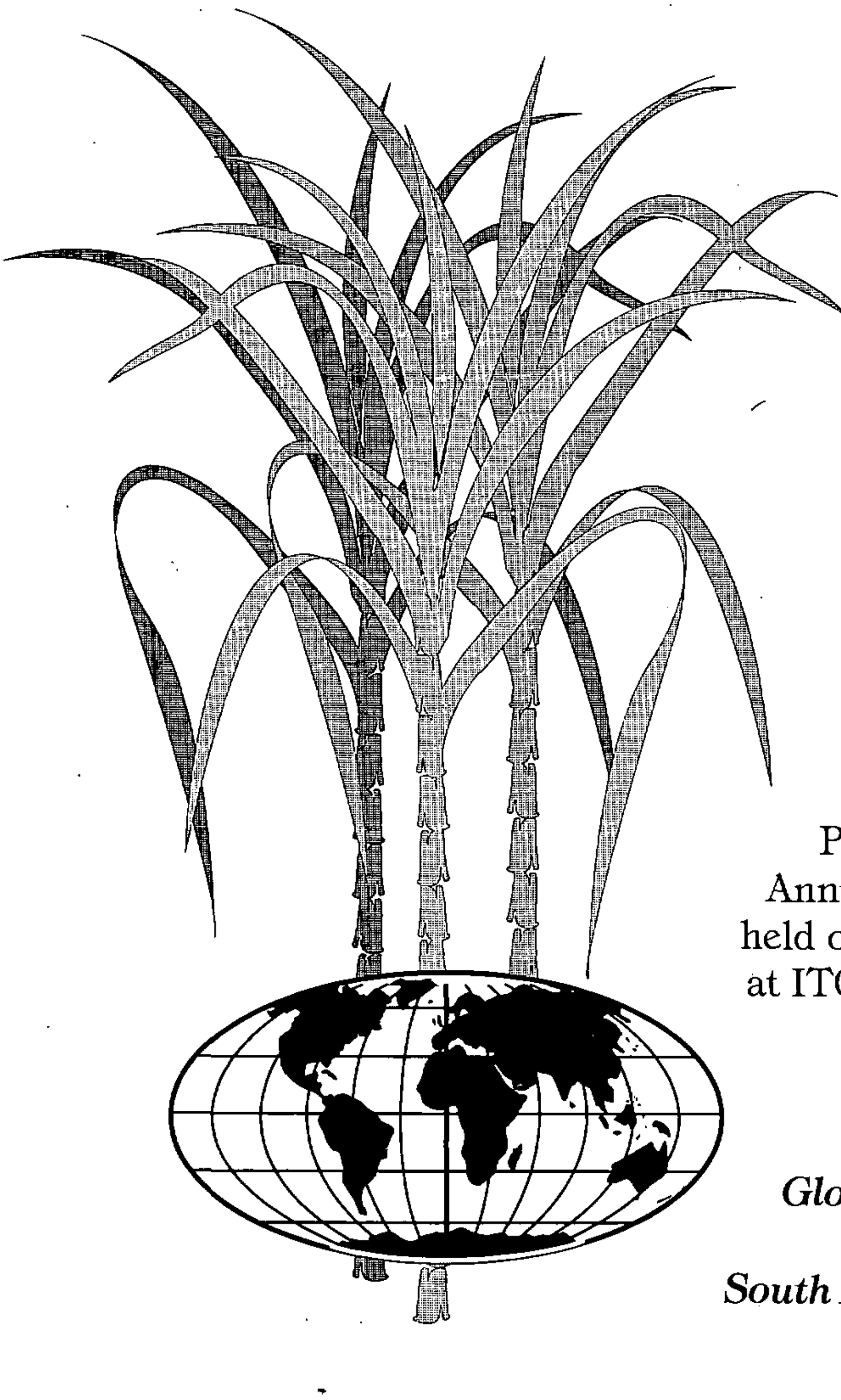
SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION



Proceedings of the
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held on 18 November 1999
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THEME:
Global Competitiveness
of the
South African Sugar Industry

R A Donaldson

SOUTH AFRICAN SUGAR INDUSTRY AGRONOMISTS' ASSOCIATION

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THE IMPACT OF CANE QUALITY ON THE SOUTH AFRICAN SUGAR INDUSTRY'S COMPETITIVENESS

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1. Introduction

In the latter half of 1995 the South African Sugar Industry embarked on a self-review process to identify factors, which could contribute to improving the competitiveness of the Industry. As a start to this process, LMC International (LMC) was appointed to do a Strategic Review of the Industry. Their conclusions were published in a final report to the Industry in January 1996. Apart from several other conclusions, the LMC Report identified that an improvement in cane quality delivered by South African growers could significantly enhance the efficiency and competitiveness of the South African Sugar Industry. The issues identified by LMC were investigated by a number of Task Groups appointed by the South African Sugar Association (SASA) and final recommendations were made to the Industry's Strategy Group in April 1999.

In writing this paper I have used information and data developed by SASA's Cane Quality Task Group (CQTG) as well as data contained in the LMC Report. For the permission granted to use this information I would like to record my thanks to the Chairman and members of SASA's Cane Quality Task Group as well as Dr James Fry of LMC International. At the same time I would like to acknowledge the significant effort and contribution made to the Industry's cane quality drive over the past three years by my colleagues at the South African Cane Growers' Association (CANEGROWERS), Graham Moor and Quinton Hildebrand.

2. The Search for an Effective Cane Quality System

When the CQTG commenced its deliberations in June 1996, it was tempting to conclude that a change to the Industry's cane payment system would achieve significant improvements in cane quality. However, Growers were quick to point out that certain material influences on cane quality were beyond their control and that more than a change to the payment system would be necessary to achieve the Industry's objectives. It is for this reason that reference is made to a "cane quality system" which encompasses both the proposed change to the cane payment system as well as the resolution of certain "linked issues" in each specific mill area.

2.1. A"stricter" Industrial Cane Payment System

The CQTG's objective was to find a cane payment system that would create incentives for individual growers to improve the quality of cane delivered to mills for crushing. This was seen as the first step in achieving significant cost effective improvements in sugar production for the Industry and thus enabling an improvement in its competitive position. The existing sucrose cane payment system and its application under the Industry's division of proceeds arrangements has failed to achieve this – under sucrose payment, an incentive is created for growers to focus on maximising the quantity, rather than the quality, of sucrose produced.

After detailed investigation of various payment mechanisms, the CQTG recommended that an industrial cane payment system based on the Estimated Recoverable Crystal (ERC) content of cane be implemented. ERC was later substituted with Recoverable Value (RV), which the members of the CQTG subsequently accepted as the fairest measure of cane quality, given South African growing conditions and the Industry's proceeds sharing arrangements.

The concept of RV was developed at CANEGROWERS by Tim Murray, who is a grower in the Noodsberg area and a member of the Executive Committee of CANEGROWERS. It is an adaptation of the ERC formula, which penalises the grower for the presence of non-sucrose and fibre in cane. The first difference with RV is that the penalty in relation to the presence of non-sucrose in cane is discounted for the relative value of sucrose which each unit of non-sucrose diverts to molasses production. The motivation for this is that in our Industry, growers and millers share in the value of both sugar and molasses – in the event that the value of molasses increases, ERC would not accurately capture the enhanced value of the non-sucrose in the cane. The second difference with RV is that undetermined losses of sucrose in the milling process are not ascribed to the level of sucrose content in cane – these losses are accounted for in the industry average overall recovery of sugar from RV delivered in the RV cane payment formula. The RV % Cane formula and the industrial RV cane payment formula are set out in more detail in Annex 1.

The impact of the RV formula on growers is that growing proceeds in the Industry are distributed amongst growers according to the tons RV, as opposed to Sucrose, produced. Annex 2 shows the impact of this redistribution of grower proceeds on the various grower groups for the historic cane quality levels achieved during the 1996/97 and 1997/98 seasons. It is important to note that Annex 2 looks at historic cane quality achieved under a sucrose cane payment system and does not take into account any improvements in cane quality that would result from the incentives created by an RV cane payment system. Furthermore, the extent of the historic gain or loss is representative of the average cane quality producer (grower) in each one of the mill areas – individual growers in each mill area could be greater gainers or losers.

Millers will also be affected by the RV cane payment system in that they will end up paying their growers a different price for their cane. The improvements in cane quality that can be made by growers is dependent on two factors – firstly, the natural growing conditions, and secondly, the effectiveness of cane farming practices and management. Therefore, millers who have mills situated in good growing areas are likely to pay more for their cane than those who have mills situated in poorer growing areas. However, management plays an important role and can make a significant contribution to an improvement in cane quality.

2.2. The "Linked Issues"

Growers have argued strongly that a change to the cane payment system alone is not in their interests. Their concern is that there are certain factors beyond their control which can influence the quality of their cane – if they have no control over these their efforts and costs incurred in improving cane quality could be in vain, or the benefits thereof will be inequitably distributed between millers and growers. These factors are known as the "linked issues and are discussed in more detail below.

2.2.1 Length of Milling Season

The first "linked issue" that growers have a concern over is that of the length of the milling season. After the removal of the pools quota system in 1994 the Sugar Industry Legislation was amended in such a way that it gave millers the sole right to determine the extent of the cane supply for their mills. This has not only placed the control of expansion of the Industry in their hands but it has also increased the incentive for them to chase cane without installing additional milling capacity. The threat for existing growers of new growers entering the Industry is that this could result in an extension of the milling season and a dilution of their cane price.

The extension of the milling season means that the existing grower has to deliver his/her fixed cane production over a longer period. With the relative sucrose (or RV) cane payment system, this exposes a greater portion of the individual grower's total deliveries to the low ends of the sucrose (or RV) curve at both the beginning and end of the season. With RV, the impact of an extended season is greater than under Sucrose because the RV curve is steeper at these positions on the curve.

On many occasions Growers have been reminded of the benefits and efficiencies for the Industry of high levels of milling capacity utilisation. This is indeed true when one looks at the impact of long milling seasons on the total growing and milling sectors. The longer the milling season, the more sugar produced, and the proceeds earned from the additional sugar production are equitably divided amongst the sectors according to their percentage shares in the Industry's net divisible proceeds. However, for the existing individual grower, who is unable to expand cane production, it comes at a substantial cost. It results in a reduction of his/her cane quality and, with new growers entering the Industry, growers' total proceeds have to be divided amongst more tons of sucrose (or RV) produced resulting in a diluted Sucrose (or RV) price.

In its deliberations, the CQTG agreed that there was a need to control the length of the milling season. It was recommended that this be dealt with at each mill area in the form of a local length of milling season agreement between the miller and the growers. A principle was established by the CQTG that these agreements should contain incentives that encourage both parties to the optimum length of season, taking into account the benefits and costs of both the mill and the average individual grower as if they were a single business entity. Furthermore, any party causing an extension of the agreed optimum length of milling season should compensate the affected party for their losses on an agreed basis.

2.2.2 Harvest to Crush Delays (HTCD) – Sucrose deterioration

The second "linked issue" that growers raise as a concern is the deterioration of sucrose (or RV) caused by mill yard delays. The RV cane payment system does create incentives for growers to reduce the levels of non-sucrose in cane. A reduction in the delay between harvesting and crushing reduces non-sucrose levels and most certainly contributes significantly to an improvement in cane quality – a closer examination of Table 1 below will show that a reduction in delays is a major contributor to improved cane quality.

Growers have argued that their control of harvest to crush delays ends at the weighbridge of the mill and that beyond that, the miller is responsible for delays in the mill yard up to the point where the cane is tested for its quality content. Growers who deliver to mills with efficient mill yards would therefore have an unfair advantage over those delivering to mills with time delays in the mill yard.

The CQTG recognised the impact of mill yard delays on cane quality and it was proposed to examine this problem at each mill area and introduce controls (if necessary), which would create incentives for both millers and growers to reduce harvest to crush delays.

2.2.3 Reduction of Ash (Soil) levels in Cane

In the formulation of the RV cane payment system, Millers have also raised some concerns. They point out that the RV cane payment system will not create incentives for growers to reduce Ash (Soil) levels in cane delivered to their mills. Ash is measured as part of Fibre content in cane and the penalty factor attributable to Fibre levels in cane is too insignificant – the "c" factor in the RV formula has a value of approximately 0.018.

This argument has been accepted and the CQTG has proposed that an Ash Reduction Scheme be introduced at each mill which will penalise high Ash levels in cane. The benefits of Ash reduction are significant - a 50% reduction in Ash levels is estimated to result in approximately R30 million savings in mill maintenance costs for the milling sector. Millers have indicated that they are prepared to share these savings on an equitable basis with their growers at the local level.

3. Status of the proposed Cane Quality System

It is pleasing to be able to say that the Industry is on the brink of achieving the implementation of the proposed Cane Quality System. During the past two years growers and millers in all mill areas have been constructively engaged in local negotiations to find workable and fair solutions to the "linked issues". It is has taken a huge effort and dedication by both parties to compromise and find solutions to problems like the length of milling season, which has been the subject of continued confrontation for as long as 60 years. As recently as last week growers and millers in all mill areas (except one) have reached agreement on the main principles that will govern the local arrangements on length of milling season, harvest to crush delays, ash reduction schemes and cane rejection criteria. The process of legally drafting these principles into Local Area Agreements is already underway.

The successful conclusion of these local negotiations has enabled the Industry to be in a position to take a decision on implementing the new RV industrial cane payment system with effect from 1 April 2000.

4. Analysis of Benefits and Costs of the proposed Cane Quality System

4.1 Enhanced Industry Proceeds – Benefits of improved Cane Quality

In order to quantify the benefits of improved cane quality, a team of technical specialists from SASA did an exercise to assess the impact on sugar production as a result of achievable improvements in cane quality. These included the removal of soil from cane, optimal topping of cane, removal of more trash from cane, and a reduction in harvest to crush delays. Table 1 below shows the progressive effect on the Industry's average cane quality as each improvement is introduced.

Table 1 : Improvements in Cane Quality for successive reductions in extraneous matter and harvest to crush delays

Condition of Cane Quality	Tons Cane	Suc %	Tons Suc	N-Suc %	Tons N-Suc	Fibre %	Tons Fibre	ERC %	Tons Sugar
Original	100.0	12.55%	12.55	2.27%	2.27	14.94%	14.94	10.80%	10.80
less Soil Ash by 0.5 unit %	99.5	12.61%	12.55	2.28%	2.27	14.51%	14.44	10.86%	10.81
less Trash by 1 unit %	98.5	12.74%	12.55	2.28%	2.25	14.15%	13.94	10.99%	10.83
less Tops by 2.5 units %	96.0	13.04%	12.52	2.18%	2.09	14.26%	13.69	11.34%	10.89
less Delays by 1.5 days	97.5	13.04%	12.71	1.95%	1.90	14.04%	13.69	11.46%	11.17
Improvements	-2.50%		1.27%		-16.30%		-8.37%		3.43%

From Table 1 it can be concluded that the above improvements in cane quality are estimated to result in the following efficiencies for the Industry:

Reduction in Cane mass	=	2.5%
Increase in mass of Sucrose	=	1.3%
Increase in mass of Sugar	=	3.4%

The investigation also showed that with greater improvements in harvest to crush delays (3 days as opposed to 1.5 days) the increase in the mass of sugar produced by the Industry could be as high as + 6.1%. This would however be difficult to achieve and would require significant changes to harvesting and delivery systems which might be too costly for the Industry.

In calculating the value of the perceived cane quality improvements for the Industry it is important to note that any increased sugar production would need to be exported at prevailing world market prices. This means that, apart from the actual extent of additional sugar production achieved, the level of the world market price and the R/$ exchange rate are the main drivers in calculating the financial value of the resulting additional proceeds for the Industry. Table 2 below shows the value of additional proceeds that could be earned by the Industry at various levels of improved cane quality (increased sugar production) and world market prices.

Table 2 : Additional Industry Proceeds in Rands resulting from various levels of Cane Quality and World Market Sugar Prices

Increase in Sugar Prodn	World Market Prices in USc/lb				
	7.00	8.00	9.00	10.00	11.00
2.0%	45,556,268	52,064,306	58,572,344	65,080,382	71,588,421
2.5%	56,945,335	65,080,382	73,215,430	81,350,478	89,485,526
3.0%	68,334,402	78,096,459	87,858,516	97,620,574	107,382,631
3.4%	77,445,655	88,509,320	99,572,985	110,636,650	121,700,315
3.5%	79,723,468	91,112,535	102,501,602	113,890,669	125,279,736
4.0%	91,112,535	104,128,612	117,144,688	130,160,765	143,176,841
4.5%	102,501,602	117,144,688	131,787,774	146,430,860	161,073,946

Note: Increases in sugar production are measured off a normal crop of 2.4 mil tons
An exchange rate of R6.15 to the $ has been applied in converting World Market Prices to Rands.

4.2 Cost of Production - the Costs/Savings associated with improved Cane Quality

In assessing the costs and savings associated with the production of improved cane quality and increased sugar production, growers and millers have done separate evaluations. It is important to note that this exercise is an extremely sensitive one for both growers and millers. The results of such evaluations are likely to be taken into account as an adjustment to the respective milling and growing sector's shares in net divisible proceeds in the final negotiation of the implementation of the new cane quality system and other proposed strategic changes to the Industry. It is therefore reasonable to conclude that the costs and savings as presented by growers and millers are to a certain degree biased and that, under such circumstances, there is an incentive for both parties to overstate costs and understate savings.

On the growing side, the South African Cane Growers' Association (SACGA) designed a grower cost survey to ascertain the increased costs and savings associated with farming for RV as opposed to Sucrose. The survey was conducted in all mill areas on a relatively small sample of growers and was designed to capture ongoing costs incurred in improving cane quality. Costs of a capital nature (once-off costs) were excluded from the analysis. The size of the sample was limited due to time constraints but included a representative sample of large-scale and small-scale growers, as well as miller-cum-planter estates. There was also a reasonable attempt made in achieving a representative sample of growers harvesting techniques and their distances from the mills. Table 3 sets out a summary of the results of the survey which shows that, in moving to an RV cane payment system, growers expected their costs to increase by R1.53 per ton of cane.

Table 3 : Grower Cost Analysis

	Grower Regions						Industry Weighted Average
	South Coast	North Coast	Midlands	Zululand	Tugela	Mp'langa	
Area under Cane (ha)	69,323	83,300	78,192	73,475	81,037	33,219	418,546
Tons Cane	3,519,236	3,581,922	4,476,271	4,390,468	3,844,479	3,117,948	22,930,324
Tons Cane Sampled							2,248,485
% Cane Sampled							9.8%
Additional Ripener	R 0.24	R 0.25	R 0.15	R 0.46	R 0.36	R 0.24	R 0.28
Lower Topping	R 0.67	R 0.85	R 0.68	R 0.86	R 0.58	R 0.94	R 0.75
Decrease HTCD	*R 0.56*	*R 0.68*	*R 0.89*	*R 0.39*	*R 0.50*	R 0.48	R 0.59
Overtime	R 0.10	R 0.08	R 0.25	R 0.19	R 0.20	R 0.20	R 0.17
Other				R 0.04			R 0.01
less: Cane Tpt Savings	R 0.34	R 0.21	R 0.14	R 0.29	R 0.22	R 0.54	R 0.27
Total Net Cost (R/t/cane)	R 1.23	R 1.65	R 1.83	R 1.65	R 1.42	R 1.32	R 1.53

The analysis of milling costs and savings was undertaken separately by three of the four milling organisations in the Industry – Union Co-operative chose not to partake in this exercise. Table 4 below is a summary of the three milling companies' cost submissions – individual mills' costs have been consolidated into industry averages of those pertaining to raw mills and back-end refineries so as not to breach confidentiality.

