SOUTH AFRICAN SUGAR INDUSTRY AGRONOMISTS' ASSOCIATION

ANNUAL GENERAL MEETING - 22 OCTOBER 1992

PROGRAMME

09h15-09h30	Chairman's Address	
09h30-10h00	RSD - an update	RA Bailey
10h00-10h30	Lessons from the drought	NA Johnston
10h30-11h00	The effect and consequences of the drought on seedcane	AB Tucker
11h00-11h30	**TEA**	
11h30-12h00	The year of the Small Grower 1992	DR Pike
12h00-13h00	Prospects for improving sugarcane through biotechnology	Dr F Botha
13h00-14h15	**LUNCH**	
14h15-14h45	The use of Automatic Weather Stations in Irrigation Scheduling	Dr R Mottram
14h45-15h15	Sugarcane modelling research	Dr G Bamber
15h15-16h00	Global warming - effects on Natal Agriculture	Prof. R Schulze

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

RATOON STUNTING DISEASE - AN UPDATE

by

RA Bailey

Introduction

Ratoon stunting disease (RSD) is generally regarded as the most economically important disease of sugarcane internationally. The rapid diagnosis of RSD on a large scale was introduced by the Experiment Station in 1977-78 and was first applied to the North Coast. The first survey of NCo376 in that area showed that a mean of 43% of all crops and 65% of old ratoons were infected. The first survey also immediately highlighted one of the main causes of the problem - 25% of seedcane sources were infected. This was the first reliable, quantitative estimate of the incidence of RSD in the industry: it indicated that the disease was widespread and was likely to be having significant effects on productivity.

The demand for rapid diagnosis of RSD grew rapidly and more than 9000 samples (approximately equivalent to fields) were tested annually in 1991 and 1992. Since the early 1980s, the diagnostic service has provided a powerful tool for continually monitoring the status of RSD in all parts of the industry and for gauging the effect of control measures.

Since the late 1970's, the Experiment Station has conducted research into a number of aspects of RSD. These include its effect on yield in different varieties, and methods of transmission and control. The current status of RSD in selected areas of the industry and research results of particular significance are summarised here.

Current status of RSD

There has been a steady decline in the mean incidence of RSD in the industry since the late 1970s in both seedcane and commercial cane. Samples tested in 1992 to date show that 13,5% of commercial fields are currently infested: this is a reduction of 50% since 1977-80 and represents pleasing, steady progress in controlling the problem (Figure 1). After a steady decline during the 1980s, the level of infection in intended seedcane sources has stabilised at 6,0-6,6% in 1991 and 1992 (Figure 1). If it is assumed that seedcane found to be infected is discarded, the level of infection in seedcane planted in most areas is now very low, with a possible mean for the industry of 2%.

Levels of RSD in commercial crops and seedcane still vary widely in different parts of the industry. The lowest levels are found in the midlands areas and Lower South Coast (eg Figure 2). The most rapid decline in RSD incidence has been achieved in the Zululand region, and it was in the three extension areas of this region that significant progress in improving seedcane quality was first made (mean data for the region are shown in Figure 3.) The highest levels of RSD are found in the three northern areas of Umfolosi, Pongola and the eastern Transvaal. In the Pongola area, levels of 11% and 41% were recorded in seedcane and commercial cane respectively in 1992, but even these levels represent an improvement over previous years (Figure 4).

It may be significant that RSD is most common in the warmer parts of the industry. Recent surveys in other sugar industries in southern and central Africa have demonstrated extremely high levels on estates in Malawi and Mozambique.

Effects of RSD on yield

The severe effect of RSD on the yield of cane grown under rainfed conditions is well appreciated. Reliable field trials conducted at Mount Edgecombe have demonstrated reductions in yield of 40% in NCo376 and 20% in N12 under "average" conditions. Even greater losses have been recorded when crops are affected by drought.

Less well appreciated is the fact that significant losses can also occur in irrigated cane. The first SASEX trial on the effect of RSD under irrigation, at Pongola in 1974, demonstrated a mean reduction in yield of recoverable sugar of 9% over a plant and one ratoon crop and a reduction in cane yield of 20% in first ratoon in NCo376. A similar reduction in yield of cane of NCo376 and significant but smaller losses in N12 (11%) and N14 (7%) have been recorded more recently (Figure 5). In the most recent trial, reductions in cane yield of 17% in NCo376 and 18% in N17 were recorded in plant cane. It is therefore clear that RSD can cause significant yield losses in irrigated cane: this is particularly likely to occur when irrigation efficiency and general conditions for growth are less optimal than those at the SASEX Pongola field station.

Integrating data on the incidence of RSD in the industry with experimental evidence of its effect on the yield of different varieties, it is estimated that losses caused by the disease currently amount to 2,3% of annual production. This is worth some R25 million (cane value). It is estimated that the current situation with regard to the value of annual losses represents an improvement of approximately 60% over the last 15 years.

Spread of RSD

The most significant findings on the transmission of RSD have been confirmation in field trials of the rapid rate at which Clavibacter xyli subsp xyli is spread during harvesting and evidence for the persistence of the bacterium in soil to infect newly planted cane when fields are replanted.

When cane knives were not cleaned during manual harvesting, 62% of stalks of NCo376 down-row from spreader plants were found to be infected after one harvest and almost all were infected after three harvests. Cleaning the knives frequently (after every metre of row cut) greatly reduced the rate of spread but cleaning the knives every 4 m was not greatly effective. Unfortunately, practical considerations limit the extent to which knives can be cleaned during manual commercial harvesting.

In two trials, significant levels of infection were detected in plant crops following previous infected crops and in the absence of volunteer regrowth. Infection of the new crops must have been caused by C. xyli subsp xyli remaining viable and infectious for up to at least three months. This finding may partly explain the persistence of RSD in areas where it is most common; it may be significant that the interval between destruction of the old crop and replanting is usually shorter in the warmer areas where the highest levels of RSD are consistently found. Further research on the survival of C. xyli subsp xyli in soil and the significance of this relative to other methods of transmission is in progress. However, a new recommendation, that where fields are known to be infested with RSD, there should be a break from cane of approximately six months before replanting, seems worthwhile.

Summary of control measures for RSD

* Seedcane must be healthy (seedcane schemes; RSD diagnosis)

* Crop destruction must be effective so that volunteer regrowth is minimised (particularly for fields known to be infested).

* A break from cane should be applied before infested fields are replanted.

