer distributor, do at least another 4 hours work with the same machine. During the off-season, the tractor can be put to further use, thereby raising its annual utilization to above the desired 1,000 hours. Another advantage of this type of loader is that it can stack the cane for removal by self loading trailers, which is desirable when down time of the transport vehicle is a major consideration.

The foregoing discussion should be adequate to stress the need for optimum utilization. While this is a major consideration, it should not be the only one but rather be considered along with other factors such as loading capacity, the transport system etc., which are discussed below.

The second factor affecting the economics of the loading operation is the rate of loading, or machine capacity and "operating" costs.

Most loaders being manufactured today are mounted on standard agricultural or industrial type tractors ranging from 35 to 65 H.P. In most instances the available power in these tractors is more than adequate to do the actual loading, while the actual operating or running cost of the machine is more or less fixed for each hour of operation. In fact, the tractor is designed to give optimum efficiency at approximately three quarters "full load" ie. at "optimum load". This point of operation is usually marked on the engine "rev-counter" and is stated clearly in the instruction manual. With this in mind, and the knowledge of the horse power potential of the particular tractor, and the amount of effort required to let us say, push-pile, grab, slew and load cane, it becomes obvious that it is most desirable that the loader being designed and constructed to fit onto the tractor, should match its performance with the available power of the tractor.

In other words, one way of comparing the efficiency and therefore the economics, of a variety of machines of similar type, is to study their respective time cycle of loading, and the average weight of bundle loaded. It will be found that the performance of some loaders, mounted on the same size and make of tractor, will differ quite significantly in this regard. It is well to remember that the tractor usually accounts for more than 50% of the capital cost of the whole machine and can incur the larger proportion of the repair costs and therefore maximum use should be made of its available power.

Factors affecting this efficiency usually concern the general design of the mechanical aspects of the loader, (ie. the efficiency of the push-piler, the grab and the slewing mechanism) as well as its hydraulics. It is possible to have two machines, both mounted on the same type of tractor and both costing, for example, R2-50 per hour to operate. Yet one will load at a rate of 35 tons per hour, and the other at 25 tons per hour. The unit cost of loading would therefore be 7.15 cents per ton, and 10 cents per ton respectively.

The essence of this study therefore is the average tons loaded per hour over an extended period and the expected operating cost per hour.

Summarising the economic factor, optimum utilization and optimum operating efficiency are essential for low cost of loading. Under these circumstances operating cost becomes more important than capital cost. As with most materials handling equipment, it is often found that higher capital cost usually results in a lower cost per unit of work done. Hence the move towards more expensive high capacity, highly efficient machines capable of loading up to 60 tons per hour. If this is beyond the scope of the average grower, then he should seriously consider the multi-purpose machine.

Terrain

Terrain places various degrees of limitations on all of the loaders presently being commercially manufactured. It must be accepted that a certain percentage of the Natal cane belt must eventually cease to grow cane once complete mechanisation becomes a necessity. This may take many years and the eventual day prolonged even further by future machinery development. However, it is worthwhile to consider the situation as it exists at present.

The multi-purpose front mounted loader's major limitation is terrain. This is because this machine carries its load of cane over the front axle of the tractor which reduces the weight on the rear traction axle when under load. Under more or less level conditions, this is not serious since the rear axle is adequately counter weighted to compensate for this weight transference. Experience so far has shown that the limiting slope under dry conditions is about 1 in 5.

The Sugar Association Mechanisation Committee did develop a rear-mounted fixed boom loader to assist with this problem in that the cane load would be carried on the traction axle rather than the front axle. Three seasons operation with this machine has justified its development since it has been successfully operated on slopes of up to 1 in 3.5. However, since the controls of the tractor had to be reversed, this machine cannot be considered as a multi-purpose machine.

The slewing boom loaders have been developed to the point where some at this stage have no slope limitations when loading into the tractor drawn trailer. The limitation here is not with the loader but rather with the transporting vehicle. Loaders have been fitted to four wheel drive tractors and one is regularly being operated on slopes of 1 in 3 to 1 in 3.5. Trailers have capsized, however with improved design, and by the operator not filling them to their maximum height, it has been found that cane can be taken off some pretty steep slopes.

Slopes in excess of 1 in 3 must be treated with caution. The Experiment Station is developing a cane extraction unit with winching cables and a slewing loader which will be operated from contour roads and the more negotiable sections of cane-fields. Slope places no limitations on this machine since it can winch a 1000 pound bundle of cane up almost any slope. Time of loading ie. capacity and manoeuvreability on narrow contour roads have presented problems in recent field trials, however it is hoped that these will be reduced when the machine is redesigned. At present it is felt that this is the only possible solution to the extreme slopes.

Types of loaders

The basic types have already been mentioned, namely the fixed boom, and the slewing boom. Both of these types can be either front or rear mounted. The front mounted machines enable multi-purpose usage in the case of the fixed boom loader, and easier detachment and lower cost with the slewing loaders. Generally speaking, it can be said that the fixed-boom loaders are better suited for building cane stacks for eventual loading by self-loading trailers, or for direct loading into stationary vehicles, while slewing loaders are high capacity machines used for loading direct into the transport vehicle running alongside.

An early decision must be made regarding type of grab when selecting a loader. There are basically two types namely, a push-pile grab and the non-pushpile grab. These terms are self-explanatory in that the former is used as both push-piler and grab when taking cane from a windrow, whereas the latter is worked in conjunction with a separate push-piler. The push-pile grab is commonly found on front-end loaders, whereas the other is used on high capacity slewing loaders where the time cycle can be reduced slightly by the operator being able to hold one bundle of cane in the grab while push-piling a second. This reduces downtime while waiting for the trailer to pull into position alongside the loader.

The non-pushpiling grab is also used in trash conditions where the trashed cane is left in bundles on the trash or in cleared spaces among the trash which in either case prohibits the use of push-pilers. This system also applies in extremely stoney conditions where push-piling will result in stones being loaded with the cane.

Of growing importance is the push-piler itself and the degree to which it will pick up dirt, stones or cane roots. Push-piling does tend to be a dirty job, however push-piler design and operator skill are important factors in keeping this to a minimum. This mechanism should be so designed as to be able to get beneath the cane windrow and yet not dig too deeply into the earth. It should also tend to lift the cane off the ground so as to allow any earth picked up to filter through the cane and fall back onto the ground. The shape and size of the push-piler should be such as to prevent both short and long cane from sliding out to one side or dropping through the middle during the push-piling operation.

The grabs come in various shapes and sizes; however there are two major points to consider. The first is the ease with which a bundle of cane can be grabbed off the ground or push-piler without picking up dirt, and secondly, the extent to which the tines of the grab can close around a small bundle of cane so as to prevent spillage.

The booms of slewing loaders can be fitted with or without "crowding ram". This second ram in the boom enables the operator to place the bundle of cane either closer or further from his tractor as required. This is especially important when operating on hillsides where the travel of the loader and trailers are not always parallel at the same distance from each other.

The tractors can be fitted with hydrostatic transmissions or Torque convertors which eliminates the normal clutch. This is very desirable where fixed boom loaders are used and where a lot of forward and reverse travel is required. It does cost quite a bit extra but is most certainly worth the expense if the tonnage moved is high enough.

<u>Harvesting and Transport Systems</u>

While the decision to mechanise the loading operation depends to a very large extent on the economics of the particular circumstances concerned, the selection of the type of loader is largely dependent on the harvesting and transport systems to be employed. In fact, transport is a major consideration.

If one studies cane handling in Natal from the point of cutting to the eventual milling, one will find that more often than not the cane is handled seven times. These are cutting, stacking, self-loading by trailers, off-loading at mill yard stock-pile and finally, loading into the mill carrier. This can be reduced to three times where a tramline is used, to five times if the cane is delivered direct from field to mill by self-loading trailer, and can go as high as eight or nine times where two transhipments are required.

Opposed to this is the cut, load, direct transport to mill carrier system employed with the "combine" cut-load harvester where only two handlings are required.

Studies of cane production costs will show that these multiple handlings of cane can be expensive and for this reason any new developments in mechanisation should consider the possible elimination of some of these handlings. For example, it can be asked why stack cane mechanically for eventual loading by self-loading trailers and why not rather load directly into suitable trailers? The answer to these questions will, however, depend almost entirely on the type of transport involved, the daily tonnage allocation, and the distance of haul.

It must be appreciated that to load a vehicle in the field with some mechanical loaders will take considerably longer than if a self-loading trailer were used. Infield loaders load at rates of from 10-60 tons per hour, while a self-loading trailer will load a 5 ton stack in 5 minutes ie. a rate of 60 tons per hour.

If a front end loader is used to load, say, 40 tons of cane per day at 10 tons per hour, the downtime incurred while loading will be 4 hours. If an 8 hour day is envisaged, this only leaves 4 hours for actual haulage work which, at an average haulage speed of 8 m.p.h. for tractor trailer combinations and 35 m.p.h. for 8-10 ton trucks, means that only 32 miles and 140 miles can be travelled by these respective vehicles. Using a self-loading trailer, the loading would only involve about 40 minutes thereby leaving 7 hours and 20 minutes for transporting the cane.

It is essential therefore to work out the time cycles of the various vehicles which could be used. The following schedule is suggested.

Time Cycle

a) Loading time: Front-end loader - 10 - 15 tons per hour.
Slewing loader - 25 - 60 tons per hour.
Self loading trailer - 5 minutes per bundle (3-7 tons)

b) Travelling time: tractor trailer units - 8 m.p.h.
8-10 ton lorries - 35 m.p.h.
10-24 ton lorries - 20 m.p.h.

c) Offloading at mill or siding - 10 minutes per lift

d) Downtime for smoke etc. - 5 minutes per load

Once the average cycle time in minutes has been determined for a particular load of cane in tons and the distance haul, this figure is then divided into the total number of minutes available in a working day. This will then give the number of loads which can be moved per day, which when multiplied by the average weight will give the total tons which can be moved.

Only by carrying out these calculations for a variety of systems, and then comparing the costs of each, can one make an accurate assessment of the economics of each.

Following are two examples for two sets of hypothetical growers, each with the same haulage distance and daily allocation, both using front end loaders but one stacking cane mechanically for transport with a self-loading trailer, and the other loading direct into a tandem trailer or lorry.

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Burn.

Example 1.

Known data

a) Daily allocation: 40 Tons
b) Distance haul: 3 miles
c) Self-loading trailer: 5 tons per load
d) Tandem trailer: 10 tons per load
e) Average speed: 8 m.p.h.

Cycle Time

		Self-loading Trailer	Tandem Trailer
Loading	:	5 minutes	60 minutes (10T at 10T/hr.)
Travel	:	45 minutes (6 miles at 8 m.p.h.)	45 minutes
Off-load	:	10 minutes (1 lift)	20 minutes (2 lifts)
Downtime	:	5 minutes	5 minutes
Total		65 minutes	130 minutes
Number of loads		8	4
Total time taken		520 minutes (8hrs. 40mins.)	520 minutes (8hrs. 40mins.)

From the above example, it can be seen that it will theoretically take the same time to load and move the cane in both cases, viz., 6 hours 40 minutes.

However, in the case of the system using the self-loading trailer, the loader will have stacked the 8 five ton stacks within 4 hours and would therefore be free to do another 4 hours work cultivating etc., whereas in the case of the tandem trailer, the loader would have to be on call for loading throughout the day. In addition, the tandem trailer would require a much larger tractor to haul it than would the self-loader. Under these circumstances it would appear that the stacking operation would be the most economic.

Example 2.

Known data

a) Daily allocation : 48 tons
b) Distance haul : 35 miles
c) Transport, direct field to mill, 8 ton lorries
d) Transport, 4 ton stacks, infield to gantry, to mill 8 ton lorries
e) Average road speed for lorry 35 m.p.h.

Cycle Time for Lorries

		Direct loading	Stacking, self-loader and transhipping
Loading	:	48 minutes (8 Tons at 10 ton/hour)	10 minutes (2 bundles x 5 min.)
Travel	:	120 minutes (70 miles at 35 m.p.h.)	120 minutes
Offload	:	10 minutes (one lift)	10 minutes (one lift)
Downtime	:	5 minutes	5 minutes
Total		183 minutes	145 minutes
Number of loads		6	6
Total time taken		1098 minutes	870 minutes
Using 2 lorries			
Time taken per lorry:		549 minutes (9hrs. 9 mins.)	435 minutes (7 hrs. 15 mins.)

