SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION

PETT/1b/3.4.7/527
6 September 1991

Annual Meeting

Date : 24 October 1991
Venue : Conference Room, SASA Experiment Station
Time : 8.45 am

P R O G R A M M E

8.45 - 9.00	Chairman's Report	
9.00 - 9.30	"What can be mechanised"	E Meyer
9.30 - 10.00	"Harvesting machinery"	M Boast
10.00 - 10.30	"New ideas"	T Boevey M Boast D Dinkleman
10.30 - 11.00	Contract operations on a cane farm	P McGugan
11.00 - 11.30	**TEA**	
11.30 - 12.00	Varieties - SASEX Agronomy Programme	NG I-Bamber R McIntyre
12.00 - 12.30	Mosaic and variety choice	RH Lloyd
12.30 - 13.00	Phosphogypsum use in cane	JH Meyer
13.00 - 14.15	**LUNCH**	
14.15 - 15.00	Swaziland Agronomy Research	SSA
15.00 - 15.45	SASEX Agronomy Research	SASEX

SOUTH AFRICAN SUGAR INDUSTRY
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WHAT CAN BE MECHANISED ?

by
E Meyer

Introduction

It would appear that increasing labour costs together with possible unionisation and the general rising aspirations of agricultural labour will encourage the agricultural sector to reduce their labour force and consider mechanising more of their farming operations.

In theory it is possible to mechanise virtually any farming operation. However, at present of all recurring costs, mechanisation already accounts for over 50% of the non land production costs. The question of whether to mechanise or not, is generally difficult to answer. This is because labour costs vary considerably between the various cane growing regions. When considering any increase in mechanisation, each farmer must continually assess his own situation and answer the following two very important questions:

i) Is it practical ?
ii) Is it cost effective ?

In many farming countries throughout the world, there are examples where there was a relatively large swing towards mechanisation. The tendency was to over-capitalise and this resulted in poor machine utilisation. In many instances the introduction of mechanical equipment has not resulted in an immediate reduction in the number of labourers on the farm. On the contrary, labour often remains employed under such circumstances. These include incorrect decisions and poor planning. Furthermore, the demand on management is in many cases even greater for a highly mechanised enterprise compared with a labour intensive operation.

Factors that influence machinery competitiveness and cost effectiveness include the following:

Management
Good machine management and mechanisation planning are prerequisites for cost effective operations.

Machine utilisation
The total cost to operate any machine depends on the amount of work it performs per year. If mechanised operations are to be competitive machinery must be well utilised and perform optimally. A common mistake made by purchasers of expensive mechanised equipment is that predicted costs are often based on potential output and not the actual output achieved. This often

results in mechanised operations costs being higher compared to doing these tasks manually.

Field efficiency
It is of little use to improve the utilisation of any machine if it is not operating at maximum effectiveness while it is working. Field efficiency is affected by factors such as management, machine reliability, field layout and conditions, operator performance and the type of machine.

Scope for mechanisation

In certain regions of the sugar industry there is considerable scope for mechanising many more of the farming activities. The northern irrigated areas, the north coast as well as the midlands have great potential for increased mechanisation when one considers field layout and topography.

The data shown in Figure 1 indicates the number of growers and their respective areas in the various production groups in the sugar industry. It can be seen that 78% of the growers operate on less than 200 hectare farms which is approximately 47% of the cane land. The scope for fully or substantially increasing mechanisation on these relatively small areas economically on an individual basis is very limited. If the present labour supply and machinery costs are borne in mind it is felt that manual and mechanised farming operations are generally in balance with one another for private growers under the current economic conditions.
When considering an average farming enterprise the question is often asked, which operations should one concentrate on when considering a greater degree of mechanisation.

The average labour cash wage distribution and labour utilisation in the sugar industry are illustrated in Figure 2 and 3 respectively. It is clear from these illustrations where the greatest opportunities exist for mechanisation if the need to mechanise arises. The main activities in these areas include:

Harvesting
Planting
Weed control
Fertilisation
General maintenance

It is felt that there are many operations that need not be fully mechanised but rather semi-mechanised: i.e. planting fertilising and weed control at this point in time. Examples of such possibilities are the fertiliser and herbicide operations currently in use at the SASA Experiment Station's La Mercy farm. Here fertiliser is applied with a 1 000 kg trailed distributor which is filled at the home depot using a bulk dispensing system. Herbicide is applied using a 600 litre tractor mounted tank equipped with six hand held lances resulting in a constant application pressure and speed.

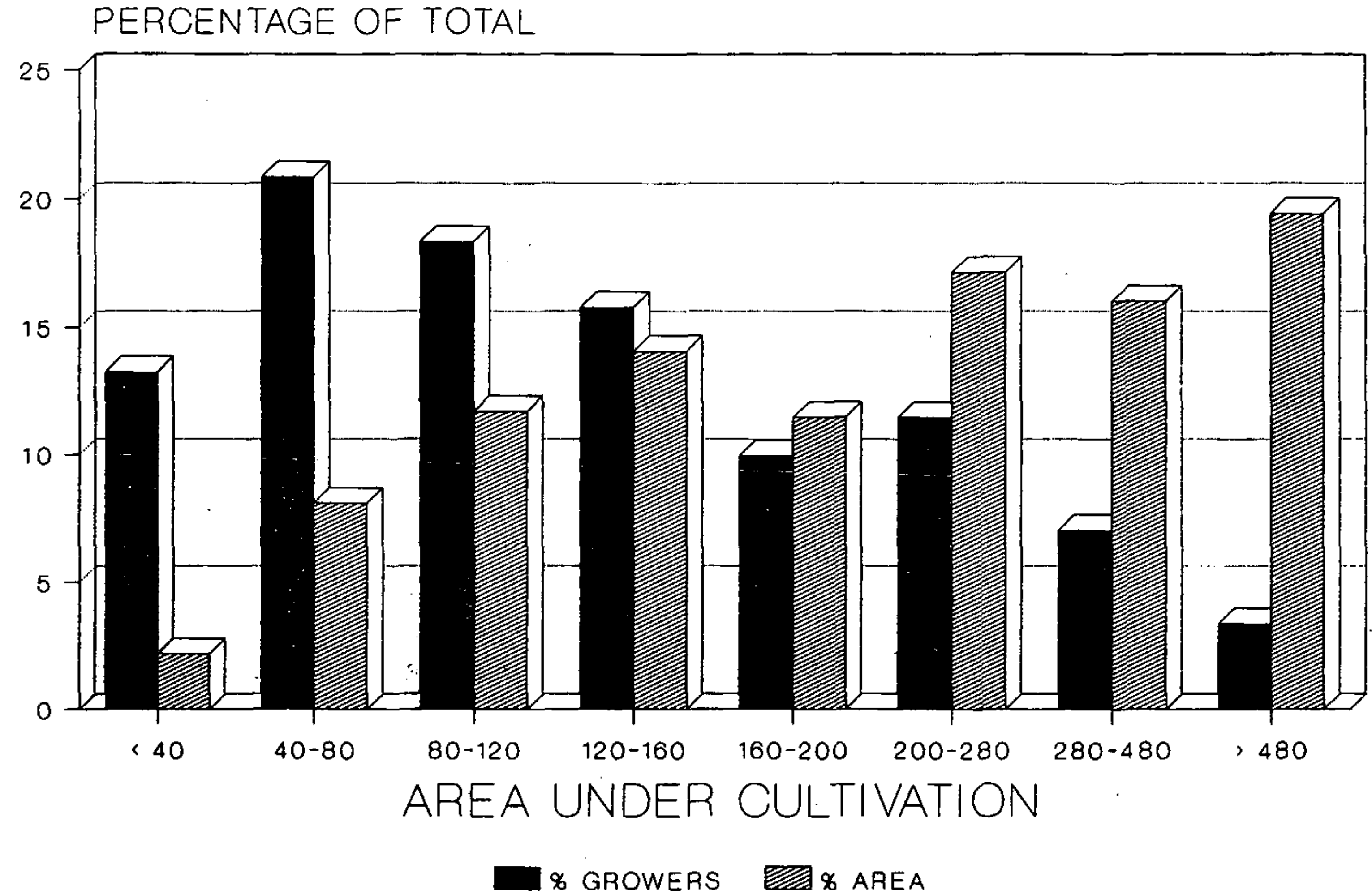
Conclusions

In the agricultural sector, labour and machines should be looked at as two complementary resources. They should be used in varying proportions at any given time to obtain the highest level of profitability. On the one hand the South African farmer will have to improve his overall mechanised farming efficiency and on the other hand stabilise and make optimum use of their human resources by upgrading and improving labour productivity if a fair margin of profitability is to be maintained. It is felt that much can still be achieved in the field of labour productivity by correct management, selection, training and improved manual aids.

If the abundant labour supply, the need for employment and the flexibility of hand labour is borne in mind a large scale move towards mechanisation in the immediate future in the sugar industry is not predicted.