RAB/

20 October 1992

Fig 1: The RSD situation in the industry, 1977-92

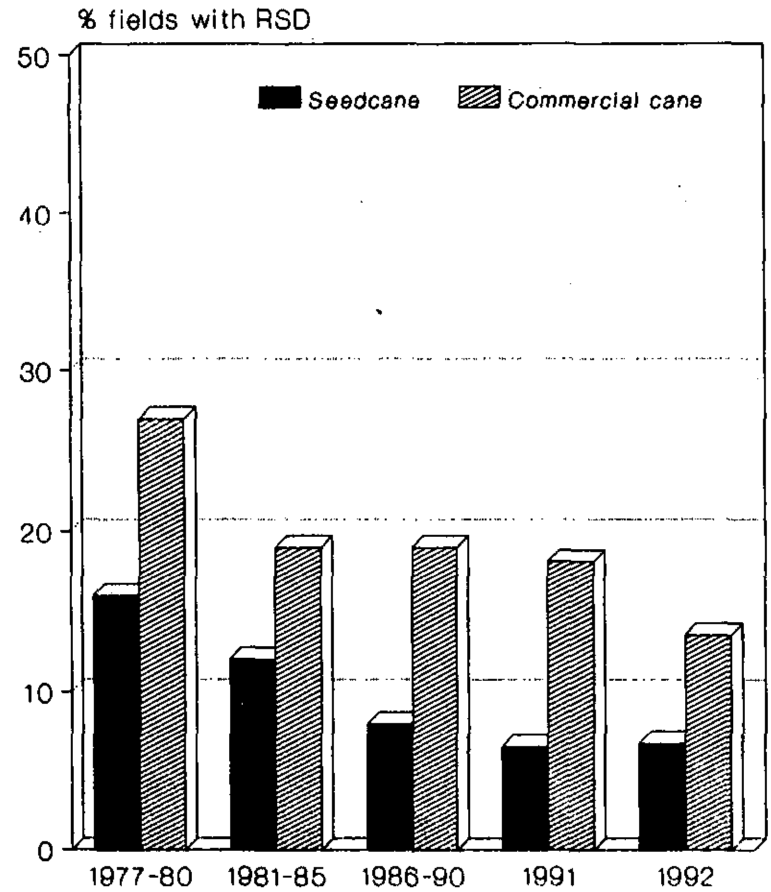


Fig 2: RSD incidence, Midlands region, 1977-92

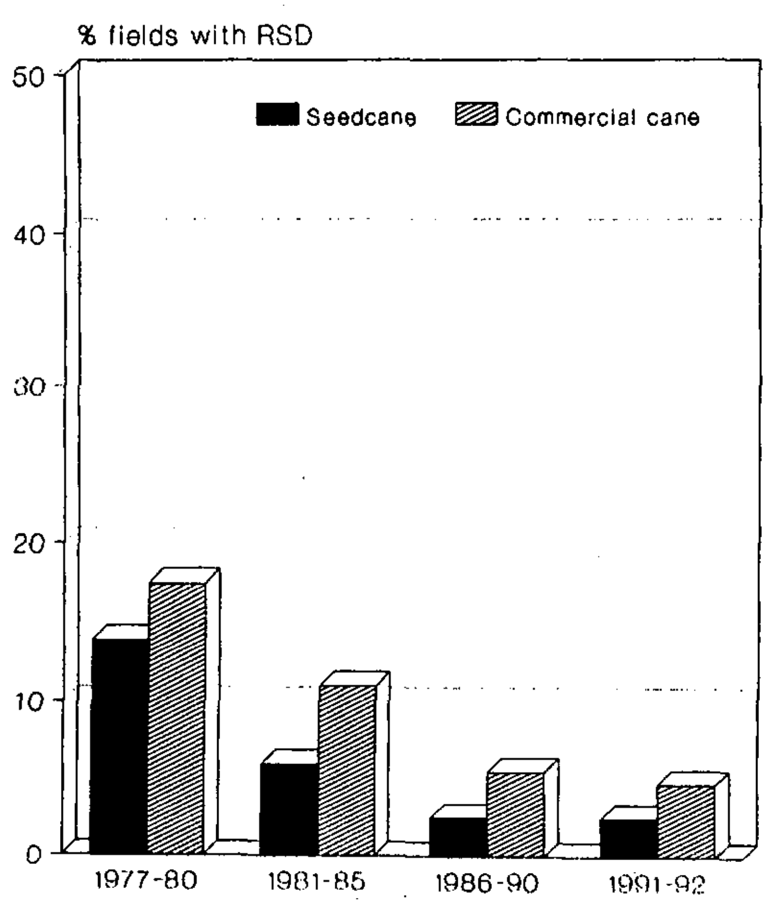


Fig 3: RSD incidence, Zululand region, 1977-92

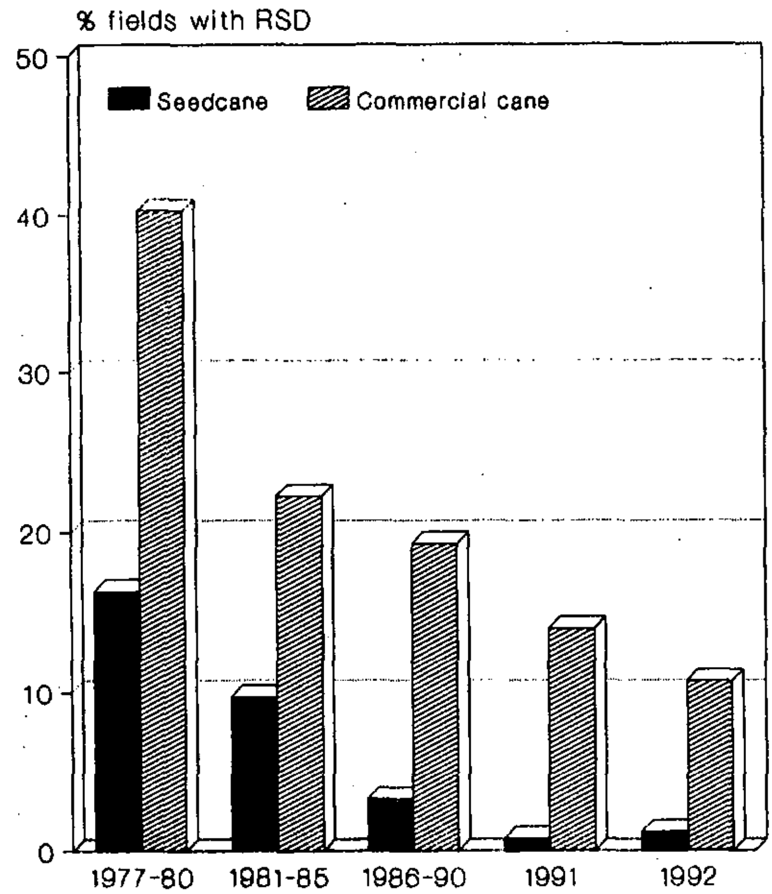


Fig 4: RSD incidence at Pongola, 1977-92

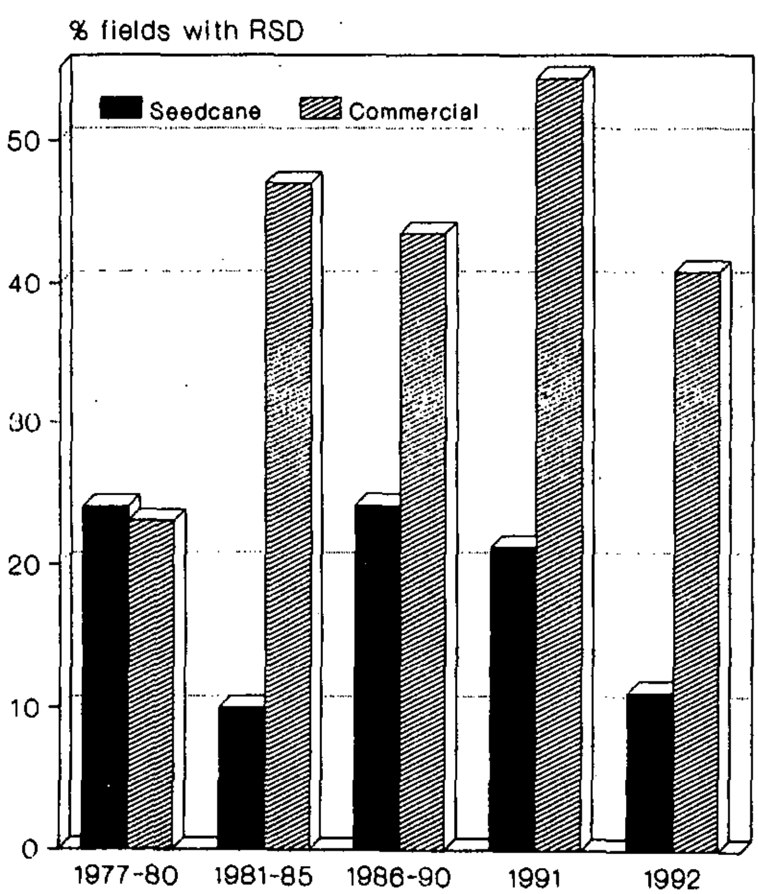
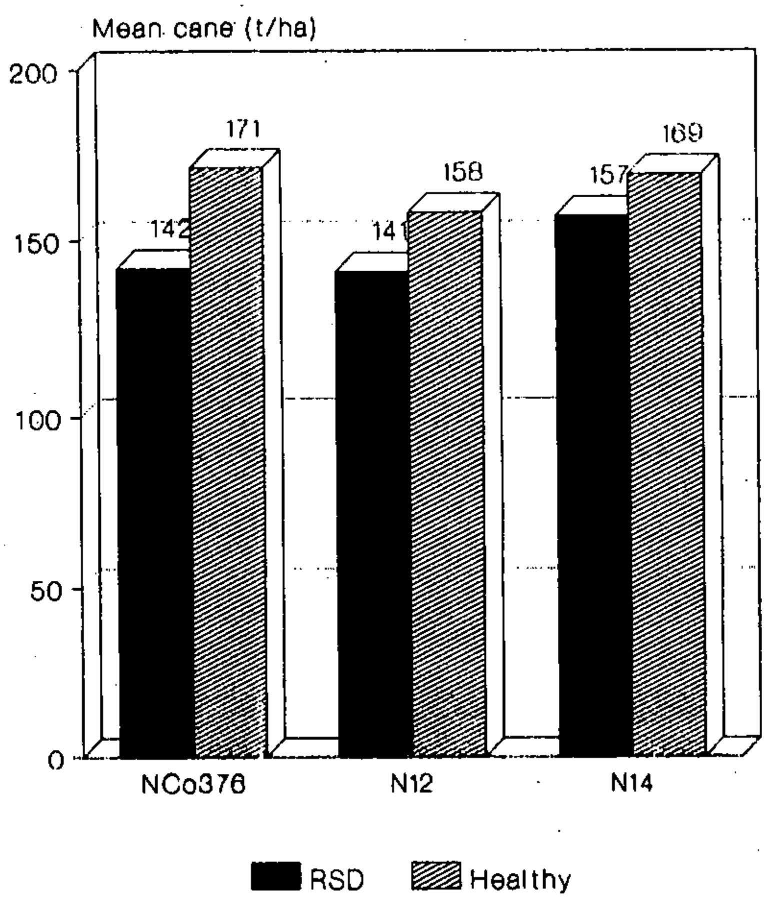


Fig 5: Effect of RSD on cane yield at Pongola, P - 3R, 1988-91



SOUTH AFRICAN SUGAR INDUSTRY AGRONOMISTS' ASSOCIATION

LESSONS FROM THE DROUGHT

(Summary of Presentation to be made at the S. A. Sugar Industry Agronomists' Association's Annual General Meeting to be held on 22 October 1992).

INTRODUCTION

The South African Sugar Industry experienced one of the worst droughts this century. The Lower South Coast was badly affected.
Rainfall recorded at C. G. Smith Sugar Ltd - Umzimkulu for the fifteen month period ending September 1992 was 50,6% of long term average.

The decision was taken not to open the Umzimkulu Mill for the 1992/93 season and all the sugar cane was diverted to the Sezela Mill.

Many problems faced both the miller and the sugar cane growers because of the drought.

CANE ESTIMATES

Cane estimating proved to be extremely difficult as there was no reference point or past experience to rely on. Rainfall, budgets and cash flow forecasts were difficult to determine with any degree of confidence.