While the above example shows that by stacking mechanically it will take only 7 1/4 hours to move the cane to the mill as opposed to 9 hours and 9 minutes by direct loading; and while the loader would take 4.8 hours first thing in the morning to stack the 12 four ton stacks thereby being able to do other work during the remainder of the day, by so doing the grower would also have to have a haulage tractor and self-loading trailer, plus transhipment gantry in order to move his cane.

Under these circumstances it would be far more economical to load direct onto the lorry and deliver the cane straight to the mill. Of course this type of set-up depends on the terrain and is inclined to be more susceptible to hold-ups due to wet weather.

The above examples should serve to indicate the type of study which must be made into the harvesting and transport system before any economic study can be made.

It must be stressed that each particular case has its own peculiar set of circumstances which must be studied before any recommendation can be made. The overall policy, however, should be towards using a minimum of labour, obtaining optimum utilization of equipment, and doing as little handling of the crop in the harvesting process. If these considerations are borne in mind, the resultant system should prove to be both efficient and economic.

15th October, 1968.

DOORNKOP SUGAR COMPANY (PTY) LIMITED.

HOT WATER TREATMENT.

At the recent seminar on H.W.T. held by the S.A.S.A. Experiment Station for the benefit of those interested in the growing of sugarcane, this subject was covered in some detail.

It is my intention therefore to pick out a few of the main points, brought out at this seminar, on which we at Doornkop have had some limited experience.

Effect of R.S.D. on Cane Yields.

The main reason for hot water treatment is naturally to eliminate the Ratoon Stunting Disease virus from the nursery seed material.

This disease is known to be a major cause of reduction in yields, a fact which was illustrated by Mr. G.M. Thomson in his talk on "Disease and its Effect on Cane Yields".

We recently harvested the first ratoon crop of a trial, situated in a high yielding area on Inanda soil series, which was designed to compare the yields obtained from planting the best available untreated seed cane of three varieties, with those yields of the same varieties, the seed cane for which had been taken from hot water treated nursery stock.

Under these conditions, the effects of the disease might not be expected to be as marked as those cited by Mr. Thomson, who used known diseased material for comparison.

This was in fact so, as the attached harvest results of the plant and first ratoon crops of the Doornkop experiment show.

No significant response to hot water treatment was recorded in T.C.A. for either crop for the varieties N:Co.293 and N:Co.334. For the variety N:Co.376, the mean of the yields from the untreated plots was 16% lower in plant cane and 17% lower in first ratoon, than the mean yields from those plots planted to treated seed.

It so happens that, in common with many parts of the Sugar Belt, the variety N:Co.376 is grown on over 60% of our quota area. Thus the implications of the results of this experiment make it imperative that we ensure an adequate supply of seed from hot water treated stock for our commercial plantings.

Irrigation of Nurseries.

Mr. Whitehead, in his address at the seminar, pointed out the importance of irrigation as an insurance to nursery production.

Unfortunately, we have been unable to implement this in the past and in consequence to droughts, have suffered from shortages of treated seed for limited periods.

The nature of many of our valley bottoms is such that they are not suitable for nursery sites. This is because these areas are often narrow and at higher altitudes, there is a danger of frost.

This situation is to be alleviated with the introduction of a furrow irrigation scheme, which will eventually cover some forty acres. The water supply will come from the less contaminated mill effluent which we are not permitted to return to the river.

Control of Other Diseases.

Not directly connected to hot water treatment but nevertheless of importance in nursery management, is the control of other diseases in the nursery.

Eradication/.....

Eradication of diseases in the fields from which the material is to be supplied for treatment, would be ideal. This is often practised where the material is obtained from old nurseries and strict selection at the plant will help further in this regard.

Whereas Mr. G.M. Thomson recorded yield losses of up to fifty percent in the variety N:Co.376 as a result of ratoon stunting disease, his data on losses due to mosaic were just as noteworthy. Yields of varieties N:Co.293 and N:Co.376 have been as much as from sixty to ninety percent lower in mosaic infected cane, as compared to those from healthy cane.

Disease inspections of the nurseries at Doornkop last season led to the rogueing of 642 stools of mosaic infected cane from 94 acres. This is equivalent to 0.1% infection, which, although not apparently significant, could, if this material had been used as seed, aid considerably in the spread of the disease.

Assuming the diseased stools to average ten sticks each, we would have 6,420 sticks and with three eighteen inch setts to each stick, a total of 19,260 setts could be obtained. At 6,000 stools per acre, this material would completely cover over three acres.

At the same time as rogueing for diseases, all volunteers from the previous crop are removed. Mixed varieties are frequently supplied in the material to be hot water treated and this could, if it were not discarded, result in an additional problem over and above that which is presented by the volunteers.

In instances where it has been overlooked, this impure material has at least been hot water treated and therefore should not act as a source of reinfection for R.S.D. as is the case with volunteers in the nursery. It could, however, be a source of infection for other diseases, such as smut, mosaic and gumosis, especially where the impurities consist of some of the older varieties, for example, Co.301 and Co.310.

Doornkop Operation.

The hot water treatment plant at Doornkop is operated on two shifts for sixteen hours a day, during which period a total of six frames of approximately one ton of seed cane each, are treated.

This is costed on a daily and tonnage basis as under:

Supervision:		
2 Indians per day at R1.00 each	= R 2.00	
±6 tons per day		= R0.33 per ton
Operation of Plant:		
6 units/day @ R0.65c per unit	= R 3.90	
±6 tons per day		= R0.65 " "
Sett preparation & frame loading:		
10 units/day @ R0.40c per unit	= R 4.00	
1 Induna " R1.20c	= R 1.20	
±6 tons per day		= R0.87 " "
Fungicide: (mercuric)		
10 lb double strength per 2 weeks @ R16.00	= R 1.60	
±6 tons per day		= R0.27 " "
Depreciation, Wear, Maintenance & Power:		
10% of R2,500 per annum (i.e. R250 per annum)		
275 frames per annum @ 6 frames per day = 46 days	= R 5.43	
±6 tons per day		= R0.91 " "

Page Three/...

Transport of Seed Cane to field:

1 Fordson tractor, trailer & driver
(11 hours @ R1.60 per hour) = R17.60

±6 tons per day = R2.93 per ton

Total Cost per ton = R5.96

Growers, who supply seed for treatment, are charged on this basis, which includes delivery to the farm

Delivery is undertaken to ensure the prompt return of frames and baskets and also to prevent damage to the seed if tipping out of the baskets became necessary prior to collection at the plant.

Doornkop Notes.

(a) Seed Cane:

We prefer to use seed material of about eighteen months of age in preference to younger cane for treatment, as the older cane is less likely to be affected by temperatures in the tank.

A simple guillotine type machine, a diagram of which is attached, is used for chopping the cane into setts of the required length and this handles about five sticks at a time.

(b) Temperature Control:

Thermostatic control of the temperature in the tank has not proved satisfactory within a limit of half a degree.

The temperature is therefore controlled manually on a switch and this has proved reliable.

The recording thermometer has been calibrated with a standard thermometer to read actual temperature and this is checked constantly by means of a standard thermometer in the top of the tank and a dial thermometer, with flexible tube, recording the temperature at the bottom of the tank.

The tank is well insulated and this obviates frequent manual adjustment of the temperature, the switch being operated four or five times during the two hour treatment period.

(c) Plant Design & Construction:

i) Providing that insulation of the tank would not be detrimentally affected, a lighter material, such as fibre glass, could be used to advantage for the construction of the lids.

ii) Pipe flanges should if possible be located so that they are bolted to the exterior of the tank insulating layer and not set in a recess within the material. This will improve insulation and leaks will be more readily seen.

iii) By locating the bases of the tanks at ground level, free drainage has been assured, and the covered surface drains can easily be cleared of extraneous matter.

iv) It has been noted that even slightly impaired water circulation in the tanks will result in a poor distribution of heat, therefore every effort should be made to obviate this problem.

A structural improvement for cleaning purposes could be made by protruding the ends of the upper circulation pipes through the walls of the tank to facilitate the insertion of a suitable ramrod to clear these pipes of trash. The bend, which is situated at the end of these pipes on the inside of the tanks and is closed with a bung, should, however, not be dispensed with, as it is more convenient to flush water through this passage after cleaning.

The/.....

The suction pipe at the bottom of the tank should be easily removable and the fitting of a screw-in bung on the blind end of the pipe would again facilitate cleaning. I would not suggest cleaning this pipe by means of a ramrod while it is in position, for fear of damaging the electrical elements.

General.

The S.A.S.A. Experiment Station must be congratulated on the intensification of its propaganda programme to convince cane growers of the benefits to be derived from the hot water treatment of seed cane and the good management of nurseries.

The cost of these procedures is infinitesimal in comparison to the likely revenue gain resulting from increased yields and should certainly amount to less than the equivalent value of 1 ton of cane per acre harvested off the commercial fields.

Our plant at Doornkop has been visited much more frequently than in the past by parties interested in constructing plants of their own. These groups have represented not only Miller-cum-planters but also Planters' Groups, and, in two cases, even individual large scale Growers.

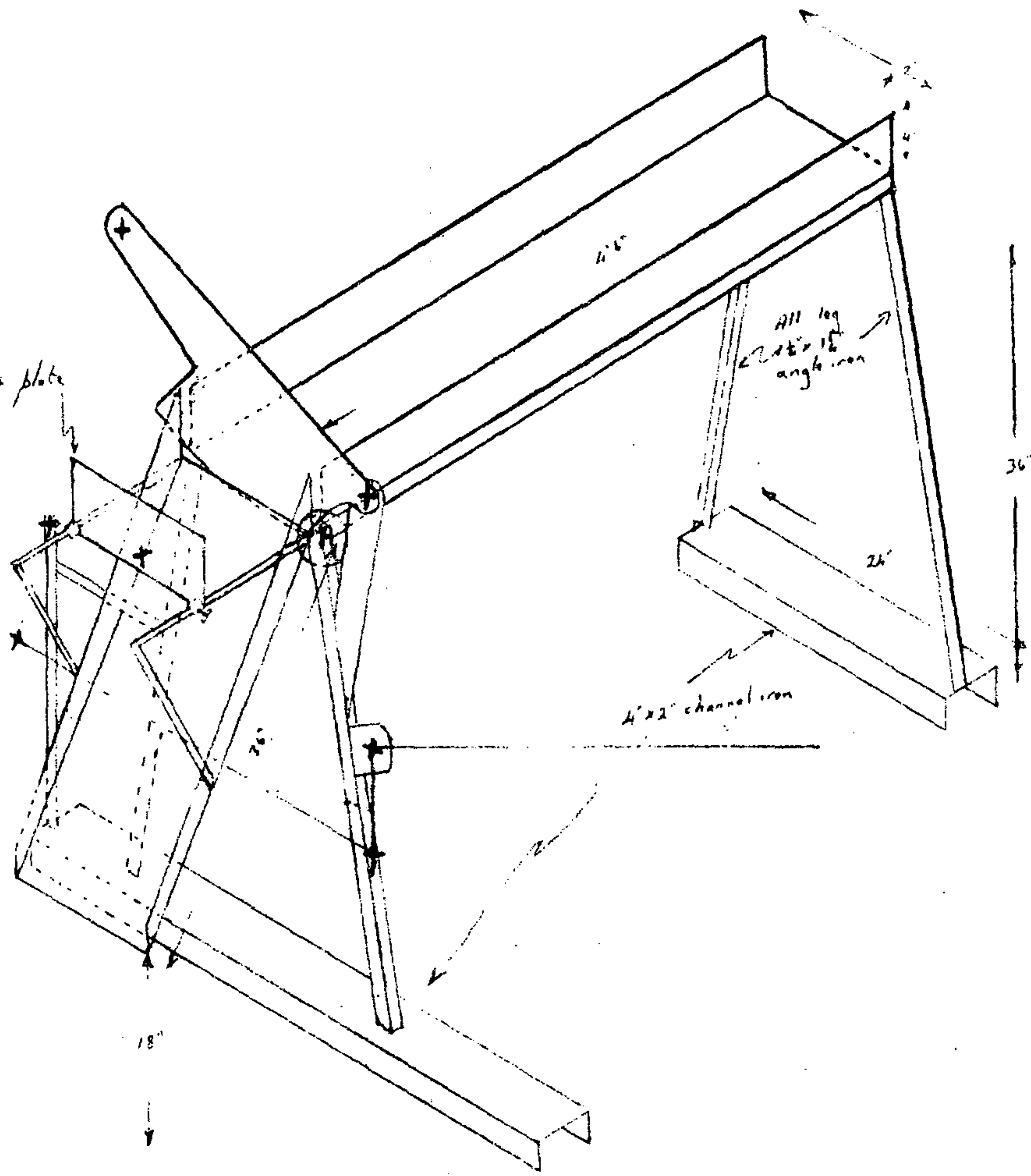
Even our own Growers have become more enthusiastic and their requests for treatment of seed this year amount to double the tonnage of that treated on their behalf in 1967.