FIGURE 1

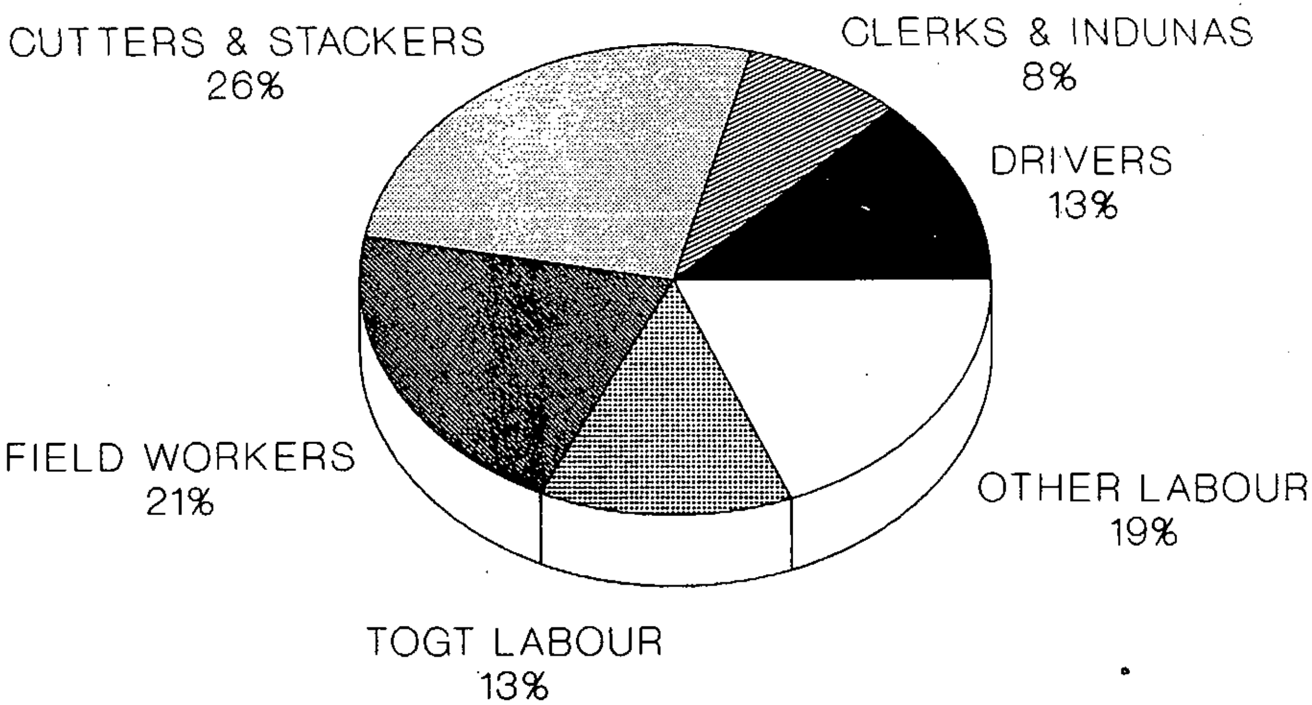
CANE AREA DISTRIBUTION 1989/90



SOURCE: SA CANE GROWERS

FIGURE 2

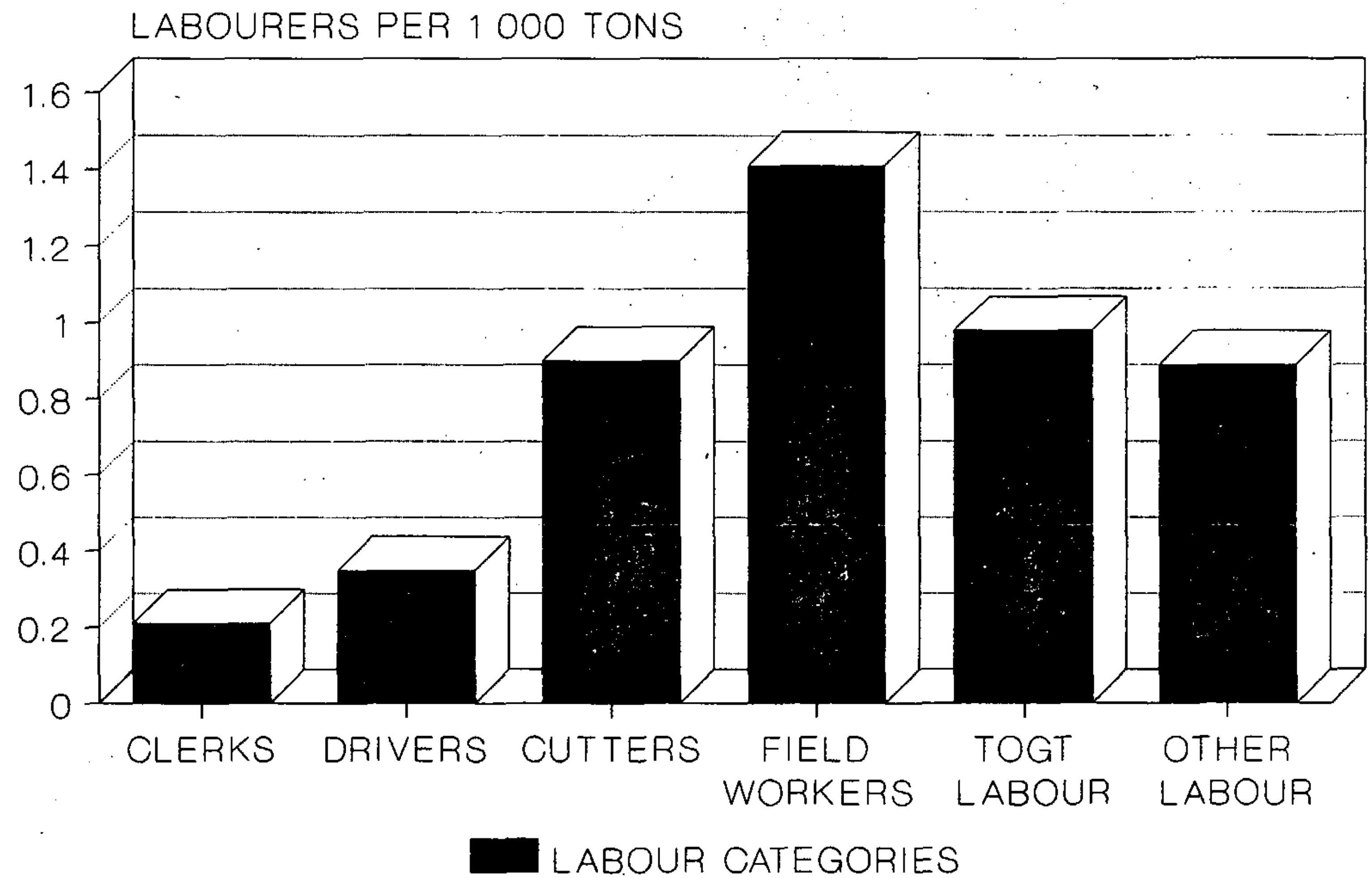
LABOUR WAGE DISTRIBUTION 1989/90



SOURCE: SA CANE GROWERS

FIGURE 3

LABOUR UTILISATION 1989/90



SOURCE: SA CANE GROWERS

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Use of Contractors in Mondi Forests Division

P McGugan

In July of 1989 the Forests Division of Mondi was asked to proceed with the reduction of its unskilled labour component by the allocation of increasing forestry/agricultural activity to contractor and parallel to this programme, to improve the conditions of service and remuneration to its permanent employees.

Senior management investigated the options that were available and included those of using manpower service companies and small business contractors. The use of the latter was preferred for the following reasons:

1. Undue reliance on large contractors could be avoided.

2. Development of small contractors in a variety of tasks facilitates flexibility.

3. Change from the current to the contractor system could be effected in a selective and incremental basis.

4. The Group could draw on overseas experience where the practice is more fully developed.

5. This route could provide definite opportunities to develop small business initiative and activity. It could also strengthen the fabric of rural society rather than damage it by a swift change to high tech mechanized operations.

6. Elements of the current work force, Black and White, showed much interest in the opportunities that might arise.

However, for such a programme to succeed, it was recognised that certain difficulties had to be overcome and a number of pitfalls avoided, namely:

1. The pool of contractors in the industry is small and would take time and effort to enlarge. Training, advice and other resources must be committed for the purpose.

2. The achievement of cost savings through the use of contractors is uncertain in the short to medium term since lower wage levels may be countered by lower productivity per manday.

3. Large scale shifts of employees to contractor alternatives could give rise to resistance unless handled sympathetically.

4. The co-existence of company labour with a variety of contract labour during the period of change and doing the same job at possibly inferior rates of pay could be a source of discontent.

A list of guidelines and principles for the administration of contracting policy for Forests and Farms was drawn up and is presented in Annexure A.

In Mondi Farms we now have the following operations contracted out:

Land Preparation
Planting
Fertilizing
Weed Control
Pest and Disease Control
Ripening
Harvesting
Haulage.

1. **Harvesting**

Currently we have 79% of our crop out to contract - (265 000 tons) and in 1992 the entire crop will be on contract.

2. **Planting**

All planting this season is on contract.

3. **Weed control**

Approximately 60% of the programme is contracted out, and it is our intention to move all of this to contract, the limitation at this stage being the number of strategically placed contractors that are available.

4. **Pest and Disease Control**

Here we are primarily looking at smut control. Clearly, trained operators are essential, but we have the facility to train. This is one area where very close supervision is a must.

5. **Fertilizing**

This is an area in which we are hoping to expand the contractor element. At present only 10% of the area is on contract.

What is our situation now, two years down the track? Have we achieved a significant reduction in unskilled labour numbers? Are we effecting cost savings? Have we developed the small business sector? Do we continue to provide employment albeit indirectly to a large number of people who depend on the industry?

Unskilled labour numbers

	1991	1990	1989
Actual	527	795	1100
Budgeted	805	1050	1200

Cost savings

	(R/t)	(R/t)	(R/t)
Transport	0,75	1,25	0,75
Housing	1,46	1,04	1,72
	2,21	2,29	2,47

Contractors

We are now doing business with approximately 25 contractors, large and small, with some 90 000 mandays previously used in Company now committed to contracts.

The answer to the preceeding question has to be an obvious yes, and although it is still early days, there is no doubt that the decision to move to the contract system in the employment of unskilled labour was a correct one.

PMcG/lb
17 October 1991

ANNEXURE A

PRINCIPLES AND GUIDELINES FOR THE
ADMINISTRATION OF FORESTRY CONTRACTING POLICY

1. Serving employees should be given every opportunity and assistance in establishing themselves as contractors.

2. Contractors should be permitted to lease Company machinery and equipment at economic rates to minimize initial capital requirements.

3. Direct financing of contractors by the Company should be avoided. Payment to contractors should be prompt and regular to assist cash flow. Payment initially should be established from the base provided by current standards and costs.

4. Mangement services should also be available to contrators in the form of financial, technical and human resources advice and the use of training and clinic facilities. Appropriate charges would be levied as the process develops.

5. Codes of practice should be established which regulate standards and methods of contract work. These should include reference to the safety, hygiene, insurance and legal obligations of employers.

6. Contractors should not be encouraged to expand more rapidly than their skills and resources allow but their professional development should be seen to be of value to the company and industry.

7. Unqualified contractors should not be used in activities which place the Company's reputation and long term interests at risk.

8. Mangement procedures and systems must be developed for the proper selection, regulation and payment of contractors.

9. Company relations with contractors should be conducted through line management.

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Varieties - SASEX Agronomy Programme

R K McIntyre

Objective

The objective of the variety trial programme is to evaluate and assess released varieties and pre-release varieties in the bulking-up stage and to provide growers and advisors with reliable and comparative information regarding their performance.

Background

The released variety trial (RVT) programme has been conducted since 1966 and over 400 crops have been harvested to date. The results are stored on a data base system. The variety NCo376 has always been included as a standard variety and it is possible to compare all varieties by the way in which they relate to NCo376. From each harvest, the relative performance of the varieties may be compared as each variety has been subjected to the same climatic and environmental conditions.

Present situation

At present, 47 replicated field trials are conducted at 22 sites representative of the various regions and soil types and are sited on the north and south coasts, the hinterland region, the midlands (including mistbelt), Zululand, Umfolozi and the northern irrigated area. Six permanent trial sites; Pongola, Mtunzini, Dalton, Ottawa, Hillhead and Paddock, have been in existence since 1971.