CANE FIRES

The drought together with strong coastal winds made conditions extremely hazardous. Many hectares of mature and immature sugar cane were burnt in the Industry. One of the worst fires on the Lower South Coast occurred in the Paddock district, where an excess of 40 000 tons were burnt, homes destroyed and sadly two lives were lost.

CANE HARVESTING

Drought, high Eldana borer levels and cane fires resulted in low yields and made the harvesting of sugar cane extremely difficult for the cane cutter.

A change in the method of harvesting was implemented so as to maximise payloads, ensure that the crop was harvested and to enable the cane cutter to be adequately rewarded for his efforts.

Payment for cane cutting was based on area cut and area of cane hand stacked rather than tons cut or tons hand stacked.

The area cut or stacked varied according to the estimated yield of each field.

Due to the deterioration of cane quality and stalk mortality, certain cane fields had to be abandoned in preference to fields of higher quality.

SUGAR CANE QUALITY

Fibre percent cane peaked at 19,7%.
Moisture percent in cane dropped from 67,6% to 63,9%. Weekly sucrose percent cane peaked at 15,7%.
Many consignments of sugar cane received at the Sezela Mill had high levels of ethanol.

SEED CANE

Good quality seed cane is unavailable this year. Some growers had to reduce or abandon their replant programmes. The drought together with the numerous cane fires demonstrated that there is a definite need for regionalised seed cane or transplant nurseries within the Mill Group area.

RATOON VERSUS REPLANT

Due to the shortage of seed cane decisions had to be made whether to replant a field, allow it to ratoon, or to gap up the ratoon.

This was further complicated by the fact that is was difficult to determine what percentage of a field had actually died. An observation on our farms was that cane cut in August appeared to germinate faster than that which had been cut in the early part of the season.

WATER SUPPLY

Farms, sugar mills and rural communities were adversely affected.

At Sezela a six kilometre pipeline had to be built to ensure that the mill did not run out of water.

Boreholes, streams and certain rivers dried up and farmers had to cart water over long distances for domestic use. Where wetlands and sponges had not been exploited water tables remained relatively high and were able to support small communities with water.

In some rural communities there was no water at all. Companies, businesses and farmers with dams assisted by supplying water to these people.

WEED CONTROL

Application of Herbicides

Decisions had to be made whether to apply long term or short term herbicides once the first rains fell. In areas where cane fires had occurred the debate was whether to use aerial application or tractor mounted boom sprayers. Due to the grower having to carry the risk of possible damage to other crops, the decision was made to apply herbicides by tractor mounted boom sprayer and knapsacks.

CONCLUSIONS

Forecasting

Short to medium term weather predictions must be taken into consideration when planning and budgeting. The Weather Bureau is willing to assist in this regard.

Seedcane

A good supply of quality seed cane is our most important critical success factor if we wish to stay in business.
There is a need for regionalised seed cane and transplant nurseries within Mill Group areas.

Water Supply

In addition to their own requirements, farmers who had reasonably sized dams were able to supply water to people in need.

Survival

Innovation, being sensitive to environmental factors, the effective use of assets, the securing of a good supply of high quality seed cane and the involvement of the community is necessary for sugar cane farming to survive.

N. A. JOHNSTON

SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION

The effect and consequences of the drought on seedcane

by
A B Tucker

In June 1992, SASEX set up an ad hoc committee to address the likely adverse effects of the drought on seedcane.

LP&DC Committees were requested to carry out an assessment of the likely shortfalls of 1st and 2nd stage nursery seedcane, or if surpluses of approved seedcane were available for areas in need.

All committees reported back by 31 July and the following picture emerged:

Shortfalls were identified on the South Coast and in Zululand. Local shortfalls on the North Coast and in Pongola could be met from within these areas. Umfolozi and the Dalton areas reported surpluses available to supply other areas, while the Northern Region areas could balance requirements from internal sources. Small growers are likely to be the worst affected.

It was clear that Committees would be relaxing their usual more stringent standards to accommodate the situation, although freedom from RSD was a bottom line requirement.

As the drought continued after the normal time for spring rains to commence, a follow-up request rom SASEX was made to LP&DC Committees to update the seedcane supply situation and report back by 15 October.

The original reports on the availability of seedcane remain largely unchanged. A relatively high percentage of growers have not committed themselves.

The reasons for this are:

It is still too early to ascertain to what extent there is ratoon failure present, which necessitates replanting.

Growers are concerned that they cannot afford a normal replanting programme (12% replanting has to be funded first before a grower qualifies for an additional loan for the extra replanting).

They realise it will be difficult obtaining seedcane anyway.

That the price of seedcane will be particularly high as it will be equated with A pool prices at the high sucrose levels being experienced this season.

The problem is compounded by the early closure of the mills this season. Growers with potential seedcane will send it for milling if they do not secure firm orders as they will almost certainly be getting A pool prices for it.

To sum up, these are the probable consequences, once the small amounts of seedcane are used up:

Growers will gap fill plant cane or younger ratoons
or they will take one more crop, even if gaps are present and plough out next season,
or fields will be fallowed for 1 year,
or replanted with unapproved commercial cane.

Whichever approach is adopted, the impact could cause deterioration in the health of the crop or delay the recovery to a normal crop.

There is an important step which must be taken irrespective of the foregoing:

Nurseries must be properly planned and planted right now to ensure adequate seedcane of the right quality is available for a favourable above-average replant programme in the 1993/94 season.

The use of transplants which can be generated rapidly to produce uniform, disease-free mother seedcane, is an obvious option to take.

Commercial transplant nurseries are now in operation in Malelane, Pongola, Umfolozi, Nkwalini, Gledhow and Sezela. These may not be able to cope with demand, but properly planned programmes could generate a large turn-over of seed material.

The transplant system has the potential to produce a far better quality seedcane than the conventional method.

This exercise has resulted in each committee adjusting their normal survey programmes to give priority in searching for potential seedcane which could be offered at the lower threshold levels being adopted.

Previous nurseries, and fields known to have been planted from approved sources of seedcane are being inspected, checked for RSD, and cleaned up, if this is needed.

The contingency plan being made by the SASEX RSD testing services and LP&DC Committees should ensure that most growers will be using an acceptable quality of seedcane.

ABT/lb/ext\rep
19 October 1992

SOUTH AFRICAN SUGAR INDUSTRY AGRONOMISTS' ASSOCIATION

THE YEAR OF THE SMALL CANE GROWER 1992 "SONQOBA SIMUNYE"

by
DR Pike, SASA Experiment Station, Private Bag X02, Mount Edgecombe

Background

"Three decades of independence in sub-saharan Africa has produced substantial evidence as to why many agricultural and rural development projects are not performing well at this stage of Africa's economic history".

This is the stated opinion of Professor Johan Van Zyl, Dean of the Faculty of Agriculture, University of Pretoria, in a series of three articles in the June edition of the Farmers Weekly.

He gives a number of convincing examples. He goes on to say that:

"There is consistent evidence that human capability and institutional barriers to development were neglected and even ignored in the drive to increase foreign aid flows to African Agriculture.

Over the past two decades he says that there has been a lack of analytical and empirical research, in fact, he suggests that development literature is virtually silent on rural institutions in Africa and how to develop them to serve communal (small holder) farmers!

In a pioneering investigation of the economic development process of 23 countries of the world, from 1850-1914, it was concluded that institutions mattered most in distinguishing between countries experiencing more successful economic growth".

As in South African and prior to Independence in Zimbabwe we know that the basic agricultural institutions, there of research, extension, credit and marketing were primarily servicing large scale commercial (or white) agriculture.

The black smallholder sector was engaged solely in subsistence farming. Zimbabwe therefore inherited a dual agrarian structure. At Independence these institutions were charged with giving increased priority to the needs of communal (smallholder) farmers.

It is also true to say that the focus there has changed so much now in favour of the latter that large scale farmers have to rely heavily on agribusiness firms and consultants for extension service.

Clearly an initiative to strengthen human capital and institutional base for smallholder farmers must emerge" unquote.

One key performance area is therefore the empowerment, if you like, or institutional development through training in establishing an effective grassroots administrative structure.

"Its the vision", as outgoing Chairman of the KwaZulu Cane Growers' Association, Mr WTV Luthuli maintains, "is to develop leadership of small growers by concentrating on strengthening the functioning of the Mill Cane Committees.

From now on representation will be based on the mill area and not be production orientated as in the past".

Empowerment of Small Growers

And so it is at the bold and may I say praiseworthy initiatives of the South African Cane Growers' Association, they have brought the Small Cane Grower structure into the forefront of 1992 by assisting small growers to play a full and active part in the sugar industry.

Changes in the Small Cane Grower structure, increased, equal, small/commercial grower representation, institutional development training and the formation of a small grower Development Trust Fund are all contributing to make it possible for small cane growers to achieve this status! The effect is to place the representation of small growers on an equal footing with that of quota growers.