Acknowledgements:

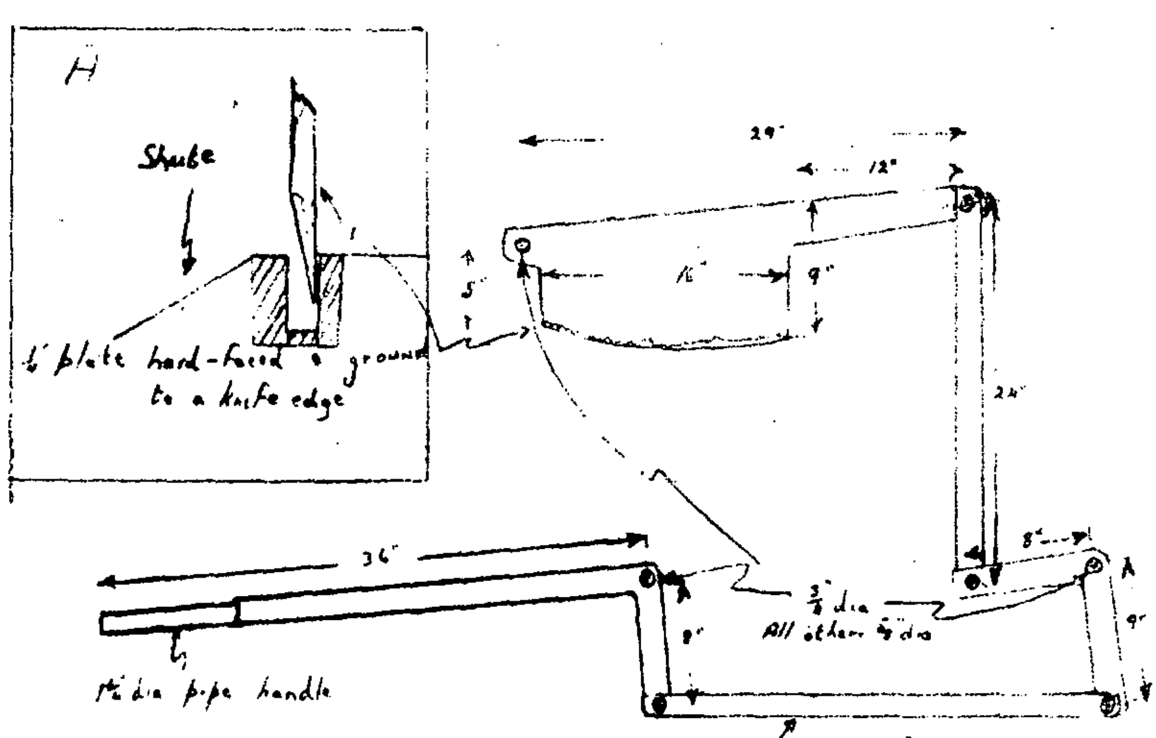
Mr. M.G. Murdoch, Biometrician at the S.A.S.A. Experiment Station for his analysis of the experiment.

L. ALLSOPP.

9.10.1968.



Adjustable plate
All leg angle iron
36"
24"
4"x2" channel iron
18"



H
Shute
plate hard-faced & ground to a knife edge
29"
12"
16"
9"
5"
24"
8"
36"
9"
33"
pipe handle
All links

DOORNKOP SUGAR COMPANY (PTY) LIMITED.

"RATOON STUNTING DISEASE TRIAL"

Catalogue No.: 294
This crop: 1st Ratoon
Site: Langespruit Section, L12 (Y)
Altitude: 2,000 ft.
Soil series: Inanda.
Design: Random Block (5 reps.)
Variety: see treatments.

Fertilizer (lb.p.a.)	N	P	K
1st Ratoon:	147	17	125
Plant :	126	81	125

Water regime: Dryland.

Soil Analysis:

pH	OM%	Clay%
5.81	11.64	14.9

p.p.m.

P	K	Ca	Mg	Na
20	129	827	160	44

Age: R1 - 22 months; 11.66 - 9.68
P - 24.5 " ; 10.64 - 11.66

Rainfall: R1 - 84.56 ins.; P - 75.40 ins.

Irrigation: Nil.

Object: To compare the yields of three released varieties, planted with seed obtained from hot water treated nursery stock, among themselves and to the yields of the same varieties which were planted with the best available untreated seed.

Treatments:

1. N:Co. 376 from hot water treated nursery stock.
2. N:Co. 293 " " " " " "
3. N:Co. 334 " " " " " "
4. N:Co. 376 from best available untreated stock.
5. N:Co. 293 " " " " "
6. N:Co. 334 " " " " "

Results:

1st Ratoon.

TREATMENT	T.C.A.			S. % C.			T.S.A.		
	Un-treated	H.W.T.	Diff.	Un-treated	H.W.T.	Diff.	Un-treated	H.W.T.	Diff.
N:Co. 376	63.6	76.7	13.1	15.6	14.9	-0.7	9.95	11.48	1.53
N:Co. 293	61.7	67.2	5.5	15.2	15.1	-0.1	9.36	10.12	0.76
N:Co. 334	71.0	69.6	-1.4	16.0	16.2	0.2	11.38	11.25	-0.13
S.E. of treatment mean	3.57			0.21			0.57		
L.S.D. (0.05)	10.8			0.6			1.7		
(0.01)	14.9			0.9			2.4		
C.V. %.	11.7			3.0			12.0		

Comments:

1. N:Co. 376 shows a significant increase in T.C.A. but S. % C. is depressed, due to hot water treatment.

2. The analysis does not yield significant evidence that the varieties differ in response to hot water treatment, however, the responses for N:Co. 293 and N:Co. 334 are very different.

3. Unfortunately, variability is greater in this first ratoon than was the case with the plant crop.

Results:/....

Results:

Plant Cane

TREATMENT	T.C.A.			S. % C.			T.S.A.		
	Un-treated	H.W.T.	Diff.	Un-treated	H.W.T.	Diff.	Un-treated	H.W.T.	Diff.
N.Co. 376	53.1	63.2	10.1	16.14	16.03	-0.11	8.53	10.20	1.67
N:Co. 293	58.4	58.9	0.5	16.11	16.20	0.09	9.41	9.55	0.14
N:Co. 334	60.5	61.1	0.6	16.64	16.38	-0.26	9.87	10.20	0.33
S.E. of treatment mean	1.42			0.161			0.223		
L.S.D. (0.05)	4.3			0.48			0.67		
(0.01)	5.9			0.67			0.93		
C.V. %	5.3			2.2			5.2		

Comments:

1. For T.C.A. and T.S.A., there is significant evidence of an effect of hot water treatment. This effect varies with variety.

   N:Co. 376 is the only variety to show a significant response to hot water treatment.

   Without hot water treatment, N:Co. 293 and N:Co. 334 yield significantly more than N:Co. 376.

2. For S. % C., apart from the significantly higher sucrose percent cane for N:Co. 334, there is no significant evidence of any effect.

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS ASSOCIATION

NOTES ON HEAT TREATMENT OF SEED CANES AT HULETT'S - MOUNT EDGECOMBE

BY

P.J.M. DE ROBILLARD

----

1. THE TREATING PLANT consists of :

a) The boiler for steam production

b) Heat exchanger

c) Hot Water stand-by tank - approx. 600 gallons.

d) Circulating pump

e) Two Hot Water treating tanks. 700 gallons each

f) Cooling tank with fungicide and insecticide.

Total hot water in circulation : approx. 2,000 gallons

Capacity of pallets holding the seed cane : 1500 lbs each
= 3,000 lbs Seed Cane per treatment cycle.

Ratio of cane to water = 1 to 6
Water circulated/hour = 6,000 gallons
i.e. all water in the heat treating tanks is re-circulated 4 times/hour.

Temperature control is by -

1) A thermostat set at 50/51°C, fixed to the pipe leading from the stand-by tank to the heat exchanger. This automatically closes or opens the steam valve to the heat exchanger.

2) Negretti and Zambra thermocouples fitted inside the treating tanks.

3) A mercury hand thermometer to check temperature at different points in the treating tanks.

Hot Water from the pump passes through a manifold and is distributed under pressure along the bottom of each tank by 5 perforated pipes. The overflow is piped back to the stand-by hot water tank.

This method of circulation is a departure from the conventional way of spraying the hot water on top of the cane and circulating back from the bottom outlet. The question then is which method is the best for good heat transfer and for the smooth running of the plant?

2. OBSERVATION AND TRIAL ON GERMINATION.

As far back as 1960 it was noticed that, starting from pure tap water, there was a gradual increase in the concentration of plant nutrients in the hot water.

This information was passed on to J. Anderson, then Microbiologist at the Experiment Station, who found that diffusion of nutrients occurred not only from the cut ends of the setts, but also from the buds. It was assumed that poor germination often associated with Hot Water Treatment could be in part due to loss of nutrients from the buds.

Circa 1963 the Revue "Fertilite" mentioned increased germination in canes treated in a dilute solution of Urea.

In 1965/....

In 1965 a trial was planted on the Blackburn flat to assess the effect of Hot Water Treatment on germination.

Varieties : NCO 376 and N50/211

Treatments : A - Control
B - H.W.T. in pure water
C - H.W.T. in N.P.K. Solution

the concentration of the plant nutrients being -

N - 600 p.p.m.
P - 125 p.p.m.
K - 1000 p.p.m.

which represents roughly the concentration of those nutrients in the cane juice.

Length of lines was 40 feet, and the number of buds planted per line was 90.

At the time of incipient stooling when germination counts were stopped the results were as follows:

	NCO 376		N50/211	
	Av. of Counts per line	% of Total	Av. of Counts per line	% of Total
A.	72.0	80.0	63.5	70.5
B.	78.0	86.7	77.5	86.1
C.	76.5	85.0	89.0	98.9

3. CHANGE IN THE PROCESS.

When the existing plant started at Mount Edgecombe 250 baskets were supplied.

These were made of angle iron frame with the sides and bottoms of diamond mesh grid iron welded to the frames.

Each basket measured 18" x 18" x 18" and contained approx: 100 lbs of setts. 14 baskets were used on each pallet.

The baskets were costly, were easily broken, heavy to handle and at the end of the treating season they had to be dipped in hot linseed oil as protection against rust during a 10 months period of inactivity.

In 1962, at the I.S.S.C.T. Congress in Mauritius, Cutler and Vlitos gave a paper on the Natural Auxins of Sugar Cane. They noted that "free Auxin content was depressed in stems that had been treated in water at 50°C for 20 minutes. Loss of apical dominance and improved germination of the lateral buds along the axis of the stem were associated with heat treatment".

During Season 1963, when heat treatment was resumed, a few lines in each seed bed were planted with whole stalks of 5' or more in length after the normal 50°C/2 hours treatment. Observations by Section Managers ranged from good to normal, to poor germination. This was not indicative of any adverse effect as, even with the standard 18" sett and the commercially planted untreated setts, germination can still be very variable. The proportion of whole stalks heat treated was gradually increased every year, and it is now the practice at Mount Edgecombe to plant all nurseries with heat treated whole stalks.

No critical/....