Table 4 : Miller Cost Analysis

	Raw Mills	Back-end Refineries	Industry Weighted Average
Tons Cane	15,150,000	7,400,000	22,550,000
Additional Raw Mill Fuel Costs	R 0.32	R 0.71	R 0.45
Additional Fuel for off-crop Refining		R 0.31	R 0.10
Additional Raw Storage Costs for off-crop Refining	R 0.10	R 0.22	R 0.14
Additional Sugar Storage Costs	R 0.03		R 0.02
Cash Flow implications	R 0.25	R 0.16	R 0.22
Operational Cost Savings	R 0.01		R 0.01
Total Net Cost (R/t/cane)	R 0.69	R 1.40	R 0.92

4.3 Other Benefits and Costs associated with the new Cane Quality System

In addition to the costs and benefits identified in items 4.1 and 4.2 above there are others that need to be accounted for in analysing the total impact of the cane quality system on the Industry's efficiency.

Molasses production will be affected by a reduction of approximately 4 to 5% - this represents a decrease of between 30 000 to 40 000 tons which will impact on molasses export proceeds. The current value of molasses on the world market is severely depressed and currently the Industry suffers a loss per ton exported. However, it is more appropriate to use a more long-term value in accounting for this impact – for the purpose of this analysis a value of R 100 per ton is more representative of a normalised situation. At this value per ton of exported molasses, the impact of the cane quality system on molasses proceeds is a decrease in proceeds of between R3 mil to R4 mil for the Industry.

An increase in sugar production will mean that the additional 81 600 tons of sugar will need to be transported to the port – the current average export sugar transport cost is approximately R 53 per ton. Fobbing costs will also be incurred at the port - the average variable fobbing cost per ton of sugar is in the region of R 25 per ton of sugar exported. The industry will therefore incur an additional R4,3 mil in sugar transport costs and another R2 mil on fobbing costs.

4.4 Summary of estimated Industry Benefits and Costs resulting from the adoption of the proposed Cane Quality System

The schedule below reflects a summary of the estimated total net benefit for the Industry of the cane quality system.

	Current Ind	New Ind	Variance	
Impact on Production			tons	%
Tons Cane	21,840,000	**21,292,128**	-547,872	-2.5%
Tons Sucrose	2,740,920	**2,776,493**	35,573	1.3%
Tons Sugar	2,400,000	**2,481,600**	81,600	3.4%
Tons Molasses	873,600	**836,781**	-36,819	-4.2%

	World Market - Sugar Prices in USc/lb			
	@ 10 USc/lb	@ 9 USc/lb	@ 8 USc/lb	@ 7 USc/lb
Proceeds				
Inc Export Sugar Proceeds	110.6	99.6	88.5	77.4
Dec Molasses Proceeds	-3.7	-3.7	-3.7	-3.7
Impact on Ind Proceeds (R mil)	**106.9**	**95.9**	**84.8**	**73.7**
Industry Costs				
Increased Sug Tpt Costs	4.3	4.3	4.3	4.3
Increased Fobbing Costs	2.0	2.0	2.0	2.0
Impact on Ind Costs (R mil)	**6.4**	**6.4**	**6.4**	**6.4**
Production Costs				
Inc Growers' Costs	32.6	32.6	32.6	32.6
Inc Millers' Costs	19.7	19.7	19.7	19.7
Impact on Prodn Costs (R mil)	**52.2**	**52.2**	**52.2**	**52.2**
TOTAL IMPACT OF CQS (R mil)	**48.3**	**37.3**	**26.2**	**15.2**
Growers' Share @ 64.4337%	31.1	24.0	16.9	9.8
Millers' Share @ 35.5663%	17.2	13.3	9.3	5.4

5 Analysis of the improvement of SA Industry's World Competitiveness

In order to assess the improvement of the South African Sugar Industry's world competitiveness one can compare the Industry's field and factory performance, before and after the implementation of the cane quality system, with that of other major sugar producing industries. It is important to note that the performance after the implementation of the cane quality system is an estimate at this point in time.

The performance statistics of the other sugar industries are those that appear in LMC's final report.

5.1 Field Performance

Field performance can be measured in a number of ways. In Diagrams 1, 2, 3 and 4 below, the Industry's field performance indicators (under Sucrose and under RV) are compared with those of other industries. This comparison shows the following:

-Improvement in Sucrose Yield (per ha under cane) from 6.4 to 6.5 tons.
-Improvement in Sucrose Yield (per ha harvested) from 9.0 to 9.2 tons.

-Improvement in Sugar Yield (per ha under cane) from 5.8 to 6.0 tons.
-Improvement in Sugar Yield (per ha harvested) from 8.1 to 8.4 tons.

Diagram1

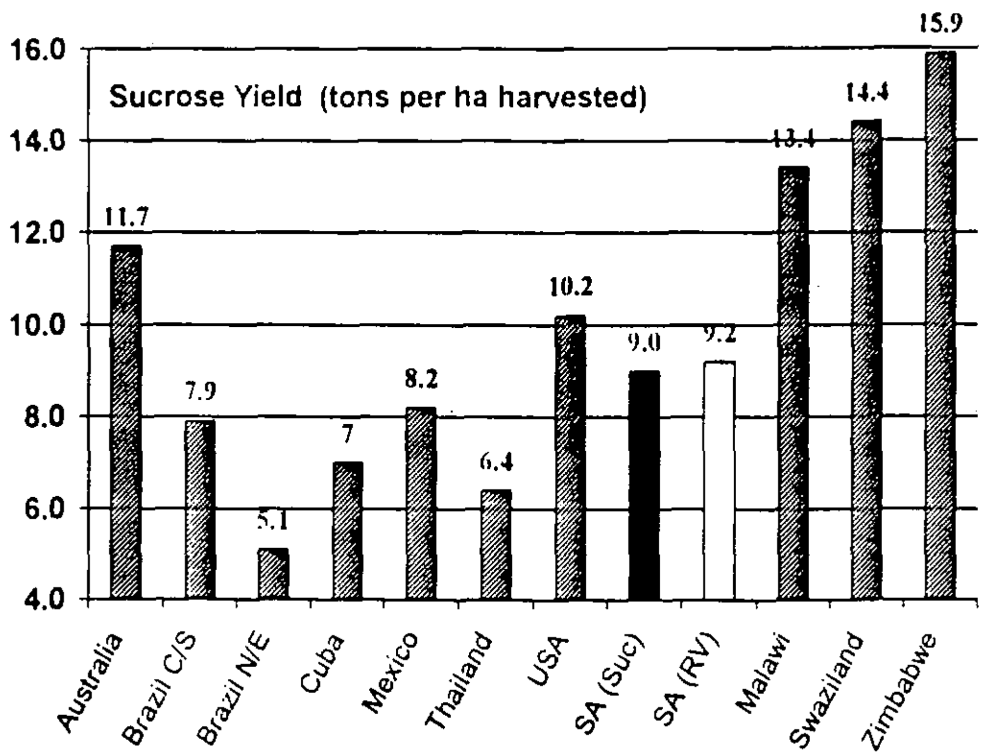


Diagram 2

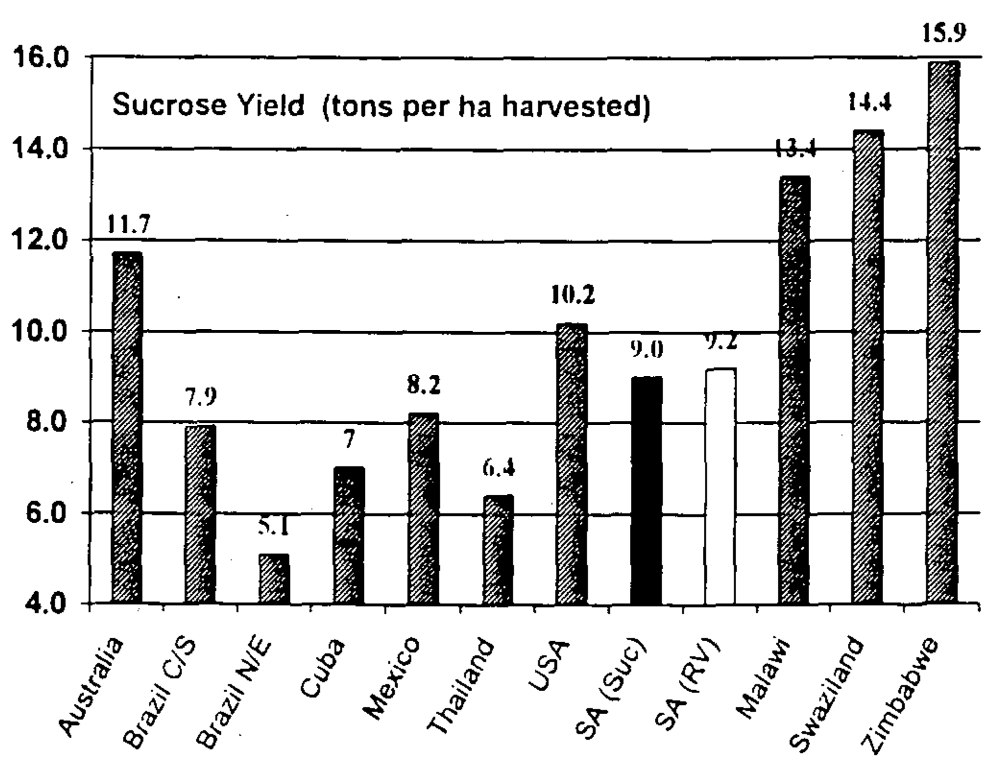


Diagram 3

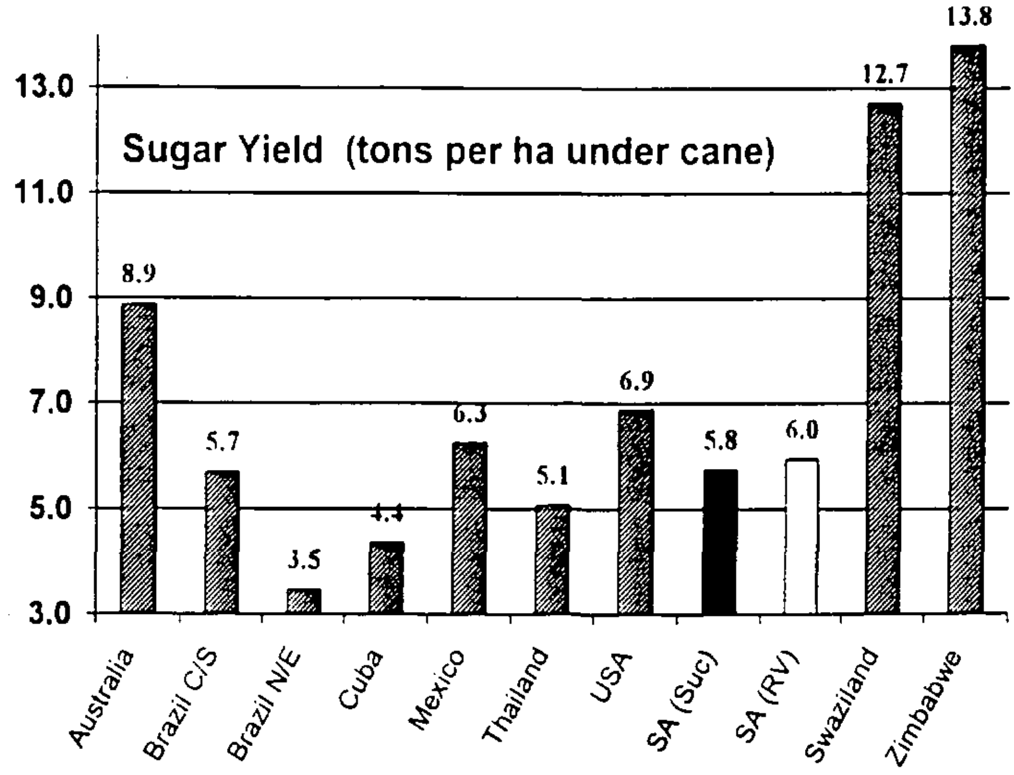
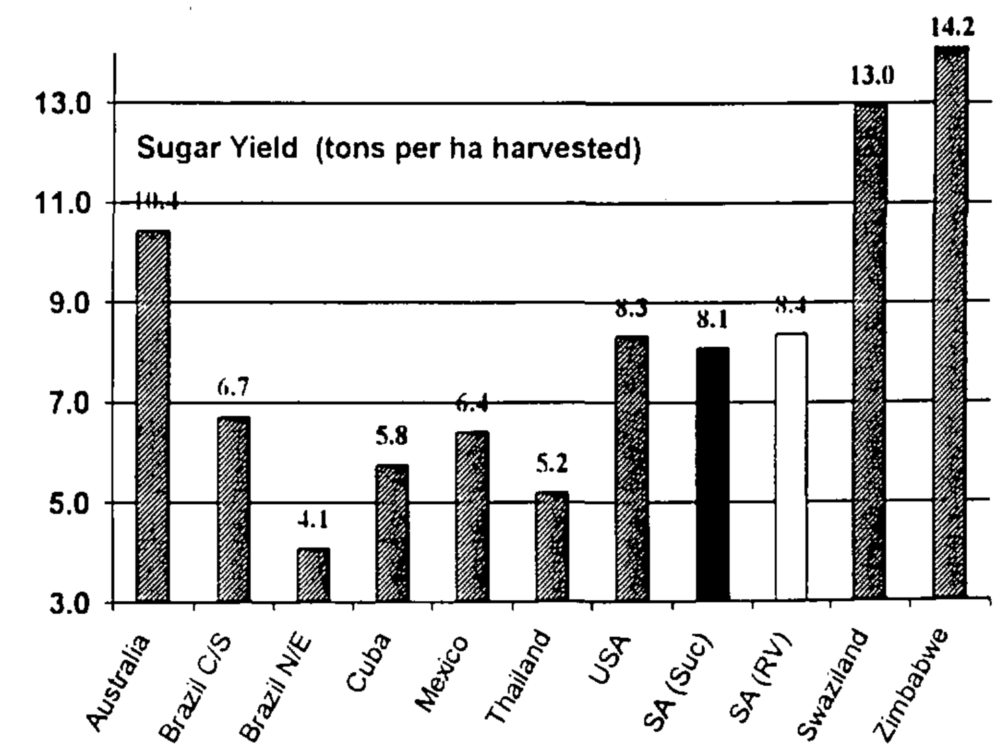


Diagram 4



It is interesting to note that cane yields will come down by approximately 2.5% as a result of the cane quality system. This is mainly as a result of the incentives created by the system to top cane lower. The result is that the length of milling season will be reduced - this creates an opportunity for the miller to fill up this additional capacity with additional cane supply. This will however be controlled via the local length of milling season agreements so as to avoid growers being compromised.

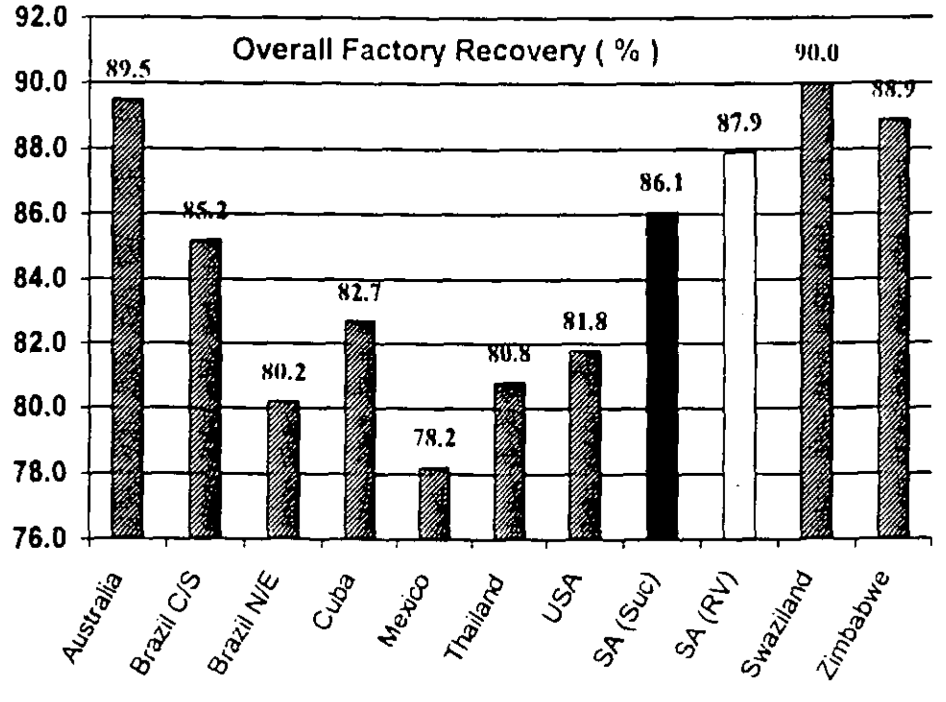
Field performance will improve under the proposed cane quality system. This is most noticeable when one looks at the improvement in sugar yields per hectare. However, the relative position of the Industry's field performance in comparison to other sugar industries will not improve materially.

In comparing field performance with other industries, there are two factors that place the South African Industry in an unfavourable position. Firstly, the length of milling season in South Africa is far longer than that in most other industries (SA 38 weeks; Australia 22 weeks; Mexico 23 weeks; Brazil 26 weeks; Zimbabwe 32 weeks; Swaziland 31 weeks). This has a material impact on sucrose (and RV) yields, which are reduced due to delivery of cane in the wetter months of April at the start and, November and December at the close of the season. Secondly, the presence of the eldana borer in the coastal cane growing regions of South Africa results in the harvesting of immature cane. This has had a dramatic effect on both cane yields as well as sucrose (and RV) yields per hectare. The implementation of a cane quality system will not be able to impact on these disadvantages.

5.2 Factory Performance

South Africa's milling factories are highly competitive in world terms. It has been shown that the proposed cane quality system will result in improvements, which will enable millers to improve their overall recoveries of sucrose from cane delivered. These improvements are illustrated in Diagram 5 below, which also compares South African factories' overall recoveries with those of other sugar industries.

Diagram 5



Another important indicator of factory performance is milling capacity utilisation. This is influenced mainly by the length of the milling season. It is in this area that the Southern African Sugar Industry has a substantial advantage over other industries. The proposed cane quality system will not shorten the current long-term average milling season. The local agreements on length of milling season *merely ensure that growers are compensated by their miller if the miller is* responsible for extending the season beyond an agreed optimum. An expansion of the area under cane without the installation of additional milling capacity currently results in the miller earning increasing marginal profits whereas the individual grower faces a reduction in cane quality and a dilution of the sucrose price. The proposed local length of milling season agreements will redistribute the net benefits of an extended season between grower and miller on an equitable basis. It is essentially an internal arrangement between grower and miller and will not erode the current efficiency of the Industry in respect of long milling seasons – the miller's incentive to extend the milling season and improve capacity utilisation will however be reduced.

The local length of milling season agreements will also create incentives to improve overall time efficiencies (OTE) of the mills. Millers and growers will be penalised if they contribute to a reduction in the OTE by paying compensation to the aggrieved party. This should result in the Industry's average OTE improving.