Figure 1

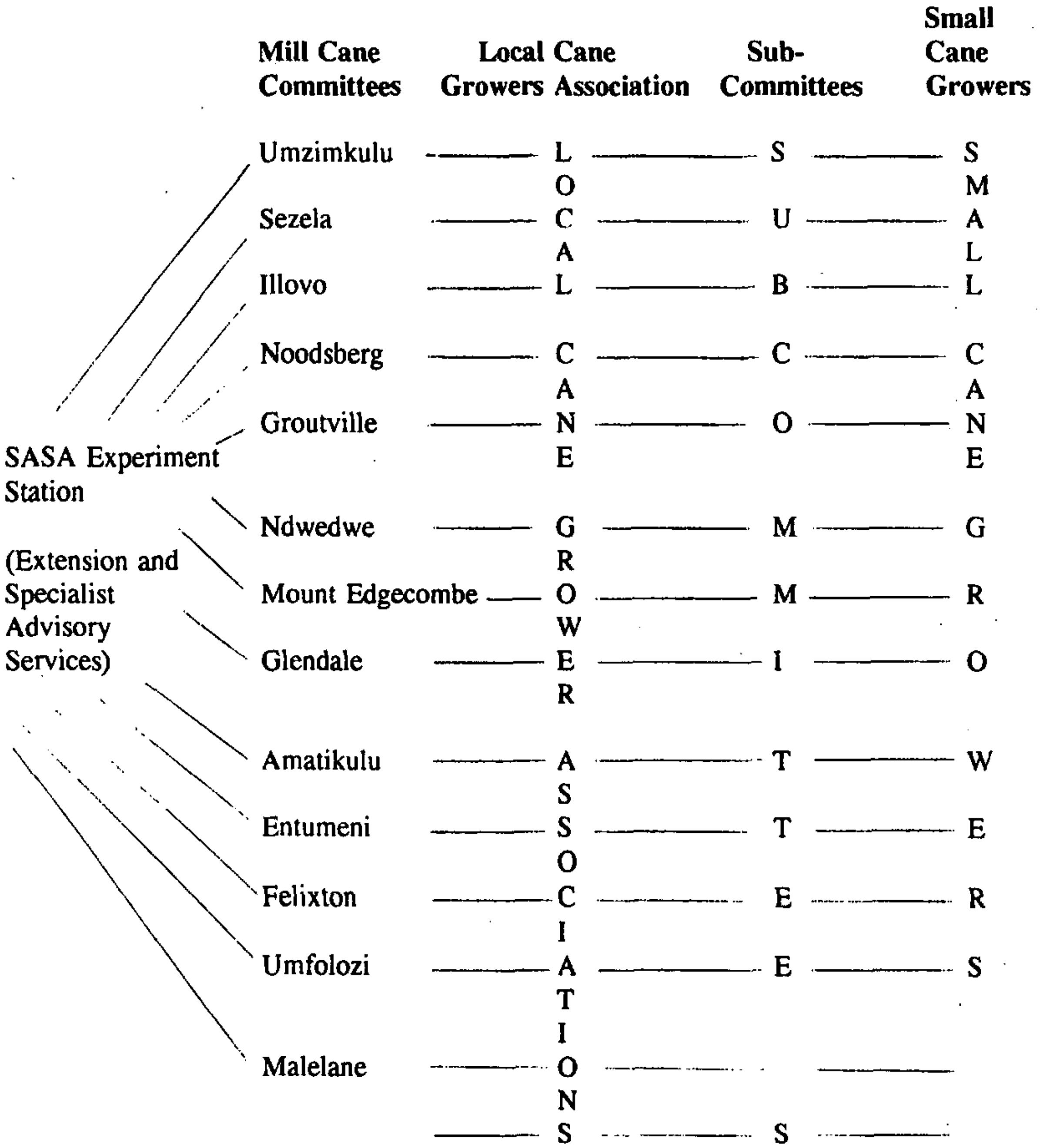
Old structure (Representation proportional to production)	**New structure** (Representation now mill area based)
Board of Directors (SACGA) (3)	SASA Council (1)
↓	↓
Executive Committee (8 + 1)	Board of Directors SACGA (28)
↓	↓
Central Committee (84)	Local Grower Council (32)
↓	↓
Mill Cane Committee (24)	Mill Cane Committees (84)
↓	↓
Local Cane Growers Association (149)	Local Cane Growers Association (226)
↓	↓
Sub-committee (330)	Sub-committee (334)
↓	↓
Small Cane Growers (±41 000)	Small Cane Growers (±41 000)

NOTE: Figures in brackets indicate number of small grower members.

In January 1991, the Small Cane Grower Association requested SASA Experiment Station to support their initiative in strengthening their Mill Cane Committees.

The Experiment Station therefore focused their communication system at the Small Cane Grower structure thus:

Figure 2



TOTAL	13	226	334	±41 000

Extension Services: KwaZulu Department of Agriculture ? ?
Contractual and Input Services Mill Development Agencies ?

In the company of the Administrative Secretary (Small Cane Growers Association), the Experiment Station concluded a number of rounds of meetings with most Mill Cane Committees in 1991.

The objective here was to promote the principles and practices of Programme Planning, i.e. "Doing the Right Things at the Right Time". People do not plan to fail, they just fail to plan!

For good reason other activities such as Crop Estimates and Establishing cane harvesting, transport and transhipment rates were included. These form the basic five and part of their essential seasonal operations.

Further, if the grand design, and I believe it is, all part of adopting a well organised and disciplined approach to economic cane production, then I see no reason why a millcane committee cannot manage their total cane farming operation as any estate manager would in the commercial farming sector!

Initially only one mill cane committee responded to the motivation for Programme Planning. However, once word got around of the value of this extension programme, applications from other mill cane committees, notably Glendale, Entumeni, Umfolozi and Ndwedwe followed.

Unfortunately due to lack of Extension staff and to other priorities it was not possible to pursue these requests.

Consequently the extension programme was only conducted with the Amatikulu Mill Cane Committee. This programme started in May 1991. Events included 14 field days, plus lectures and visits which were enthusiastically supported.

Correct and timeous application of fertilizer using the tin and string method, and effective weed control at the right stage were two of the more important practices covered, and the extent of adoption was measured.

Figure 3: Members of the Amatikulu Mill Cane Committee prepare to apply fertilizer using the tin and string method

With reference to Figure 2, the next phase is to cascade a similar extension programme to the next tier of the small cane grower structure: the local cane growers associations. The phase after that would be to extend this programme to all sub-committees, who will be expected to pass the word further onto the small growers they represent. This involves those in the upper echelons who have been trained being used as trainers for those in the lower echelons as described.

At this stage another priority emerged and that was a pilot institutional building training programme to be implemented with the Felixton, Entumeni, Amatikulu and Sezela Mill Cane Committees commencing in March 1992.

A sum of 71 000 American dollars has been donated by the United States Agency for International Development (USAID) for this purpose.

An example of what has come out of the Institutional Development is the Amatikulu Mill Cane Committee's programme of work for 1992/93 as part of their Strategic Plan for 1988 as follows:

1.	Soil Analysis	:	**Contact SASEX** - 1) soil map of area; 2) soil sampling; 3) Assess FAS recommendations and 4) implement recommendations.
2.	Roads and Bridges	:	**Contact SASEX** - 1) Cane extraction plan/LUP?; 2) contact KDA for machinery; 3) improve existing roads, zones and stream crossings.
3.	Contractors	:	Cane Haulage - improve efficiency of existing contractors. Each sub-committee to identify those to be trained to become full-time contractors - KTT or SASEX. 3 x 1 day courses on Business Principles.
4.	Training	:	Ratoon management - all sub-committees as per **SASEX** programme 1991/92 Amatikulu as described.
5.	Finance	:	For existing growers. Sub-committees to estimate drought relief measures.
6.	Seedcane	:	Identify growers with cane suitable for seed, check with P&D, and estimate each sub-committee requirement. Work out replanting schedule.

It is obvious from the above that the Experiment Station's involvement in small grower development is expected to be considerable, refer to items 1, 2, 3, 4 and 6.

Some Thoughts and Recommendations for the Agronomists' Association

In Zimbabwe the institutionalisation of on-farm research is having the effect of intensifying the interaction between communal farmer structure on the one hand and extension and research workers on the other.

In normal seasons the phenomenal growth of maize and cotton production shows that success of increasing crop production is not achieved by strengthening only one institution, rather the co-ordination effort of them all.

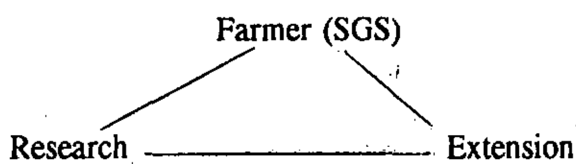
It is the combination of affordable and profitable technology, support institutions which facilitate the uptake and use of improved (adapted) technology. Again it must be orientated and negotiated with the smallholder structure.

In his keynote address, Prof. PE Hildebrand, University of Florida and past President of the International Association for Farming Systems Research and Extension maintained that whatever farming systems are in use, focus on the client farmer by research and extension must be a prime consideration.

The need to involve the farmer from the beginning in a well co-ordinated "on-farm" rather *than "on-Experiment Station" research programmes was considered fundamental.*

He hinted strongly of participation in a wide range of physical environments.

The important thing is to meet the farmer on his own ground and build up local management capacity thus:



"Get closer to the client"

In consultation with each Mill Cane Committee then in order to accommodate the small grower community in an endeavour such as this, trial/replications/demonstrations sites could be strategically located in each mill area.

These could be clustered for logistical purposes, taking into account such environmental factors as soil, climate, topography and small grower characteristics.

Alternatively, these sites could even be located at each of the three SASA Regional Training Centres at Nyangwini (SZ), Ndwedwe (MS) and Esingweni (AK) respectively.

Experiment Station could provide advice, for example, Agronomy, FAS, etc on how to set up, run, monitor and evaluate such aspects of: weeds, no weeds, fertilizer, no fertilizer, trash, burn,new varieties, etc.