No critical experiment on germination of whole stalks was done by the Company; the reader is referred to a paper by G.M. *Thomson - Proceedings of* S.A.S.T.A. Congress, April, 1967 - entitled "The Effect of Hot Air Treatment and Hot Water Treatment on the Germination of 12 Sugar Cane Varieties in Natal".

4. A NEW TREND

A Hot Water Treating Plant is costly to build and up to the present its use is limited to the establishment of nurseries, or 10 % of the area to be planted every year.

In January, 1968, a suggestion was put to the Management advocating the planting of commercial fields with whole stalks heat treated at 50°C for 20 minutes. It was estimated that the total number of units required per acre would be 5 labour. For various reasons it was not possible to use this method during the March/April planting, but it was successfully done in September this year on 40 acres of nurseries with whole stalks heat treated 50°C/2 hours. The units of labour employed *and the cost of planting worked out as follows:*

Cutting Seed Cane, Loading etc.	:	15 units	@ 59c	=	R 8-85
H.W. Treatment	:	3 units	@ 128c	=	3-84
H.W. Treatment	:	3 units	@ 112c	=	3-36
H.W. Treatment	:	11 units	@ 59c	=	6-49
2 Sirdars	:	2 units	@ 132c	=	2-64
Planting	:	20 units	@ 59c	=	11-80
2 Mules covering, Leader Boys and Drivers	:	4 units	@ 59c	=	2-36
		58 units			R39-34

It has been established that these units can plant 10 acres/Day which brings the utilisation of labour for planting to 5.8 units/acre at a cost of R3-94.

The field was of clansthal Sands and no fertiliser was applied at planting.

5. POSSIBLE DEVELOPMENTS

In view of the savings which can be effected by extending the duties of the Hot Water Treating Plant, there is a possibility that all plantings could be done with heat treated 2 hours 50°C material, provided the capacity is big enough to plant 30 acres/day.

Assuming a normal planting programme of 2500 acres/annum the sequence could be -

Spring Planting	2000 Acres
March/April Planting	500 Acres
	2500 Acres

a) Plant Hot Water Treated, 2 hours 50°C, whole stalks in August, September, October.

30 Acres/day x 70 Days = 2000 Acres

b) Supply all fields with H.W. treated whole stalks in November/December.

c) Plant all March/April fields with disease free canes from established hot water treated commercial fields.

This would do away with the part areas of fields with cane nurseries, and it is hoped would eventually eradicate R.S.D.

THE SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION.

POINTS ON THE DESIGN AND OPERATION OF A HOT WATER TREATMENT PLANT.

OLD SYSTEM :

For approximately twelve years, up until July, 1968, the Hot Water Treatment Plant at Tongaat consisted of one 1100 gallon Hot Water Tank, heated by nine electric elements totalling 45 kilowatts, and one Mercane Dipping Tank of the same capacity.

Sixteen small Sett Baskets were packed with setts approximately 2 ft. long, and these baskets fitted into a large crate which was lowered into the Hot Water Tank.

The crate was lifted and lowered by means of an Overhead Electric Hoist which was moved by hand along the crawl beam which extended out through a pair of double doors at the South end of building in which the plant was housed. Circulation of the water in the Hot Tank was accomplished by means of a 3" centrifugal pump driven by a 3 h.p. motor. A full crate of cane, cut into setts, contained approximately 1500 lb. cane, and the capacity of the plant working on a three shift basis was approximately 6 tons per 24 hour day.

Costs per 6 tons :

Electricity - 1 1/3 hours in every 3 hours @ .76 cents per unit		R3.62
Labour		9.00
	Total	R12.62
	Cost per ton	R2.10

MODIFICATIONS :

The plant performed quite satisfactorily with electric heating, but it was felt that a considerable increase in production was required, and that this increase could be effected at a reduced cost per ton of cane. There have been many problems which have not been corrected because of cost considerations resulting from the old plant being modified rather than the construction of a completely new plant. The following modifications were made :-

1) Installation of a second 1100 gallon Hot Water Tank complete with 3" centrifugal pump, motor, manifold and piping for water circulation.

2) Fitting of two Burkay gas-fired Water Heater Units, with an individual heating capacity of 300,000 B.T.H.U.'s per hour, and a gas consumption of 15 lb. per hour. These units are equipped with separate circulation pumps and the hot water is fed into the bottom of the tanks through a manifold extending the full length of the tank. Temperature is controlled either manually through electric solenoid switches or via thermostatic control. The thermostatic control is not sufficiently accurate for the Hot Water Treatment process however.

3) Construction of a third crate, and the modification of the two existing crates, for cooking whole stick. A lifting device was made so that the tops of the crates could be left open. The ends of the crates were covered with heavy wire mesh and one end was hinged for easy access.

4) Extension of the overhead crawl beam through the Northern wall so that cane could be brought in at the Southern side, treated, and removed from the Northern side.

5) Installation of a 1½ ton electric overhead hoist with manual travel, on the crawl beam.

6) Installation of a twin pen recording thermometer graduated in 1^{o} C. divisions.

PERFORMANCE :

The system of gas water heating has performed very well since its inception. Some problems were encountered initially with loose pieces of trash blocking the filters to the heater coils but this was overcome by better trashing. With whole stick cooking, the weight of cane per cooking is in the region of 1800 lb. and an average of 16 tons of cane per day can be easily maintained with one operator and two assistants per eight hour shift. These three men are responsible only for loading the cane into the crate, treating it and unloading the crate. Cane is brought in and taken away by the transport and labour from the fields.

Cost per 16 tons :

Gas - 1 hour in every 3 hours @ 30 lb. per hour and 5 cents per lb.		R12.00
Labour		9.00
	Total	R21.00
	Cost per ton	R1.31

Initially the cane was loaded and unloaded by hand, but this has now been changed to a system whereby the cane is loaded by hand into the crates which act as a former for the bundle. Two cable slings (or chains) are placed inside the crate prior to loading, and the bundle of cane is then removed from the crate after treatment by means of a lifting bar. It has not been possible to dispense with the crate since there is insufficient clearance from the ground to the crawl beam to allow for handling of the bundle. Because of only limited space under the crawl beam on the discharge side, it has not been possible to stack bundles of treated cane, and this has resulted in considerable increased labour usage.

IDEAS FOR A NEW PLANT :

From experience gained, a number of suggestions can be made for specifications for a new plant.

1) Steam heating via exhaust steam from the factory - Even with the bulk low gas price (5 cents per lb.) enjoyed by Tongaat, the cost of heating is considerably more than half the total operating costs.

2) Ground level tanks with the advantages of good insulation, easy access and maximum space available for the overhead hoist.

3) At least 12 ft. clearance from the top of the tanks to the crawl beam so as to allow easy handling of bundles of cane instead of crates.

4) An extended crawl beam on the intake and output sides of the plant to allow for adequate storage and separation of varieties.

5) Pre-bundling of cane in the fields, using a trailer fitted with a partitioned back so that bundles would be made to the correct size. This pre-bundling should eliminate a considerable amount of extra handling and attendant eye damage and extra labour usage.

E.C. GILFILLAN.

ECG/DMW,
Maidstone,
16th October, 1968.

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

OLIGO ELEMENTS: P. COIGNET

Oligo elements, trace elements or minor elements are the names given to some metallic and non-metallic elements such as Cu, Zu, Mn, Fe, Mo, B, Si, Na, Cl, Co, and others which play vital functions within the plant, in order to carry on all its activities.

No farmer would ever dream of producing a crop without being certain that the three major elements, N, P, and K, are made available in the right amount to the future crop, in order to obtain the maximum yeilds from his fields. Many a time he may overlook the other major elements S, Ca, and Mg, - taking for granted that the soil or the fertilizer carriers will supply them in sufficient amounts.

When it comes to the oligo elements, misnamed minor elements, he is under the impression that they are of minor importance to the crop production and that they are required in such small amounts that mother earth has an inexhaustible supply of them to look after the requirements of all his future crop. Actually, any element absorbed by the plants play as an important role in the plant physiology as any major plant food.

In the past when all the crop residue, factory by-products and farm-yard manure were returned to the fields, little or no problem of trace elements deficiency were encountered in crop plants. The position changed when heavy yields were obtained with the use of chemical fertilizers where cumulative built up of some trace elements on one side, and exhaustion of some trace elements on the other, caused a shifting of strength in the various links of the fertilizing elements chain. The stress of heavy crops caused the weakest link to break, as was the case lately in the maize triangle, where yellowing of maize caused crop failure, due to a combination of trace element deficiencies.

The function of the obligo elements in the plants are as important as are the major ones, commanding many vital functions within the plant cells themselves.

For instance the enzymic reactions are activated by traces of metal ions such as Fe, by forming links between the enzyme - protein on one hand and the substitute on the other. Others, like zn, control the formation and functioning of the auxins within the plants.

2/.........

Trace element deficiency in plants is due, not only to absence of these elements in the soil, but also to soil conditions which render them unavailable to crops. The classical examples being the muck or peat soils where some organic compounds have combined with metallic ions such as copper and zinc and have rendered them unavailable to the plant roots or over-liming in the case of boron.

Very low pH renders the Mo, unavailable to crops. Consequently when a crop suffers from any oligo element deficiency one must remedy the soil conditions responsible for such a state of affairs before going into the expense of applying the deficient obligo element itself.

Even the chemical sprays are not always effective in the treatment of trace element deficiency, because as in the case of zinc, when it is caused by an excess of P, within the plant zn, is immobilised or precipitated within the vascular tissues and there is no translocation of this mettalic ion from the older leaves to the young growing leaves.

COPPER:

As with most trace elements, its uptake from the soil by plant roots is dependant, not only on the amount contained in that soil, but also on the soil conditions:- namely,
(a) physical, (b) chemical, (c) biological.

(a) At a high soil pH its availability is markedly decreased due to its immobilisation.
(b) A soil containing a very high phosphate will immobilise, partly or completely, the copper ions so as to render them unavailable to the crop.
(c) A very high organic matter content in peat and other organic soils, which contains a very high microflora, will have very little copper available for plant growth, due to competition for the same plant food.

Role of copper in plant metabolism:

Copper is closely associated with most enzymic activities in the plant tissues. As in all metallic oligo elements, it helps in the synthesis of the chloroplasts and in their normal functioning, although they do not enter into their molecular composition. Copper, for instance, is so closely connected with chlorophyll that in its absence photosynthesis is at a standstill, resulting in the eventual death of the plant thus affected.

Copper is also known to lengthen the life of plants by preventing the degeneration of the chlorophyll. In combination with other trace elements, it also diminishes the cold and frost damage in green leaves, probably by decreasing the freezing point of the plant sap or by rendering the cell walls of the leaves more elastic - thus preventing them from bursting under the pressure of the freezing sap. Copper ions also help to conserve water in the plants, thus helping the crop in time of drought.

Our field experiments at Reynolds Bros. Estates in Equeefa, Mt. Rosa, Upper Sezela (Lynton field), Heatherley (Basin fields), confirmed these findings. Our plant cane which received copper sulphate at the rate of 20 lb./acre, together with 10 lb. of sinz (ZINC) sulphate, stood the last drought well when compared with the portion of the fields which were not topdressed with these salts.

IRON:

Although needed in very small amounts, its role is vital to plant life. It is present in most soils by the ton, forming the basic part of clays, yet adverse soil conditions may render it unavailable to plant roots. This deficiency is translated visibly in the chlorotic appearance of the plant.

The soil conditions which renders iron unavailable to crops is practically the same as in all metallic trace elements, as previously described.

The presence of iron in plants is important as it is associated (perhaps indirectly) with the formation of chlorophyll.

Lime induced chlorosis, as encountered on maila sick land which served as a dumping ground for old filter press cake, is very hard to cure. Judicious application of compost, treated with ferrous sulphate at the rate of 50 lb./acre does very markedly improve the position.

Iron chlorosis may appear in soils containing a very high concentration of metallic ions. Fields contaminated with factory effluents, containing a high concentration of metallic ions may cause iron chlorosis. Also some dolomitic limestone may contain high proportions of metallic ions, which may adversely affect the iron uptake of the crop, and develop an iron chlorosis.

These facts bring home how trace element deficiencies are caused more by soil conditions where an excess of one trace element affects adversely the uptake of the other, rather than the lack of that element in the soil itself.