A proportion of the variety trials (13 at present) are managed by grower co-operators as an integral part of their commercial fields. These trials have been termed estate variety trials (EVT) and SASEX involvement is restricted to the design, planting, harvesting and interpretation of the trial results.

Of the 20 varieties currently approved for planting in the industry all are included in one or more of the existing trials.

Variety x management/treatment considerations

Included in some of the trials are the following treatments:

1. Variety x split/delay nitrogen - midlands
2. Levels of potassium on four varieties - Pongola
3. Variety x age of cutting - Ottawa, Mtunzini
4. Variety x ripeners
5. Variety x white grub
6. Variety x transplants
7. Variety x weed competition.

New trials/varieties

1. New varieties currently being tested are:

    1.1 N21
    1.2 79F1321 (released as N22 in irrigated areas)
    1.3 81F3402.

2. Proposed new variety trials are:

    2.1 Nkwalini - variety/mosaic resistance
    2.2 Empangeni - variety trial
    2.3 Umzimkulu - variety x age of cutting
    2.4 Sezela - variety trial.

Results

Data from each crop are statistically analysed by the Biometry Department and the results are made available in the following forms:

1. Agronomists' Association Reports
2. 'Choice of varieties' notes - updated annually for the short course and for Extension staff
3. Variety Assessment - SAR.

RKM/lb
17 October 1991

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Varieties-SASEX Agronomy Programme. Part 2. NGI Bamber

The rationale behind the RVT programme has been explained by Mr. Ross McIntyre and it is now necessary to show how conclusions are reached about the likely behaviour of the different varieties in the industry. Some of these conclusions are supported by the results of more detailed trials which are not included in the RVT programme. These detailed trials were and are being designed to help us to predict the performance of the newer varieties on sound physiological principles.

New data captured from the RVT programme is added at least once a year, to a data base which was started in 1980 and includes the results of trials going back to 1966. NCo376 was and is included in all RVT's and all measurements including yield, are related to corresponding measurements for NCo376 grown under identical conditions.

Our conclusions are based on the following principles:

1. The relative performance of varieties depends largely on their response to non-discrete variables such as water, temperature, light, soil depth, age and season of harvest. Discrete variables, such as soil type or locality, affect performance largely through the above list non-discrete growth factors.

2. The yield of NCo376 is at present the best means available for determining the integrated effect of the growth factors on variety performance.

3. The effect of factors that are not fully reflected in the yield of NCo376 may be determined statistically with the help of multiple regression analysis.

4. Bias is reduced to a minimum by comparing all varieties through NCo376 and by varying the growing conditions as much as possible. Age at harvest is one of the most influential factors and many RVT's are harvested in two cycles so as not to favour a particular type of variety.

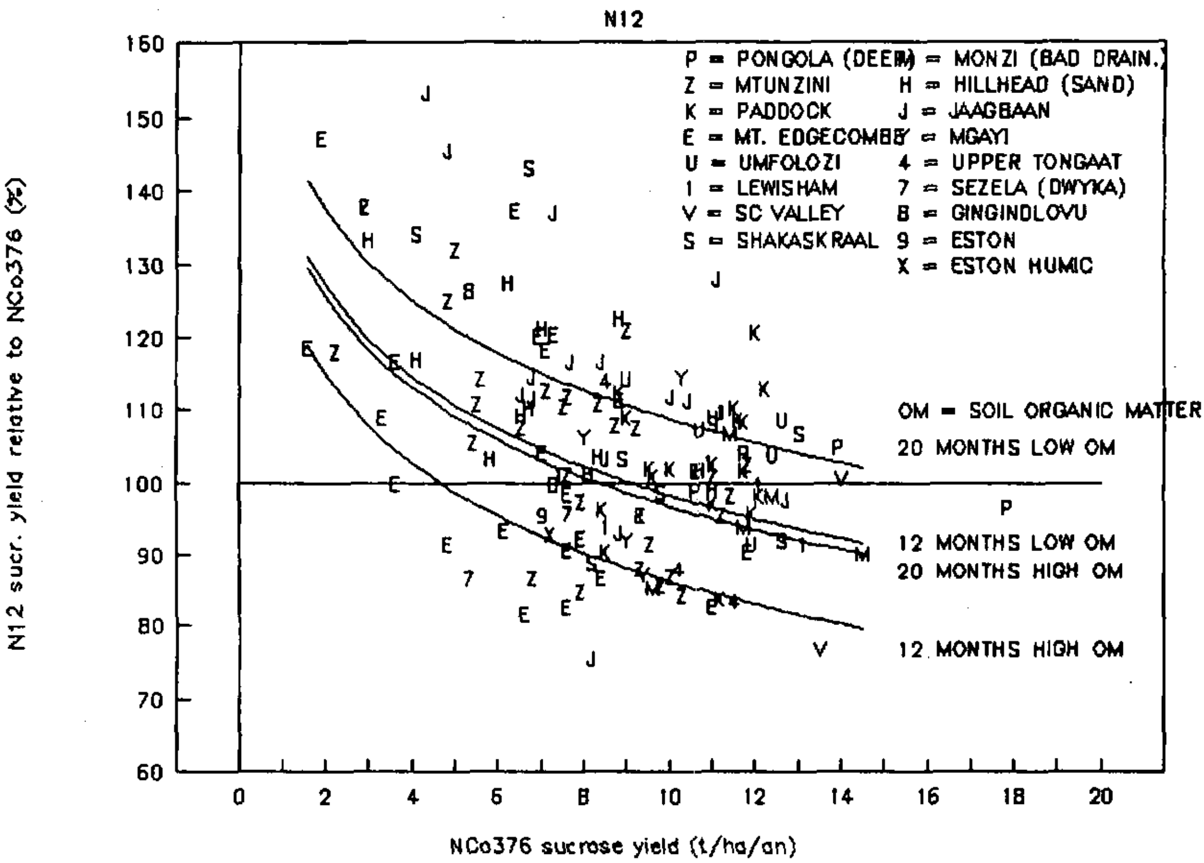
The implications of these principles are as follows:

1. The results of trials in a locality should be interpreted in the light of the results obtained elsewhere. A single trial on an estate does not represent a large enough range in the variables encountered on the estate.

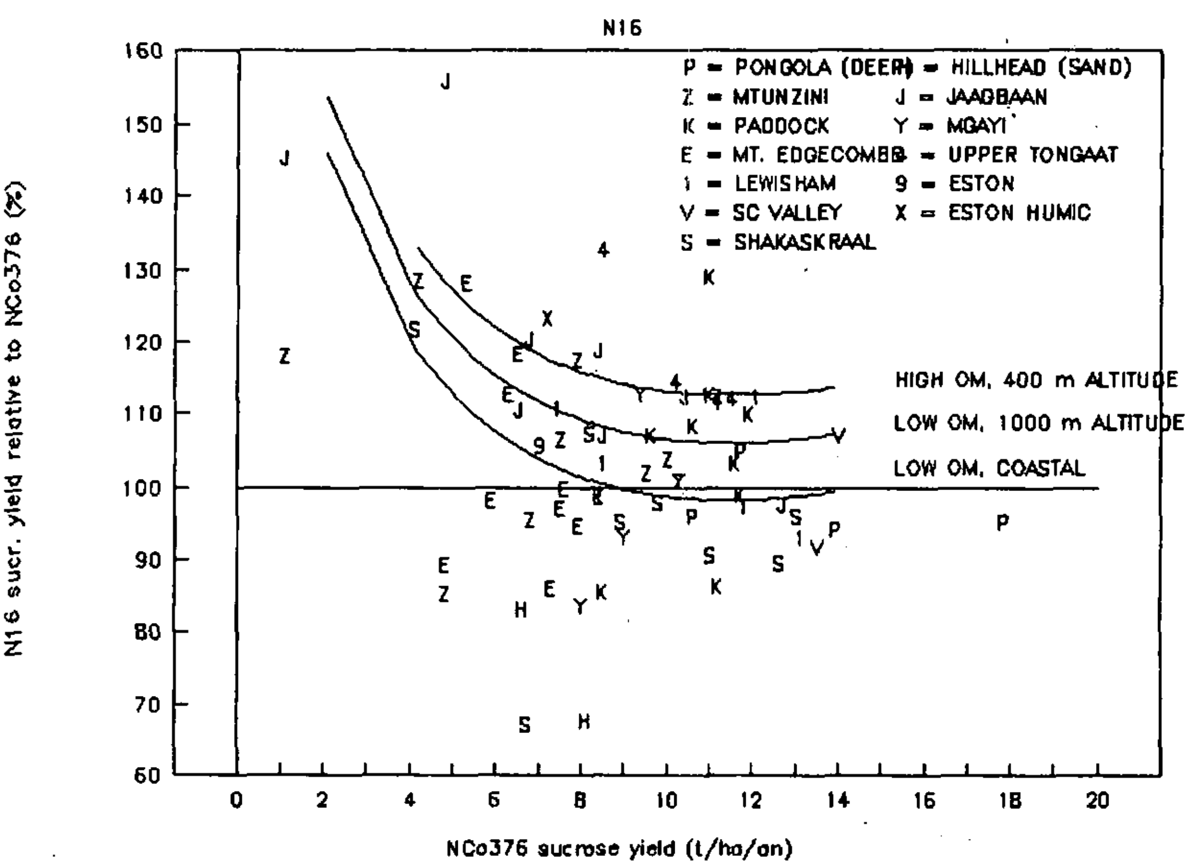
2. New varieties should be included in RVT's at as many localities as possible even if they are not likely to be successful in a particular locality. By doing this we broaden our understanding of the varieties and we also get some surprises.

3. The conclusions reached by analyzing field records could be wrong because of unknown or deliberate bias. These records should always be interpreted in the light of the results from controlled experiments.

The following examples show how the performances of N12 and N16 are predicted.