6 Conclusions

The implementation of the proposed cane quality system (an industrial RV cane payment system and local mill area agreements on the "linked issues") will result in improved efficiencies and competitiveness for the South African Sugar Industry on the basis that:

1. The introduction of a cane payment system will create incentives for the individual grower to improve the quality of cane delivered to mills. This will enhance the level of competition between growers.

2. The satisfactory conclusion of local area agreements will ensure that the factors, which contribute to improved cane quality and hence the Industry's efficiency, are controlled in an equitable manner. This will ensure that the partnership between the milling and growing sectors in the Industry is strengthened.

3. The cane quality system will enhance Industry proceeds (under normal conditions), which exceed the production costs and industrial costs associated with the introduction of such a system. This in itself represents an increase in efficiencies for the Industry in that the total cost of production per ton of sugar will be reduced.

4. The cane quality system will result in an improvement of the Industry's field and factory performance levels.

RECOVERABLE VALUE (RV)

1. THE RV FORMULA

$$\text{RV \% cane} = S - dN - cF$$

Where S = sucrose % cane

N = non-sucrose % cane

F = fibre % cane

And d = the relative value of sucrose which each unit of non-sucrose diverts from sugar production to molasses

c = the loss of sucrose from sugar production per unit of fibre

1.1 Calculation of the factor d

The factor d represents the quantity of sucrose lost to molasses per unit of non-sucrose, but with a credit for the value of the molasses recovered per unit of non-sucrose, and is calculated as follows:

$$d = \left\{ 1 - \frac{m \times P_m}{R_{sERC} \times b_{ERC} \times P_s} \right\} \times b_{ERC}$$

where m = industry average molasses yield per unit of N delivered

P_m = industry average net realisation per ton of molasses

R_{sERC} = industry average unit recovery of saleable sugar from ERC delivered (ERC calculated without the "a" factor applied to S in the formula)

b_{ERC} = the ERC "b" factor

P_s = industry average net realisation per ton of saleable sugar

and

the ERC b factor is determined as follows:

b = tons non-sucrose in molasses and sugar x tons sucrose in molasses tons non-sucrose in cane | tons non-sucrose in molasses

1.2 **Calculation of the c factor**

The factor c is determined as follows:

$$c = \frac{\text{tons sucrose in bagasse}}{\text{tons fibre in cane}}$$

2. RV CANE PAYMENT FORMULA.

$$\text{Price per ton cane} = \frac{\text{RV \% cane}}{100} \times \frac{R_{s/RV}}{100} \times \frac{G}{100} \times P$$

where RV % cane = relative RV % cane

$R_{s/RV}$ = Industry average percentage recovery of tons saleable sugar from the tons of RV delivered for the season.

G = Growers' percentage share of the division of proceeds.

P = Price/ton of saleable sugar i.e.

$$\frac{\text{Net divisible proceeds}}{\text{Industry total tons saleable sugar}}$$

GROWER PROCEEDS - SUCROSE VS RECOVERABLE VALUE (RV)

Annex 2

ASSUMPTIONS:

Historic Cane Quality based on average of 1996/97 and 1997/98 seasons.
Local Market Proceeds are valued at 1999/00 prices.
Export Market Proceeds are valued off a base price of 9 USc/lb.
Average Molasses Proceeds per ton = R165
Growers Share of DOP = 64.0337%

	Mill Area	Tons Cane	Suc %	Tons Sucrose	RV %	Tons RV	Sucrose Proceeds	RV Proceeds	Historic Gainer / Loser R/t/cane
1.	Union Co-op	1,458,615	12.93%	188,647	11.97%	174,524	190,533,213	193,573,785	**2.08**
2.	Entumeni	788,114	13.12%	103,373	12.13%	95,596	104,406,826	106,030,442	**2.06**
3.	Malelane	2,908,376	13.80%	401,257	12.69%	369,166	405,269,937	409,462,196	**1.44**
4.	Eston	2,015,065	13.09%	263,829	12.01%	242,054	266,466,815	268,474,864	**1.00**
5.	Noodsberg	2,745,972	12.51%	343,447	11.44%	314,134	346,881,824	348,422,863	**0.56**
6.	Amatikulu	3,589,183	12.63%	453,209	11.54%	414,266	457,740,897	459,484,932	**0.49**
7.	Pongola	2,323,597	12.88%	299,268	11.75%	273,025	302,260,243	302,826,577	**0.24**
8.	Darnall	2,667,498	12.43%	331,640	11.33%	302,334	334,955,947	335,334,941	**0.14**
9.	Umzimkulu	2,532,085	12.54%	317,505	11.42%	289,117	320,679,621	320,675,733	-0.00
10.	Komati	2,321,386	13.27%	308,071	12.07%	280,184	311,151,724	310,767,343	-0.17
11.	Sezela	4,485,836	12.38%	555,528	11.22%	503,530	561,083,383	558,492,219	-0.58
12.	Umfolozi	2,449,225	12.61%	308,966	11.43%	280,057	312,055,978	310,626,160	-0.58
13.	Gledhow	3,543,204	11.80%	418,098	10.68%	378,520	422,278,909	419,836,325	-0.69
14.	Felixton	5,295,602	12.60%	667,293	11.40%	603,908	673,965,500	669,826,264	-0.78
15.	Maidstone	3,981,858	11.96%	476,224	10.80%	429,951	480,985,994	476,882,166	**-1.03**
	Industry	43,105,616	12.61%	5,436,353	11.48%	4,950,366	5,490,716,810	5,490,716,810	

Sucrose Price /ton	1010.00
RV Price /ton	1109.15

CHALLENGES FACED BY CANE GROWERS IN A NEW ENVIRONMENT

Peter Wise

To appreciate the magnitude of the challenges facing Maidstone Growers it would be useful to have an insight into the situation growers find themselves in on the eve of the change in the industrial cane payment from a sucrose scheme to one based on Recoverable Value.

During the 1990's, local growers have :

a) endured an extension to their milling season, to 36 weeks, as a result of the closure of the Mount Edgecombe Mill ;

b) suffered, and continue to do so, the ravages of eldana and its restriction on the age of harvest ;

c) in 1997 grower indebtedness grew by 27% ;

d) in 1998 interest rates rose to record highs ; and

e) in 1999 we started the season with a cane price 12% lower than the previous year, whilst at the same time suffering from a regional drought that reduced the expected crop by 20% between the first estimate in April and the last one in October.

We now face a 5 month off-crop!

However, we have been fortunate in that two years ago, Tongaat-Hulett Sugar instituted a local RV scheme within the confines of the existing sucrose based scheme, which allowed our Regional Economist, Extension Officer and growers to study and grapple with the mysteries of the RV scheme before it became accepted industrially.

Some of the findings didn't fill us with too much optimism but helped to direct our focus toward the areas that required most attention.

For example, a study of the last 10 years of cane supply to Maidstone revealed :

The optimum length of Milling season, for growers, under the RV curve was 28 – 30 weeks. Recent negotiations with the Milling Company had settled on a 36 week length of season for Maidstone!

Maidstone Growers would have lost an average of 94 cents per ton of cane, under the proposed RV scheme –vs- a sucrose based scheme, during the 10 year period of study.

Of MAJOR concern, however, was the discovery that almost 86% of the area under cane on the coast and hinterland was being harvested each year resulting in immature cane that was penalised under the RV scheme.

The trend toward cutting younger cane might have been started by high levels of eldana in intended carry-over cane, but in my opinion, is now being driven by growers suffering from cash-flow problems.

To prosper under a quality cane payment scheme, the grower has to overcome obstacles that prevent him from delivering fresh, clean and mature cane to the mill.

Each category has differing degrees of difficulty, management and in-put costs but all are inextricably linked.

Fresh Cane

It is possible and practical to consistently achieve a burn/harvest to crush delay of less than 48 hours. It does, however, incur additional costs.

All weather roads and zones must be maintained as must in-field , zone and haulage equipment. Driver overtime is required on occasions.

To burn 3 or 4 times per week raises costs by having to open fire breaks, provide water carts to each burn and reduces the available work time for those attending each fire – often by 10-13% (i.e. 1 hour per 7.5 hour day, by the time they get to their work station after burning).

Labour attitudes to working on public holidays and absenteeism after pay days cause mill slow down or one tandem switch-offs resulting in back logs and delays to cane in the pipe line. Maidstone has a poor record of "No Cane Stops". Growers must improve in this area. It extends the length of milling season which impacts negatively on payment under the RV scheme.

Runaway fires will increase the risk of losses due to 'old cane' unless grower and haulier co-operation is improved. Delays beyond 4 – 5 days – often the norm – will be heavily penalised under an RV scheme.

Clean Cane

To achieve consistently high standards, attention must be paid to cutter training, supervision and reward.

Growers have, for years, emphasised and incentivised cutter productivity directed at tons cut per day. Droughts and economics have forced growers to increase the area burnt each year and pay less attention to topping correctly.

Cutting young, low yielding cane of variable stalk length has placed pressure on the cutters to achieve their 'TASK' and earn a bonus so, understandably, 'topping' and 'base' cutting 'standards' have dropped.

Both scenarios are heavily punished under an RV scheme. Burning restrictions and the realisation that our soils are suffering from continued burning have caused growers to consider increasing the area trashed at harvest. This practice impacts negatively on cutter comfort and income and requires very sensitive negotiation, training and a change in reward to accommodate a reduction in extraneous matter. Older, more mature cane with good yields, would help considerably toward the changing of attitudes but this category remains more difficult to manage than that of fresh cane!

Mature Cane

For growers to compete under an industrial RV cane payment system, the production of *mature cane in the Maidstone area is the most vital component of cane quality.*

The existing levels of fresh and clean cane can be improved by instant management whereas the production of 'mature' cane is a lot more difficult when taking into account the young age existing at present, growers finances and eldana, which is endemic to the area.

A study of the cost/benefit comparison, carried out by the Regional Economist, on the effects of extensive harvesting within an industrial RV Scheme, could assist growers to pace the changes required.

Cane Ripeners, used prudently, could play a vital role in the transition process by artificially improving cane quality at both ends of the season. Application by aircraft, flying off compass bearings, requires further study on our undulating terrain. Ground applicators might offer better options to Management.

Eldana remains the single most limiting factor to harvesting older cane in the Maidstone area. Research in the biological and chemical fields has quickened and expanded but doesn't offer commercial solutions in the short and medium term.

Growers have in the past relied on the variety N12 as 'their resistance' to eldana in the high risk areas of hot dry aspects, shallow soils and carry over ratoon fields. However, its slow growth causes problems if droughts and/or high levels of eldana require its early removal.

Perhaps growers need to consider changing the long accepted practice of harvesting 12 month old cane in well watered valleys, slopes and South facing aspects and consider those areas as more suited to producing older and more mature cane that wouldn't attract Eldana as readily as areas that suffer regular stress.

The breeding and release for commercial use of varieties N27, N29 and N31 which offer rapid growth, high sucrose content and similar resistance to eldana as N12, are therefore very valuable additions to management options.

The timing of the re-planting is another management tool to avoid eldana peaks and bring the cane close to maturity before harvest.

Eric Hulbert's work which, he will present later, made a huge contribution in bringing individual growers' attention to the areas that mattered most to them. He, Graham Moor and Adrian Wynne brought their professional expertise to bear in collecting, collating and interpreting data for each individual large grower and through cell meetings, numerous other growers. They prevented the possibility of us being carried away with producing RV % results and not remaining focussed on high yields at a high quality at a high recoverable value!!!

In my opinion, there has never been a greater need or opportunity for intense co-operation between Research, Development, Extension, Economists, Millers' and Growers'. Maidstone has such a get together planned for the New Year.

A host of alternate crops – Litches, Macadamias, Citrus, Paw-Paws, Flowers, Bananas and Vegetables are replacing sugar cane on farms that have additional underground water or streams. Water remains the limiting factor but the areas under cultivation are becoming fairly significant.

These crops offer vertical expansion in income where growers aren't able to purchase adjoining or nearby properties.

They do come with greater risk from the effects of violent weather – as happened recently – and greater difficulties in the marketing of the produce, but they do offer the opportunity of significantly better returns than cane and in some cases, allow parents to employ their sons on their existing farms.

I believe this trend will continue to grow unless growers are able to stem and reverse the spiral of reducing margins, unlike their milling colleagues, who, during the same period covered by this paper, announced record profits.

Mr Chairman, whilst the growers are faced with major challenges in our new environment, innovative management and the highly skilled support services offered by our industry will offer partial or complete solutions to most situations – it will cost more and take a bit of time, but the alternative is not worth contemplating.

Agronomic Planning to enhance the competitiveness of TSB Estates

M Slabbert
Transvaal Suiker Beperk

(Paper not available at time of printing)

The relative importance of imported varieties in the SASEX selection programme at Pongola.

By KJ Nuss, SASEX, Mt Edgecombe.

The SA sugar industry was started in the 1860s with sugarcane imported from other countries and it was completely dependent on this source for new varieties. This dependence continued until the release of NCo310 and the ability to make crosses at Mt Edgecombe in 1945. Before 1925, varieties could be imported from any source and by any person. In 1925, a quarantine glasshouse was commissioned in Durban through which all varieties had to be imported. Importation of varieties has continued ever since and nowadays a new quarantine facility at Mt Edgecombe is being used.

Bond (1977) reviewed the results of yield trials of about 330 imported varieties and compared these with the yields of varieties bred at Mt Edgecombe and selected at Pongola. Bond concluded that the sucrose yield of imported varieties were inferior to those of local selections. Furthermore, the former were more susceptible to diseases occurring at Pongola.

This paper reviews the results of imported varieties tested from 1978 to 1994.

Trial procedures

Sugarcane varieties may only be imported into South Africa by SASEX and the condition is that they are quarantined for two vegetative generations in the quarantine facility at Mt Edgecombe. Prior to an import, a permit has to be issued by the Section of Quality Control of the Department of Agriculture.

The decision on which varieties are imported is made by staff of the plant breeding department. It is usually based on information in literature and personal contacts with breeders from other sugar industries. Usually, the major commercial varieties are received form the exporting country. A few varieties have been imported following requests from individual persons of the sugar industry. The source of the varieties is also checked to prevent any unwanted diseases being imported in case they can not be detected. Following the closed quarantine, the cane is planted in an open quarantine where the cane is inspected frequently to ensure that no unwanted diseases are in the cane. Seedcane from these plots is then transported to Pongola to be propagated for planting in stage 3 of the selection programme.

At stage 3, the imported varieties are planted together with locally selected clones in two replications of two lines each. These are harvested, sucrose samples are taken and the best 96 of the 400 clones are planted in stage 4 in three replications of six line plots. Stage 4 trials are evaluated over three crops. After the plant cane results are available, the best 28 clones are selected for planting in five off-station trials in stage 5. The performance of varieties in this stage determines which variety will be propagated for eventual release.

All trails are inspected at least twice in every crop for the presence of diseases, and if eldana is evident, the stalks are split to determine the amount of damage. All clones planted in stages 3, 4 and 5 are also planted in smut screening trials and the stage 5 entries are planted in eldana screening trials at Mt Edgecombe.

When all stage 5 trails have been completed, each clone will have been inspected for diseases about 60 times and 56 plot weights determined. A variety is released on the good performance in these trials, inspections and screening trials.

Results of testing imported varieties

Stage 3 trials

Varieties from more than 20 breeding stations were tested and the important sources are shown in Table 1. Most varieties were imported from Zimbabwe because these are varieties selected from seed the Zimbabwe industry buys from SASEX. As there is severe smut pressure in Zimbabwe, these varieties are a good source of smut resistant varieties for the SASEX breeding programme. 37 Q varieties were imported from Australia and 35 from two US mainland programmes at Canal Point and Houma. A number of varieties were imported because they were so impressive where they were growing. These include HJ5741from the Caribbean (It succumbed to smut as it later did in the Caribbean) and Jar60/5 from Cuba (here it was not good).

Stage 5 trials

Forty-four varieties were selected from stage 4 to stage 5. (No results form stage 4 trials is presented here.) The relative yield of these varieties compared to that of NCo376 is given in Table 2. The sucrose content of almost all varieties was superior to that of NCo376 but the *sucrose yield was in most cases not comparable. The mean sucrose yield was 94% of that of* NCo376. This is similar to the means of locally selected clones in stage 5. The mean ranking of each variety is also given in Table 2. The means of 15,7 indicates that most varieties were ranked in the middle of the trails and only a few had a ranking in the single digit. The mean ranking of N19 was 4.9. The best local varieties in the particular years are shown in Table 2. Some of these were not released (78F1025) despite good ers yields. This was because they were susceptible to one or more diseases.

The ers yield of twelve varieties was comparable or more than NCo376. Only one of these varieties was released. This was CP66/1043 planted in 1979 in stage 5 trails. The ers content of this variety, particularly early in the crushing season, was very high, up to 6 units ers more than that of NCo376. With that, it was resistant to smut and other diseases. The reasons for not releasing the other varieties are given in Table 3.

Several imported varieties that are major varieties in the country of origin did not yield well in SA. These include F166 and ROC1 from Taiwan, Q124 from Australia (now producing 40% of the sugar in Queensland), SP70-1143 (was the major variety in Sao Paolo State, Brazil). No Mauritian variety reached stage 5. Variety NA56/62 yielded quite well at Pongola but in Brazil it was a very productive variety and was at one stage grown on more than 1 million ha.

Discussion

The ers yields and disease resistances of imported varieties in this study were not as good as those of the best local varieties. This confirms the earlier conclusion by Bond. It is essential and economically sound to breed and select varieties in conditions in which they are to be grown. Varieties from Reunion appear to perform particularly well at Pongola and that is in contrast to the Mauritian varieties.

Imported varieties are, however, an important additional source of new germplasm for the breeding programme. Several N varieties are seedlings of imported varieties: N19, a seedling of CB40/35, N21 of CB38.22, N24 of Q96, N27 of NiN2 and N29 and N35 of CP57/614. Three of the four grandparents of N30 are imported varieties.

Conclusion

The imported varieties tested at Pongola do not yield as well and are more disease prone than the clones bred at Mt Edgecombe and selected at Pongola. They are; however, an important source of genes that can supplement and enhance the breeding programmes at Mt Edgecombe.

Acknowledgements

The results of the trials reported on in this paper were planted by staff at the Pongola Research Station. I am indebted to A Van der Merwe, RT Culverwell, and A Botha of the Plant Breeding department and farm manager W Benninga for all the work done to obtain the results and to staff of the Pathology and Entomology departments for screening the varieties.

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Table 1. Origin and numbers of clones evaluated in stage 3 at Pongola from 1979 to 1994

Country of origin	Selection code/s	Number of varieties imported
Argentina	NA, TUC	10
Australia: BSES	Q	35
: CSR	Various	9
Brazil	CB, SP	16
Japan	Ni	22
Mauritius	M	29
Reunion	R	16
Taiwan	F, ROC	15
USA Florida / Louisiana	CP	37
Zimbabwe	ZN	63
Others: India, Cuba, Colombia, Puerto Rico	Co, CL, Jar, MZC, PR etc	37
Total number tested in stage 3		300

Table 2. Yields and ranks of imported varieties selected to stage 5 at Pongola form 1979 to 1994.