5/..........

ZINC:

Traces of zinc are indispensable to plant life, in the fact that they command the production of auxins within the plant, chiefly Indoleacetic acid, which is enzymatically produced from tryptophan which requires Zn, as a catalyst for its synthesis. Plants grown in soil deficient in zinc fail to grow normally and exhibit the dwarfing of leaves and shoots which usually show a lower moisture content than in the non-affected plant. The osmotic pressure of the sap of the younger tissue, in zn deficient plants ranges from 5 to 9 atmosphere, whereas in healthy plants it varies from 5 to 6 atmosphere.

The translocation of zinc ions within the plant itself are affected by the concentration of other ions, chiefly in the presence of an excess of phosphates. (Bidulph 1945).

Zinc is not translocated from older tissue to the young growing tissue which exhalt the deficiency of this element.

The intensity of light affects directly the zinc deficient plants, this deficiency becomes more quickly apparent in plants exposed to direct sunlight than those grown in diffused sunlight.

At Umgai Coffee Plantation in T.M.S. cartreff series, the coffee trees grown in the open showed advanced stages of zn, deficiency (prior to zinc spraying) whilst those grown in the shade developed normally. A zinc spray on sugar cane at Upper Sezela in 1958 gave a short-lived result, whilst soil application in the following crop gave long lasting effects.

Shear in 1953 reported that application of traces of zinc in conjunction with potash application, reduced frost damage. Inspired by these results, in 1959 Reynolds Bros. Ltd., issued an allowance of trace elements to the portion of the fields which were badly affected with frost year after year and positive results were obtained at Equeefa, Mt. Rosa and Upper Sezela where the fields thus treated stood the frost well, whilst those next to them were parched after severe frost.

Zinc Toxicity:

Zinc toxicity was reported long before its beneficial or nutritional value was discovered, due to effluents from factories containing this element in fairly large amounts, contaminating and causing damage to cultivated fields and pastures.
The small difference between adequate and taxic zinc is reported by Robey (1932): 0.001 mg. gr. zinc/100 ml. solution stimulated plant growth, whereas 0.005 mg. retarded growth.

6/.........

MANGANESE:

The importance of traces of manganese for plant life lies in the fact that it acts as a catalyst in the synthesis of the chlorophyll molecule from its components as well as the proper functioning of photosynthesis.

Manganese is also a constituent of some respiratory enzymes, probably in assiociation with iron. Application of manganese salts to compacted and poorly aerated soil have proved beneficial to root development. It also helpsthe functioning of the enzymes responsible for the synthesis of protein from their amino acid components.

Here is may be inferred that any unbalance in the relation of manganese to the other trace elements, may bring about conditions favourable to the propragation of pathoginic viruses from some amino acids.

Manganese availability to crops, depends not only on the total amount present in the soil, but also on the medium in which they grow. Soil acidity pH 5.0 to pH 6.5 favours the availability of manganese whilst its availability is reduced by extremes of alkalinity (from pH 7.5 to 10) as well as extremes of acidity (pH 5.0 - 4.0).

Manganese is also immobilised by some soluble organic substances in the soil, as in the case of copper.

Plants can utilise divalent Mn^{++} but cannot use manganese in its tetravalent form.

Manganese toxicity is frequent under very acid conditions favourable for the solubility of such elements. Manganese does also accumulate in plant cells, under certain conditions, to toxicity levels where it interferes with the proper functioning of the cell metabolism.

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BORON:

Boron exerts several important functions in plants, the main one being to help the translocation of other nutrients within the plant. The primary role of boron in the plant is to enhance the uptake of Ca, and the absorbtion of cations.

It also exerts a vital function in the multiplication of cells, in the meristematric tissues of plants. Any deficiency of this element results in the dying back of special tissues. It is also of great importance in the germination of polen grain. (Dr. H.V. Vexhüll). Its availability is at its maximum from pH 5.0 to 7.0, it then decreases from 7.0 to 8.5 and then its availability increases again to pH 10.

It is absorbed by the plant roots only, and sprays are ineffective in combatting B, deficiency in crops. In extreme cases of deficiency 15 - 20 lb. of borax can be safely added to the main fertilizer per acre - above that amount it becomes toxic to cane growth, accompanied by the dying back leaves, starting from the older ones.

The phytoxicity of baron is so well known that it has been utilized as herbicides, where vegetation has to be suppressed completely, along the tram lines for instance. This element being absorbed chiefly by the plant roots, as it becomes available in small amounts at a time, its effect is long lasting.

MOLYBDENUM:

The utilization of nitrates in plants is directly dependant on the presence of certain elements, chiefly molybdenum, which availability in the soil depends upon the pH of this medium and the presence of calcium. The addition of limestone to some nitrate fertilizers is a wise move, where Mo, is unavailable in the soil the sugar cane leaves revert a bluish green hue indicating the accumulation and non-utilization of nitrogen in these tissues.

In extreme cases of molybdenum deficiency the addition of 2 to 4 lb. of sodium molybdate/acre is sufficient to cure this deficiency. Above this level it becomes toxic to crops.

Liming of the soil enhances the availability of molybdenum and the absorbtion of calcium in the plant counteracts the toxicity of molybdenum and other toxic substances in the plant cells.

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CHLORIDES:

Chlorides are present in various proportions in most plants, which is taken up chiefly by the roots.

Chloride main function in plants, for which however it is not specific, is an osmotic pressure regulator and cation balancer in the cell sap and the plant cells themselves. (Russell).

Above a certain concentration it becomes toxic to sugar cane plants, as in the case with fields exposed to sea spray, which causes the leaves to be scorched and scalded.

It is reported that it has a beneficial effect in hastening maturity.

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SILICON:

A very high proportion of the mineral matter taken up by the graminea family is silica, as reflected in the composition of their ashes. Its presence in plant tissues is known to counteract Mn, toxicity.

Great emphasis has been given lately in the tropics to its complete depletion from old senile laterites, where its deficiency affected sugar cane yields adversely.

Silicon's main role in the soil is to increase the phosphate availability to plants, chiefly in soils rich in Al, and Iron which tends to immobilise the phosphates. d'hotman de Villiers in Mauritius, attempted to reguvenate these soils by adding bosalt dust, with some success. Owing to the tonnage of grit to be added it was found uneconomic and consequently more concentrated forms of mineral, such as sodium silicate, are being employed to replenish these soils of this deficient material, with significant increase in yields.

In South Africa, our dwika soils and other heavy clay soils may derive some benefit from the application of furnace ashes, which are very rich in silica. These ashes may also act mechanically by opening and aerating these badly compacted soils.

SODIUM:

Sodium, like all minor elements absorbed in the plant tissue does fulfil some useful role in the plant metabolism. Although at present not quite fully understood, it is reputed to increase the succulence of the plant, that is, the amount of water held by unit dry weight of leaf tissue. (Russell).

It is also reported to increase the yield of sugar beet, thereby increasing the sugar output per acre.

UPPER SEZELA

BIG FIELD - TABLE MOUNTAIN SANDSTONE ORDINARY

PLANT CANE - VARIETY NCO 382

Replication	1	2	3	4	5	6	7	Mean
	Nil	Cu	Fe	Mn	Zn	B	5 ele-ments	
1	37	80	42	48	50	68	72	57
2	49	72	48	45	51	43	77	55
3	46	69	41	45	49	45	78	53
4	42	78	40	38	60	42	65	52
5	57	79	49	50	44	45	74	57
6	43	72	55	47	57	47	73	56
7	46	70	46	49	55	57	80	58
Mean	46	74	46	46	52	49	74	

Average yield for 44 acres of cane with the above Trace element, except for Boron gave 64 Tons/acre

Crop and Field experiment reaped in 1964/65 season

UMZINTO SECTION

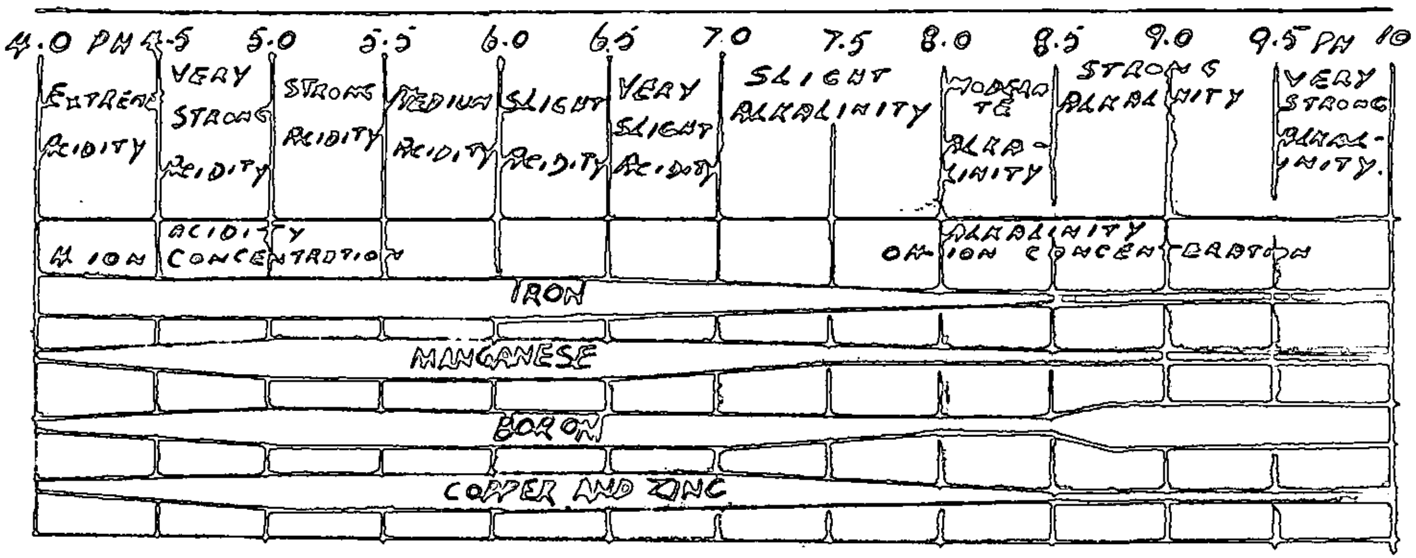
HOSPITAL FIELD - OLD GRANITE

PLANT CANE - VARIETY NCO 376

Replication	1	2	3	4	5	6	7	Mean
	Nil	Cu	Fe	Mn	Zn	B	5 ele-ments	
1	55	67	53	58	56	50	68	58
2	62	62	58	58	57	54	73	60
3	67	69	64	57	57	52	70	62
4	60	68	63	55	65	50	73	62
5	52	75	61	60	61	58	72	62
6	55	71	50	55	56	56	65	58
7	49	68	50	57	58	50	68	57
Mean	57	68	57	57	58	53	70	

This field reaped on an average over 76 Tons/acre in the 1964/65 season with the same application of Trace elements except for Boron.

Oligo elements availability,
in relation to PH values of the soil,
Extracted from efficient use of fertilizers.



SOUTH AFRICAN SUGAR INDUSTRIES AGRONOMISTS ASSOCIATION

ARABICA COFFEE PRODUCTION IN NATAL

From historical records it is known that coffee plantations were established in Natal as early as 1844 and it is said that, by 1860, there were 4000 acres under coffee. This figure however, is probably somewhat exaggerated.

The decline of the industry at the beginning of the century can probably be attributed to a number of causes :-

(a) "Coffee rust","leaf miner" and "borer" and the lack of requisite fungicides and insecticides to combat these diseases and pests,

(b) wind and erratic rainfall, and

(c) the rapid rise in popularity of the tea and sugar industries.

It was not until 1961, during a period of restriction in the sugar industry that consideration was again given to the possible cultivation of coffee as an alternative and or complementary crop to sugar cane.

Mr. Robinson, the Director of the Lyamungu Coffee Research Station in Tanganyika was invited at that time to investigate the feasibility of growing coffee. Following his favourable report the South African Coffee Growers' Association was formed and this body was responsible for the importation of seed from Kenya in 1962.