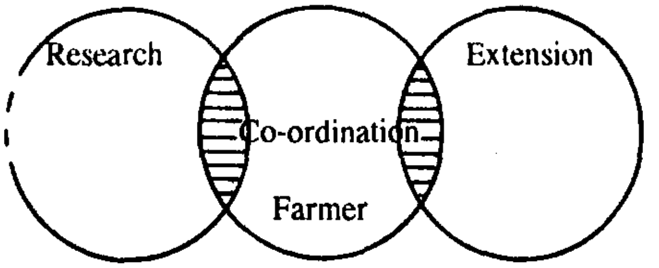
The onus should be on the small grower structure to provide the implementation and managerial aspects of these trials. Again SASA Experiment Station would be involved in purely an advisory role?

This is, as an initial research activity, indicating the small grower structure specifically and giving it the choice of what action if prefers.

I believe the important things to do is to jointly identify a research programme that the small growers structure are involved in.

Focus and co-ordinate it with the small grower structure so that the effort is seen as grower managed, grower implemented and grower evaluated.

Requests for change must come from the small grower structure together with their contribution and their participation in monitoring and interpreting results.



Meet the small grower on his own ground so he can establish, approve, disapprove research proposals. We must put small growers back in control.

It may be of interest to note that there has been a shift worldwide away from the individual or family unit to a more communally orientated research systems and programmes.

This would appear to suit the small grower structure better and their modus operandi in particular, thus contributing to greater grower productivity and certainly maximum economic yields.

Summary

One approach might well comprise of the following steps:

1. Characterisation and understanding of small grower development systems - get closer to the small grower. Invite guest speakers from this sector. Visit their cane supply area.

2. Design and negotiate technological alternatives. Minimum tillage, trashing, management practices.

3. Test and evaluate research with the small grower structure.

4. Draw up formal recommendations.

5. Diffusion and dissemination of tested innovations for wide scale application.

In conclusion

Coming together is a beginning
Working together is progress
Staying together is success.

DR Pike
Extension Officer : Small Cane Growers
18 September 1992

References

1. Cane Grower (1991: 1 and 2). Training for Small Cane Growers. Newsletter of the SA Cane Growers' Association Vol. 4, No. 7. Durban.

2. Experiment Station: (1992:28) Extension Department Reports July. Mount Edgecombe.

3. Laker. Prof. G (1992:1) Farming Systems Research - Extension FSR-E Newsletter No. 3 July. Faculty of Agriculture. University of Florida.

4. Pike, DR (1990:3 and 4). Report on a Visit to Zimbabwe and Malawi. July : Internal.

5. Pike, DR (1992: 2, 3 and 4) Farming Systems Research - Extension. "Extension in the 1990's" March. Report on Conference : Internal.

6. Pike, DR (1992: 2). Proceedings of the South African Sugar Technologists' Association : "Communicating good agricultural practices to small cane growers in KwaZulu : 1982-1002" June, Mount Edgecombe.

7. SA Sugar Journal, (1992: 226) Cane Growers' Annual General Meeting, Vol. 76 No. 7 July, Durban.

8. SA Sugar Journal (1992: 236). A New Structure for Growers Association, Vol. 76. No. 8 August, Durban.

9. SA Sugar Journal (1992: 276 and 278). Quota and small growers on an equal footing. Vol. 76. No. 9 September, Durban.

10. Van Zyl, Professor Johan (1992: 12 and 13). 'Lessons from Zimbabwe'. Plain Speak : Farmers weekly 12 June 82024 Mobeni, Durban.

11. Van Zyl, Professor Johan (1992: 18 and 19). 'Lessons from Zimbabwe'. Plain Speak : Farmers Weekly 19 June 82025 Mobeni, Durban.

12. Van Zyl, Professor Johan (1992: 37 and 39) 'Lessons from Zimbabwe'. Plain Speak : Farmers Weekly 26 June 82026 Mobeni, Durban.

<u>SOUTH AFRICAN SUGAR INDUSTRY</u>
<u>AGRONOMISTS' ASSOCIATION</u>

PROSPECTS FOR IMPROVING SUGARCANE THROUGH BIOTECHNOLOGY

F.C. BOTHA

1. INTRODUCTION

For the purpose of this presentation, biotechnology is defined as the integrated use of plant physiology, biochemistry and molecular genetics. The rapid increase in knowledge pertaining to the expression of genes, gene structure and organisation, and the explosion in available technology has opened new and exciting possibilities for crop improvement.

Modern biotechnology involves an integrated multidisciplinary approach to biological problem solving. As a result most research programmes are conducted by research teams rather than individuals. One example is the recent success with genetic transformation of maize. The single paper published was the outcome of more than five years of research conducted by nine senior researchers. The participation and success of any biotechnology programme is depended on available expertise in biochemistry, physiology and basic aspects of genetics.

Unlike the popular belief, molecular genetics is both slow and time consuming and definitely does not result in a high turnover. Any biotechnology programme is therefore a long term investment.

2. TECHNOLOGY INVOLVED

The whole driving force in modern biotechnology can be related to three major discoveries. The first was the discovery of the restriction enzymes. These enzymes are able to cut a DNA molecule at a specific site by recognising a specific nucleotide sequence. Restriction is normally around a symmetrical axis. This results in three to four single stranded nucleotide over-hangs, referred to as sticky ends. When in solution, these ends will spontaneously rehybridise through hydrogen bondage. However, the DNA nicks in the DNA strands can not be restored spontaneously.

The second contribution was the discovery of the enzyme DNA-ligase that links nucleotides in DNA strands by forming a phosphodiester bond between two adjacent nucleotides.

These two enzymes created the ability to excise specific DNA fragments and allowed the joining of isolated DNA fragments. This forms the basis of genetic engineering. In addition the technology for DNA transfer to plant material has develop substantially. Frequently used methods include the *Agrobacterium* mediated transfer, electroporation, micro fibers, micro injection and particle bombardment.

Knowledge about the regulation of gene expression resulted in the isolation and characterisation of specific gene promoters. The expression of foreign introduced genes can therefore be regulated in the recipient plant. Over expression of "anti-sense" genes can be employed to selectively remove undesired phenotypes.

The discovery of the thermostable DNA polymerase of *Thermus aquaticus* (Taq polymerase), transformed the polymerase chain reaction (PCR) method from a tedious to a simple and robust method that could be automated. Many copies of specific target *loci* in the DNA of an organism can be synthesised in a few hours. Combined with better and faster gel analytical methodology, the synthesised DNA can be compared to detect polymorphisms. This technology has contributed significantly to the preparation of high density genetic maps of certain plant species.

The utilization of DNA markers in a breeding programme has several advantages over other previously used molecular markers. Iso-enzymes, secondary metabolites and proteins all suffer from the disadvantage in that there is a strong interaction between their presence and factors such as age, tissue type and the environment. Selection is therefore dependent on both the age of the plant and the prevailing conditions. In contrast, the DNA in all cells of an individual is the same, and is unaffected by the environment.

3. EXAMPLES OF SUCCESSES ACHIEVED

Untill recently genetic transformation of plants was restricted to the dicotyledonous plants. Transformation was also mediated largely through the Agrobacterium Ti-plasmid. However, during the last three years several monocotyledons have been successfully transformed. At present most of the agronomically important plants have been transformed.

The goals of transformation have focused on three areas, namely herbicide resistance, insect and virus resistance and alteration in end product or phenotype.

Plants are sensitive to "Round up" because the active ingredient glyphosate inhibits the key enzyme 5-enolpyruvylshikimate-3-phosphate synthase (ESPS synthase) in the shikimate pathway. This primarily prevents the synthesis of the aromatic amino acids. By the introduction of a genetically engineered copy of the enzyme, Monsanto has produced a variety of plants resistant to "Round up". The active ingredient of "Basta" is glufosinate-ammonia. This compound inhibits the enzyme glutamine synthethase (GS). A bacterial GS enzyme was discovered that exhibits no sensitivity to "Basta". Through genetic engineering the bacterial gene was transferred to plants and the resultant plants are completely resistant to the herbicide.

Bacillus thuringiensis produces a large glycoprotein (BT-protein) which can be cleaved by a protease in the mid-gut of the larval stage of several *Lepidopteran* species. The hydrolysis products of the BT-protein are extremely toxic. A Bt-gene was originally isolated and transferred to tobacco by researchers at Monsanto. The resultant plants expressed the foreign gene and limited resistance was obtained. In subsequent work the gene was further modified to ensure higher levels of resistance. Cotton, tomatoes, potatoes and several other plants have now been transformed with the modified Bt-gene, and as a result high levels of insect resistance were obtained.

A novel approach was employed to achieve virus resistance in a variety of plant species. Plants were transformed with a chimeric gene construct containing a very potent promoter and the gene encoding the virus coat protein. The presence of high virus coat protein levels in the cell results in resistance. The underlying mechanism for this phenomenon is still poorly understood. Recent results with virus structural genes have indicated that transformation with manipulated viral structural genes might provide a better method to achieve virus resistance. Apparently, broad range protection can be achieved by over expression of the viral structural genes.

One of the most important plant products is oil. However, most plant oils are low quality products due to the high level of desaturation. Downstream processing to alter the level of desaturation is costly and therefore most plant oils are of little commercial value. Desaturation of stearate to oleiec, linoleic and linolenic acid is mediated through the enzyme stearate desaturase. By introducing an "anti-sense" stearate desaturase gene into canola plants, the level of stearate was increased from 2.8% to more than 40% in the seeds.