Year planted	Variety	Mean of all crops vs NCo376			Best local clone
		Ers diff	Ers yield % control	Rank	
1979	B41227	0.1	80	21.0	74F832, 95%
	CP66/1043	4.6	103	6.7	
1981	B51129	2.0	92	17.0	1980
	B6160	-0.2	73	26.6	N19 at 112%
	F166	1.5	96	15.7	
	M124/59	0.1	91	15.0	1981
	MQ57/728	0.4	97	11.1	76F2198 at 107%
	Q90	1.1	85	21.5	
	R565	1.2	103	9.6	
	Wava	0.7	88	18.0	
1982	Q93	0.6	85	23.0	77F637 and 77F840
	Q96	2.0	93	18.4	at 104%
	Q97	1.9	90	21.3	
1983	M31/45	0.8	87	21.5	78F1025 113%
	NA56/62	1.3	102	9.5	
1984	Co62175	1.5	112	6.4	
	Co6415	1.7	96	15.6	N22 at 105%
	KF70/190	2.8	97	13.9	
	MZC74/187	2.5	100	13.3	
	NiN2	0.6	99	13.4	
1985	CP68/1067	2.0	85	15.1	
	MZC74/275	1.5	98	10.6	80F2147 at 103%
	R568	0.7	86	17.1	
	R570	1.2	98	11.6	
1986	Co775	0.1	83	18.2	N23 at 106%
1988				N24 at 108%; N26 at 105%	
	CP72/2086	2.5	104	10.3	
1989	CP75/1257	3.0	94	16.1	N25 at 109%
	Q99	1.2	85	23.4	
1991	(SP70-1143)	(-0.6)	(84)stage 4 only		N28 at 104%
	SP70-1406	0.7	97	15.0	N32 at 111%
	78Z1635	0.9	99	15.2	
	79Z3266	0.4	93	17.5	
	79Z3275	1.8	103	9.8	
	ROC 1	2.4	95	18.9	
1992	80Z3167	0.5	92	21.3	N30 at 110% and
	80Z4311	0.0	92	22.6	+2.9 ers
	CP70-321	2.1	98	16.2	88F3353 at 107%
1993	CP70-1133	1.4	97	15.6	Smut 8
	CP72-1210	2.5	87	18.8	
	CP79-0332	2.7	95	15.8	
	H73-6110	0.4	95	16.4	89F2262 at 105%
1994	Q119	0.1	92	17.4	
	Q135	1.3	99	12.6	
	R70-0070	1.5	108	7.7	
Mean (44)		1.30	94.0	15.7	

Table 3. Diseases and eldana ratings in the most promising imported varieties tested at Pongola from 1978 to 1994

Variety	Disease ratings			Eldana	Reasons for not released
	Smut	Leafscald	Other diseases	rating	
Co62175	S2	Ls2	-	E 5	Smut in field
CP72/2086	S2	Ls2	-	E5	Mosaic in field
MZC74/174	S8	Ls5	Rust	E6	Smut in field
MZC74/275	S8	Ls5	Rust, gumming	E4	Smut in field
NA56/62	S5	Ls8	Rust	E6	Severe smut, leafscald
NiN2	S8	Ls2	Rust	E3	Severe smut in field
R565	S5	Ls8	Gumming	E4	Smut, leafscald in field
R570	S2	Ls2	Ring spot	E3	Smut, leafscald in field
R575	S8	-	-	E5	Smut severe
SP70-1406	S5	Ls9	Severe rust	E3	Smut and rust
ZN79-3275	S1	Ls2	M2, gumming	E7	Yield low

AGRONOMIC EVALUATION OF RELEASED VARIETIES IN SOUTH AFRICA

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Introduction

The released variety trial programme of the Agronomy Department at SASEX was established during 1977. This programme was initiated because it was believed at the time that the number of environmental sites and managerial treatments that a variety was subjected to in the Plant Breeding selection programme was limited. Once a variety was released into the industry there was no further testing on varieties by SASEX. A programme was initiated in the Agronomy Department that involved the establishment of variety trials around the sugar industry to provide a continued assessment of varieties after release. At the same time farm and agronomic practices were evaluated to provide growers and extension with updated information and recommendations.

Variety trials were initially established at six permanent sites. The sites were located at Paddock (coastal hinterland), Ottawa (coastal north), Hillhead (coastal sands), Mtunzini (coastal Zululand), Midlands (mist belt) and Pongola (northern irrigated). All these trials were planted, harvested and completely managed by the staff in the Agronomy Department. These sites on their own were thought not to be representative enough of the whole sugar industry so further trials were established on grower co-operator farms to represent a wider range of environmental conditions. Apart from the trial layout, planting and harvesting operations and data analyses, done by the Biometry and Agronomy Departments, trials on grower co-operator farms are managed entirely by the grower (this mainly involves weed control and fertiliser application). The Extension Department plays an essential role in the success of these grower co-operator trials. When looking for a new trial site Extension Officers select good co-operators in their particular areas where the soil and environmental conditions are representative of a large portion of this region. When trial results become available copies are sent to the Extension Officer in the particular region where the trial is located and this information is then passed on to all growers in this region. Results are also sent to the Plant Breeding Department to keep them updated on the performance of newly released varieties.

The objective of this paper is to describe and explain the importance of the released variety trial programme to the South African sugar industry.

The present variety evaluation programme

The objective of the Released Variety Trial Programme is to provide extension and growers with additional and updated information and recommendations regarding the performance of commercial varieties under different environmental and agronomic situations.

At present not only are newly released varieties planted into agronomy variety trials but also varieties due for release (varieties still going through the process of being bulked up). This is done with the hope that at the time of release there may then be some extra information for growers as well as that coming from the Plant Breeding trials. The performance of these varieties together with the existing commercial varieties is evaluated in these trials.

The variety NCo376 is used as a control variety in all agronomy variety trials. With the current shift of the industry to the more recently released and more region specific varieties, N12 and N16 are included in all rainfed trials along the coastal region and in the midlands, while N14 and N19 are included as control varieties in all irrigated trials. There is usually a minimum of 8 varieties included in each variety trial with 4 to 6 replications of each variety. The common plot size is 6 rows of 10m. The outer two rows are guard rows while the inner four rows are known as the net rows. To ensure that these trials are representative of a commercial field the competition effects between neighbouring varieties is removed. All measurements are taken on the inner four rows (sucrose samples, weights and agronomic measurements). The end stool effect on the net plots is also removed at harvest. The layout of the trial is discussed with the Biometry Department at SASEX. The placement of the varieties and replications in the field is dependent on the statistical trial design determined by the Biometry Department.

New variety trials are being established on the more recently acquired SASEX farms as well as on co-operator farms that are representative of a larger range of environmental conditions. The suitable location of these new SASEX farms was determined by a study group with the main aim of ensuring that Plant Breeding trials are more representative of the major agroclimatic zones found in the South African sugar industry. They are located at Kearsney (coastal hinterland), Gingindlovu (average to low yield potential - coastal), Empangeni (high yield potential – coastal), Bruyns Hill (high yield potential – midlands) and Glenside (average to low yield potential – midlands). The SASEX farm in Pongola was the only farm that was kept by SASEX and the establishment of variety trials on this farm remains unchanged.

A new SASEX farm is due to be established at Komatidraai in Mpumalanga in the year 2000. Variety performance and the response of varieties to ripeners will be evaluated on this farm. Agronomy variety trials are also established in areas not represented by SASEX farms and these are located on the South Coast, Midlands South, Mtubatuba and North Coast Zululand.

Measurements and treatments that varieties are exposed to in the Agronomy variety trials include:

1) yield responses
2) agronomic characteristics,
3) partitioning of stalk components (fibre, sucrose, non-sucrose and moisture contents),
4) cutting cycles - yield responses to different planting and harvesting dates (early, mid and late season harvesting),
5) age at harvest (e.g. 12 versus 18 months),
6) row spacing (narrow versus normal),
7) ripener response (Fusilade Super, ethrel and the combination treatment),
8) nutrient requirements (different nitrogen and potassium levels).

All trial results are entered onto an agronomy database (AGROBASE) together with weather and soil information, where all trial records from the 1970's can be found (Bezuidenhout, 1998). This allows for easy access and good analyses of all variety trial information.

All data collected from SASEX variety trials are made available to the South African sugar industry in a number of different formats. Results are regularly presented formally as scientific papers at the South African Technologists' Association Conference. They are also presented informally as Link articles. Information sheets on all the commercial varieties are published and regularly updated and sent to growers. The Agronomy Department is in the process of setting up a web page on the SASEX web site specifically for variety advice. This will allow growers quicker and easier access to updated variety information. SASEX offers a Senior Certificate Course for students or growers from South Africa and other African countries. Lectures on agronomic characteristics of varieties and variety choice are given twice a year as part of this course. The recommendations presented in this course are based on many years of variety trial results.

Growers' days are held at trial sites at harvest time so growers can observe the differences between varieties under specific conditions. The frequency of these Growers' days is dependent on the extent of involvement of the Extension Officer for a particular region. In some cases growers are exposed to the newly released varieties for the first time at these events. These events provide a relaxed forum for growers, extension officers and the variety agronomist to discuss performance of varieties not only observed in these trials but also experienced by the growers themselves.

It is difficult to calculate a cost benefit of the Agronomy variety evaluation programme as there are many factors and people involved in making recommendations to growers. All these factors and people contribute in some significant way to the final decision made by the grower. A few examples showing how this programme can benefit growers will however be mentioned. Results from agronomy variety trials planted in the midlands and coastal hinterland regions have shown that N16 produces on average 1.3 tons sucrose/ha/annum more sucrose than NCo376 when planted on humic soils. Some variety trials have shown that N12 yields very well on the weaker coastal sands and on poorly drained and shallow soils. Other variety trials have shown that N12 does not perform as well as NCo376 on the better soils found in the Zululand and Umfolozi areas (McIntyre and Nuss, 1998). It has been clearly shown that N12 requires a significantly longer cutting cycle than NCo376. The minimum harvest age of N12 for the different regions are as follows: North Coast (14 months), South Coast (15 months), Hinterland (16 months), and Midlands (>17 months). These recommendations were made based on results collected from many agronomy variety trials.

When N19 was released in the south in 1989, agronomy variety trials confirmed the Plant Breeding Department's recommendations. These trials then went further to recommend more specific environmental conditions that were suited to this variety. While N19 was shown to perform well over a wide range of soil and climatic conditions in the rainfed areas planting is to be avoided on the shallower, poorer, and sandy soils where water stress is more likely to occur (McIntyre and Nuss, 1996).

A systems approach

The Agronomy Department has recently taken on a systems approach to their research programme. The aim of this systems approach is to incorporate all data collected from trials to be included in a crop model that aids researchers in making recommendations and crop predictions.

There are two projects which form part of the variety evaluation programme that have recently been initiated to make use of this systems approach. One project focuses on the determination of attributes that describe varietal differences of sugarcane. These attributes will then be incorporated into the CANEGRO simulation model (Inman-Bamber, 1991). In the past the crop model has been based mainly on one variety, NCo376, although this model does attempt to simulate N12 and N14. A growth analysis trial is being established in December 1999 at Mount Edgecombe to study nine different commercial varieties in detail in order to incorporate varietal differences into the crop model. Once a varietal effect or factor has been incorporated into the crop model the model could be used as a tool to rationalise the post-release variety trial programme. For the model to be more effective it will become necessary to increase the number and frequency of measurements on each variety and in each trial. In practice this will result in a reduction in the number of agronomy variety trials planted around the industry; but may increase the need to visit trials more often.

The second programme involves the refining of the VTYECON variety decision support tool (Inman-Bamber and Stead, 1990). This computer programme has been developed to assist the grower in choosing the most profitable variety for a given set of management and environmental circumstances. Each variety will have an economic value depending on its sucrose yield and its agronomic characteristics that may influence farm management practices. This decision support tool will reflect the latest information from variety trial work and once set up will be made user-friendly so that in time extension officers will be able to use it to advise growers in their mill region.

Collaborative projects

Varieties differ in terms of their milling characteristics. It is important for millers and growers to be aware of varietal differences. Juice quality and fibre content will influence the milling process.

In 1994 and 1995, the Agronomy Department at SASEX initiated a joint project with the SMRI (Sugar Milling Research Institute) to investigate the effect of different varieties and locations on the colour, ash and silicon in cane (Lionnet, 1997). The colour of the juice can impact on sugar quality and refining costs. Silicon has been found to cause problems with the evaporators and ash impacts on the recovery of sucrose in the milling process. Extracts from juice samples of different varieties were collected for two consecutive years at harvest from 16 agronomy variety trials.

A similar project was set up at the beginning of 1999 with the SMRI involving 18 variety trials at a number of different locations. The juice samples are being analysed for ICUMSA colour, pH, brix, sulphated ash, inorganic phosphate, calcium, potassium, gums, and soluble silicon. The Chemistry and Soils Department at SASEX is also involved in this project in that they are determining the status of nitrogen, phosphorus, potassium, calcium, magnesium and silicon present in the different varieties at harvest. Depending on the outcome of the results obtained at the end of 1999 this project may be continued for further year.

Global competitiveness

This kind of variety evaluation programme is quite unique to South Africa, although there are a few other African countries (eg. Malawi, Swaziland, Zimbabwe) that have commercial variety evaluation programmes. Generally, there are no formal post release variety evaluation programmes outside of the African continent. However, recently the Bureau of Sugar Experiment Station of Australia (BSES) has initiated a post release variety programme based on the SASEX programme (Hogarth, personal communication).

There is a very strict variety release policy in Louisiana, USA, which means that very few varieties are being released into the industry. Varieties are also removed from the recommended list quite quickly, without extensive testing, with the result that there are only eight varieties currently recommended for planting in Louisiana (Milligan, personal communication). At present two varieties make up 80% of the area under cane. With so few varieties available for planting growers are able to very easily evaluate the varieties themselves without requiring a large post release variety evaluation programme. There are, however, many risks associated with having only two varieties being planted on such a large scale. These risks include the possibility of these varieties becoming susceptible to a particular pest or disease present in the industry or these varieties being exposed to a new disease that these varieties have not yet been tested for.

In Florida, USA, varieties are not tested as strictly as in Louisiana prior to release and are more readily released into the industry. This indicates that there are many varieties available for growers but there is no post release variety testing programme following up on the performance of these varieties once they are released. The adoption of these new varieties is dependent on grower experience over time (Milligan, personal communication).

The Texas sugar industry is a co-operative and the agronomist from each sugar mill decides which varieties are to be grown in their mill area (Butterfield, personal communication). There is no variety release programme but the Plant Breeding programme seems to be very comprehensive in their testing of promising varieties. Varieties are tested across five sites on different soil types. Based on the plant cane results of these trials the most promising five or six varieties are then replanted in similar trials one year later. The best varieties will then have been in ten trials for three crops before the mill region decides on which variety to bulk up.

In northern Argentina there is a similar variety release programme to that found in Texas. Once a variety is available commercially the mill agronomist is responsible for deciding on which variety will be released to the growers in a particular mill area. There is no formal release or testing strategy (de Ullivarri, personal communication).

Although there is no planned variety evaluation programme in Mauritius some estate agronomists do plant variety trials on their estates to test the performance of newly released varieties (Domaingue, personal communication). This seems to be dependent on the estate and the agronomist working for the estate. In the case of growers not forming part of a large estate, extension officers from MSIRI will assist growers to establish their own variety trials if requested.

An advantage to the South African released variety evaluation programme over what occurs internationally is that one research scientist manages the programme at one centrally placed research station, SASEX. In this way all the data is stored centrally and recommendations can be made with greater confidence. The research conducted at SASEX is funded by South African millers and growers and is for the benefit of South African millers and growers.

This situation can be compared to that more commonly observed outside South Africa where there are a number of agronomists, growers or extension officers planting trials on different estates specifically for their unique conditions. The data and information collected from trials is restricted to those estates or mills conducting the trials. Although this may benefit a particular estate or grower it will not necessarily be for the overall benefit of the country.

Conclusion

The Released Variety Evaluation Programme at SASEX is an extremely successful programme that is fairly unique to South Africa. The South African Sugar Industry is spread over a very wide range of soil and agroclimatic zones. There are also many different management styles and levels of the growers themselves that range from small, medium to large-scale growers. The correct choice of variety by a grower in terms of its specific adaptability, economic viability, age of cane at harvest and overall management cost can make a large difference in the overall profit incurred at the end of a season.

The SASEX trials are well planned and managed in a consistent way over many seasons and across many different environmental sites so that the data can be used confidently to make reliable recommendations to growers. Extension officers, growers and researchers are dependent and benefit from the advice that emanates from this released variety evaluation programme.

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SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

Some notes on cane growing in Mocambique

by

P Turner, Sugarcane Research Services

Introduction

Four sugar growing areas are currently being rehabilitated in Mocambique. Two of these are located in the south of the country just north west of Maputo and the other two are located at Beira and on the Zambesi. Although there are probably many differences between these areas there are also similarities and for the purpose of this presentation one estate, that of Acucareira de Mocambique situated at Mafambisse 50 km from Beira forms the basis for these comments.

The location of the sugar mill and fields at Mafambisse are on the Pungue river flood plain and are at a latitude of 20 degrees south. In contrast Durban is 30 and Dwangwa 12 degrees south.

The weather pattern and soil type have a major influence on the functioning of the industry. The rainfall pattern is a clear one of very low winter rain and excessive summer rains. As can be seen December, January, February and March are very wet months and November can also be wet in some years. This coupled with the fact that the soils are primarily of the Rensburg form plays a critical role in determining milling season and also growing conditions. Although the long term mean annual rainfall is 1230 mm, as much as that received in the rainfed areas of the South African industry, the distribution is poor and irrigation is required.

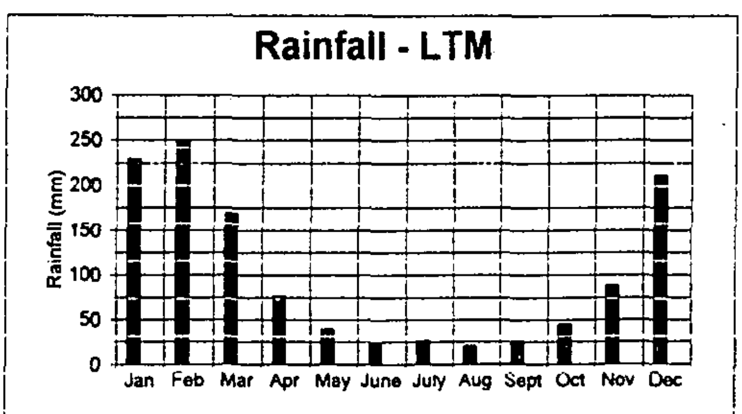

Figure 1. Long term mean rainfall at mafambisse.

Class A pan evaporation is very constant throughout the year and this indicates clearly the need for irrigation in the winter months but not from December to March.

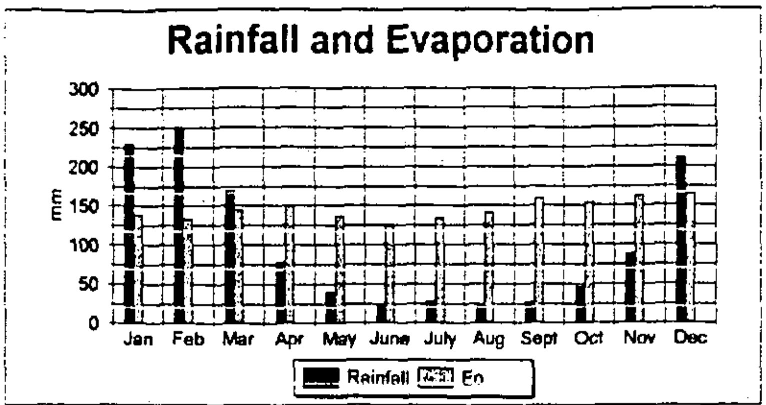

Figure 2 Long term mean rainfall and evaporaion at Mafambisse.