N12
P = PONGOLA (DEEP)
M = MONZI (BAD DRAIN.)
Z = MTUNZINI
H = HILLHEAD (SAND)
K = PADDOCK
J = JAAGBAAN
E = MT. EDGECOMBE
Y = MGAYI
U = UMFOLOZI
4 = UPPER TONGAAT
1 = LEWISHAM
7 = SEZELA (DWYKA)
V = SC VALLEY
8 = GINGINDLOVU
S = SHAKASKRAAL
9 = ESTON
X = ESTON HUMIC
OM = SOIL ORGANIC MATTER
20 MONTHS LOW OM
12 MONTHS LOW OM
20 MONTHS HIGH OM
12 MONTHS HIGH OM
N12 sucr. yield relative to NCo376 (%)
NCo376 sucrose yield (t/ha/an)



N16
P = PONGOLA (DEEP)
H = HILLHEAD (SAND)
Z = MTUNZINI
J = JAAGBAAN
K = PADDOCK
Y = MGAYI
E = MT. EDGECOMBE
4 = UPPER TONGAAT
1 = LEWISHAM
9 = ESTON
V = SC VALLEY
X = ESTON HUMIC
S = SHAKASKRAAL
HIGH OM, 400 m ALTITUDE
LOW OM, 1000 m ALTITUDE
LOW OM, COASTAL
N16 sucr. yield relative to NCo376 (%)
NCo376 sucrose yield (t/ha/an)

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Mosaic and Variety Choice

R H M Lloyd

It has been estimated by the Experiment Station that diseases currently cause an annual loss amounting to approximately 6% of industrial sucrose production. About half of this loss is due to RSD and the remainder is caused by other diseases, including red rot, smut and mosaic. The extent of losses caused by diseases varies considerably from area to area, depending on the local incidences of different diseases. In some areas, losses may well exceed the industrial mean loss of 6%. The results of SASEX field experiments show that the yield of NCo376 can be reduced by 40% if the level of mosaic is high (SASTA Proc. 1987). In areas and on farms where it is common, mosaic must therefore contribute significantly to total disease losses. An attempt at a meaningful cost interpretation of these losses is shown in Table 1.

Table 1

A Pool @ R476/ton @ 12,8% sucrose = R61/ton (x80%) =	R48.80
B Pool @ R250/ton @ 12,8% sucrose = R32/ton (x20%) =	R 6.40
Average value per ton =	R55.20
6% =	R 3.30

Assuming an average farm production of 10 000 tons, an additional revenue of R33 000 is sacrificed annually (less the costs of harvesting and transporting the additional 600 tons).

Can we afford to ignore this source of revenue?

Mosaic situation

Historically the Midlands and the hinterland of the South Coast and North Coast have demonstratd the greatest occurrence of this disease. However, the mean percentages of mosaic infection are rising in parts of Zululand and in the North Coast and the coastal areas of the upper South Coast (Figure 1). Levels are insignificant in the Northern areas. Mosaic is therefore spreading into some "non-traditional" areas. Once established, mosaic is extremely difficult to control.

Options for mosaic control

Once mosaic becomes established in an area in crops and in the grass vegetation, it becomes almost impossible to produce mosaic-free seedcane. Aphids spread the disease into all susceptible varieties. Spread of the disease may be extremely rapid, as is currently being experienced in the Sezela coastal areas.

The long term control is variety change to less mosaic-susceptible varieties

Palliative control measures include:

i) Healthy seedcane - seedbeds sited away from bush and grasslands.
ii) Complete eradication of previous crop.
iii) Good grass weed control - host plant vegetation.
iv) Choice of planting date - plant early spring and late autumn.
v) Roguing (not effective where levels are high).

* NB Transplants appear to be attractive to aphids because of the wide spacing. However, the transplant system solves many other problems and therefore should not be discarded.

Variety choice

In the Dumisa area of inland Sezela, average mosaic levels have steadily decreased as the plantings of N12 and other new, less susceptible varieties have increased (Table 2).

Table 2

Season	Average mosaic level (%)
1984/85	8,2
1985/86	7,5
1986/87	6,7
1987/88	3,8
1988/89	2,7
1989/90	1,4
1990/91	2,1

Unfortunately past variety breakdowns are not available but Table 3 illustrates the current situation.

Table 3

	Variety				
	Cane area (ha)	NCo376	N12	N16	Other
Sezela: Coastal	21807	65%	6%	4%	25%
Sezela: Inland	10060	44%	32%	2%	22%

Table 4 illustrates the incidence of mosaic in some new varieties and in NCo376 in a trial conducted by the Experiment Station at Dumisa in 1990. The superior resistance of the new varieties is clearly illustrated:

Table 4

Variety	Age 5,4 months	7,7 months
	Mosaic %	Mosaic %
NCo376	10,7	12,3
N12	3,0	3,9
N16	2,3	4,4
N17	3,0	4,8
N21	1,4	1,5

A more detailed comparison of the susceptibility of different varieties to mosaic is shown in Figure 2. This comparison is based on the results of numerous variety trials conducted by the Experiment Station at Eston.

The choice of variety ~~trial~~ will depend largely on the geographic area and the permisible varieties recommended together with the incidence of mosaic. The conversion of a farm out of susceptible varieties and into new ones involves many considerations; not least is the length of time it takes to shift the balance in favour of disease resistant varieties that fulfil the production standards required.

Very often the problems in selecting alternative varieties are the most suitable age vis-a-vis cycle interval, and the time of year for harvest. Figures 3, 4 and 5 are extracts from FRS results in the Sezela area showing variety comparisons in relation to production and age at harvest.

Table 5 indicates production levels for different varieties grown on Dwyka-derived soils. It highlights the fact that, although certain varieties are recommended for longer cycle intervals (16-18 months), this does not necessarily preclude their use for shorter cycles in coastal areas.

Table 5

Variety	Tons cane/ha	Tons cane/ha/mth	Av. age (mnths)	Tons sucrose/ha/mth
NCo376	69	4,8	14,3	0,59
NCo310	69	5,1	13,5	0,65
N12	79	5,6	14,1	0,71
N14	57	4,3	13,3	0,54
N16	72	5,0	14,4	0,63

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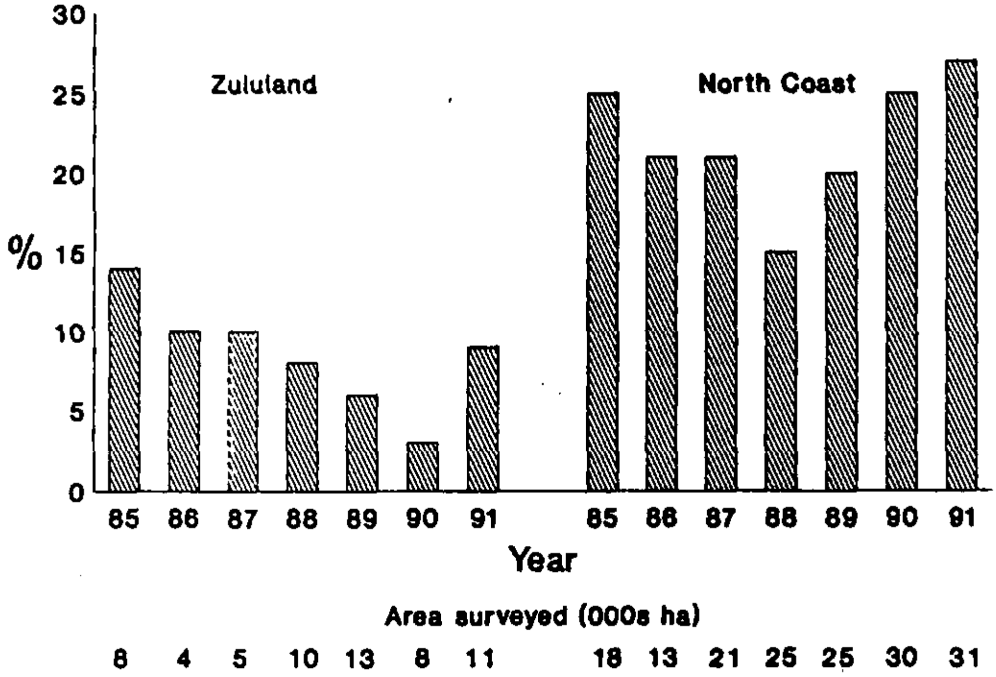
17 October 1991

FIGURE 1: MOSAIC SURVEY DATA BY AREAS/REGIONS
(1984/85 TO 1990/91)
% Area with mosaic



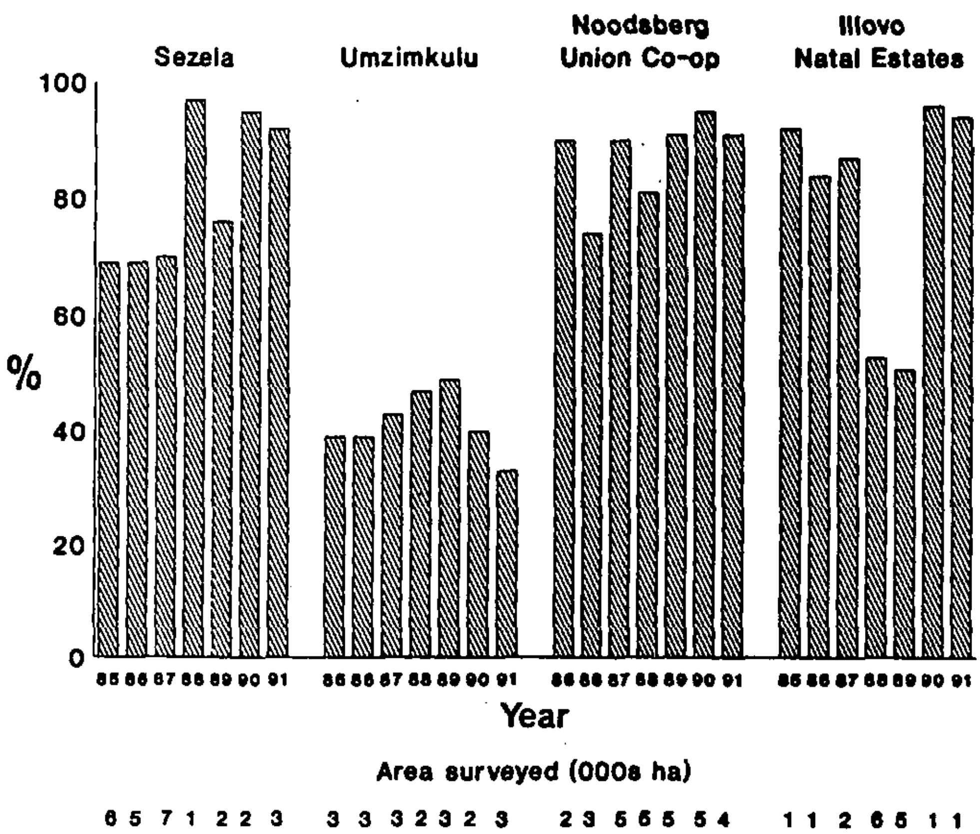


FIGURE 2:

INCIDENCE OF MOSAIC

Percent shoots with mosaic in varieties at Eston

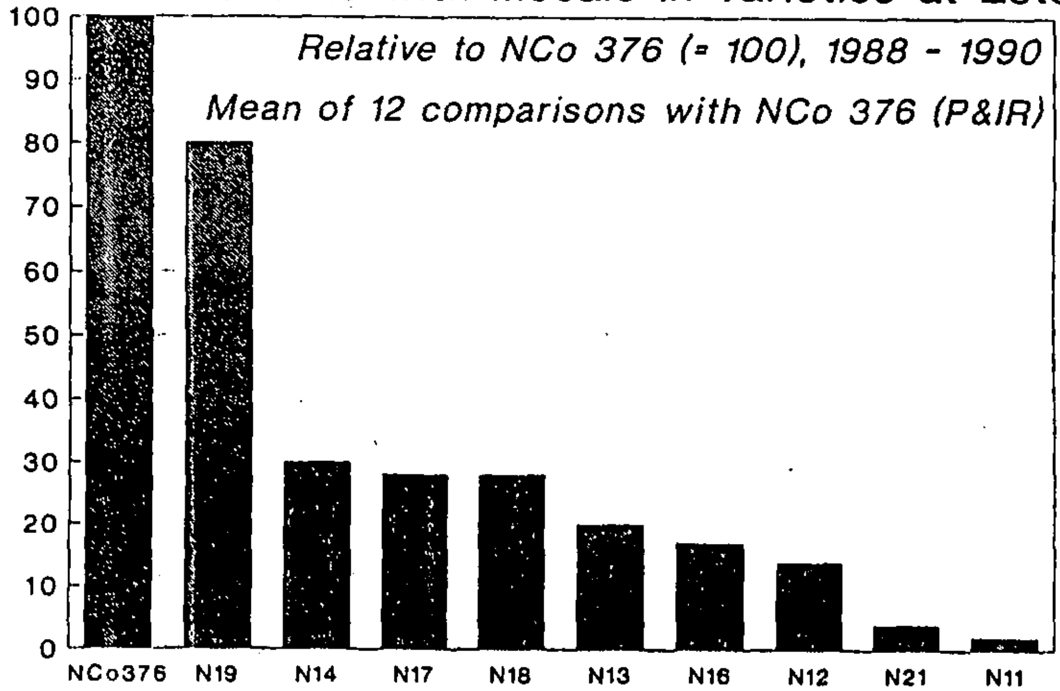


FIGURE 3:

VARIETY VS AGE (DWYKA)

Tons suc/ha/m

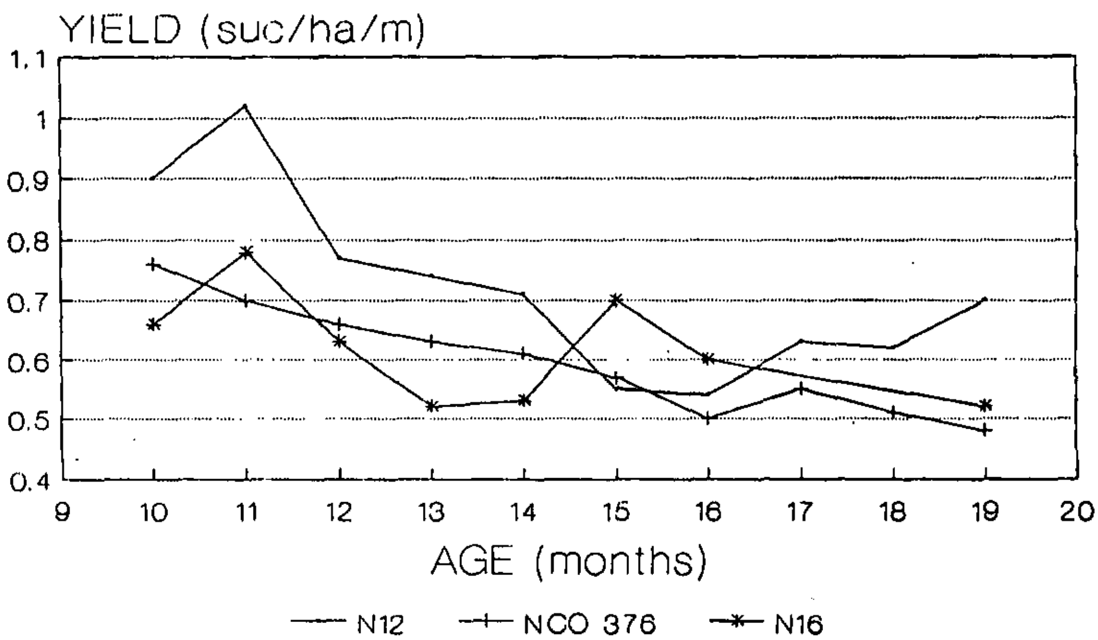


FIGURE 4: **VARIETY * AGE (TMS)**
Tons suc/ha/m

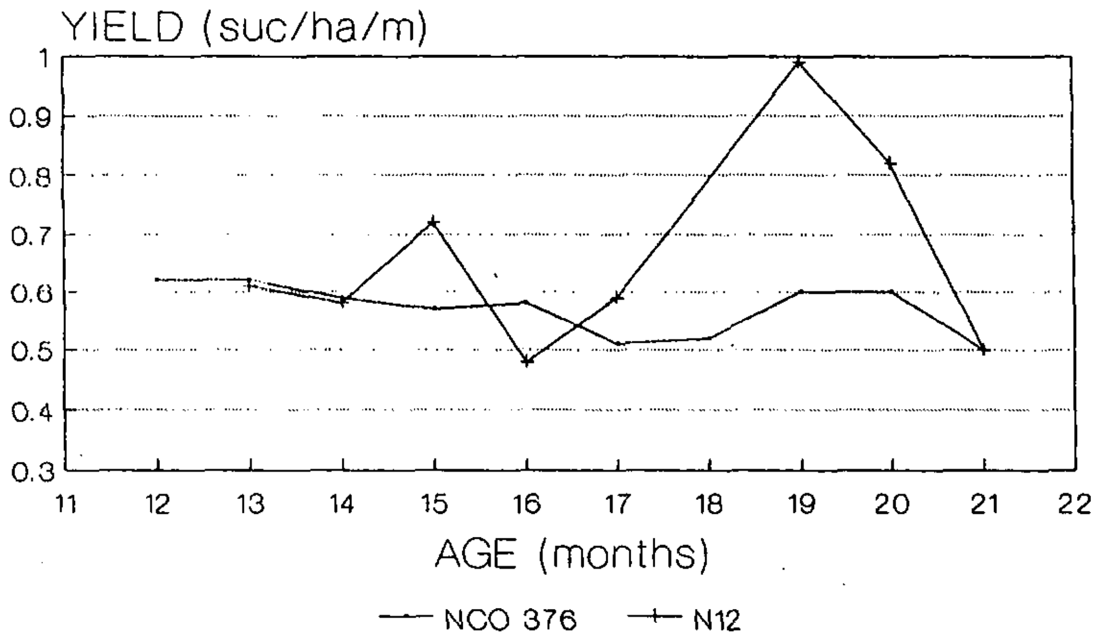
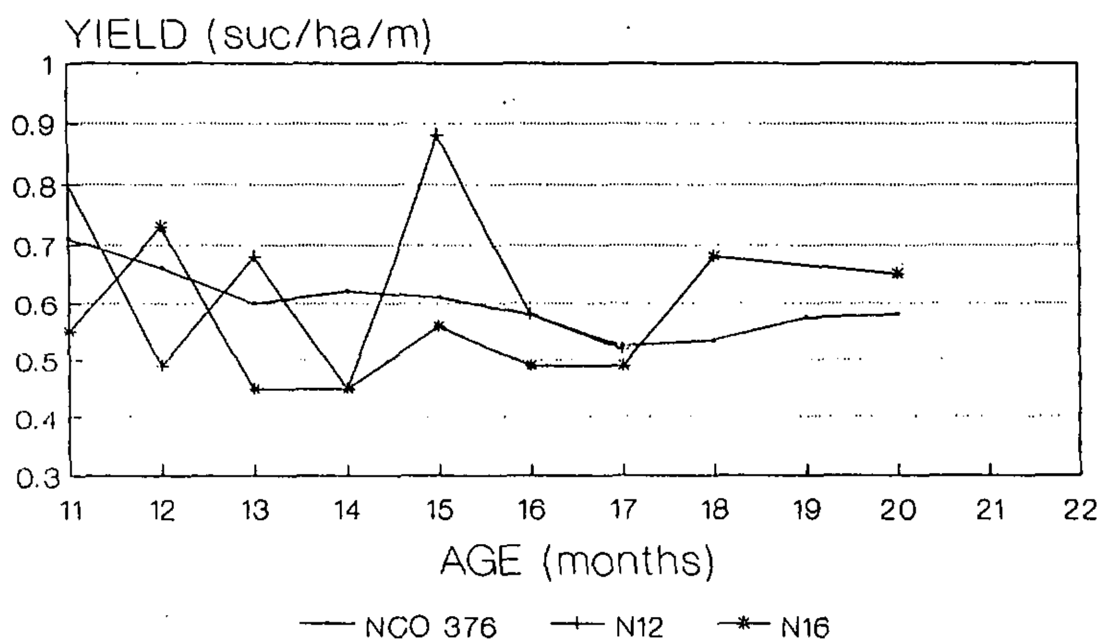


FIGURE 5: **VARIETY * AGE (UMZINTO)**
Tons suc/ha/m



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23 October 1991

SOUTH AFRICAN SUGAR INDUSTRY
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CURRENT RESEARCH INTO TESTING THE VALUE OF PHOSPHOGYPSUM IN AMELIORATING ACID SOILS

by J H Meyer

INTRODUCTION

The detrimental effects on plant growth of toxic levels of exchangeable aluminium (Al) and other problems associated with highly weathered soils such as low levels of plant available phosphorus (P), calcium (Ca) and magnesium (Mg) and marked P fixation are well known. In the South African sugar industry a number of investigations have been conducted to improve the productivity of sugarcane on acid soils in the Natal Midlands (Meyer 1970, Moberly and Meyer 1976, Meyer and Dicks 1979). Consequently recommendations for the use of both lime and additional P at planting are frequently made by the Fertilizer Advisory Service of the Experiment Station.

Attempts at improving cane growth on these acid soils have continued and during the past five years investigations by the Chemistry and Soils and Agronomy departments have concentrated on testing the value of phosphogypsum as a substitute for lime as well as in combination with lime for more cost effective amelioration of Al toxicity in plant and ratoon cane.

Modus operandi

Research so far has been conducted on three fronts:

Field trials

° Seven Oaks (NTE)
(Kranskop form, plant & 1st R
Variety N12)

Still in progress

° Eston (Stainbank)
(Inanda form, 7th R,
Variety N12).

° Eston (Keyser)
(Inanda form, plant,
Varieties N12 and N16)

° Eston (Keyser)
(Inanda form, 5th R,
Variety NCo376).

° Harden Heights (Union Co-op)
(Griffin form, Plant cane,
Varieties N12 and N16).