Ethylene is involved in the ripening of fruits from several species. By characterising the metabolic pathway of ethylene biosynthesis, the key reaction steps were identified. The ethylene synthesis in tomatoes was altered using two different approaches. In the first, a bacterial gene that converts S-adenosylmethionine (SAM) to a metabolic inactive derivative (SAM deaminase) was cloned into tomatoes. The second approach was to clone an "anti-sense" aminocyclopropane carboxilc acid synthase gene into tomatoes. The latter enzyme is the rate regulatory enzyme in ethylene biosynthesis. Both methods resulted in tomatoes with a dramatically increased shelf life.

Barnase is a very potent bacterial RNase. The host organism protects itself against the enzyme by the production of an inhibitor called barstar. Using a tapetum specific promoter and the barnase gene, male sterile plants were obtained. Male sterility is extremely important for controlled fertilisation in seed production. Furthermore a cross between a plant expressing barnase and a plant expressing barstar, will result in a fertile F-generation. It is calculated that labour costs alone will be reduced by millions of dollars through this technology.

The most recent development provides a novel way to selectively remove the marker gene which is normally used to trace transformants. The presence of the marker gene, usually a bacterial gene, in the transformed plant, was one of the major reasons for consumer resistance to transgenic plant material.

Other examples of successes already achieved include; higher levels of starch in potatoes; synthesis of high amounts of C_{12}-fatty acid; cold resistance obtained with a fish antifreeze protein; higher levels of storage protein; improved storage protein quality in seeds; and retarded aging of tissues.

4. SUGARCANE BIOTECHNOLOGY

It was against the background of the impact of biotechnology already seen on plant science, that an international memorandum of agreement was signed on July 1, 1991 by all the major sucrose producing countries in the world. The underlying principle of free exchange of information between the signatories of the agreement should be seen as an attempt to recover lost ground. In comparison to other major crops, research on the potential use of biotechnology for crop improvement in sugarcane is lacking.

As an international effort, research is funded at two institutions in the USA to generate a genetic map of sugarcane. Both groups are using PCR technology for this purpose. The data generated in these programmes will be combined with the RFLP data which was obtained from the Cornell programme. The latter was jointly financed by Copersucar and the Hawaiian Sugar Planters Association. Presently, more than 150 markers have been placed on the map. The aim is to have eight hundred markers on the map by the end of 1994. Such a high density map should span the entire genome with no gaps of more than five centimorgans.

A very exciting prospect is the potential use of a bulk segregation analysis (BSA) to identify genetic markers. SASA will place special emphasis on the potential application of this method to obtain markers that could be emploit in our breeding programme. This aspect will therefore receive the highest priority in the short term. The project on BSA is also part of the international biotechnology programme.

SASA is involved in collaboration with the CSIR to investigate to potential use of a Bt-gene to obtain sugarcane plants that will be resistant to *Eldana*. A Bt-gene from a local *Bacillus* strain which is toxic to *Eldana*, was isolated and sequenced by the group at the CSIR. The gene was also cloned into a *Pseudomonas* strain which occurs on the sugarcane stalk. Although the transformed *Pseudomonas* express the introduced BT-gene, the level of toxicity to *Eldana* is unsatisfactory. Present studies are focused on ways to increase Bt-gene expression, and as well on the potential transfer of the Bt-gene to sugarcane.

A strong correlation between the wax composition on the surface of the sugarcane stalk and resistance to *Eldana* exists. This phenomenon and its potential application in the breeding programme will receive attention in the next year.

The tissue culture facilities and expertise at SASEX are now well established. This activity forms the backbone of the genetic engineering activity. Work is already underway to introduce both marker genes, and a "anti-sense" gene into sugarcane.

The future success or failure in the genetic engineering project on sugarcane will largely depend on the ability to direct gene expression in the target tissue at the right time. The isolation and identification of suitable promoters will therefore receive a high priority from 1994 onwards.

A solid understanding of the key reaction involved in traits such as sucrose accumulation and resistance will contribute to the isolation of the relevant genes. This will allow the transfer of specific genes without a typical sexual cross. Research on the role of key enzymes in sucrose accumulation is already underway. As more post graduate students join the group, the research in this area will be expanded.

5. CONCLUSION

The short term objectives of the biotechnology programme are to establish a firm activity to exploit the use of genetic markers to assist in the breeding and selection programme. The longer term aims include genetic manipulation of sugarcane and the characterisation of genes which are involved in the phenotypic expression of traits such as resistance, tolerance and sucrose production. At this stage the potential benefits of genetic engineering are limited to single gene controlled phenomenon.

The potential applications of biotechnology in sugarcane improvement are unlimited. Things which appear impossible at present will most probably be a reality in the future. It is therefore important to realise that any biotechnology programme is an investment for the future. It is already evident that any agricultural based industry which does not invest in biotechnology will most probably become redundant.

However, despite the importance of biotechnology it is important that its limitations should be appreciated. The most important limitation is that it is a time consuming exercise with a high technology requirement. Conservative estimates are that it takes ten years to identify and characterise a specific gene and a further five years for the introduction of such a gene into a new recipient plant.

SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION

THE USE OF AUTOMATIC WEATHER STATIONS IN IRRIGATION SCHEDULING

by

Dr Roy Mottram
Department of Agricultural Meteorology
University of the Orange Free State

INTRODUCTION

Crop production depends entirely upon the supply of resources such as water, nutrients and solar radiation. In many areas of the world and especially in Southern Africa, water is the major factor limiting crop production.

Competition for our limited water supplies is increasing. This competition does not only exist between the agricultural, municipal and industrial sectors but <u>within</u> the agricultural sector itself.

In 1989 it was reported that of the 70% of surface water resources allocated to irrigation in Southern Africa, up to 30% is lost before reaching the edge of the cropped surface. Water can and has been saved by correct scheduling of irrigation.

In recent surveys in different irrigation areas, the following problems relative to irrigation scheduling were identified:

- no accurate record of irrigation amounts
- tendency to over-irrigate
- tendency to cut short irrigation before the crops have reached maturity
- there exists little or no irrigation scheduling
- irrigation systems are not always calibrated
- the design of the irrigation system is not always suitable.

These problems are not unique in Southern Africa. Researchers have attributed the disappointing levels of performance encountered in many recently constructed irrigation schemes in developing countries to the large differences between irrigation theory and practice.

In Southern Africa, the Water Research Commission is promoting research on maximising irrigation project efficiencies.

The objectives of this paper are to:

a) Describe the simulation models used to calculate the atmospheric evaporative demand used in the water budget technique employed.

b) Examine the results of this irrigation scheduling technique.

c) Propose solutions to scheduling irrigation within irrigation areas.

METHODOLOGY

1. Automatic weather stations

Automatic weather stations (AWS) comprising of dataloggers and associated sensors, which do not require commercial power at the site, have been set up in irrigation areas around Southern Africa. Solar panels are used to supply power to those AWS and the data is either stored on magnetic tape and thereafter the data downloaded onto computer or data is accessed via direct cable link, modems and telecommunication networks.

Hourly values of incoming solar radiation, temperature, relative humidity, wind speed and direction, and rainfall are monitored by these AWS. Where there are relative humidity sensors, a wet bulb thermometer is installed.

After retrieval, these data are checked, sorted for the most recent 24 h period and merged into data archives.

2. Simulation models

Reference crop evaporation (Eo) is defined as the rate of evaporation from an extensive surface of 80 to 150 mm tall green grass of uniform height, actively growing, completely shading the ground and not short of water.

The Penman-Monteith approach is used to determine Eo. In a meeting held in FAO, Rome in 1991, a report for prediction of crop water requirements was presented. In this report unanimous agreement was reached that the Penman-Monteith equation was the best method for estimating Eo.

Equation 1 represents the Penman-Monteith equation:

$$Eo = [s(Rn-G) + Cp\rho\ (e_m(T)-e)\phi_a]/[s + \gamma\ (1 + \phi_a/\ \phi_v] \ldots\ldots \text{(Eq. 1)}$$

where

s = slope of the saturated vapour pressure vs. temperature curve (at T) (mbar $°C^{-1}$)

Rn = net radiation (mmd^{-1})

G	=	soil heat flux density (mmd^{-1})
ρ	=	density of air
Cp	=	specific heat of air
e_m	=	saturated atmospheric vapour pressure (mbar)
e	=	actual atmospheric vapour pressure (mbar)
ϕ_a	=	atmospheric conductance of gaseous exchange (function of wind speed and crop height)
ϕ_v	=	conductance of vegetative surface to gaseous water diffusion.
γ	=	psychrometric constant (mbar $°C^{-1}$).

In order to schedule irrigation it is necessary to determine the atmospheric evaporative demand (AED). By definition the AED is the water vapour transfer to the atmosphere required to sustain the energy balance of a given vegetative surface, in its present growth stage when the water status of the root zone permits unhindered plant evaporation and the water status in the top 150 mm equals its current value. It is important to note that this definition of AED acknowledges the dominant influence of the atmospheric conditions, and also basically accounts for crop type, crop growth and soil surface water content.

A programme in the crop growth simulation system, PUTU, determines the AED which can vary from 0 to 15 mmd^{-1}.

$$AED = kc.Eo$$

where,

kc	=	appropriate crop coefficient, and
Eo	=	reference crop evaporation.