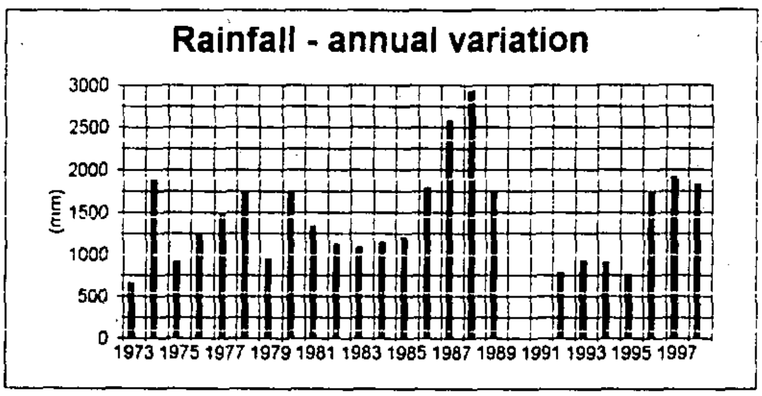

Figure 3. Annual rainfall from 1973 to 1998 at Mafambisse.

Being a flood plain the topography is extremely flat with an altitude of 8-10 m at 50 km upstream from the mouth. The soils are mainly Rensburg form with shallow vertic topsoils of between 10 and 50 cm but more commonly about 30 cm. These are typical vertic horizons with montmorillonitic clay with its swelling and cracking characteristics. The implications of such soils are that they have extremely poor infiltration rates when wet, moisture is held at high tensions, they cannot be traversed when wet and they become very hard when dry. In short they are difficult to manage and play a crucial role in constraining the milling season length due to the difficulties of infield operations in the wet. As a result of these weather and soil conditions the normal milling season is from May to October.

Apart from the obvious difficulties of drainage and correct irrigation, conditions are ideal for flowering and even N19 flowers profusely at Mafambisse. There are two endemic pests, a borer Chilo saccharíphagus and a white grub Heteronychus licas. Due to understandable difficulties during the war years in Mocambique diseases such as RSD and smut were not controlled adequately and resistant varieties were not accessible. Likewise a lack of fertilizers and herbicides resulted in poor weed control and nutrition.

In contrast to the above problems associated with the weather and soil conditions there are some aspects of cane and sugar production which are favoured by them. The reduced milling season results in naturally high cane quality and it appears that pest pressures are also reduced, particularly white grub, by the early completion of milling. Cane germination and growth is poorer the later the cane is planted or ratooned and hence the advantage of early closure of the milling season.

Further detail on some of these aspects follows.

Soil, field layout, irrigation and drainage.
Soils with vertic A horizons ie swelling cracking properties are often regarded as difficult to manage because of their tendency to seal and the resultant low infiltration rates. However when they have cracked high initial infiltration rates are possible and for this reason furrow irrigation has been advocated and practiced on many of them. Soils with a gley subsoil ie Rensburg, and particularly shallow topsoils, however pose problems of bringing gley subsoil to the surface when laying out fields to obtain the necessary fall for furrow irrigation. The system in place at Mafambisse is overhead sprinkler with cambered beds of 18m. This allows for access to Cameco loaders and Bell Tractor trailer combinations to run alongside each other on the relatively high ground. A variety of systems could be used such as ridge planting, furrow irrigation or even drip irrigation which would allow for surface water removal but each one of these has some serious constraints and different abilities to satisfy the delicate water requirement of not too much and not too little. An added problem with these soils is their susceptibility to salinity and sodicity which has developed in some areas.

Varieties
NCO 376 has on this estate like many others been the major conrtibutor to production but inevitably has performed poorly in the many stress situations as well as building up high disease levels. It is also a profuse flowering variety under Mafambisse conditions and therefore has been treated for flower control in fields scheduled for late season harvest. In comparisons between treated and non treated areas this year it was evident that flower control was not completely effective but late harvested untreated fields showed higher cane yields and lower sucrose % cane resulting in a net benefit to treated cane.

Diseases- Smut, RSD, Red rot
These diseases occur as would be expected with NCO376 being the major variety. The occurrence of red rot is common and a question remains as to whether this is closely related to borer infestations or whether cracks and other factors are the dominant cause.

Pests
Chilo sacchariphagus
Chilo sacchariphagus surveys conducted at the beginning of the season show a decline in infestations since 1996 and relatively low % damage. However surveys carried out later (July/ August) show a higher percentage of stalks bored and damage. Red rot has also been recorded in borer surveys and it is apparent that this can be a significant contributor to stalk damage.

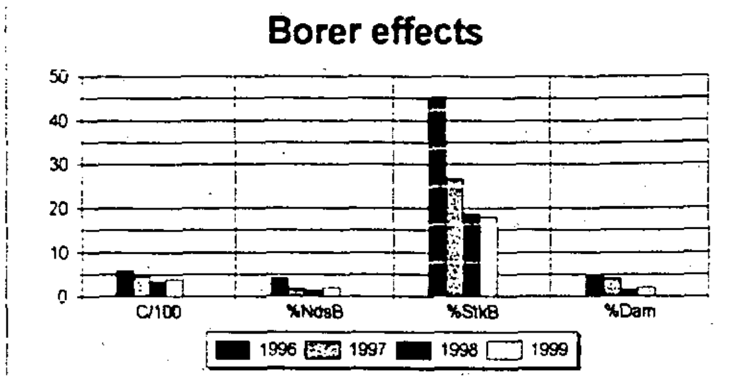

Figure 4. Effects of Chilo sacchariphagus on cane in terms of Chilo/100 stalks, % nodes bored % stalks bored and % damage.

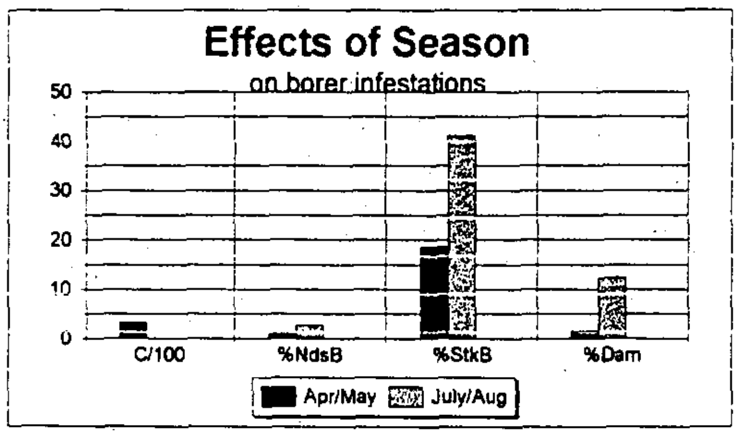

Figure 5. Effects of season of survey on borer infestations and damage.

Heteronychus licas
White grub is a significant problem on at least two estates in Mocambique. Wet conditions are required for most of the stages of the life cycle and irrigation has been cited as a contributing for white grub infestations in sugarcane in Zimbabwe where dry winters would have prevented the completion of the life cycle. The sugarcane growing areas near Beira are low lying flood plains which are naturally wet and this may be a reason for the high infestations. Populations of larvae have been much lower in 1999 than occurred in 1998 and possible reasons for this could be the longer dry off utilised this year, the use of light traps in 1998 decreasing the population or natural causes.

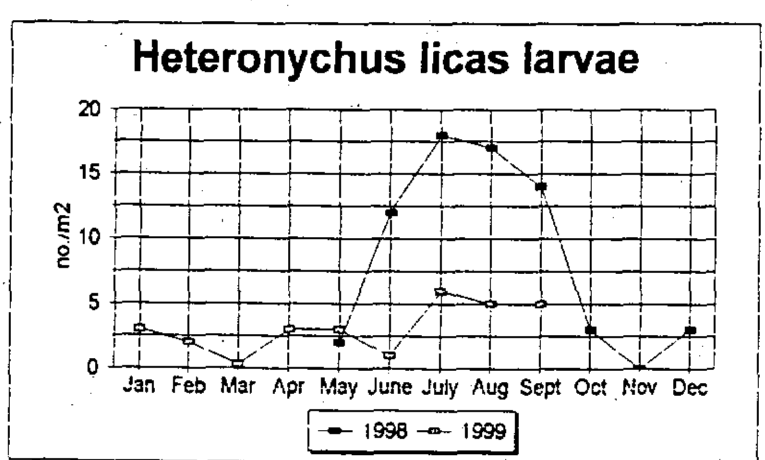

Figure 6. White grub larvae populations in 1998 and 1999.

Heteronychus licas larvae pupate and then later emerge as adult beetles in November December. The adults do considerable damage to young plant and ratoon cane by boring into shoots at the base causing death of these shoots. They live for about 2-3 months in which time they lay eggs below the soil surface. First instar larvae emerge and feed on soil and dead organic matter. Second and third instars feed on cane roots in the absence of organic matter. The larvae populations are highest from December to July but do occur at any time of the year.
to July but do occur at any time of the year.

Nutrition

The soils are slightly acid with adequate potassium and marginal phosphorus with moderate to high p fixation. Generally no nutritional problems have been experienced inspite of no potassium being applied.

Ripening

Fusilade Super has been used in the early season with success but difficulties with establishing mill opening dates have limited the benefits. A perceived benefit of Fusilade is its effect on drying out the crop to improve the burn at the beginning of the season.

Flowering and its control

Conditions with high temperatures and high rainfall in February over the period of flower initiation are ideal for flowering and the percentage flowered stalks is normally very high. Shy flowering varieties such as N19 are known to flower quite heavily at Mafambisse. Ethephon has been applied to most fields due for late season harvest as a standard practice but weather conditions at the time of application in February limit the effectiveness. In comparisons between treated and non treated areas this year it was evident that flower control was not completely effective but late harvested untreated fields showed higher cane yields and lower sucrose % cane resulting in a net benefit to treated cane.

Weed control

The weed spectrum is wide with Cyperus rotundus, a range of grasses including Panicum maximum, Rottboellia cochinchinensis, Sorghum sudanense, creeping perennial grasses, and a wide range of broadleaf weeds including creepers. Some weeds are specifically associated with wet conditions and are more difficult to control. The heavy clay soils could be expected to pose a serious problem for pre-emergence chemicals but combinations have been found which work extremely well under the circumstances. The normal problems associated with weeds at the start of the rainy season occurs at Mafambisse and the wet fields mean that hand weeding is particularly difficult.

Conclusions

Cane growing in Mocambique, like any other area, has it's peculiar problems and a few serious challenges but some corresponding advantages. In particular the weather and soil conditions are extremely difficult to contend with, but the shorter milling season provides an advantage in cane quality.

DEVELOPMENTS IN RIPENING OF SUGARCANE

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INTRODUCTION

About 79% of the crop in South Africa is not irrigated, and thus good rainfall distribution and soils with good water holding characteristics largely dictate the area sprayed from year to year. The renewed interest in ripeners between 1996 and 1998 stems from improved weather conditions, a larger choice of good varieties and improved technology transfer. The transfer of up-to-date technology ~~can be~~ has been achieved through several avenues, other than by scientific publications. In the South African context use is made of *Information sheets*. These are written by specialists and distributed to the farmer with updated and concise information on specific aspects of sugarcane production. These are supplemented by several other communiqués: (1) *newsletters* sent to growers by the Extension division at critical times of the (4) *talks* presented by extension personnel and specialists, (5) *Farmer's days* and *road shows* where short and less formal presentations of the most recent research developments are presented also serve to expose farmers to the technology most applicable to their region, (6) sugarcane *technology courses* run at Mount Edgecombe and, (7) *talks* presented *by agri-chemical representatives* are two additional avenues through which information is transferred.

The impact from better information transfer is seldom easily quantified, but for chemical ripeners year, (2) articles on topical issues are compiled by specialists at different times of the year in a widely circulated newsletter –*The Link*, (3) contact with growers is often through the area treated when weather conditions are favourable may be a good indication of this. During the past three seasons the total area sprayed by commercial aircraft has more than doubled, from 18 614 hectares during 1995 to 38 605 hectares in 1997. It is estimated that an additional 31 000 tons of sucrose may have been produced during 1997 through chemical ripening.

Millers have for some years been aware of the benefits from chemical ripening. Besides the gain in sucrose yields, the higher purity of ripened cane explains the better recovery of sucrose. In recognition of this some millers have subsidised part of the costs of the chemical and/or its application as an incentive to farmers to use ripeners.

The current negotiations around payment related to cane quality have also brought chemical ripening into reckoning where it may not have been considered before. Millers are also contemplating milling for longer periods than usual. Extending the milling season by opening earlier or crushing later will increase the immature portion of the crop and should therefore favour more extensive use of chemical ripening.

Therefore the factors which may be contributing to the wider adoption of chemical ripening are better technology transfer, incentive schemes from millers and cane payment schemes that focus on cane quality. In any specific year, however, good rainfalls in late summer and autumn will be the major factor determining the use of ripeners, particularly in dryland situations, in South Africa.

An estimate of the additional sucrose produced due to ripeners

The estimated average gain of 0.8 tons of sucrose per hectare (Rostron, 1996) is conservative when compared with the average 3.2 tons gained over three crops (Donaldson and Inman-Bamber, 1982) from glyphosate at Pongola. It may, however, be a realistic average response under commercial conditions, which include irrigated and non-irrigated sugarcane. During 1997 the expected average sucrose yield response translated to a gain of 31 000 tons of sucrose (R25 million at 1997 price of sugar and costs of chemicals and spraying). It does not take into reckoning the benefit from more efficient milling performance.

DRYING-OFF TO RIPEN SUGARCANE

Numerous studies on this subject have been done in southern Africa with conflicting results, consequently some farmers dry off for periods during which potential evaporation is four times the plant available water capacity (PAWC = total available soil moisture). This is far in excess of the rule-of-thumb of twice PAWC and there may be several reasons for this. The data from these studies, which were drawn from 35 experiments, were analysed to provide benchmarks for productivity increases that can accrue from drying-off (Robertson and Donaldson, 1998). The results of this analysis are being linked to crop simulation models that assess the risk and profitability of drying-off strategies (Robertson et al, 1998). We are presently formulating drying-off recommendations for the South African industry using the CANEGRO simulation model (Donaldson and Bezuidenhout, unpublished). These simulations are based on the analysis that showed that sucrose yields are increased or not affected by stress that reduces relative stalk biomass by 4%.

The benefits from using chemicals to ripen irrigated sugarcane are mostly based on the difference in yields from sprayed and non-sprayed sugarcane that has not been dried-off. Such comparisons are not entirely correct when estimating the benefits from chemical ripening since the best alternative to ripening cane with chemicals (not dried-off) is by ripening cane through a drying-off process. Experiments conducted at Pongola, South Africa, have shown that similar sucrose yields can be achieved by drying-off as from ripening vigorously growing (not dried-off) cane with Fusilade Super (fluazifop-butyl). The recent analysis of drying off experiments show that cane yields are not reduced to any greater extent than from ripeners and therefore savings from lower irrigation costs (savings from water and electricity), and not transport costs, weigh in favour of ripening sugarcane by drying-off . Rainfall may disrupt the ripening process induced by drying-off but the risk is very much lower for winter/spring harvesting than in summer/autumn.

FUSILADE SUPER

Stress - a reason for variable responses?

It is quite possible that sometimes smaller responses to Fusilade Super are due to stress that develop immediately prior to, or after, application. Dickson et al (1990) suggest that at the onset of stress Abscisic acid (ABA) levels rise and esterase activity decreases in plants - both of which may decrease the activity of fluazifop-butyl. ABA regulates plant activities to maintain the integrity of plasmallema which are partly composed of lipids. The formation of lipids is disrupted by the action of fluazifop-butyl on Acetyl Co-enzyme A carboxylase. Carboxylesterases in the plant metabolise fluazifop-butyl to a more active acid form (Gronwald, 1991). Thus, it is possible that as stress develops less of the fluazifop-butyl is hydrolysed to the acid form due to higher ABA and lower esterase levels. During mild to moderate stress leaf development and stalk elongation slow down but photosynthesis may be little affected. Because leaf and stalk production then demand less photosynthate, greater amounts are stored as sucrose. Under such conditions the benefits from applying a ripener are greatly reduced. In an experiment on the varieties N12 and N16 at Mount Edgecombe the effects of mild stress on the responses to Fusilade Super were different for the two varieties. Typical symptoms developed on N16 but on N12 only slight necrosis around the spindle and some distorted leaf growth could be seen. The sucrose yields of N12 were raised by 1.2 ± 1.0 tons while the response of N16 was 4.2 ± 1.0 tons per hectare. The variety N12 tolerates stress better than most other commercially grown varieties in South Africa. It does so by (leaf rolling) (Inman-Bamber, 1986) and probably adjusting ABA and esterase levels sooner to stress. The mild symptoms from Fusilade Super when applied to stressed cane have since been recorded on several other occasions. The aforementioned reasons for poor responses to fluazifop-butyl do not preclude the possibility that higher rates could be more effective under certain conditions, as is the case with the variety N14 (Donaldson, 1989; Leibbrandt, 1989).

A high rate of photosynthesis after applying a ripener is necessary for sucrose accumulation whereas the chances of damage by infield operations during harvesting are reduced by drying-off. It is for these reasons that a short drying-off period is advocated when chemicals are used to ripen a crop.

Residual activity of fluazifop-butyl

As with other ripeners, there is sometimes evidence of increased tillering in crops following the use of Fusilade Super. There is, however, no evidence that this apparently greater vigour is of benefit in terms of cane yield. At the other extreme, few cases of adverse residual effects from Fusilade Super were reported before 1988 (Donaldson and Van Staden, 1989). Since then several cases have been documented (Turner, 1988; Anon, 1988; Richard, 1995). A recent case of poor ratooning of a commercial field was observed in South Africa, where the vigour and growth of the crop were visibly retarded for several months after the previous crop had been sprayed with a high rate (75 g a.i./ha) of Fusilade Super. The common factors in these cases suggest that Fusilade Super may reduce yields in the following crop if high rates are applied in cold, cloudy weather when soils are saturated. Weather conditions, particularly temperature and light, affect the absorption, translocation and metabolism of fluazifop-butyl (Balinova and Lalova, 1992; Coupland, 1989). Therefore, it is possible that the under certain conditions there is slower metabolism and greater translocation of the chemical to the roots. Then, as the following crop regenerates with rising ambient temperatures, the chemical is re-mobilised into the emerging shoots where growth is disrupted. However, the hypothesis that Fusilade Super sometimes has adverse residual effects due to weather conditions and high rates on sugarcane, needs to be verified.