Glasshouse trials

° Summerhill
(Hutton form 6 crops,
sorghum)

° Eston, Keyser
(Inanda form, 3 crops

° Richmond, Smith
(Nomanci form, crop cane)

° Paddock
(Three soils, Glenrosa
x2, Oakleaf and three
crops sorghum)

Still in progress

° Eston (Keyser)
(Inanda form, sugarcane)

Laboratory

° Permeameter
studies

° Assessing
new soil
tests.

Seven Oaks

The trial established five years ago as a joint project with the University of Natal, to investigate the effect of phosphogypsum (PG), dolomitic lime (DL) and superphosphate (SS) on sugarcane yields on a Kranskop form soil with a moderately toxic Al content, has been completed (Meyer, Turner and Fey, 1991). The main treatments were as follows:

0,5 and 10 t/ha PG
30, 60 and 90 kg P/ha as SS
1,5; 3 and 6 t/ha DL

Based on the combined yield responses from the plant and first ratoon crops (see Table 1) the main treatment effects may be summarised as follows:

° Treatments with SS (+3,0 t/ha sucrose response) were overall superior to those with PG (+2,0 t/ha sucrose response) and little response was obtained to DL.

° In the plant crop there were no beneficial effects from the low rate of PG (5 t/ha) on either cane or sucrose yields. The high rate of PG (10 t/ha) depressed both cane and sucrose yield significantly at the 5% level.

° In the first ratoon crop a significant residual response both in cane and sucrose yields was obtained to the low rate of PG (5 t/ha) applied at planting. The high rate of PG (10 t/ha) also produced a significant residual response but this treatment was no better than the low rate of PG.

° The efficacy of applied PG declined with increasing rate of P. For example the residual response to 5 t/ha PG in the presence of 30, 60 and 90 kg P/ha decreased in the order 2,8; 2,3 and 1,1 ts/ha respectively (see Fig 1).

° A significant interaction between PG and lime applied at 3 t/ha was also apparent. Residual responses to the 5 and 10 t/ha PG treatments were 2,1 and 3,6 ts/ha respectively at the 3,0 t/ha rate of lime compared with 1,3 and 0,8 ts/ha at the 1,5 t/ha rate of lime (See Table 2).

° Residual response to supers was more marked in the absence of PG. Responses to 60 and 90 kg P/ha were 0,7 and 2,6 ts/ha respectively at the G_0 level compared with 0,2 and 0,9 ts/ha respectively at the G_1 level.

The effects of phosphogypsum over a six year period on some of the chemical properties of the soil profile were as follows:

° There was a marked accumulation of sulphur at a depth of 300 to 500 mm.

° Movement of calcium down the profile due to PG reached a peak after two years and then progressively declined.

° Severe reduction in magnesium levels in the upper part of the profile with accumulation at depth before removal by leaching.

° A small but consistent decline in pH in the topsoil (0-200 mm).

° Improvement in available P content of the topsoil (0-200 mm) from 4 to 8 ppm.

° An initial reduction in exchangeable aluminium (EAI) from 70 to 24 ppm at the 400 to 600 mm depth in the 10 t/ha PG treatment (see Figure 2), though after six years the effect of PG on aluminium was hardly detectable.

Although the results suggested that PG was unlikely to be an economic substitute for lime either when topsoils are very acid or for supers when soil P levels are deficient there is evidence that in combination with lime a number of supplementary benefits could be obtained. For example the 5 t/ha PG and 6 t/ha DL and 10 t/ha PG and 3 t/ha DL combinations produced the highest sucrose yields in the 1st ratoon crop (see Table 2). The reasons for these synergistic effects were considered to be due to an improved P, Ca, Mg and S status of the profile and reduced Al content at depth as follows:

* **Improved P status.** The 5 t/ha PG treatment improved extractable P levels on average from 4 to 8 ppm while 6 t/ha dolomitic lime increased P levels on average from 5 to 8 ppm. The combination of these two treatments improved P availability even further to 11 ppm which could well account for this treatment combination producing one of the highest sucrose yields in the 1st ratoon (see Table 2).

* **Increase Mg availability.** The high rate of PG (10 t/ha) reduced the Mg content to near deficiency from 55 to 26 ppm, but in the presence of 3 t/ha dolomitic lime the Mg content was restored to 43 ppm.

* **Improved Ca distribution.** PG was considerably more effective in improving the Ca status at depth than lime. For example sucrose yields of the first ratoon crop were significantly correlated with third leaf Ca levels ($r = 0,67$) from PG treatment whereas liming showed little or no effect on Ca uptake.

* **Reduction of Al toxicity at depth.** Whilst Al toxicity was not considered to be a major growth limiting factor there was evidence from root washing studies of a weaker band of roots between 200 and 600 mm depth and this was associated with Al levels that were in excess of the 55 ppm limit for toxicity in soils of intermediate texture.

The results given in Table 3 suggests that the efficacy of PG or lime in reducing Al levels at depth is improved when these are applied in combination. For example the high rate of PG reduced the Al content in the 200-400 mm subsoil horizon from 63 to 48 ppm but in the presence of 3 t/ha lime was further reduced to 36 ppm. The marked retention of sulphate ions at depth supports the popular hypothesis that toxic Al^{3+} ions are complexed by sulphate to form a less toxic by soluble $AlSO_4$ ion pair.

Other agronomy trials

Between 1989 and 1990 three new trials with PG were established in the Eston area, as there is widespread interest in its use but insufficient experimental evidence to recommend its use in sugarcane.

Trial FT PG/1/89R (Eston)

This trial was established on an existing ratoon crop of N12 on an Inanda form soil (topsoil 49% clay, pH 4,95, EAI 113 ppm, acid saturation 64%, P 23 ppm) selected in conjunction with the growers consultant. The objective of the trial was to test the response to surface application of PG as this would be an attractive or relatively easy method of ameliorating soil acidity in standing ratoon cane. Plots (8 replications) were treated either with 5 t/ha PG broadcast on the surface or left without PG. The crop was harvested at an age of 16,5 months with the following results:

	Mean yield (eight reps)			
	tc/ha	sucrose % cane	ts/ha	EAI ppm
Control	51,6	12,52	6,4	141
5 t/ha PG surface applied	52,4	11,85	6,2	128

Stalk height measurements conducted in the current crop at crop age of 5 and 9 months showed slight residual effects to the PG treatments.

	Growth measurements			
	5 months		9 months	
	Height (cm)	Counts x10^3	Height (cm)	Counts x10^3
Control	60	255	100	197
5 t/ha PG	65	246	104	197

Although the trial will be continued for a further crop it is unlikely that a marked response will be obtained to PG. Pre-plant soil analysis has shown that this soil is well supplied with sulphur (99 ppm) and it is known that this element is very effective in detoifying Al. The Al/S ratio (1:1) is well below the ratio of 2:1 which is considered to be associated with a response to PG.

Trial FTL G5/90/P and FTL + PG6/90/R5 (Eston)

A second site was identified in the Eston area on a deep sandy clay loam Inanda soil where Al was at a toxic level throughout the profile (topsoil, EAI 120 ppm, acid saturation 75%, subsoil EAI 110 ppm, acid saturation 65%) and the Al/S ratio averaged 3,5. Two trials have been established at this site, one as a plant crop designed to compare lime incorporated under conventional planting conditions with and without PG, with deep incorporation of lime. Growth measurements to date indicate no beneficial effects from any treatments. In the second trial designed to compare surface applied gypsum with lime incorporated in the interrow of a 5th ratoon crop, growth measurements suggest a small advantage in stalk height to the surface applied PG treatment. Benchmark plots at both trials have been selected and changes in pH, Al, Al/S ratios, acid and base saturation will be monitored to a depth of 600 mm.

Trial Gypsum/CaS_1O_3/88 (Dalton)

A joint co-operative trial with gypsum, lime and silicate slag established by Union Co-op at Harden Heights as a plant crop on a Griffin form clay soil (pH 4,55, clay 60%, EAI 72 ppm, acid saturation 46%) using two cane varieties (N12 and N16) was harvested and the yields of the plant crop are shown in Table 3. The 5,0 t/ha PG treatment showed a 10% yield improvement over control but the response was not significant. None of the other treatments showed any benefit. It is unlikely that Al toxicity or acid saturation were the reasons for the response to PG as regression analysis showed no relationship between plot yield on the one hand and associated Al levels in the top and subsoil on the other.

Glasshouse trials

As an adjunct to the field studies a number of glasshouse trials have been conducted to determine how effective PG is when applied to soils containing toxic Al. In the six trials conducted so far, using sorghum babala as an indicator crop, significant responses to treatment with either PG or lime were obtained in five cases (see Annexure 1). In general, responses to PG were superior to lime on the heavier textured soils whereas lime appeared to be more effective on the light textured soils. However, the relative advantages did not prove to be significant. In general, where combined PG/lime treatments were tested, these were considerably better than when lime or PG was used separately.

Treatment differences were also apparent in the chemical analyses of the soil. Lime markedly reduced the level of exchangeable Al whereas PG resulted in only a small decline in Al. All treatments caused marked increases in exchangeable Ca, while PG lowered soil pH values and increased P and S contents.

Laboratory studies

Permeameter study

A leaching experiment was conducted in the laboratory using brass permeameters to study the effect of PG treatment on the chemical behaviour of soil from the Seven Oaks trial site. Disturbed samples of topsoil (0-200 mm) were treated in duplicate with the equivalent of 10 t/ha PG and packed to a uniform bulk density. The equivalent 3 000 mm of de-ionised water was passed through the columns over an eight day period. Samples of percolate were analysed at regular intervals for EC, pH, Al, Ca, Mg, S and Zn.

Ca, Mg and Zn ions were the first to emerge in large concentrations, followed by low concentrations of Al and S. The results suggested that most of the plant available Mg had been displaced following 400 mm of percolation. Considering the large amount of S contained in PG it was surprising to find how little had leached through confirming field observations that most of the S is retained in the soil in the sulphate form. Overall the 10 t/ha PG was only marginally more effective in leaching out Al from the soil. Evidence from the column study corroborated that obtained in the field and glasshouse which suggests the immobilisation of Al within the soil as some basic Al sulphate complex.

Predicting gypsum requirement

While the response to lime was due to the combined effects of neutralising Al and an improved Ca status, it is more difficult to account for the response to PG in view of the low pH values and the small change in Al levels and acid saturation following treatment. This is a world-wide phenomenon as there is currently no reliable method of calculating gypsum requirement levels under different conditions. Traditional methods used for lime requirement (ie., acid saturation, ex Al, pH, buffering capacity etc) have not proved suitable.