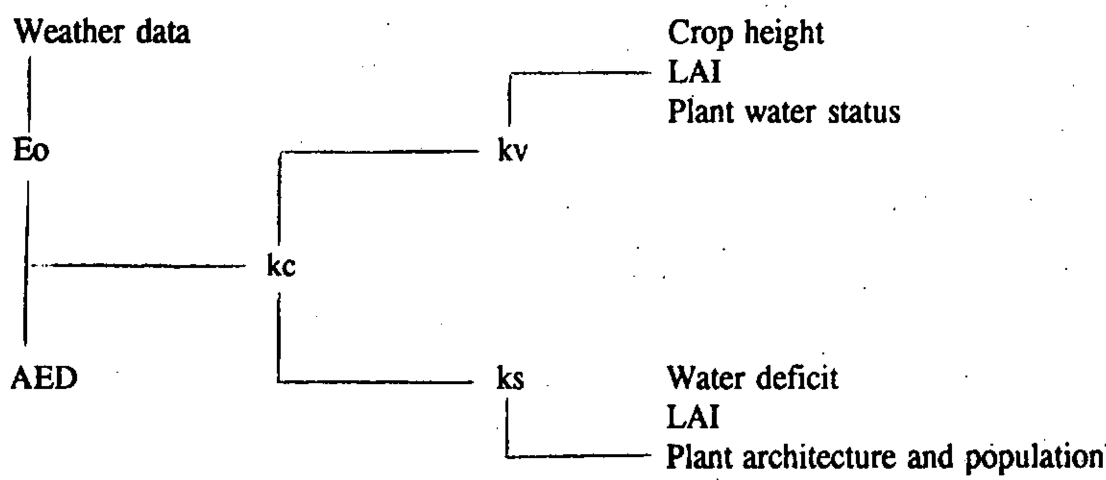
This crop coefficient kc may be defined as,

$$kc = kv + ks$$

where,

kv	=	fraction of reference crop evaporation supplied by plant evaporation
ks	=	fraction of reference crop evaporation supplied by soil evaporation.

The major problems encountered with the use of crop coefficients to determine AED stem from the failure to account for the variation in kc due to variation in the ks as the soil surface dries. PUTU computes kv, ks and kc in the manner illustrated below:



The soil water balance equation employed in PUTU is:

$$W = Wo + I + R - D + W - AED$$

where,

W	=	soil water content (mm)
Wo	=	soil water content at 24h00 (mm) (water content at end of previous day)
I	=	irrigation amount (mm)
R	=	rainfall (mm)
D	=	drainage out of the root zone (mm)
	=	change in soil water content due to root extension and capillary flow (mm)
AED	=	atmospheric evaporative demand (mm)

The inputs for PUTU are daily weather data and specific plant and soil characteristics. The programme determines the soil water balance for nine soil layers, after requesting the depth of each layer (e.g. 150 mm).

RESULTS AND DISCUSSION

Table 1 illustrates an output for AWS 11 in the Winterton area

Table 1 : Daily weather data computed from hourly weather variables collected from Station 11, Winterton

DOY	Tmax	Tmin	Rain	RADD	Eo	SVDD
168	19.8	1.4	0	11.7	2.2	16.2
169	15.4	1.3	0	10.0	2.3	14.1
170	14.9	-1.7	0	12.5	2.2	12.1
171	19.2	-1.2	0	11.3	1.8	15.0
172	21.8	4.7	0	12.5	4.5	19.5

where,

DOY = day of year
Tmax = maximum temperature (°C)
Tmin = minimum temperature (°C)
Rain = rainfall (mm)
RADD = mean incoming solar radiation (MJ d^{-1} m^{-2})
Eo = reference crop evaporation (mm)
SVDD = calculated saturated vapour pressure deficit (mbar)

Table 2 illustrates the output of PUTU for AWS 11.

Table 2 : Daily output of crop growth, water use and requirement using the simulation model, PUTU, with data from Station 11, Winterton

Farmer's Name: FREESE Land No: Grootdraai Top

Plant population:	Crop	Planting date
300 pl m^{-2}	Wheat (Gamtoos)	1-6-1990
Soil Description:		Effective rooting depth
Hutton		0,8 m
Soil water content: (mm m^{-1})	Upper limit - 263 Lower limit - 144 Initial - 248	

DOY	FW (%)	LAI (%)	IR (mm)	Rain (mm)	PERC (mm)	PPAW (%)	AED (mm)	DEF (mm)
168	0	12	0	0	0	52	0.9	26
169	0	12	6	0	0	50	1.0	27
170	0	12	5	0	0	59	1.0	22
171	0	12	0	0	0	66	1.1	18
172	0	14	0	0	0	61	2.6	21

where,

FW	=	water stress factor (0-100)
LAI	=	leaf area index (%)
IR	=	irrigation amount (mm)
PERC	=	drainage out of root zone (mm)
PPAW	=	relative (profile) plant available water (%)
AED	=	atmospheric evaporative demand (mm)
DEF	=	water deficit below the upper limit (mm)
	=	maximum amount of water required (mm)

The water stress factor FW, is determined by iteration process for each day, climate and soil condition. It is expressed as a fraction of physiological water stress existing in the crop.

The water deficit below the upper limit DEF, is the amount of water required to replenish the soil profile (rooting zone). Should the irrigator not irrigate on the planned day, the water budget will continue using the near real time weather data until such time as he is able to do so. The FW value must be examined each day during this delay to avoid imposing a stress on the crop. Monitoring FW is vital when practising deficit irrigation.

Water management trials using PUTU were conducted on selected farms in the Winterton area. These involved running the model for each irrigation system and comparing the crop yields with the surrounding farms/lands in each case. Table 3 illustrates the benefit of irrigation scheduling using the PUTU system.

Table 3 : Crop yields obtained using PUTU as compared to the mean yield of surrounding areas/lands in the Winterton area

Farm	Season	Crop	PUTU		Surrounding area - crop yield (kg ha^{-1})
			Crop yield (kg ha^{-1})	Water applied (mm)	
A Muirhead	89/90	Soyabeans	2950	680	1800-2300
J Muirhead	89/90	Soyabeans	2700	680	1800-2300
D Sclanders	89/90	Maize	9800	740	7800
J Muirhead	90	Wheat	6100	420	4000-4900
L Freese	90	Wheat	6500	420	4000-4900

No comparisons could be made with the water used by the surrounding areas as no irrigation amounts are recorded by the irrigators and many of the irrigation systems need calibrating to ensure even water application.

It is as a result of these economic yield increases that the Winterton irrigation boards are currently using these techniques to allocate water to their members.

CONCLUSIONS

Automatic weather stations enable a computerised weather network to be established in order that data may be collected, collated and crop water use values disseminated in sufficient time to enable the irrigator to react before crop water stress prevails and yield reductions are subsequently incurred.

The simulation models and programmes used in the IPE project have proved successful in the Winterton and Reitz areas during the past with profitable results to the irrigator. The operation of these models is relatively simple providing the operator has basic hands-on computer knowledge and experience. However, before irrigators can use these models themselves, they must understand the basics of water budget scheduling and be able to develop a normal year irrigation schedule as a planning tool.

Efficient use of water is dependent upon both good irrigation scheduling and being able to apply irrigation water uniformly. It is proposed that consultants are involved in the different irrigation districts to set up and operate an irrigation scheduling programme for their irrigators, to set up AWS and to implement irrigation system evaluation programmes.

SOUTH AFRICAN SUGAR INDUSTRY AGRONOMIST ASSOCIATION
October 1992

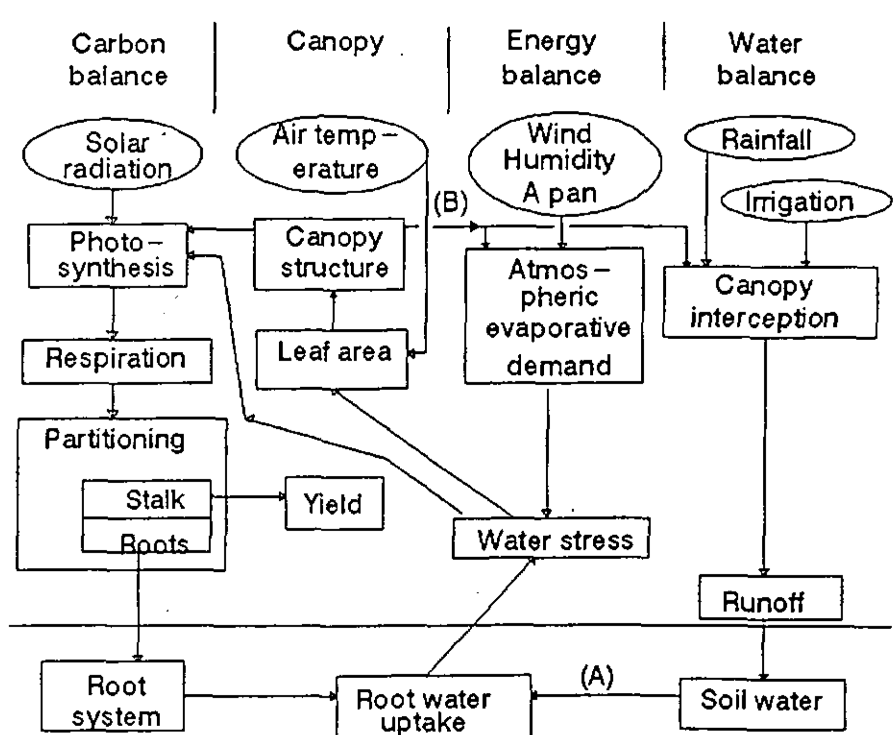
Sugar-cane modelling research
Geoff Bamber

Computer models are now part of everyday life. The stock market, the insurance industry, the weather forecast and space exploration could not operate without them. What about agriculture ? In many ways biological systems are far more complex than those already mentioned but scientists are always inspired by difficult tasks and many have devoted their lives to building models of farm crops.