Today Coffee has returned to Natal after a century of experience and scientific development has been gained in other parts of the world. Many proven technologies have become available to the grower for controlling situations which, in the past, have otherwise lead to crop failure and the decline of industries. Given a stable market, the coffee grower can look forward to achieving optimum and regular yields within limitations of his enviroment.

In this brief report it is the intention to deal firstly in general terms with coffee production and secondly in more detail with some of the more important technologies which influence coffee production such as pruning, pest control, chemical weed control, fertilizer and irrigation.

SUITABLE CONDITIONS FOR GROWING COFFEE

Coffee requires a fertile, well drained soil of good depth, a rainfall of between 40 and 60 inches per annum, fairly well distributed over the crop cycle, freedom from frost, protection from wind, and a plentiful supply of labour.

The above conditions limit the crop to the coastal strip of Natal and the North Eastern Cape at altitudes below 2,500 feet and in the Eastern Transvaal at altitudes up to 3,500 feet.

Soils derived from Dolerite, Table Mountain Sandstone, Granite and Red Recent Sands appear to be the best suited to the growing of coffee.

Warm slopes with a North or North East aspect so that they have the full benefit of the sun in winter are the most suitable. Under Natal conditions supplementary irrigation can be advantageous.

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CULTIVATION:

a. Nursery Practice

The seeds are first planted into closely sown nursery beds well prepared with organic material. At the first true leaf stage selected seedlings are transplanted into either secondary seed beds at spacings of 8 inches by 8 inches or into 6 inch diameter Polythene pots. All seedlings whether in the initial or secondary stage seed beds are heavily mulched with grass. Full low level shade is maintained over the seed beds in the early stages but this is gradually reduced until the seedlings are ready for transplanting into the plantation when the shade is removed completely. Seedlings are moved out of the nursery into the plantation at about 15 months, after germination.

b. Land Preparation Planting - Spacing

Planting is preceded by subsoiling, heavy Rome harrowing or ploughing and light disc harrowing.

The spacing of trees varies somewhat from plantation to plantation depending on various circumstances. A spacing arrangement of 7 feet between trees in the row and 10 feet between rows in echelon or staggered row, is commonly used. This system facilitates the use of tractor mounted sprayers and improves the efficiency of spraying.

Depending on the slope, contour planting with contour drains is normal practice.

Organic material together with ½ lb. of balanced N.P.K. fertilizer is added to each hole prior to transplanting of the seedling from the nursery.

Once trees are planted out they are immediately mulched, the material being placed in 6 ft. bands in the inter-row. This mulching which is common practice in the industry and is maintained throughout the life of the tree consists of either Napier fodder or sugar cane trash.

c. Windbreaks

The constant and severe prevailing winds that exist on the Coastal area present one of the major problems to the Coffee Industry in Natal making the use of windbreaks essential.

Grevillia robusta is commonly grown as a permanent outside windbreak with Leucaena glauca as a permanent internal windbreak. Tephrosia candida is used as an internal windbreak in the initial period and is removed in the second or third year.

d. Varieties

The two major varieties at present being grown are S.L. 28 and S.L. 34. Other varieties such as S.L. 14, H. 66, K.P. 162 and N. 39 also imported from Kenya are grown in small quantities. It is still too early to assess the superiority of any of these varieties under South African conditions.

e. Pruning

Four systems of pruning are at present being practiced with the view to establishing that system which is best adapted to this

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environment. These systems are the East African Multiple Stem, Single Stem, Agobieda and a variation of the Single Stem. The latter system is the most popular and one in which the main stem or two main stems primary growth is capped at approximately six feet to restrict any further upward growth. This capping encourages secondary growth on which the crop will ultimately be borne. The number of secondaries which are removed depends to a large degree on what level of crop it is estimated that the tree can safely carry. The normal method of effecting this is the removal of alternate secondaries growing on opposite sides of the primaries and the removal of all upward and downward growing secondary growth.

In a temperate climate such as that experienced in Natal overbearing presents a problem which is overcome by pruning or by the removal of a percentage of the crop when the beans are at the pin head stage.

f. Fertilization

Fertilizer is applied to trees of 3 years and older in September, November and March at the rate of 3 ozs. Urea, 4 ozs. Superphosphate and 5 ozs. Potassium sulphate per tree per application.

In certain areas there is evidence of zinc deficiency which is rectified by the use of zinc sulphate.

The critical levels of nutrient application have not as yet been established.

DISEASES AND PESTS

In the Nursery the common pathogiens are Fusarium species. Hemileia vastatrix and cercospora coffeicola and the common insect pests are cutworms and Termites. The fungi are controlled with copper fungicides and the insects with Deildrin.

The most serious disease in mature trees at present, is "Leaf Rust" caused by H. vastatrix and the most serious pest "Leaf Miner", Lencoptera meyricke. The former is controlled by the use of Copper-oxychloride and the latter with Parathion. Spraying of these compounds is done with tractor mounted low volume (30 galls./acre) sprayers at regular intervals during the year. Normally 8 to 10 applications per annum.

There is at present no evidence of "C.B.D." caused by Colletotrichum coffeanum in the industry.

Harvesting and Processing

The harvesting season commences in April and ends in August at which stage the cherry is pulped, the bean fermented and sundried. This operation is carried out in small estate factories, while the removal of the parchment and grading of the bean is done in the central factory operated by the Coffee Association.

Yields and Quality

While it is still early to comment on the potential yield of coffee in this area the results so far achieved are encouraging. The yields of 9 and 10 cwts. from 3 year old trees have been attained during the past season.

Reports on the quality of South African grown coffee from brokers and Kenya have shown this coffee to be of a high standard but possibly a little light bodied. It has been noted that the body does improve as trees mature. During the last season the price paid for this coffee varied between R660 and R824 per ton.

There is an indication that the quality of coffee improves the higher the altitude at which it is grown and the later in the season it is harvested.

No differences in the yield or quality of different varieties is at present evident.

Labour

The anticipated labour strength required during the harvesting period is 1 (one) unit per acre, and during the non-harvesting season .35 units per acre.

Research

In collaboration with the Department of Agricultural and Technical Services investigations are being conducted into fertilizer responses, methods of pruning, degree of pruning in relation to fertilization levels, varieties and the resistance of various strains of Hemileia vastatrix to fungicidal treatment.

Costs

a. Estimated Cost of Establishment per Acre

Nursery	5-00
Land Preparation	22-00
Windbreaks	5-00
Planting and Maintenance for 4 years (including cultivating, pruning, mulching etc.)	110-00
Fertilizer for 4 years	40-00
Chemicals for 4 years	40-00
Irrigation - Installation	50-00
Operation for 4 years	60-00
Supervision for 4 years	120-00
Factory	15-00
	R467-00

b. Estimated Annual Operating Cost per Acre

Maintenance of plantation	80-00
Fertilizer	20-00
Chemicals	20-00
Irrigation	16-00
Depreciation @ 5%	24-00
Interest on Capital @ 6%	26-00
Supervision	30-00
Factory	2-00
	R218-00

c. Estimated Annual Revenue

Estimated yield of 1500 lbs. of parchment coffee per acre per annum @ 30c per lb.	R450-00

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Marketing

All coffee is at present sold on behalf of the Coffee Growers' Association by appointed agents, and has all been purchased for blending with other coffees for sale on the local market.

Earlier in this report reference was made to certain important aspects which influence coffee growing such as pruning, pest control, chemical weed control, fertilizer and irrigation. Although we can draw on the experience and scientific knowledge from overseas countries, these findings must nevertheless, be adapted to our specific conditions, and in this respect we still have much ground to cover.

The following cover these various aspects separately, although their relationship and interdependence will become evident to the reader.

Pruning:

Our coastal climate stimulates a vigorous growth and early bearing, consequently pruning systems which have been developed in a more moderate climate such as the Kenya Highlands, will require modification to suit our conditions. Furthermore, if we are to depend on temporary unskilled labour (togt) then any chosen pruning system should be relatively simple.

There is little doubt that some system of pruning is necessary to regulate production and balance bearing with vegetative growth. But the operation is essentially a fruit thinning and rejuvinating process where only unwanted wood is removed because severe pruning will encourage excessive vegetative growth at the expense of bearing. Disease and insect pests are a threat to any coffee grower, particularly in the humid coastal conditions of Natal, consequently an open tree with foliage well off the ground is an important consideration in order to permit spray penetration.

The life of a coffee tree can be divided into a formative and cropping period. The formative period commences when the seedling is planted out from the nursery and entails the training of a strong framework consistent with the type of pruning system to be followed when the tree comes into bearing. During the cropping period the old wood is removed and new bearing wood is established, using a combination of one or more known pruning systems; four distinct pruning systems can be quoted, although others may also exist.

1) The East African Multiple stem system is generally recommended and the most widely used for a number of reasons.

(a) Ease of pruning and suitability to unskilled labour is an immediate attraction. Furthermore the tree is open and and spray penetration is effective.

(b) Two or three main stems are allowed to develop and a crop is borne on a 3-4 ft. head, while all other branches beneath the head are pruned off each cropping season.

(c) Treestrained on this system are reported to give regular crops and high grade beans because the crop is borne on young vigorous primaries.

Unfortunately, under our climatic conditions, the bearing stems are likely to grow too rapidly before a transition can be made to the next cycle, and for this reason certain modifications may be required to encourage early suckering which involves the use of some pruning techniques characteristic of the single stem system.

2) The East African single stem system, if carried out correctly, permits effective control of the vegetative growth and bearing wood, also the tree is well formed and spray penetration unimpeded. This method

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requires a high degree of skill, experience and good judgement, consequently the system is slow and necessitates trained personnel which is costly. Briefly this pruning system allows a strong main stem to develop by skillful capping, while on the main stem approximately twenty well spaced primaries are permitted to remain. The crop is borne on primaries and secondaries within this framework and, during subsequent years, thinned out to approximately four bearing secondaries on each primary. It will be appreciated that improper pruning can easily result in excessive vegetative growth creating a dense tree or alternatively die-back from over bearing.

3) The Kona multiple stem system was developed in Hawaii and is similar in some respects to the East African multiple stem system. But in this case the tree is permitted to produce 4-5 stems of different ages; in the first instance two followed by one each subsequent year. A stem is, therefore, retained 4-5 years before being pruned off and replaced by a new sucker, however the rapid growth of main stems which tend to smother suckers under our local conditions would appear to be one of the main problems of this pruning method.

4) Two other systems which can be mentioned in passing are :-

(a) the Dehorning system, which is a drastic practice of cutting the tree back to a stump every fourth year and allowing 3-4 main stems to grow unpruned.

(b) Sun Hedge system of closely spaced trees running on the contour in two or more rows, the hedges being separated by cover crops or grass. This system is reputed to give high yields, be easily managed, and is relatively trouble free during the first five to fifteen years.

Spraying for Pest Control

Disease and insect control will undoubtedly emerge as an important cultural practice, due to the favourable climatic conditions of our humid coastal region which encourages the development of pests and diseases.

Effective disease and insect control pre-supposes a study of the organisms' life cycle and also an understanding of suitable chemicals for their control, furthermore the timing and method of treatment application is equally important.

There are many insect pests and diseases known to attack coffee, and those which have warranted particular attention in Natal so far are :-

1) Leaf Rust (Hemileia vastatrix) the occurrence of which has grown in proportion over the past two years and spread to most coffee plantations. A great deal of fruitful work has been conducted on the control of this disease overseas. Resistant varieties of Arabica have been selected against certain physiological races of Hemileia vastatrix. In Natal race II is known to exist and we find S.L. 34 susceptible to the physiological strain, whereas K.7, which is considered resistant, has not been planted to any great extent as yet. The life cycle of rust, mode of infection, conditions favouring its development and also the control measures are well known, but like most diseases, control measures are preventative and not curative. This basic research and experience gained in other countries must therefore be superimposed on our own climatic conditions to arrive at a working programme until the results of local research indicate a need to change the assumed programme.

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A 50% copper oxychloride is used at the rate of 5 - 7 lbs. per acre as a preventative spray, but the unresolved problem is when to apply treatments under our erratic rainfall and moderate temperature conditions. When rust spores germinate on the surface of the leaf, entry can only be gained via the stomata, which are on the lower surface of the leaf in coffee trees. Therefore preventative sprays are only effective if they are directed onto the lower surfaces of leaves. Air blast sprayers or mist blowers are generally preferred for spraying as they provide good penetration, use relatively low volumes of water, and apply the specified quantities of chemical accurately and quickly.