Two avenues have so far been pursued at the Experiment Sation. Research has shown that where PG is applied Al may be rendered non-toxic either by displacing OH from surfaces of Al and Fe hydrous oxides (self liming effect) or by the formation of a less toxic but soluble $AlSO_4$ ion pair. A knowledge of the S status of a soil thus becomes important as soils that are well supplied with sulphur are unlikely to respond to gypsum, as the inherent S content of the soil will assist in complexing Al. Preliminary analysis of response and soil analytical data suggests that the EAI/S ratio is a better indicator of a response to either PG or lime than EAI <u>per se</u>. Soils with ratios below 2:1 are unlikely to respond to treatment with gypsum or lime.

Another avenue that is being studied is the 'responsiveness gypsum test' that was developed in the USA. It relies on the fact that soils which respond to gypsum also appear to exhibit salt sorption as well as higher pH in soil slurry with gypsum than with calcium chloride. The greater the difference in pH or the higher the concentration of gypsum sorbed the more likely is a response to gypsum. Work on both methods is continuing. It is possible that the Al/S ratio will indicate when a response to gypsum is likely whereas the salt test would indicate how much gypsum is needed.

Conclusion

Notwithstanding the claims that have been made by the trade concerning the effectiveness of PG, it is clear that more research is required before SASEX may be able to give recommendations on the use of this product. At this stage caution should be exercised by growers on the large scale use of this material for the following reasons:

° Glasshouse responses to PG treatment have not been verified in the field trials.

° Most researchers world-wide agree that PG is not an economic substitute when topsoils are acid or for superphosphate when soil P levels are deficient. Two to three times the quantity of PG relative to lime would be required to achieve the same short term effect on Al saturation. This implies that PG must be used in conjunction with lime only where subsoil acidity may limit root proliferation. Unlike maize, subsoil acidity does not appear to be a major limiting factor for cane.

° High moisture content and high transportation costs are also major constraints on its use. The high moisture content also maked it difficult to obtain a uniform application of PG.

- As PG leaches Mg and some K from the profile, it should not be used without additional Mg (as dolomitic lime) or K where soils are not well supplied with K.

Despite these apparent drawbacks, the need for an effective means of ameliorating soil acidity under a minimum tillage system or standing ratoon cane are good enough reasons to continue with this programme of research.

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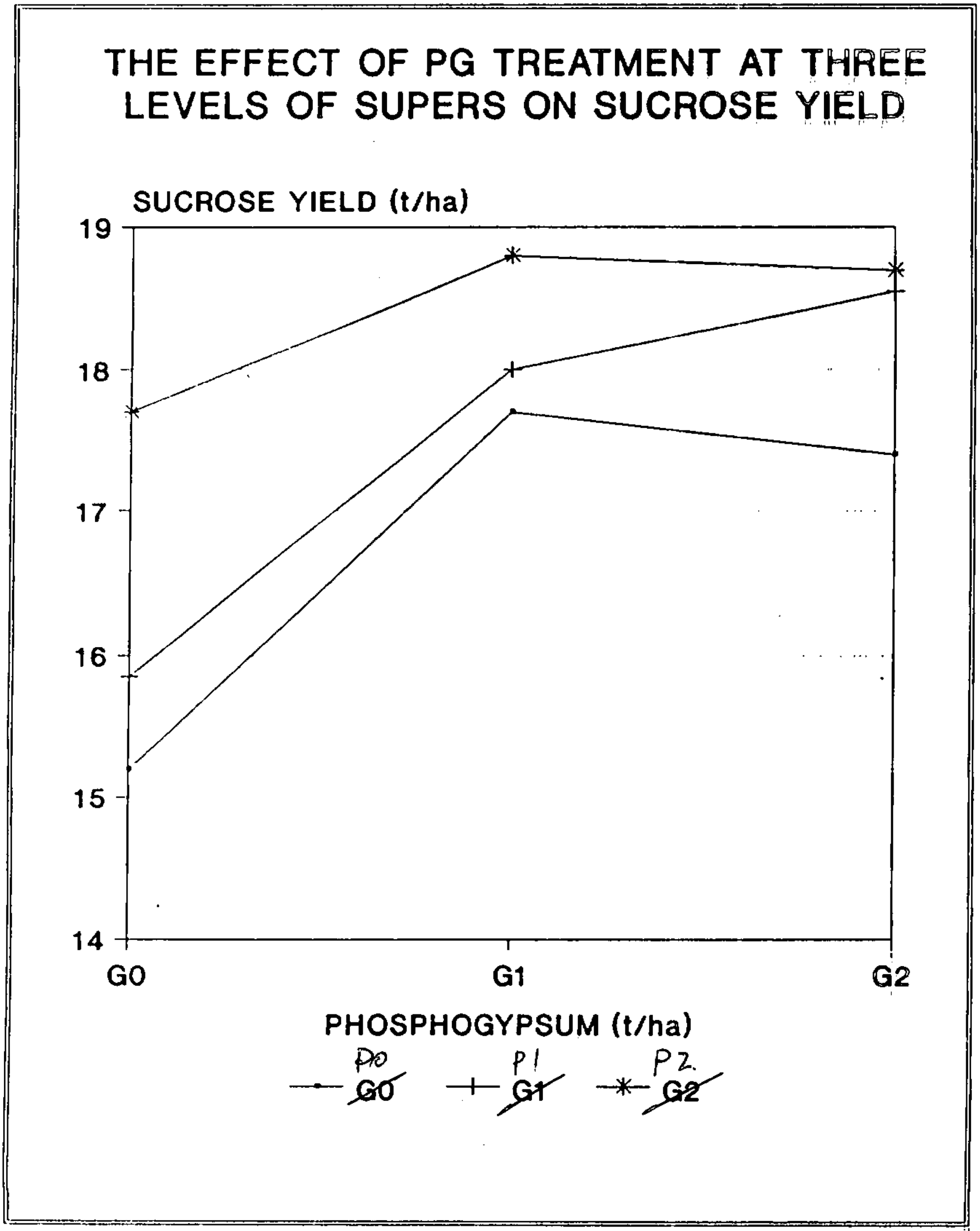
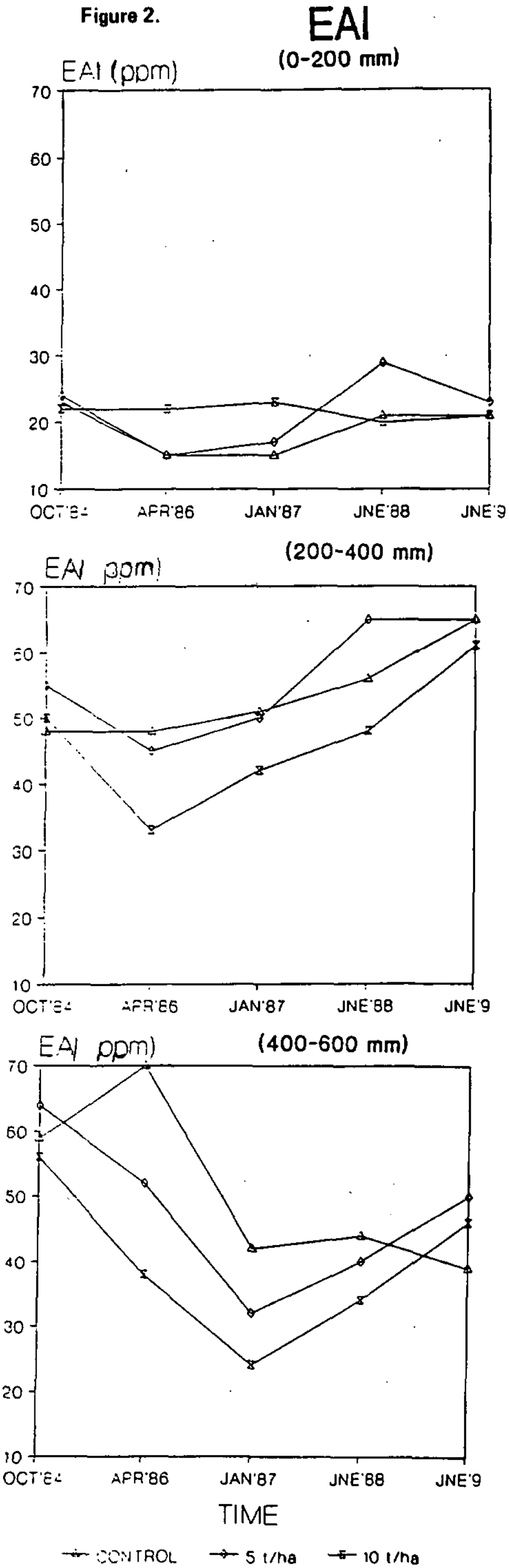
Figure 1.



THE EFFECT OF PG TREATMENT AT THREE LEVELS OF SUPERS ON SUCROSE YIELD
SUCROSE YIELD (t/ha)
19
18
17
16
15
14
G0
G1
G2
PHOSPHOGYPSUM (t/ha)
Po
P1
P2

Figure 2.



EAI
(0-200 mm)
EAI (ppm)
70
60
50
40
30
20
10
OCT'84
APR'86
JAN'87
JNE'88
JNE'9
(200-400 mm)
EAI ppm)
(400-600 mm)
EAI ppm)
TIME
CONTROL
5 t/ha
10 t/ha

Table 1. Summary of yield and crop characteristics at harvest of plant and first ratoon crops

Treatment	Rate No.	Rate Units t/ha	Plant tc/ha	Plant suc % cane	Plant ts/ha	1st Ratoon tc/ha	1st Ratoon suc % cane	1st Ratoon ts/ha	Cumulative response tc/ha	Cumulative response ts/ha
Phosphogypsum	G0	0	114	13,56	15,4	126	12,95	16,3	-	-
	G1	5	117	13,11	15,3	140	13,14	18,4	+17*	+2,0*
	G2	10	104	12,80	13,2	143	12,66	18,1	+7	-0,4
		kg/ha								
Single supers	P0	30	102	12,95	13,7	129	12,80	16,8	-	-
	P1	60	116	13,25	15,1	136	13,01	17,5	+21**	+2,1**
	P2	90	117	13,27	15,1	144	12,93	18,4	+30**	+3,0**
		t/ha								
Lime	L1	1,5	111	13,45	14,3	135	13,03	17,3	-	-
	L2	3,0	113	13,08	14,9	136	12,93	17,7	+3	1,0
	L3	6,0	111	12,94	14,6	138	12,78	17,8	+3	0,8
LSD	P = 0,05		13	0,62	1,4	8	1,56	0,85	11	1,13
	P = 0,01		22	1,05	2,3	13	2,37	1,41	18	1,85

Table 2. : Sucrose yield of the 1st ratoon crop and selected soil properties in relation to PG and DL treatment