VARIETY RESPONSES TO RIPENERS

During the past decade it has become more apparent that varieties react differently to chemical ripening. Much of the earlier research had been done on the variety NCo376 (Donaldson and van Staden, 1989). It is now clear that this variety responds better to ripeners than the more recent commercial varieties. The slightly higher rates of Fusilade Super needed to ripen the variety N14 (Donaldson, 1989) and the erratic responses of N14 to ethephon (Leibbrandt, 1989) are evidence that varieties need to be screened individually for each chemical. Some of the more recent varieties are either more sensitive to stress or accumulate sucrose very rapidly during the first 9 to 10 months. Consequently juice purities are high and often more than 50% of the stalk dry matter is in the form of sucrose. With such characteristics (variety CP66/1043) the good responses to chemical ripening that are common to NCo376, are less likely to be achieved. Although responses to Fusilade Super are also smaller in these varieties they are mostly still economically beneficial. When a variety, such as N19, responds differently to ethephon and Fusilade Super from one season to the next, despite conditions being conducive to both ripeners, the matter of recommending a chemical becomes more complicated. It is fortuitous that N19 responds consistently to the combination of ethephon followed by Fusilade Super. Like N19, both NCo376 and N25 respond better to the combined ripener treatment than to any of the single treatments. The gains from the combination treatment in some varieties, however, are sometimes not sufficient to offset the additional costs of the chemicals and their application (Donaldson, 1996). Distinguishing between these two groups of varieties is important in optimising the inputs and returns from this husbandry practice.

POTENTIAL FOR WIDER USAGE ?

About 37% of the irrigated crop and about 2% of the non-irrigated crop were ripened with chemicals in South Africa during 1997. While a substantial part of the irrigated crop could be ripened by drying-off, there is still scope for greater chemical usage when sugarcane is harvested annually during months of high rainfall. Much of the non-irrigated sugarcane is grown on terrain that makes application by fixed wing aircraft or by ground rigs very difficult. The purveyors of the chemicals do not condone using mistblowers, microlight aircraft and overhead sprinklers to apply ripeners because the chances of maldistribution, drift and/or volatilisation of the chemical are greatly enhanced by these methods. However, formulations of the chemicals are being developed specifically for ultra-low volume application and are being tested commercially. The unpredictable rainfall and older age at which cane is harvested are additional reasons for the limited use in these areas. It is anticipated that the greater usage of chemical ripening will therefore largely come from the present expansion of irrigated areas, a more stable supply of irrigation water in these areas, longer milling seasons and possibly from cane payment schemes that reward better quality cane.

SOME ENVIRONMENTAL ISSUES

(1) The pressures to reduce the amount of chemicals used on crops will continue. Brokers of South African sugar are requesting information regarding the nature and amounts of chemicals used in sugarcane cultivation. This may be an indication that a sector of the world community is becoming serious about buying **commodities that have had minimal exposure to agri-chemicals**.

(2) Vegetable and fruit farmers that are neighbours to sugarcane fields sprayed with ripeners (particularly ethephon) have reported crop failures that they suspect have been caused by **drift**. Greater attention to detail is needed to apply chemicals safely. The chances of drift are greater when droplet-size is reduced in a spraying operation. Adopting any method of application which reduces droplet-size should be done with due caution – if at all.

(3) The US Environmental Protection Agency (EPA) is drafting new regulations that will reduce the **maximum allowable residues** of pesticides that can be left on the crop by an additional ten fold factor unless the chemical company can prove that the chemical is not especially toxic to children.

OTHER COUNTRIES AND PRODUCTS

Ripeners are either being researched or applied in most sugarcane industries. Some of the countries cited in publications are Hawaii, US (Florida, Louisiana, Texas and Puerto Rico), Taiwan, Brazil, Mauritius, Guyana, Cuba, Colombia, Indonesia, Malaysia and Australia. In Africa at least some growth regulation work has been done in Sudan and Zambia but most of the technology filters out from Zimbabwe, Swaziland and South Africa. In recent publications two products that have not been tested in South Africa are showing promise as ripeners. Curavil contains methyl sulfometuron and has been tested in Brazil with some success and Touchdown (the trimesium salts of glyphosate) is being used commercially in Guyana. In Australia there is renewed interest in chemical ripening mainly due to low quality at the start of the milling season which is being extended into autumn months.

FUTURE RESEARCH

Recently there has been an increase in the number of new varieties released for cultivation under irrigation. Providing information on the most suitable ripening method for these varieties and for those for which we have little data will be the main focus in the programme.

Gallant Super (haloxyfop-R methyl ester) has recently been registered for ripening autumn harvested sugarcane in South Africa. Little is known about the responses of the present commercial varieties to this chemical. However, since it has the same mode of action as Fusilade Super it is likely that the efficacy of the product will be governed by similar factors.

Sugarcane is increasingly being milled during the summer months when crops cannot be crushed within the usual milling period. During the summer months growth is particularly vigorous and ripeners applied 35 to 40 days before harvesting has sometimes reduced cane yields to the extent of negating the possible gain in sucrose yields. A schedule based on growing degree-days needs to be developed to accommodate all possible growing conditions throughout the South African sugar industry.

An analysis of the changes in the components of the sugarcane stalk caused by ripeners may be needed to elucidate the process of dry matter partitioning that favours the accumulation of sucrose. Such an analysis can also provide benchmarks of the possible gains that can be accrued from using ripeners. Quantifying the changes to the components may be an essential step for incorporating chemical ripening into growth simulation models.

CONCLUSION–Are we contributing to global competitiveness?

The correct use of chemical ripeners has proven to be an essential practice in maximising profits of sugarcane farming in South Africa. Not only is this contributing to global competitiveness but we have, judging by the extensive references to South African research in two recent reviews on chemical ripening (Eastwood and Davis (1997) and McDonald and Kingston (1999)), probably been one of the front-runners in this technology. The review by the Australian authors, McDonald and Kingston (1999), dedicated three pages to the research done in South Africa and little more than half a page to research ~~on~~ in other countries. "A scientist dedicated to ripener research since work began on the subject in 1968", has been cited as a reason for the consistency of the South African work.

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EXTENSION APPROACH TO IMPROVING CANE QUALITY

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A. Introduction

In recent years an incentive to change from a sucrose cane payment to a recoverable sucrose payment system cane from the LMC report.

During 1996, technical information available to this industry on cane quality was assimilated into a useable form by a SASA Adhoc Cane Quality Committee. Local grower leadership was then introduced to a cane quality payment (ERC at that time) and other linked issues during a series of Bosberaads around the industry, initiated by SA Cane Growers.

This paper is an attempt to give an outline of Extensions' (SASEX) role in explaining what the individual grower needs to do in the field in order to maximise any new cane payment system (ERC and later RV). The experience at Maidstone is described.

The task for extension falls broadly with two challenges :

1) To ensure the grower understands what changes and why he has to make them in his farming system – from a sucrose producing potential to a recoverable sucrose producing potential on his farm.

2) Promote an information system to enable the grower to interpret his cane quality data on a weekly/monthly and annual basis and, where necessary, make the required management or field changes.

B. Challenge 1 – Clean, Fresh and Mature

During an in-service training session, Quinn Mann and Trevor Culverwell introduced to fellow extension officers the concept of improved cane quality (ERC or RV) coming from clean, fresh and mature cane and this formed the basis for the Maidstone Extension thrust; mostly in small group meetings. These meetings were shared with the local REAM (Graham Moor) who dealt with the financial implications. This dual thrust was important in subsequent seasons when a local RV cane payment system was implemented in the Maidstone mill group.

a) Clean Cane

A valuable tool in describing to growers the contribution or non contribution of various parts of the cane stalk to cane quality is shown in APPENDIX 1. This is an artificially constructed stalk designed to represent the "Industrial Average"
and might represent annual cane quality. Various calculations were done to illustrate the effect on cane quality at different topping heights and subsequent

saving in transport costs. During the meetings demonstrations were given on topping height and practical methods of adjusting topping height were shown.

b) Fresh Cane

A comprehensive harvest to crush exercise, conducted by the then Sugar Industry Central Board (Convenor : Arnold Brokensha), was undertaken for the Amatikulu, Jaagbaan and Umzimkulu mills during the 1974/75 season. The findings of the report served as a basis for developing a survey method for estimating/measuring delays at Maidstone. The 1974 survey results produced parameters for cane delays found in the field as a result of the various management practices encountered. For example, the average burn to harvest delay with different burning regimes were found to be as follows:

Burn to harvest delay

Burning cycle	**Average delay from burn to cut (hours)**	
	No overlap burning	**1 day overlap burning**
i) Daily	3	31
ii) Three times per week :		
a) Mon; Wed; Fri	15	43
b) Tue; Thurs; Sat	19	47
iii) Twice per week :		
a) Monday and Thursday	27	55
b) Tuesday and Friday	31	59
c) Wednesday and Saturday	35	63
iv) Once per week :		
a) Monday	63	91
b) Tuesdays	67	95
c) Wednesdays	71	99
d) Thursdays	75	103
e) Fridays	79	107
f) Saturdays	83	111

By observing their burning practices over a period of two weeks, each grower was asked to discern the minimum, average and maximum burn to harvest delays and the percentage of tons involved in each category. This enabled his weighted average burn to harvest delay to be estimated.

In a similar manner, the in-field harvest delay (from the commencement of harvest to delivery to the loading zone) can be estimated from survey results produced in this report.

Harvest to Loading Zone delay

	Delay
Cut and stack and load – day one	3 hrs
Cut and stack day one } load day two }	30 hrs
Cut, windrows and load (hand or machine) – day one	3 hrs
Cut, windrows (hand or machine) – day one } Load (hand or machine) – day two }	30 hrs
Cut and windrow – day one } Stack – day two } Load and despatch – day three }	54 hrs

Where cane is transhipped, the delay on the loading zone can be measured by means of a "profit and loss" account. Growers were asked to record the number of stacks delivered to the zone and shipped from the loading zone on a daily basis. This was then analysed using a programme written by Carel Bezuidenhout from the Agronomy Department and adapted for the purposes of a Maidstone survey. The measurement of cane delay on any zone is accurate provided it can be assumed that cane arrives and departs on a first in first out basis. See APPENDIX 2.

It is believed that this is a relatively acceptable but effective method of estimating cane delay but to date only a pilot survey has been completed. The result of a 12 farm survey is as follows :

	Burn to harvest delay	Harvest delay	Zone Delay	Total Delay
Survey result	29.2	27.7	28.3	77.2
Achievable *	15	16.5	15	46.5

* 3 burns a week, 50% cut and hauled on the same day.

c) Mature Cane

The presence of eldana in the Maidstone area severely reduces the age of harvest. A reasonably accurate estimate of the age of harvest was obtained from cutting cycles using data extracted from the 1999/2000 first Mill estimate. The results for the four homogeneous areas of large private growers are as follows:

	Average farm age of harvest (months)		
	Min	Max	Average
Coastal Sands	10.5	13	11.9
Coastal Heavy Clays	10.8	14.6	12.5
Rising plateau (Cartref)	11.1	16.0	13.0
Upper plateau (Mistbelt)	14.6	18.0	16.3
Average			14.0

Young cane, harvested early in the season, plays havoc with cane purities and this impacts on any RV cane payment system. This is illustrated in a trial conducted at the old Central Field Station for seven ratoon crops harvested in May and November at 12 months and 18 months of age between 1967 and 1974.

	Purity %	
	May	November
12 months	78.0	88.8
18 months	88.3	89.5

Individual growers have been notified of their average age of cane at harvest, and the implication for RV cane payment on young cane harvested early in the season is apparent.

There is pressure, especially by millers, for large areas of cane to be ripened artificially. Most of the cane produced by private growers is dryland. The recommendation for the use of ripeners by SASEX and Extension is that the decision whether to use ripener or not should be taken on a field by field basis with growing conditions judged on a weekly basis. Generally, Fusilade is the ripener of choice as the ripening period is about six weeks and soil moisture can fairly easily be predicted for that period. The three months growing condition required for Ethrel is too long unless the cane is irrigated or the soil has other ground water sources.

As Fusilade requires a minimum of 8 to 10 green leaves with long green tops, a full soil profile and a 100 ton yield for a return of 0,8 tons sucrose, soil depth and clay content are important aspects (besides rainfall) in predicting a 0,8tons (400%) return.

It is estimated that when the following factors are taken into account, only 10% of the fields meet the above criteria in any one year. This is due to unfavourable conditions found on

- hill tops (especially coastal sands)
- shallow drought- prone soils
- grey soils in valley bottoms

- steep fields
- minimal response to carry over fields
- insufficient heat or sustained rainfall in Spring/early Summer
- unfavourable weather conditions every second year on average

Growers who spray under less than ideal conditions may do so profitability but also run the risk of making no return and, as measuring response under commercial conditions is nearly impossible, may never know what their return has been. Over time, the advantage in cane quality due to ripening of persistent risk-takers may be measured.

C. Challenge 2 – Interpretation of Data for Corrective Action

The key to getting growers to understand the implication of a RV cane payment system is to ensure an understanding of the components of cane quality. A system developed by Murt Murdoch, when attempting to discern the parameters of eldana damage in the early 1980's, is an ideal method in that the quality measurements used can be obtained from cane payment printouts. It is also important for growers to realise that under the present RV formulae (RV = S – 0.35 NS – 0.02 F), attainment of a high sucrose % is an essential first step and that management factors relating to purity then assume added importance (APPENDIX 3).

The calculation of quality components from cane payment slips to allow a grower to compare his weeks quality with that of the mill average is as follows:

From cane payment			Fibre	Brix	DM	Brix% DM	Purity	Sucrose
Sucrose	12.62							
Fibre	14.85	Mill weekly Average →	14.85	14.81	29.66	49.9	85.21	12.62
NS	2.19							
Sucrose	11.92							
Fibre	17.33	Grower weekly Average →	17.33	14.92	32.25	46.3	79.89	11.92
NS	3.00							

Difference	108.7	92.8	93.7	94.5
Check	108.7	X 92.8/100	X 93.7/100	= 94.5

If the quality information is presented to the grower in this fashion, he should be able to ask and then to answer questions as to why his sucrose is 94,5% of the mill average. .

In the above example, the grower's cane has low moisture and usefully high dry matter (DM), i.e. 108,7% of the mill average. However, the useful Brix part of that DM is low at only 92,8% of the mill average. The high DM% is therefore probably due to extraneous matter, a fact confirmed by the high fibre%. Finally, of the Brix (total sugars), the grower finds he has high percentage of reducing sugars, starches and gums giving him a purity of only 93,7% of the weekly mill average. This could be due to factors such as high topping or lengthy burn to crush delays. Further reasons for differences in quality components are given in APPEDIX 4.

It is believed that once growers have grasped the concept shown above and the above calculations provided for them on a routine basis on their payslips, then good progress can be made to improving cane quality. In newsletters from the extension desk, this concept has been promoted (see APPENDIX 5).There is wide variation in cane quality within homogeneous areas and this emphasises the important role that management has in cane quality control. The use of a simple spreadsheet programme can be used to make the required calculation, see APPENDIX 6.

It has been informative to examine the quality components of the Union Co-op Mill where it is in the interest of growers to send in high quality cane (milling profits) and where field management is closely monitored.

1997/98 Season to date (27/12/97)

Mill	Percent of Industrial Average			
	DM %	**Brix % DM**	**Purity**	**Sucrose %**
Maidstone	97	98	98	94
Eston	102	100	102	105
Union Co-op	95	108	103	105
Noodsberg	99	102	102	103
Industry	30.27	49.4	84.96	12.71

1999/2000 Season to date(16/08/99)

Mill	Percent of Industrial Average			
	DM %	**Brix % DM**	**Purity**	**Sucrose %**
Maidstone	100	97	98	95
Eston	103	104	103	111
Union Co-op	100	105	103	110
Noodsberg	100	104	102	108
Industry	30.67	53.13	85.31	13.91

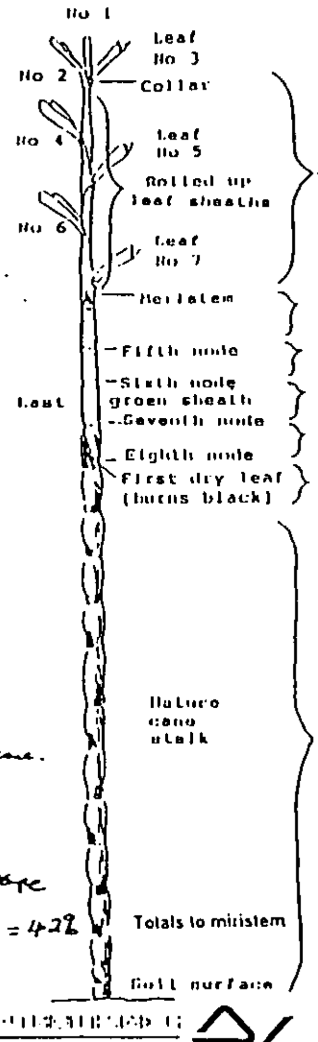
It is not certain why Union Co-op has a markedly low DM% relative to other Midland mills in the wet 97/98 season (younger cane, deeper soils or higher rainfall?) but the management practices are such that the DM is full of Brix which also has good purity.

In the drier 99/00 season, DM% is more similar (poor rainfall in all areas) yet Brix% DM and purity are still high relative to DM. It is concluded that if DM% is reasonably good (mature cane), together with high Brix% DM and purity, management practices must have been good. This line of reasoning is built into APPENDIX 7, which enables various combinations of quality components to be interpreted in order to explain field management.

This has enabled Extension to contact the worst 20 farms with the lowest RV cane payment on a quarterly basis and inform the growers as to possible reasons for poor cane quality.

The Extension effort over the past few seasons to bring about change and the understanding of cane quality on individual farms has only been possible due to data regularly supplied by the Biometry Department at SASEX.

EXTENSION DIVISION



2½ units inhouse average.

Mass t/ha	Sucrose %	Brix %	Purity	Fibre %	ERC %	Dry mat %	Moist %	Tons suc	Non-suc %	Tons non-suc	Tons fibre	ERC %	Tons ERC
12.50	0.20	4.00	5.00	16.00		20.00	80.00	0.03	3.00	0.48	2.00	-2.13	-0.27
									NB!				
3.00	0.30	7.00	4.29	14.00		21.00	79.00	$\boxed{0.01}$	6.70	0.20	0.42	-3.54	$\boxed{-0.11}$
3.50 (10.5)	1.00	7.50	13.33	13.00		20.50	79.50	$\boxed{0.04}$	6.50	0.23	0.46	-2.73	$\boxed{-0.10}$
4.00	2.00	8.00	25.00	13.25		21.25	78.75	$\boxed{0.08}$ $\boxed{.13}$	6.00	0.24	0.53	-1.49	$\boxed{-0.06}$ $\boxed{-.27}$
4.50	4.00	9.00	44.44	13.50		22.50	77.50	0.18	5.00	0.23	0.61	0.99	0.04
5.00	8.00	11.00	72.73	14.00		25.00	75.00	0.40	3.00	0.15	0.70	5.96	0.30
80.00	14.68	16.48	69.08	14.13		30.61	69.39	11.74	1.80	1.44	11.30	13.13	10.51
Totals to meristem 100.00	12.45	14.93	83.37	14.02		28.95	71.05	12.45	2.48	2.48	14.02	10.59	10.59
	11.86		83.1	15.7	Maidstone gro.								.27
													10.86

Price R/ton.

$\frac{100}{12.5} = 8:1.$

$\frac{925}{8} = $ R115 per ton cane.

R11516

12.45 @ R925

Total ERC advantage

2.93
1.50
.37
R 4.80 per ton.

$100 \times \frac{4.8}{115} = 4.2\%$

2½ units Tops
2.5 tons per 100 tons
.025 tons per ton
0.025 × 15 × R1.00 = 37.5 cents

Meristem to 7th Node

10.5 tons per 100 tons.
0.1 ton per ton of cane
at 15 km. 0.1 × 15 × R100 = R1.50

R2.93
= R2.93 per ton.
+
transport saving
R100 per t km @ 15 km.