2) Leaf Miner (Leucoptera Spp) has been the subject of sudden outbreaks from time to time. A small white moth lays its eggs on the upper surface of the leaf, the larvae hatch and enter through the epidermis, whereupon they burrow and consume the tissues in patches leaving only the epidermal layers. The timing of control sprays should be related to moth population and it is recommended that trees be sprayed one week after the peak moth population is observed. But infestation can appear so rapidly and without a clearly defined peak population period that the recommended timing is not easily achieved. However, parathion is a very effective control measure which can penetrate the epidermis and kill all larvae stages. The systemic insecticide Rogor is also effective against larvae within the leaf, having the advantage of being safer to handle although more costly than parathion.

Other pests which have been observed in Natal but have not yet reached serious proportions are :

Antestia Spp, Mealy Bug, Scale Insects, Berry Moth, Stem Borers and Snout Beetle.

Regular stem banding with dieldrin provides an effective control of ants and enables the natural enemies of mealy bug and scale insects to arrest their development, but should heavy infestations occur, then organophosphorus compounds can be used to effect good control. The berry-moth and antestia can also be controlled by organo-phosphorus compounds, and snout beetle in young coffee with Sevin.

Fortunately coffee berry disease (Colletotricum coffeanum) has not given any cause for concern so far. However, the same causal organism has been observed as Brown Blight of the leaf and ripe berry therefore conditions have obviously been unfavourable for serious immature berry infection.

Nutrition

Annual crops grow rapidly and generally show a marked response to fertilizer treatments. On the other hand a coffee tree which develops relatively slowly and has a life span of many years, is subject to unseen changes and a build-up of reserves which take place over a period of more than one season, and being an evergreen the leaves as well as the wood are used for storage purposes. Furthermore, the inter-relation of cultural practices and environment can have a marked effect on the trees' nutritional reserves and the effectiveness of fertilizer treatments.

Crop removal studies have shown that substantial amounts of Nitrogen and potash are required by the coffee plant in a ratio of between 1 : 1 and 1 : 2. Phosphate requirements on the other hand appear to be very much lower, in the order of one quarter that of N & K. Levels of fertilizer must vary according to soil type and the intensity of culture. Sun grown coffee on an intensive plantation scale usually requires heavy fertilizer treatments, while extensive shade grown coffee appears to survive at lower levels of nutrition. This situation can be appreciated when one considers that a more rapid growth and heavier bearing is characteristic of sun grown coffee, whereas trees growing under shade develop at a slower tempo and have a more protracted ripening period.

Fruit maturation and ripening is a critical period in the cycle of the tree when heavy demands are made on the nutrient reserves and the influence of other practices or lack thereof also become evident. The ripening berries of heavy bearing sun grown coffee draw on carbohydrate reserves from the bearing wood and leaves, and with the rapid ripening conditions experienced in Natal, demands can exceed supply, causing over bearing and die-back. Judicious pruning, adequate fertilizer, protection against diseases and insects, moisture control by mulching and irrigation, are all factors which help to minimise over-bearing. Nevertheless, it is unlikely that the condition will be eliminated entirely, especially with a heavy bearing variety such as S.L. 34, and the peak ripening period we experience at low altitudes without shade.

Work carried out in many parts of the world shows a fairly close agreement regarding fertilizer ratios, and an N.P.K. balance of 4 : 1 : 4 to 4 : 1 : 6 is in keeping with many recommendations for bearing coffee trees; whereas rates of application vary somewhat, depending on the intensity of cultivation. Initial findings in Natal also indicate that a 1 : 1 N & K ratio should meet the requirements of most bearing trees and profitable responses have been obtained from rates of over 100 lbs. / a N & K in each case. Furthermore there are trials to show that even double this amount can be profitable. Zinc deficiencies have been observed in Natal, but this may be effectively remedied by incorporating Zinc in the routine spray programme. Trials are in progress to establish levels of N.P.K. and the relationship of leaf analysis to crop requirements.

Weed Control

It is not proposed to argue the merits of different weeding methods, as cultivation, hand weeding and mulching all play a role in controlling weed growth, which is without doubt detrimental to coffee production. Chemical weed control is no new innovation to the coffee industry, in fact it has the benefit of many years of experimentation and use in East Africa. From this experience, paraquat, the substituted ureas and triazines have emerged as standard herbicides which may be applied under similar conditions and rates of application as in the case of sugar cane. For obvious reasons, 2, 4-D cannot be used with any degree of safety, but dalapon can be applied with caution for the control of perennial grasses. Pentachlorophenol is not recommended as it taints the flavour of the coffee, therefore paraquat is the only suitable contact herbicide available, but care should be taken not to spray foliage or the green stems of young trees. In this connection an ingenious spray apparatus has been developed called an "Arbogard".

The degree to which chemical weed control is used will depend on labour availability and utilization, and also the importance attached to damaging surface feeding roots by cultivation.

RELEASED VARIETIES.

N:Co.293. Parentage Co.421 x Co.312.

Distributed in 1952. It tends to flower profusely and is susceptible to smut, which limits its value. However, where conditions do not favour flowering, and smut is not a serious problem - which is usually the case in the Mistbelt - N:Co.293 is a valuable variety. It is not a particularly strong ratooner, and if harvested when conditions for growth are unfavourable, it may ratoon badly. It is a relatively thick-stalked variety which is easily trashed.

N:Co.310. Parentage Co.421 x Co.312.

Distributed in 1945, it is still an important variety in South Africa and is grown in many other parts of the world as well. It has a high sucrose content and is particularly suited to very fertile conditions. It still provides about a quarter of cane produced in South Africa, but is declining in popularity. Its disease resistance is not all that could be desired - very susceptible to gumming, fairly susceptible to smut and chlorotic streak.

N:Co.334. Parentage Co.421 x Co.312.

Is of limited value because of its extreme susceptibility to dry conditions. Under efficient irrigation, it can be a useful variety. It has an above average sucrose content, fairly thick stalks, ratoons satisfactorily, and is exceptionally sparse flowering. Sharp spines on the leaf sheath can make harvesting an unpleasant task. Distributed in 1957.

N:Co.339. Parentage Co.421 x Co.312.

Would undoubtedly have become a major variety had it not proved susceptible to what appears to have been a new strain of mosaic disease. Although itself not much affected by this disease, it becomes a danger to less tolerant varieties. It often germinates badly, but ratoons exceptionally well. It is a vigorous and adaptable variety. Distributed in 1952.

N:Co.376. Parentage Co.421 x Co.312.

N:Co.376 is a versatile variety adapted to a wide range of conditions, and succeeds on all soils except the very poorest. It is susceptible to mosaic but otherwise its disease resistance is good. Distributed in 1955, it now provides about two-fifths of the total crop.

N:Co.382. Parentage P.O.J. 2725 x Co.301.

N:Co.382 is a hardy variety, useful for adverse conditions such as low fertility coastal sands. It does not flower readily. It has hard stalks, making harvesting more troublesome. Apart from some susceptibility to smut, its disease resistance is good. Its sucrose content is below average. Distributed in 1957.

N.50/211 (Salvo). Parentage P.O.J. 2725 x Co.285.

A vigorous variety, that puts on height rapidly but does not tiller profusely. It has good disease resistance and is easily trashed, but is prone to lodging and flowering. Under adverse conditions it may ratoon badly. When conditions favour sucrose accumulation, its sucrose content is satisfactory, but under unfavourable conditions its sucrose content may fall to a very low level. Distributed in 1959. It is likely to prove more popular in times of expansion than times of restriction. It has proved most popular on the coastal sands of the North Coast. It can be of use where it can be cut annually at the peak sucrose time of year, particularly on light soils.

N.51/168. (Saraband) Parentage Co.421 x Co.331.

Recumbent when young, becoming more erect later. Capable of producing a good stand of fairly thick, tall stalks although it does not tiller profusely. Has given reasonable returns in a number of places in the cane belt but appears less suited to the higher altitudes. Ratoons satisfactorily. Some mosaic has been found, but on the whole its disease resistance appears satisfactory. Indications are that it is drought resistant. Distributed in 1963. It is capable of giving high tonnages under good conditions but tends to have a low sucrose content, which may become extremely low for crops harvested early in the season.

N.51/539. (Sabre) Parentage Co.421 x Co.331.

Resembles its sister variety N.51/168 in many respects, including, disease resistance, ratooning ability, general adaptation within the cane belt, and drought resistance. It is markedly recumbent when young, and although it too becomes more erect later, it shows more tendency to lodge than does N.51/168. It produces more stalks than N.51/168 but these are not quite as thick and tall. It flowers a little more readily than N.51/168. It has a medium sucrose content. Distributed in 1963.

N.53/216. (Samson). Parentage N:Co.293 x Co.453.

Appears best adapted to high altitude conditions, though has performed satisfactorily on alluvial soils. Sucrose content above average. Appears not to be a strong ratooner. Leaf sheaths hairy. Disease resistance satisfactory, though some mosaic and smut found. Distributed 1964.

N.55/805. Parentage N:Co.310 x Co.301.

Has given very good results on coastal sands. Elsewhere it has usually approached but not quite equalled the yields of N:Co.376. Sucrose content usually good. Susceptible to gumming, and some infection by mosaic and smut has been found. Distributed 1965.

C.B.36/14. Parentage Co.213 x ?

An attractive variety when grown under good conditions. Best results given under irrigation, though under these conditions it tends to lodge rather readily. Some infection by smut has been found, but on the whole its disease resistance is good. Sucrose content average. Leaf sheaths hairy. Distributed in 1965.

C.B.38/22. Parentage C.P.27/139 x ?

Resembles C.B.36/14 in most respects, but averages a lower tonnage and a higher sucrose content. Generally, it has appeared less promising than C.B.36/14 - particularly so at high altitudes. Foliage usually light green, becoming at times almost yellow. Distributed 1965.

N.6. Parentage Co.421 x C.P.36/85.

Released September, 1968. Resistant to mosaic, red rot, chlorotic streak diseases. Reasonably resistant to smut and gumming, and susceptible to stunting disease. Shows possible promise for high altitude areas. It has also given good results when harvested at a year old under irrigation, but its low sucrose content is likely to limit its usefulness.

RESULTS WITH SOME UNRELEASED VARIETIES.

N54/113 (N:Co.378 x Co.285)

Place	Crop	Variety	T.C.A.	S. % C.	T.S.A.	% of N:Co.376
Mtunzini	P	N54/113	54.6	15.2	8.30	92
		N:Co.376	54.3	15.4	8.36	
Powerscourt	P - 26	N54/113	108.2	16.87	18.24	159
		N:Co.376	70.3	16.40	11.48	
	1R - 20	N54/113	73.9	15.47	11.44	89
		N:Co.376	89.2	14.42	12.83	
Amanzimtoti (Lodging severe)	P - 20	N54/113	80.1	14.62	11.72	96
		N:Co.376	84.6	14.39	12.17	
	1R - 18	N54/113	39.0	13.12	5.11	72
		N:Co.376	52.2	13.68	7.13	
Tongaat	P - 16	N54/113	50.8	17.21	8.76	95
		N:Co.376	57.7	16.01	9.25	
	1R - 15	N54/113	42.4	16.36	6.95	90
		N:Co.376	35.9	14.53	5.36	
Chaka's Kraal	P - 12	N54/113	44.3	11.33	4.91	79
		N:Co.376	55.5	10.92	6.19	
	1R - 12	N54/113	72.3	13.77	10.12	109
		N:Co.376	73.5	12.73	9.25	
	2R - 11	N54/113	58.2	13.13	7.64	98
		N:Co.376	60.4	13.00	7.82	
U.V.S.	P - 12	N54/113	93.5	9.66	8.72	98
		N:Co.376	89.9	9.85	8.85	
	1R - 10	N54/113	58.5	11.73	6.86	101
		N:Co.376	58.4	11.66	6.81	
		N54/496 (N:Co.378 x Co.285)				
Mtunzini	P	N54/496	57.9	13.6	7.88	94
		N:Co.376	54.3	15.4	8.36	
Powerscourt	P - 26	N54/496	57.6	15.16	8.67	76
		N:Co.376	70.3	16.40	11.48	
	1R - 20	N54/496	51.3	15.29	7.86	61
		N:Co.376	89.2	14.42	12.83	

N54/496 (contd.)