Sugar yield (t/ha)					EAI (200-400 mm) ppm			P (0-200mm) ppm			Mg (0-200 mm) ppm		
Levels of lime (t/ha)	Levels of PG t/ha				Levels of Pg t/ha			Levels of Pg t/ha			Levels of PG t/ha		
	0	5	10	Average	0	5	10	0	5	10	0	5	10
1,5	16,6	17,9	17,4	17,3	63	55	48	5	7	5	29	24	21
3,0	15,8	17,9	19,4	17,7	52	50	36	3	6	6	100	56	43
6,0	16,6	19,2	17,6	17,8	44	46	27	5	11	9	145	65	61
Average	16,3	18,3	18,1	17,6	53	50	37	4	8	7	91	48	41

Table 3. : Summary of yield data from Harden Heights trial
Griffin form
Farmill series

Treatments	Plant crop yield	
	tc/ha	ts/ha
1. Control	89,7	12,6
2. 2 t/ha Dolomitic lime	80,9	11,2
3. 2,5 t/ha PG	87,4	12,1
4. 5,0 t/ha PG	98,8	13,5
5. 2,5 t/ha Calcium silicate	90,5	12,3
6. 5,0 t/ha Calcium silicate	85,2	11,6
LSD 5%	9,7	1,6
1%	13,3	2,1

Annexure 1

SUMMARY OF RECENT TRIALS WITH PHOSPHOGYPSUM AND LIME

Trial type	Site No.	Locality	Soil form	Clay %	Crop	Response %		Pre-treatment soil analysis (0-200 mm)					
						Lime	PG	pH (H_2O)	EAl ppm	EAl/CLAY	Acid Satn %	S ppm	Al/S
Field	1	Midlands Seven Oaks	Kranskop	27	Plant + 1st R (2 crops)	NS	S @ Low P NS @ High P ( )	4,50	46	1,70	34	54	0,85
	2	Eston (M Stainbank)	Nomanci/ Inanda	49	7R	-	NS (-2)	4,95	113	2,30	64	99	1,14
	3	Eston (Keyser)	Inanda	28	Cane (Plant)	NS*	NS*	4,75	133	4,80	65	38	3,50
	4	Eston (Keyser)	Inanda	28	6th R	NS*	Slight Positive	4,75	133	4,80	65	38	3,50
	5	Dalton (Union Co-op)	Hutton	70	Cane (Plant)	NS (-2)	NS (+7)	4,55	72	1,02	46	105	0,68
Glass-house	6	Summerhill	Hutton	46	Sorghum (6 crops)	HS (+46)	HS (+50)	4,50	400	8,70	90	90	4,44
	7	Eston (Keyser)	Inanda	29	Sorghum	S (+21)	S (+36)	4,60	120	4,10	61	49	2,45
	8	Richmond (Ian Smith)	Nomanci	27	Cane (1 crop)	-	HS (+56)	4,90	62	2,30	56	20	3,10
	9	Paddock (Bunge)	Glenrosa	16	Sorghum (3 crops)	S (+25)	S (+19)	5,00	74	4,60	-	20	3,70
	10	Paddock (Bunge)	Oakleaf	21	Sorghum (3 crops)	NS (+4)	NS (+1)	5,20	22	1,04	-	23	0,96
	11	Paddock (Lilji)	Glenrosa	15	Sorghum (3 crops)	S (+23)	S (+30)	5,20	45	3,00	-	24	1,90

JHM/lb
21 October 1991

PETT/cvp
23 October 1991

SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION
SASEX AGRONOMY RESEARCH PROGRAMME

1. Nutrition

1.1 Phosphogypsum and lime

To test the effect of lime and phosphogypsum for Al amelioration under the minimum tillage system.

To evaluate the use of phosphogypsum and lime for Al amelioration in plant and ratoon cane.

To update available trial information.

1.2 Phosphorus

To evaluate the use of phosphorus in: P-fixing soils outside the midlands. Neutral to alkaline sandy alluvial soils.

Soils with low subsoil P levels.

1.3 Potassium

To test responses to rates of K in summer harvested cane in base saturated soils of the Eastern Transvaal.

To continue one trial to test K responses under rainfed conditions.

To assess the need for extra potassium or a seasonal correction factor to leaf threshold levels for winter harvested cane in the midlands.

1.4 Nitrogen

To test the value of late N applications in the midlands on soils prone to waterlogging.

To assess responses in N14 and NCo376 to nitrogen at Pongola.

To assess responses to nitrogen in sandy granite soils of the Eastern Transvaal.

To compare the use of slurry formulations of fertilisers with granular fertilisers on a trash blanket.

To study nitrogen rates, placement, losses and cane yield using urea.

2. Trashing

To compare the effects of a trash blanket with burnt tops raked or scattered on N16 on an Arcadia form soil and on N12 in the midlands.

3. **Iron chlorosis** (in co-operation with Chemistry and Soils)

To conduct two field trials to test treatments for the alleviation of ratoon chlorosis and to measure the effects on cane growth in the midlands and Eastern Transvaal.

4. **Ripeners and growth regulators**

4.1 To test at Pongola the responses of varieties to ripeners.

4.2 To continue screening promising new products or systems.

4.3 To test at Pongola the response to ripeners with respect to :

rates
drying off
optimum spray to harvest interval.

4.4 To test the residual activity of ripeners on the growth of the subsequent crop in all ripener field trials.

4.5 To add to the understanding of the ripening process by studying the effects that ripeners have on partitioning of dry matter and accumulation of sucrose in the stalk.

4.6 To assess the response to ripeners in rainfed areas.

5. **Varieties**

5.1 **Released variety trials (RVT)**

To maintain and establish at appropriate times variety trials which include new varieties in the bulking stage (RKM).

5.2 **Estate variety trials (EVT)**

To co-operate with growers in conducting variety trials on different soil forms.

5.3 The number of proposed and established RVT and EVT trials in each region is as follows:

		Proposed	Established
5.3.1	Northern irrigated	2	10
5.3.2	Umfolozi	-	2
5.3.3	Zululand	2	5
5.3.4	Midlands South	-	2
5.3.5	North Coast	-	3
5.3.6	Durban North Coast	3	6
5.3.7	South Coast	2	4
5.3.8	Lower South Coast	2	3
	TOTAL	11	39

Included in the above RVT and EVT trials are the following treatments.

5.4 **Variety x nutrition**

(i) Variety x split/delay nitrogen at Dalton (1).

(ii) Levels of potassium on four varieties at Pongola (1).

5.5 **Variety x age at cutting at:**

(i) Mtunzini (2)

(ii) Ottawa (2)

(iii) Port Shepstone (2)

5.6 **Variety x ripener:**

To measure the interaction varieties x ripeners at Pongola.

5.7 **Variety x ripener:**

To assess susceptibility of varieties to white grub in the Midlands.

5.8 **Variety x weed competition:**

To evaluate tolerance of some varieties to weed competition at Shakaskraal.

5.9 **Variety x transplants:**

To compare the performance of varieties planted as transplants.

6. **Herbicides and weeds**

6.1 **Efficacy of new products**

Evaluate new products for pre-emerge efficacy.

Evaluate new products for post-emerge efficacy.

6.2 **Phytotoxicity of new products and mixtures for registration**

Tray site trials.

Field trials.

6.3 **Phytotoxicity x variety**

To test the sensitivity of new varieties to herbicides.

6.4 **Phytotoxicity x transplants**

To test the sensitivity of transplants to herbicides.

6.5 **Weed identification booklet**

Weed photography.

6.6 **Problem weeds**

Cynodon dactylon control with herbicides

Cynodon plectostachyus control with herbicide

Anredera basseloides

6.7 **Herbicide screening strip site**

Screening of herbicides for specific problem weeds.

6.8 Assess the effects of additives to herbicide mixtures.

7. **Cane eradication**

7.1 Improve minimum tillage techniques.

8. **Crop physiology/economics**

8.1 **Crop growth model**

To develop a physiologically based model of the cane crop with a view to optimising the choice of variety and the harvest schedule for any cane farm.

To work jointly with SMRI to develop a model of the sugar production system starting at the conversion of solar radiation via photosynthesis and ending at the production of crystalline sugar in the mill.

8.2 **Model validation**

To analyse the growth, water use and CO_2 assimilation of rainfed and irrigated cane at La Mercy.

* To quantify the processes of canopy development and light interception by different varieties using the nursery site.

* To determine the effect of soil aeration on leaf growth and CO_2 assimilation.

  To determine runoff and infiltration of water by monitoring soil water content of runoff plots.

8.3 **Evaporative demand (potential)**

To compare water use of N14 growing in the lysimeters at Pongola with estimates of evaporative demand determined from energy budget and aerodynamic considerations (Penman-Monteith estimates).

8.4 **Annual harvesting in the early part of the milling season**

SOUTH AFRICAN SUGAR INDUSTRY AGRONOMISTS' ASSOCIATION

SWAZILAND SUGAR ASSOCIATION EXTENSION SERVICES AGRONOMY RESEARCH PROGRAMME

1. NUTRITION

1.1 Nitrogen

* To continue testing the N requirements on older ratoons in the 'R' (Shortland) and 'S' (Glenrosa) set soils.

* To investigate the effect of yield potential on N requirements.

1.2 Phosphorous

* To assess the efficacy of the Truog extraction method on Swaziland soils in collaboration with University of Swaziland.

* To assess the effects of P fixation on fertilizer recommendations.

* To continue to monitor residual effects of varying levels and placement of P on a virgin soil.

1.3 Potassium

* To continue testing K in conjunction with N on 'R' and 'S' set soils.

* To establish more reliable soil threshold levels for sandy soils and heavy vertic clay soils.

* To assess the effect of season on K availability and soil threshold levels.

* To confirm the new SASEX leaf K thresholds levels for winter harvested cane.

2. VARIETIES

* To establish 3 variety trials so that a full complement of 8 variety trials are maintained to assess seasonal and soil effects on variety performance.

* To assess the responses of the released varieties to chemical ripening.

3. **RIPENERS**

* To assess the optimum date of Ethrel application for flower control on late harvested N14 and to assess the effects of Fusilade for subsequent ripening.

* To assess the optimum timing of Ethrel on early harvested N19 and to assess the optimum rate and timing of Fusilade used alone or in combination with Ethrel.

4. **SOIL AMELIORATION**

* To continue the assessment of vertical mulching on vertic soils.

* To investigate the effects of an integrated programme on the duplex soils including ridging-up, mole drainage, vertical mulching green manuring and ameliorant application.

5. **IRRIGATION**

* To determine the tolerance of sugarcane to water stress during its main growth phases with the objective of reducing water applications.

* To determine the long term effects of reduced water applications on ratooning ability and pest and disease incidence.

6. **RATOON DECLINE**

* To initiate long term trials to study the effect of monocropping on soil physical and chemical properties and their effects on sucrose yields.

PETT/dlz
14 October 1991