$925 \times \frac{12.45}{10.59} \times 10.86$
= R11809

APPENDIX 1

LOADING ZONE DELAY

from the extension desk...

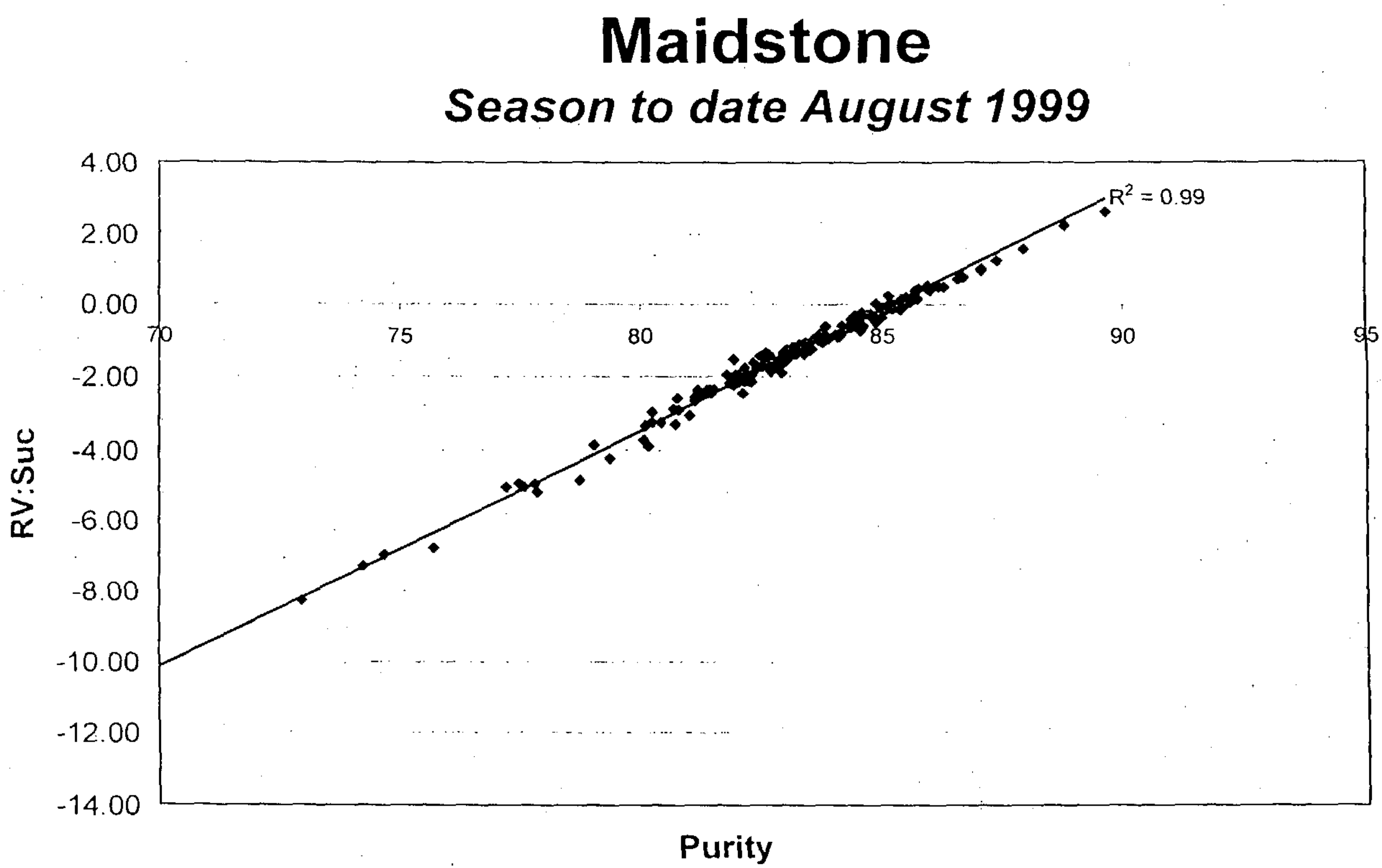
SITE:

TESTING SITE				DAY 1			DAY 2			DAY 3		
DATE	IN	OUT	BAL	IN	OUT	BAL	IN	OUT	BAL	IN	OUT	BAL
	10	10	0	10	10	0						
	12	10	2	12	10	2	0	0	0			
	0	5	0	0	0	0	2	2	0	0	0	0
	10	0	10	10	0	10	0	0	0	0	0	0
	10	0	20	10	0	10	10	0	10	0	0	0
	12	18	14	12	0	12	10	8	2	10	10	0
	10	20	4	10	6	4	12	12	0	2	2	0
	10	12	2	10	8	2	4	4	0	0	0	0
	10	12	0	10	10	0	2	2	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	84	87			44			28			12	

660	44
1092	28
756	12
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
2508	84

Weighted Av Delay 29.85714 hours

APPENDIX 2


Maidstone
Season to date August 1999
$R^2 = 0.99$
RV:Suc
Purity
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
70
75
80
85
90
95

APPENDIX 3

APPENDIX 4

QUALITY RATIOS

1. $\frac{\text{Brix}}{\text{Brix + Fibre (DM)}} \times 100$

Stalk + Trash + Tops + Sand

\+ Variety + eldana + droughted cane

2. DM/Moisture

Young cane, high rainfall, good soils

3. Purity

Young cane cut early in season
Tops
Cane delay

4. Combinations

(i) DM/moisture - same (similar)
Brix % DM - same (similar)
Sucrose different }
Purity different } = inconsistent topping

(ii) DM/moisture - different
Brix % DM - different droughted
Sucrose - different = frosted
Purity - different delay

(iii) DM/moisture - high
Brix % - Low
Purity - same = trash/sand
\- low = trash/tops/sand

Summary all groups

From the Extension desk...

	Sucrose %cane	Non-Suc %cane	Fibre %cane	Purity	Dry Matter %cane	Brix %DM	RV %cane	Relative to group average (%)					
								Suc%	DM%	Bx%DM	Purity	RV%	RV/SUC
Group 1	11.50	3.08	15.58	78.67	30.16	48.39	10.11	93	99	97	97	91	98
Group 2	11.92	3.10	14.79	79.22	29.81	50.42	10.54	96	98	101	98	95	99
Group 3	12.24	2.82	15.68	81.17	30.74	49.08	10.95	99	101	98	100	99	100
Group 4	12.63	2.43	14.85	83.80	29.91	50.36	11.48	102	98	101	103	104	102
MCP	12.65	2.97	15.46	80.94	31.09	50.28	11.31	102	102	101	100	102	100
Med Scale	12.83	2.71	15.34	82.46	30.88	50.36	11.57	104	101	101	102	104	101
	12.39	2.86	15.26	81.10	30.51	50.02	11.08						

Homogenous group comparison Group 1

Farm No	Farm	Name	Group 1	Tons	Sucrose %cane	Non-Suc %cane	Fibre %cane	Purity	Dry Matter %cane	Brix %DM	RV %cane	Relative to group average (%)				RV%
												Suc%	DM%	Bx%DM	Purity	
120434A	Grower 1		1	227	9.85	3.35	17.5	74.6	30.7	43.0	8.32	86	102	89	95	82
131913A	Grower 2		1	691	10.36	4.20	16.2	71.2	30.8	47.3	8.57	90	102	98	90	85
130291A	Grower 3		1	76	10.30	3.11	17.2	76.8	30.6	43.8	8.87	90	101	91	98	88
111963A	Grower 4		1	1734	11.38	3.03	15.1	79.0	29.5	48.9	10.02	99	98	101	100	99
135791A	Grower 5		1	758	11.60	3.08	16.3	79.0	31.0	47.4	10.20	101	103	98	100	101
122514A	Grower 6		1	1961	12.02	2.89	14.3	80.6	29.2	51.0	10.73	105	97	105	102	106
116584B	Grower 7		1	310	12.83	2.66	33.0	82.8	30.0	51.6	11.61	112	99	107	105	115
116584A	Grower 8		1	1530	13.64	2.34	13.5	85.3	29.5	54.1	12.55	119	98	112	108	124
Homogenous Group Average					11.50	3.08	17.89	78.67	30.16	48.39	10.11					

APPENDIX 5

MURTS' FORMULAE

35977.00	Fib	Brix	DM	Bx%DM	Purity	Sucrose
Set 1	Mill week Av 14.85	14.81	29.66	49.93	85.21	12.62
Set 2	Grower wk Av 17.33	14.92	32.25	46.26	79.89	11.92

Difference	108.73	92.65	93.76	94.45
Check	108.73	100.74	94.45	
%Diff	8.73	-7.35	-6.24	-5.55

Set 1	
Fibre%	14.85
Nsuc%	2.19
Suc%	12.62

Set 2	
Fibre%	17.33
Nsuc%	3
Suc%	11.92

Comment: Low sucrose is probably due to excessive extraneous matter(high fibre) and possibly high topping. Check harvest-crush delay.

APPENDIX 6

KEY FOR QUALITY ANALYSIS INTERPRETATIN				
Sucrose %	**DM %**	**BX%DM**	**Purity**	**Comment**
VH	H	VH/H	VH	Mature, clean and low topped
H	H	VH/H	H	Mature, clean cane
H	M/L	H/M	H/M	Younger, clean, very low topped, dried off
H	H	M/L	H	Younger, possibly trashed (S), low topped
M	M	H	H	Younger, clean, low topped
M	M	M	H	Very young, clean, low topped
M	M	M	M	Average Cane
M	M	M	V/L	Younger, clean, low topped, delay (?)
M	L	H	H	Very young clean, very low topped
M	L	H	M/L	Very young, clean, adequate topping
M	H	L	M	Younger with some trash(S) and tops
L	H/M	L	H/M	Younger with some trash(S) but topped
L	H/M	L/VL	L/VL	Younger with trash(S) and tops
L	L	M/L	M	Younger, clean, dried off
L	L	H	L/VL	Very young, clean and delayed?
L	L/VL	H	M/L	Very young with some adequate topping
L	L	L	L	Young with maybe a little trash(S) and tops
L/VL	VL	L/VL	L	Too young – increase age/ripen

H = High M = Medium L = Low V = Very

Dried Off = Lack of rain or ripener use
Bx%DM = is not considered to be affected bv drought or eldana this season to date

EVALUATION OF METHODS TO REDUCE HARVEST-TO-CRUSH DELAYS – SEZELA CASE STUDY

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1. Introduction

Long delays between the harvesting and crushing of sugarcane and the associated deterioration of cane quality have long been recognised as a major source of loss to the sugar industry. Different methods of reducing harvest-to-crush delays need to be evaluated without expensive and time consuming experimentation on real world harvesting and delivery systems. A joint project between the Agricultural Research Council, Institute for Agricultural Engineering, the South African Sugar Association Experiment Station and the School of Bioresource Engineering and Environmental Hydrology of the University of Natal was therefore initiated to develop a computer based model which could be used to evaluate different methods of reducing harvest-to-crush delays. This project was run as a Masters degree project and is documented fully in Barnes (1998).

The model was developed using data collected from the Sezela mill area and various strategies for reducing harvest-to-crush delays, such as altered burning and delivery schedules and implementation of harvesting groups were investigated for the mill area. Data were collected from interviews with mill, haulier and extension personnel and growers, mill records and by means of surveys of harvesting and transport systems used in the area. Detailed data on millyard operations were derived from a previous simulation model of the Sezela millyard and additional time studies that were performed in the millyard.

2. Model Formulation

The Arena Simulation System was chosen as the software with which to develop the model. Simulation modelling as it was used in this project, involves using time delays to describe various processes such as cutting, loading or transport and combining them in a manner, which represents the way that they interact in the real system. The time delays can be described using frequency distributions, which are sampled each time the delays are required in the model. Entities, which may represent tons of cane or trucks, are passed through the model, interacting with various system resources, such as loading and offloading equipment and space available in stockpiles. By recording statistics on times and numbers in queues, the variability and interactions in the system can be analysed.

The model was developed at the scale of a particular mill and the area of farms supplying it with cane, since many of the problems leading to excessive harvest-to-crush delays were thought to be the results of interactions between harvesting, delivery and milling schedules. All operations from burning or cutting up until the feeding of cane into the mill for crushing were included, since this is the time period in which deterioration of cane quality occurs. Each individual farm, or combination of farms supplying cane to the mill with their different systems of harvesting and transport had to be represented to simulate the effect of cane being delivered from various points and at different timings. A flow diagram of some systems represented in the model and the general structure of the model is shown in Figure 1.

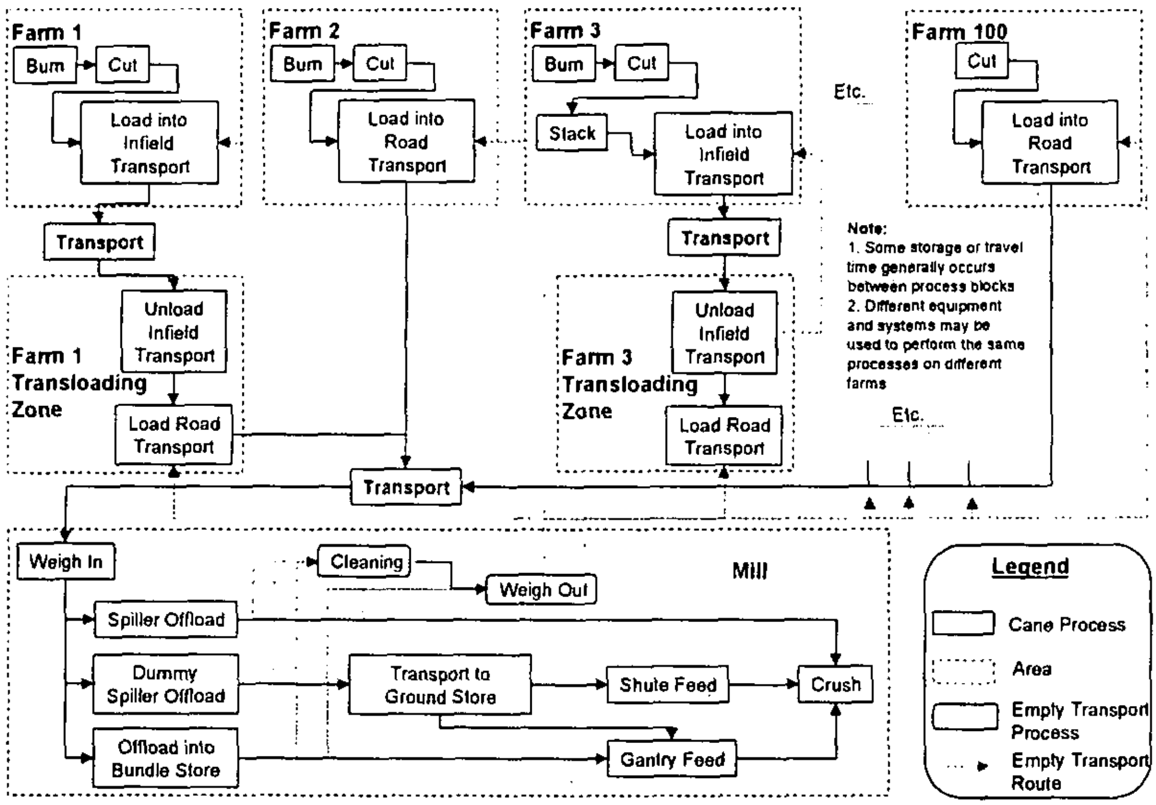


Figure 1. Structure of harvesting and delivery system in model

Data for the schedules and systems used on the individual farms were entered into an Excel spreadsheet which had macros that created text files that the Arena software read into the model. This was particularly useful in setting up the different scenarios, which were run in the model to evaluate different methods of reducing harvest-to-crush delays. Each run was set to a duration of 20 weeks so that variability in the model's output caused by the variable process times used, could be averaged out to provide a reliable estimate of average harvest-to-crush delay.

3. Model Validation

Validation of the model was performed by running the model with the inputs set up to approximate the existing situation at the Sezela mill as closely as possible and then comparing the model output with observed data. In a study performed by Illovo Sugar at the mill, the time of arrival of trucks at the mill gate was recorded over a 3-week period. This data was compared with the pattern of truck arrivals at the mill gate in the model and showed that, although some discrepancies occurred due to the method of truck despatching used in the model, the model simulated reality reasonably well.

For miller-cum-planter (MCP) cane at Sezela, records showed that the average harvest-to-millgate delay was of the order of 57 hours. MCP cane mostly falls into the category of cane offloaded directly onto the spiller tables and thus this harvest-to-millgate delay would be very close to its harvest-to-crush delay. The harvest-to-crush delay simulated by the model for cane offloaded directly onto the spiller tables was of the order of 35 hours. This discrepancy was attributed to the fact that mill and harvesting and transport equipment breakdowns, weather stoppages and delays due to managerial discretion were not allowed for in the original model.

In a follow up project, the model was altered to try and allow for breakdowns and weather stoppages (Barnes, 1999). Although the simulated delay for spiller offloaded cane could only be increased to 40 hours, it was shown that the percentage changes in overall average weekly harvest-to-crush delays from the existing situation for the various scenarios that were investigated were very similar to those obtained with the original model. This demonstrated that the trends indicated by the model were valid, despite the fact that it under-simulated harvest-to-crush delays. The results for the various scenario runs for both versions of the model are shown in Table 1.

Table 1. Results of scenario runs

No	Scenario	Original Model		Altered Model	
		Average Weekly Delay (h)	% Change from Existing Situation Scenario	Average Weekly Delay (h)	% Change from Existing Situation Scenario
1	Existing Situation	38.2		47.0	
2	Balanced Delivery Plan	39.7	3.9	48.0	2.1
3	Daily Burn Schedule	29.7	-22.3	34.1	-27.4
4	Cutting Green Cane	25.8	-32.5	34.4	-26.8
5	More Farms on Direct Delivery	35	-8.4	No Result	
6	Mon-Sun Harvesting	19.4	-49.2	No Result	
7	Mon-Sat Crushing	27.4	-28.3	33.2	-29.4
8	Single Central Haulier (100 Vehicles)	39.2	2.6	47.6	1.3
9	Single Central Haulier (80 Vehicles)	39.8	4.2	44.3	-5.7
10	Harvesting Groups	26.3	-31.2	30.5	-35.1
11	Idealised System	12	-68.6	17.1	-63.6

4. Scenario Runs and Results

The various scenarios listed in Table 1 were run to evaluate the effect of different proposed methods of reducing harvest-to-crush delays.