Place	Crop	Variety	T.C.A.	S. % C.	T.S.A.	% of N:Co.376
Amanzimtoti (lodging commenced)	P - 20	N54/496	70.4	12.31/ 13.51	8.67/ 9.51	71
		N:Co.376	84.6	14.39	12.17	
	1R - 18	N54/496	40.3	12.11	4.89	69
		N:Co.376	52.2	13.68	7.13	
Tongaat	P - 16	N54/496	60.4	16.26	9.83	106
		N:Co.376	57.7	16.01	9.25	
	1R - 15	N54/496	47.4	14.96	7.33	137
		N:Co.376	35.9	14.53	5.36	
Tongaat (Badly lodged)	P - 19	N54/496	76.3	13.81	10.55	89
		N:Co.376	75.3	15.85	11.92	
	1R - 18	N54/496	65.3	16.36	10.68	92
		N:Co.376	72.6	16.03	11.60	
Chaka's Kraal	P - 12	N54/496	43.4	10.61	4.53	73
		N:Co.376	55.5	10.92	6.19	
	1R - 12	N54/496	64.3	12.86	8.51	86
		N:Co.376	73.5	12.73	9.25	
	2R - 11	N54/496	52.4	12.30	6.46	83
		N:Co.376	60.4	13.00	7.82	
U.V.S.	P - 12	N54/496	73.9	7.96	5.88	66
		N:Co.376	89.9	9.85	8.85	
	1R - 10	N54/496	53.0	10.93	5.79	85
		N:Co.376	58.42	11.66	6.81	
Cornubia	P - 21	N54/496	71.3	14.2	10.6	114
		N:Co.376	63.0	14.8	9.3	
	1R - 12	N54/496	108	13.6	14.7	114
		N:Co.376	97.8	13.2	12.9	
		N55/516 (N:Co.310 x Co.331)				
Mtunzini	P - 18	N55/516	47.2	15.39	7.26	97
		N:Co.376	51.1	14.74	7.52	
	1R - 23	N55/516	42.6	13.78	5.84	81
		N:Co.376	50.0	14.40	7.24	
	2R - 15½	N55/516	17.0	16.09	2.73	42
		N:Co.376	37.7	17.07	6.44	

N55/516 (contd.)

Place	Crop	Variety	T.C.A.	S. % C.	T.S.A.	% of N:Co.376
Amanzimtoti	P - 21	N55/516	74.3	14.82	10.93	103
		N:Co.376	75.1	14.12	10.59	
	1R	N55/516	39.4	14.99	5.91	88
		N:Co.376	51.9	13.04	6.73	
Powerscourt	P - 21½	N55/516	77.6	15.17	11.79	99
		N:Co.376	73.2	16.24	11.88	
	1R - 18	N55/516	52.7	11.66	6.15	90
		N:Co.376	54.0	12.60	6.79	
U.V.S.	P - 11½	N55/516	48.2	10.56	5.04	74
		N:Co.376	53.9	12.87	6.82	
	1R - 11½	N55/516	55.1	12.40	6.78	77
		N:Co.376	71.3	12.36	8.78	
	2R - 12	N55/516	63.8	11.81	7.8	77
		N:Co.376	77.6	12.99	10.1	
Tongaat	P - 21	N55/516	64.7	16.01	10.34	136
		N:Co.376	49.2	15.70	7.62	
	1R - 18	N55/516	55.4	15.15	8.51	112
		N:Co.376	51.4	14.98	7.62	
Chaka's Kraal	P - 12	N55/516	43.8	10.86	4.75	87
		N:Co.376	48.0	11.43	5.45	
	1R - 10	N55/516	43.1	12.75	5.48	90
		N:Co.376	48.6	12.60	6.11	
	2R - 12	N55/516	35.9	12.8	4.68	84
		N:Co.376	41.9	13.4	5.54	
		N59/1312 (C.P.44/101 x N.M.222)				
Chaka's Kraal	P - 12½	N59/1312	68.3	14.94	10.22	101
		N:Co.376	71.0	14.24	10.1	
	1R - 11	N59/1312	72.0	13.94	9.99	127
		N:Co.376	66.18	11.91	7.88	
	2R - 12	N59/1312	43.3	12.95	5.61	100
		N:Co.376	44.8	12.50	5.59	
Powerscourt	P - 21½	N59/1312	52.5	15.77	8.29	70
		N:Co.376	73.2	16.24	11.88	
	1R - 18	N59/1312	44.2	14.49	6.41	94
		N:Co.376	54.0	12.60	6.79	

N59/1312 (contd.)

Place	Crop	Variety	T.C.A.	S. % C.	T.S.A.	% of N:Co.376
Amanzimtoti	P - 21	N59/1312 N:Co.376	53.4 75.1	14.67 14.12	7.85 10.59	74
	1R - 14	N59/1312 N:Co.376	46.4 51.9	16.13 13.04	7.49 6.73	111
Tongaat	P - 19	N59/1312 N:Co.376	65.2 75.3	15.13 15.85	9.85 11.92	83
	1R - 18	N59/1312 N:Co.376	45.9 72.6	15.91 16.03	7.29 11.60	63
U.V.S.	P - 11½	N59/1312 N:Co.376	48.7 53.9	12.07 12.87	5.65 6.82	83
	1R - 11½	N59/1312 N:Co.376	61.9 71.3	12.35 12.36	7.66 8.78	87
	2R - 12	N59/1312 N:Co.376	58.4 77.6	13.13 12.99	7.6 10.1	75
Mtunzini	P - 18	N59/1312 N:Co.376	47.3 53.8	14.07 13.19	6.63 7.08	94
	1R - 19	N59/1312 N:Co.376	54.8 71.7	15.4 15.8	8.45 11.25	75
Chaka's Kraal	P - 14	N59/1312 N:Co.376	54.4 49.4	14.5 13.4	7.86 6.50	121

OUTLINE OF THE DEVELOPMENT OF CANE BREEDING IN SOUTH AFRICA

Year	No. of Single Stools Planted	Places Planted in addition to Expt. Stn.	Series	Nos Reaching Secondary Trials	Varieties which showed promise or were released	Notes
1944	36			0		
45	0			-		
46	1,253			1	N.10	
47	0			-		
48	2,922		N.50	3	N.50/211	
49	13,331		N.51	10	N.51/168 and N.51/539	
50	11,141		N.52	7	N.52/219	Glasshouse built
51	8,183		N.53	3	N.53/216	
52	24,835	Cornubia	N.54	8	N.54/64 (=N.6), N54/113 and N.54/496	
53	32,192		N.55	9	N.55/805, N.55/516	
54	27,053		N.56	8		
55	29,714		N.57	6		
56	41,901	C.K.	N.58	11+1		Single lines transferred to Mtunzini
57	43,697	C.K. Doornkop	N.59	10	N.59/2, N.59/1312	

58	43,815	(C.K, Powerscourt,) (U.V.S. Tongaat)	N.60	12+1+1+5		Start of environment stations & planting of micro-lines
59	39,323	(C.K, Powerscourt,) (U.V.S. Amanzimtoti)	N.61	7+1		
60	46,499	"	N.62			
61	41,801	"	N.63			
62	37,918	"	N.64			
63	44,449	"	N.65			
64	45,054	"	N.66			
65	95,875	CFS, CK.	N.67			Start of sub stations
66	94,369	" " U.V.S. MZ	N.68			
67	143,276	" " " Pongola				New glasshouse built.

Present seedling raising and selection programme.

At each of five main stations - Central Field Station, Mount Edgecombe, Chaka's Kraal, Mtunzini and Pongola - 25,000 single stools are planted. These are expected to give about 2,000 seedlings for single lines, 160 for observation plots, and 30 for replicated plot trials (at each station). Sub-stations handling a quarter of the above numbers are situated at Windy Hill and Umhlatuzi. At the sole surviving environment station (Amanzimtoti section), 300 selections from seedlings raised at the Experiment Station are planted annually as single lines. In all, about 140,000 seedlings are now being raised annually. Introduced varieties are tested as observation plots at Pongola.

THE POSSIBLE AVENUES FOR APPLYING METHOD STUDY IN SOUTH AFRICAN SUGARCANE PRODUCTION OPERATIONS.

This paper can only assume the brief outline of where and how method study can bring about an improved level of productivity in the field of sugarcane production. No concrete data can be put forward at this stage simply because inadequate opportunities have as yet been recognised for carrying out such studies. However, sufficient evidence exists from work carried out elsewhere to show that considerable benefits would accrue wherever such work was instituted. Taking three major operations only, namely planting, harvesting and weeding, a reasoned statement will be made as to where such improvements could arise.

Planting:

An explanation of how the established or traditional method of planting has been observed to operate is necessary in order to create a basis for imporvement:-

CANE CUT, TOPPED, TRASHED. → THROWN TO GROUND. → PICKED UP CARRIED TO CUTTER. → CANE DROPPED ON GROUND.

→ CUTTER SQUATS ON GROUND, CHOPS CANE INTO SETTS. → SETTS OFF GROUND INTO ARETAN TANK. →

SETTS OUT OF TANK ONTO GROUND. → SETTS PLACED IN PLASTIC BAGS AND STORED. → BAGS LOADED ONTO TRAILER CARRIED TO FIELD. → BAGS DROPPED FROM TRAILER ALONG PLANTING LINES. (BAGS SPLIT)

→ SETTS TAKEN OUT OF BAGS, PLACED IN FURROW. → LABOUR COVERS UP SETTS IN FURROW BY HAND. →

FIELD COMPLETED (20-30 MAN DAYS PER ACRE).

There are many variations on the above theme but are invariably in a minor key. A suggested system for planting based on preliminary studies is as follows:-

CANE CUT, TOPPED. → THROWN TO GROUND. → PICKED UP, CARRIED TO CUTTER. → CANE PLACED IN PORTABLE RACK

→ CUTTER SELECTS CANE FROM RACK, CHOPS ON CUTTING TABLE. → SETTS FALL DOWN CHUTE INTO BASKET →

BASKET PLACED IN ARETAN TANK. → BASKET DRAINED ON RACK, STORED TWO LAYERS HIGH → BASKET PLACED ON TRAILER CARRIED TO FIELD → BASKETS LAID ALONG PLANTING LINES

→ LABOUR/MACHINE PLANTING → COVER UP BY HAND/ MULE/MACHINE → FIELD COMPLETED (7 - 10 MAN DAYS PER ACRE).

Harvesting:

The traditional form of harvesting takes place in the familiar manner:-

a) Trash

CUTTER CUTS, TOPS, TRASHES. → CANE PICKED UP, STACKED. → FIELD COMPLETED (2-2½ TONS PER MAN)

b) Burnt

CUTTER CUTS, TOPS → CANE PICKED UP, STACKED → FIELD COMPLETED (4 - 5 TONS PER MAN)

This is a straight forward operation which requires minor alterations to achieve greater outputs:-

c) Trash

CUTTER CUTS PRE-TRASHED CANE, TOPS → 8 - 10 TONS PER DAY

LOADER LOADS CANE INTO STACKS → 8 - 10 TONS PER DAY

LABOURERS PRE-TRASH CANE → ¼ ACRE PER DAY. 7 - 8 TONS PER DAY.

→ FIELD COMPLETED (3 - 3½ TONS/MAN) → MECHANISED LOADING

d) Burnt.

CUTTER CUTS, TOPS → 8 - 10 TONS/DAY

LOADER LOADS CANE INTO STACKS → 8 - 10 TONS/DAY

→ FIELD COMPLETED (5TONS PER MAN) → MECHANISED LOADING

Weeding.

Weeding is carried out using the native hoe with a long handle presently requiring up to 10 to 15 man days per acre depending cn weed infestation. The system advocated is that which relies on between a 50% and 80% kill of all weeds using mechanically applied (not hand operated knapsacks) herbicides with a small labour force trained to use swan-necked holes to remove grasses. Estimated labour requirements on average 3-7 man days per acre.