What is a model
Crop models, like the scale models of aircraft, are imitations and simplifications of the real thing. The components are mathematical equations rather than moulded plastic. A simple model that has been used effectively in our sugar industry is the 9 tons of cane per 100 mm water rule. Other simple conversions of sun energy to crop growth have been measured and used on occasions.

The Experiment Station became serious about crop modelling in 1987 and we now have a model that is best described by the following flow chart. This model effectively condenses the information contained in hundreds of papers and dissertations into a working replica of the real crop.

Flow chart of CANEGRO, August 1992

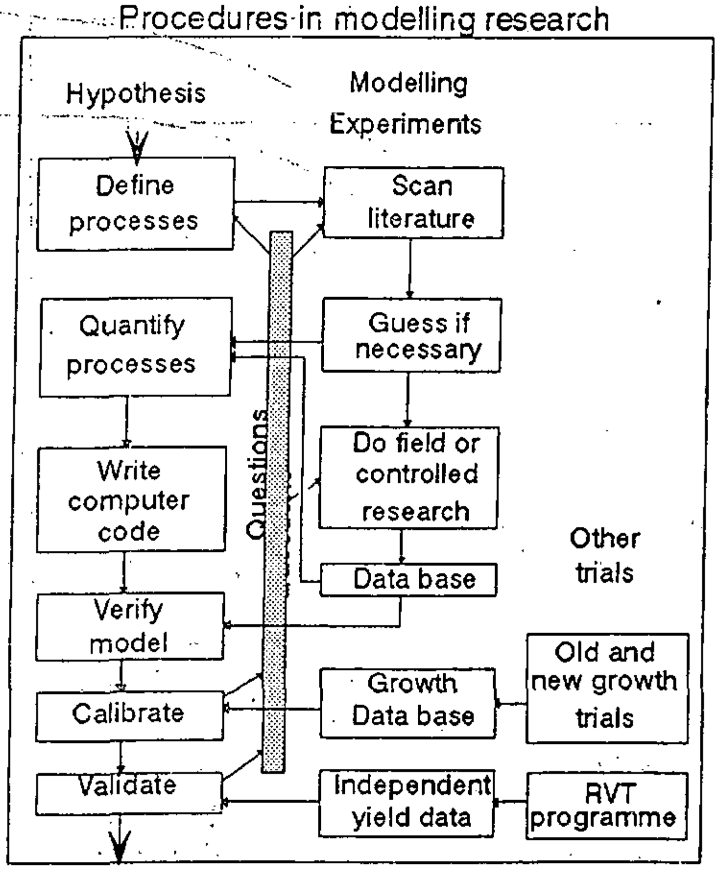


The above chart shows that carbon, energy and water are accounted for in three separated balances or budgets. The important exchanges between these balances occur at the root/soil water interface (A) and the canopy/atmosphere interface (B). Water stress occurs when the amount of water required to balance the energy budget exceeds the amount that the roots can absorb. The canopy is involved in all three balances.

How is a model built ?

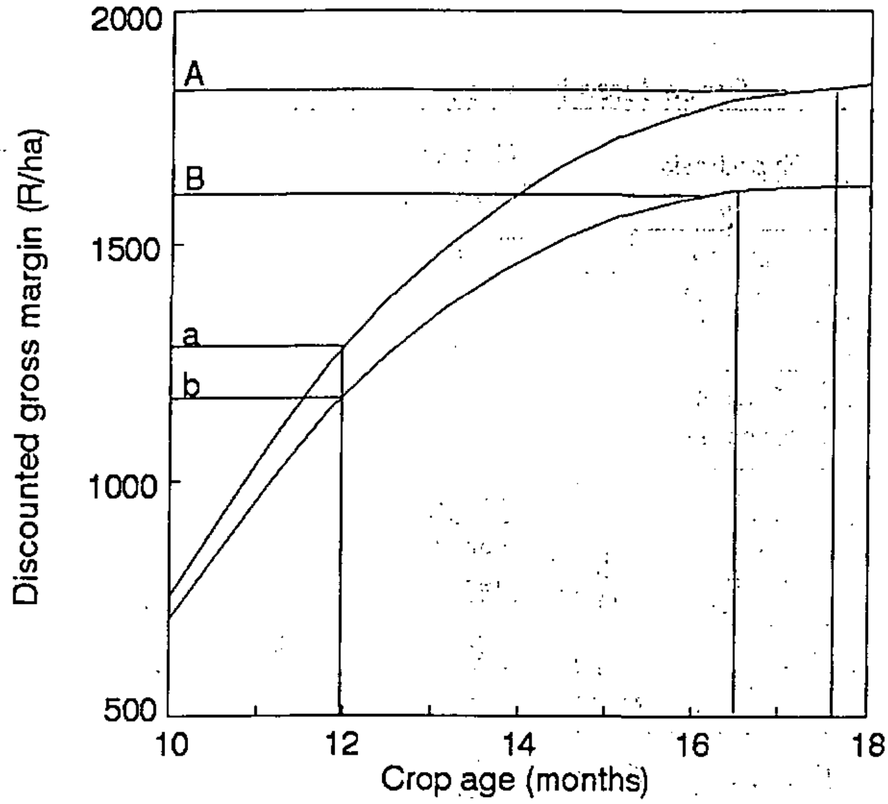
One great advantage of the crop modelling discipline is that it facilitates communication between scientists. The model presently in use is made from components obtained from all over the world. The water balance comes from a modelling team at Michigan State University. The photosynthesis routine was built by a group of American and Dutch scientists and the energy balance is based mainly on the work of British scientists. These scientists may know little about sugar-cane but the principles of crop growth are the same everywhere. Our contribution was to study the work of these people to see how it could be adapted for our own sugar-cane crop and then to research the unknown areas and supply the relevant information. The following diagram illustrates the procedure that we have been and are still following.

Procedures in modelling research



This procedure is being use by the International Benchmark Sites Network for Agro-Technology Transfer (IBSNAT) project. As the name implies, this project was conceived as a means of coordinating the work of crop and soil scientists in the US and elsewhere, in order to facilitate the transfer of technology between sites particularly to those in the developing world. Standard procedures for collecting soil and climate data have been developed and computer models are serving as conduits for the transfer of technology. Our model has recently been reviewed by some key people in the project and they have now incorporated it as the sugar-cane option together with other crop options.

What use is a model ?
This of course is the first not the last question to ask when contemplating modelling research. For us the need to model sugarcane arose when we started recommending that growers reduce the age at harvest to prevent eldana damage. Some people thought that this would increase cane productivity and others thought the opposite, regardless of eldana. The results of past experiments provided no easy answers and clearly we did not have time or resources to compare different crop cycles in different regions. Within 18 months we had a model that explained all the existing growth data of NCo376 reasonably well. Four papers were published including one which provided the following economic assessment for crops on the north coast.



Simulated effect of harvest age on gross margin.
Variety: NCo376 Soil: Swartland form
Region: Tongaat Flowering and eldana absent

If the economic and agronomic conditions assumed were correct R 435 and R 550 would be lost by cutting at 12 months instead of the optimum ages of 16.5 and 17.5 months for the low and high interest rates respectively.

The model has been used for many other purposes including:
1) Determining the yield potential of new areas.
2) Providing yield potential estimates for the variety recommendation package.
3) Providing a comparison for field records in order to focus attention on field or management problems.

4) Providing an objective assessment of the effects of soil and weather on the current state of the crop for the purpose of yield estimates.
5) Prediction of savings to be achieved with deficit irrigation. This is a method of irrigation which keeps the soil as dry as possible without materially reducing yields.
6) Prediction of stress probabilities for dam and canal design.

Some examples of the usefulness of the modelling research are given below.

1) Specialist Advisory Report UF 14 of 9/8/89.
Yield potentials were determined for the Ntondweni region of KwaZulu near Umfolozi. The project received FAF funding on the basis of this report and the area now supplies a large proportion of the cane received by the Umfolozi Mill.

2) Specialist Advisory Report SC 8 of 24/10/89.
The estimated benefit of replacing NCo376 with N12 or N16 on an estate on the south coast was as high as R320 per hectare. The company has responded to the recommendation and reports favourably on the performance of the newer varieties.

3) A paper presented to the 1991 national irrigation symposium illustrated the use of the model in helping to save irrigation water. Several simulation of this kind indicate that an average of about 250 mm water per annum can be saved without a loss in yield.

4) Specialist Advisory Report LSC 15 of 17/4/90.
For this request the model was used together with good field records to identify some problems on the estate. We showed that cane yields were declining 1.6 t/ha/an each year since 1984 for reasons other than the weather, varieties or the harvest cycle. Yields were also declining 3 t/ha/an per ratoon. We could also show that the economic optimum harvest age was between 15 and 20 months.

Future plans.
Research will be done to improve important parts of the model and to add new parts to cater for more factors. Poorly drained soils and ripeners are two factors that are now receiving attention.

This year an American Fulbright scholar is working at Natal University to link our modeling research with the comprehensive hydrology research programme (called ACRU) under the leadership of Professor RE Schulze. The links with IBSNAT and ACRU raise some exciting prospects for national and international cooperation. Some of the envisaged benefits of these links are:

1) Ability to simulate the effects of whole catchment management on cane production.
2) Ability to do 'what if' studies involving dams and canals.
3) Mixed farming simulation.
4) Direct improvements to our cane model flowing from international research.
5) Estimating the effects of global climate change on the sugar industry.