4.1 Existing Situation

The point estimate of overall average weekly harvest-to-crush delay is broken down into point estimates of the average weekly delays incurred by cane in the various stockpiles in the system in Figure 2. The long delays incurred in the NightBurntCut and BurntCut (burnt cane waiting to be cut) stockpiles are due to the practice of only burning cane every second or third day that occurs on many farms in the Sezela mill area. Cane burnt on a Monday morning may have to wait until Tuesday or Wednesday afternoon before it is cut, thus incurring an additional 24 to 48 hour delay. The long delays in the transloading zone stockpiles (Bundle Transload and Spiller Transload) are caused by the differences in harvesting and delivery schedules. Harvesting occurs Monday to Saturday and on some farms, delivery occurs Tuesday to Sunday or seven days a week, so stockpiles have to be built up in the transloading zones during the week to ensure that there is cane to transport on a Sunday. A similar reasoning can be applied to the long delays in the millyard stockpiles (BundleStore and GroundStock). The mill crushes Monday to Sunday and the bulk of deliveries to the mill arrive from Monday to Saturday, and so cane has to be built up in the millyard stockpiles during the week to supply the mill on a Sunday

4.2 Balanced Delivery Plan

The principle of balancing deliveries of cane through the course of the week was to try and reduce periods of congestion at the mill, decrease vehicle turnaround times and therefore make vehicles available again more quickly. The model indicated that this strategy would not be particularly effective, only reducing delays by approximately 3%. One possible explanation is that, although the truck dispatching algorithm in the model ensures that the day-night and weekday distribution of deliveries to the mill is balanced, it does not ensure that the deliveries are evenly distributed within a particular 12 hour period and therefore congestion may still occur at periods of peak arrivals

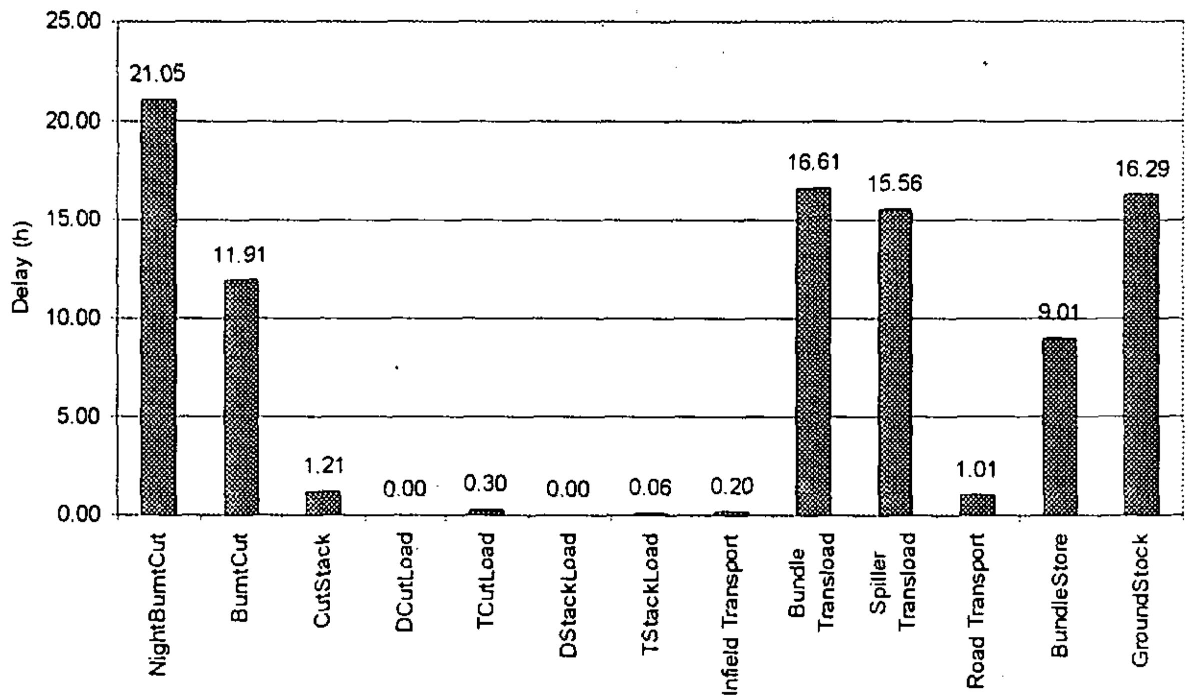


Figure 2. Average stockpile delays for existing situation scenario

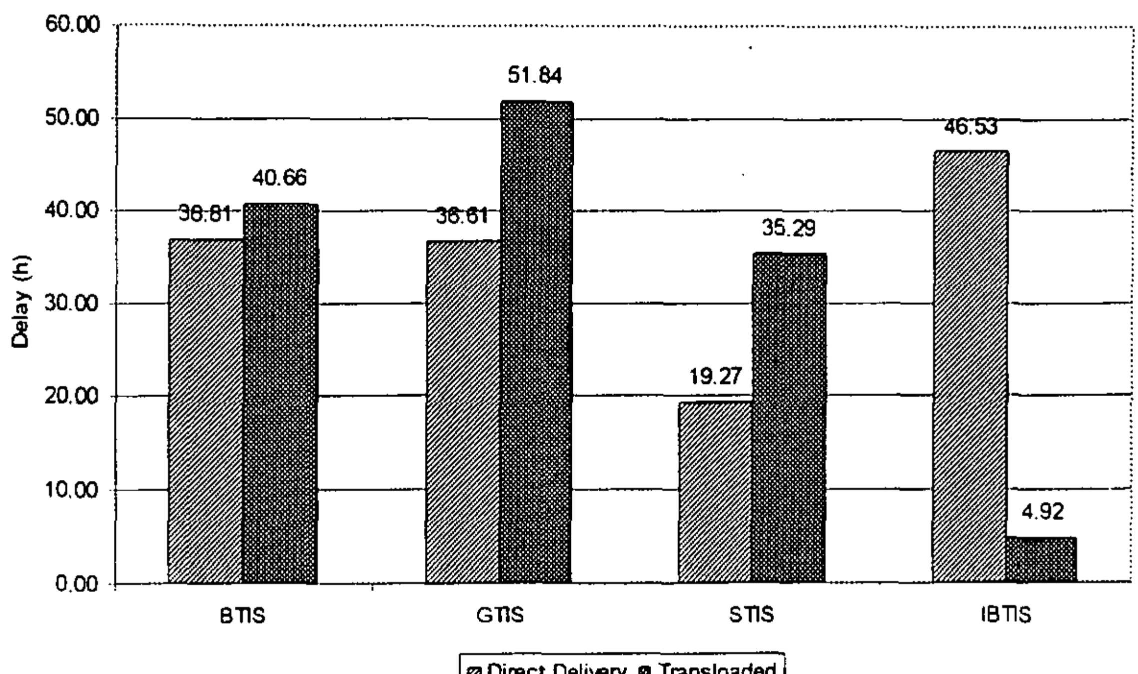
4.3 Improved management of burning schedules

A daily, mornings only burn schedule should decrease delays by ensuring that no cane stands in the field overnight, waiting to be cut. The model indicated that such a strategy would decrease delays by approximately 22%. One problem with this scenario is that, on farms with Daily Required Deliveries (DRD) less than approximately 30 tons, cane will have to wait a day or two in the field or transloading zone after being cut until sufficient cane has been accumulated to provide a full load for a truck. Therefore, for the full effect of better management of burning schedules to be useful, farms with smaller DRDs need to practise some sort of group harvesting. By wholly eliminating burning from the harvesting system, delays in the model were decreased by approximately 32%.

4.4 Farms Delivering Direct to the Mill

In this scenario, 34% of the tonnage delivered to the mill was delivered without transloading, thus eliminating delays on the transloading zones for that cane. This strategy only produced an approximately 8% decrease in overall average harvest-to-crush delay, since relatively little of the total tonnage could be delivered direct. In Figure 3 the point estimate of overall average weekly harvest-to-crush delays is broken down into the average weekly delays for components of cane that are transloaded or delivered directly to the mill as well as the components of cane that are offloaded by the various offloading facilities in the millyard. BTIS refers to the time in system or harvest-to-crush delay for bundle cane offloaded into the bundle stockpile. GTIS refers to loose cane offloaded into the ground stockpile by the dummy spiller. STIS refers to loose cane offloaded directly onto the mill table by the spillers. IBTIS refers to bundle cane offloaded immediately onto the mill tables to be crushed. The bundle cane offloaded directly onto the mill table constitutes a very small proportion of total tonnage crushed and therefore the delays recorded for this component of the cane are not representative. For the other offloading techniques, however, it can be seen that the delays for direct delivered cane are significantly less than those for transloaded cane, especially if the cane is delivered in loose form. The difference in delays for ground stockpiled cane and cane offloaded by spillers onto the mill tables is of the order of 15 hours.

Figure 3. Point estimates of average weekly delays for different offloading systems in the farms on direct delivery scenario



4.5 Matching Harvesting, Delivery and Milling Cycles

Changing to a Monday to Sunday harvesting schedule produced a 49% decrease in delays in the model. It must be noted that the daily burn schedules required in the original model for Monday to Sunday harvesting also significantly decrease harvest-to-crush delays as was demonstrated in the daily burn schedule scenario. The additional decrease in delays can be attributed to the fact that cane does not have to be accumulated in the transloading zone and ground stockpiles to supply cane for deliveries and crushing on Sundays.

Changing to a Monday to Saturday crushing schedule (which did not require daily burn schedules) produced a 28% decrease in delays which means that the decrease in delays due to matching harvesting, delivery and milling cycles in this scenario was similar to that in the Monday to Sunday harvesting scenario.

4.6 Use of a Single Central Haulier to Minimise Vehicle Numbers

Using a single central haulier for the entire mill area so that vehicle numbers could be reduced produced very little change in harvest-to-crush delays simulated by the model. The model indicated that a minimum of 80 vehicles was required to be able to transport all the cane to the mill.

4.7 Organisation of Farms into Harvesting Groups

Organisation of farms within their areas into harvesting groups with combined DRD's of at least 100 tons made it practical for all farms to be on daily burning schedule. The decrease in delays simulated in the model produced by this strategy was of the order of 31% which is approximately 8% more than that produced with conversion of all farms to a daily burn schedule alone. The extra decrease was attributed to the fact that no farms had to incur overnight delays on the transloading zones while waiting to accumulate full truckloads.

4.8 Idealised System

In the idealised system scenario the model was set up with all of the most effective of the previously investigated strategies. All farms were organised into harvesting groups and assigned to cut green cane, Monday to Sundays. The farms that could deliver direct to the mill with their current harvesting systems were assigned to do so and all farms were set to deliver cane 7 days a week. This scenario produced a decrease in delays in the model of approximately 68%.

Figure 4 shows that the average weekly harvest-to-crush delay can be as low as 4.7 hours for direct delivered cane offloaded by the spillers directly onto the mill tables. Direct delivered cane stored in the bundle or ground stockpiles before being crushed incurs an average weekly delay of the order of 11.5 hours. This is approximately 7 hours greater than the delay for cane offloaded directly onto the mill tables which is same duration as is incurred in the ground stockpile. In a similar way, the delays for transloaded cane are approximately 8 hours greater than those for direct delivered cane which is the duration of delays incurred in the spiller cane transloading zone stockpiles.

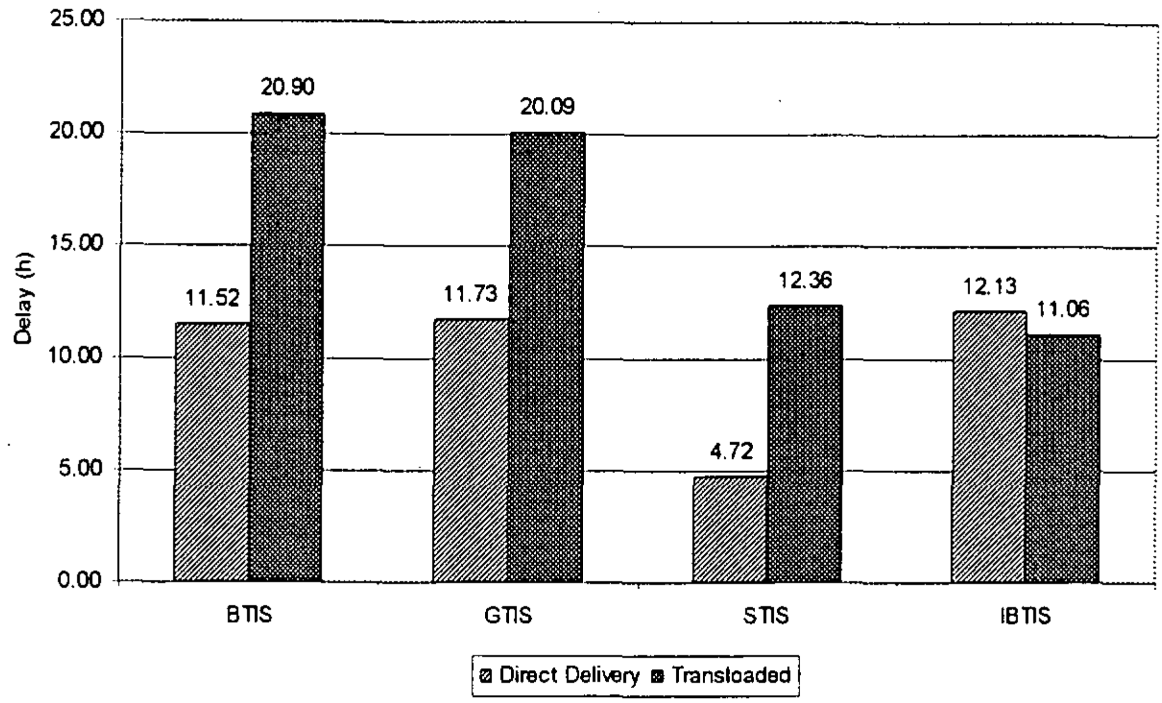


Figure 4. Point estimates of average weekly delays for different offloading systems in the idealised harvesting and deliver scenario.

5. Conclusions

The application of simulation modelling to the investigation of harvest-to-crush delays in the sugarcane harvesting and transport system was reasonably successful. The use of simulation modelling made it possible to model what is a complex system which would have been very difficult to realistically represent using other analytical techniques such as linear programming, scheduling algorithms or queuing theory. Another advantage of using simulation modelling was that all the components of the harvesting and delivery system could be integrated so that a holistic view of the system could be obtained to address the interests of both growers and millers. It also made it possible to represent the variability inherent in the system by including frequency distributions to describe different process times. One drawback of the complexity of the model was the long runtime that it required

The results of the experimental runs performed with the model indicated that the largest delays occur where burnt cane is waiting to be cut, in the transloading zones and in the millyard stockpiles. The delays in the stockpiles were the result of differences in harvesting, delivery and milling cycles and it was evident that the most significant decreases in harvest-to-crush delays can be brought about by matching these cycles as closely as possible. Changing to daily burn schedules had a marked effect on delays and was the major source of decreases in delays when individual farms were converted to harvesting groups, enabling larger areas of cane to be burnt at one time.

The model could now be reasonably easily applied to other mill areas. It would be necessary to perform a survey of the harvesting and delivery systems used in the particular area and to obtain records from the mill on information such as farm DRDs, delivery periods and hauliers which could then be used to set up the input spreadsheets for the model. If harvesting and delivery systems were encountered that are not used in the Sezela mill area (such as mechanical harvesting), these would have to be added to the model. Furthermore, a study of the particular millyard would have to be performed to provide the information required to adjust the millyard section of the model.

6. References

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Barnes, A. 1999. Report to South African Sugar Association Experiment Station: Alterations to harvest-to-crush delay simulation model. Agricultural Research Council – Institute for Agricultural Engineering, Pretoria.

CANE SUPPLY CHAIN MANAGEMENT

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Introduction

The success of any supply chain is dependent upon all the individuals that make up the links of the supply chain, co-operating with each other to achieve a common goal. In the case of any sugar mill, the common goal of the supply chain is to ensure that quality cane is rateably delivered with the optimum economic utilization of vehicles.

There have been more fundamental changes to the lives of every South African and South African Industry over the past two decades than at any time in our history. Besides the political changes, there have been fundamental changes to labour, taxation, environmental and many other facets of legislation to name a few, that have influenced the way we conduct our businesses. The speed at which information technology and communications has, and still is advancing, seems almost exponential and shows no sign of slowing.

The Sugar Industry, besides having to adapt these changes, has had to further adapt to the cathartic changes brought about by the its own deregulation's over the past two decades, and which are still ongoing. To complicate matters further, South Africa's entrance into the "global village", have forced the Industry to produce a consistently high quality product that is acceptable to an ever changing and fickle market. Unless we deliver what the market demands, where, when and how, and in doing so, continue to make a profit, we will go out of business. The energy that created by the changes can be destructive, if we let it, or should we channel it in the right direction, can be a tremendous force that can be used to our advantage.

This paper will outline the dynamics of the supply chain at Sezela, and the changes necessary for its continued success.

Keywords
DRD = Daily rateable delivery
CTS = Cane Testing Services
SMS = Short message system

Background

Similar to most mills in our industry, Sezela is reliant on private growers for nearly 80 % of its cane supply. Of the total deliveries that enter the mill yard, 95 % is by means of spiller vehicles of more than 20-ton capacity, while the balance is delivered in bundle form. Of the bundle vehicles, vehicles that have a capacity more than 20 tons deliver most of this cane. It only a very small minority (2 small growers) that have a prescriptive right to deliver cane in vehicles with a capacity of less than 10 tons directly to the mill. Approximately 55% of allocations are delivered during the day (04h00 to 16h00) and 45% at night.

Allocations are performed over a 6-day delivery week, with the majority of deliveries commencing on a Monday and ending on a Saturday. A small minority of growers delivers on a Sunday. The mill on the other hand, crushes for 168 hours per week or over 6,5 days per week. Monday is set aside as the maintenance day when one diffuser line is shut down for 12 hours for maintenance. The mill that is to crush on the Monday closes for 3 hours on the Sunday of each week to change knives and hammers. In order to ensure a reasonable tonnage for the Sunday crush, approximately 2500 tons is stockpiled in loose cane form in the mill yard and additional deliveries are accepted from growers who have fallen short on deliveries during the week or who have elected to deliver additional cane.

Control systems

After submission to the Mill Group Board of a comprehensive estimate at the start of the season, growers are issued with an allocation or d.r.d, which is based on tons per day. As independent hauliers make most of the deliveries to the mill, allocations or d.r.d's are grouped according to the haulier's customer base. For ease of delivery control and management, the tons based d.r.d. is converted to loads per day based on the hauliers average performance over the past season/month, after each Mill Group Board meeting.

Based on each hauliers d.r.d and growers historical delivery patterns, a weekly delivery schedule is compiled and entered into the weigh bridge d.r.d. computer control system. This will control each haulier's d.r.d to the day and number of loads per day that to be delivered. The schedule is then printed and forwarded to each haulier to confirm the delivery requirements. This allows the haulier time to reflect on his obligations and timeously raise any problems thus avoiding confrontations at the weighbridge. Individual growers, who deliver their own cane to the mill using their own vehicles, are allocated their own d.r.d. While the d.r.d. computer control system has the facility to manage time-scheduled vehicles, growers have rejected this notion.

The system does however, limit hauliers to day, night, or 24-hour deliveries, or day of the week on which they are entitled to deliver. Should a haulier exceed any one of the allowed parameters, the system will not process the delivery and that vehicle will be ejected from the weighbridge. The system can however, be manually overridden depending upon circumstances at the time.

Sezela differs from other mills in the Industry in that it has a totally automated weighbridge. As Sezela has a totally automated weighbridge, vehicle and grower delivery information is captured into the system by means of optically marked consignment notes and vehicle registered transponders. Data such as vehicle registration numbers, time, grower codes, field numbers and loading zones are all captured automatically by the system.

Vehicles arriving at the mill must wait in a two-queue staging area to be called by traffic lights onto the weighbridge. The traffic lights are activated by the weighbridge computer system that monitors the outflow of vehicles from the mill yard and according to pre-set parameters, calls vehicles from the queue. Once weighed, the vehicle is allocated by the system to the waiting offloading point in the mill yard. Once a haulier achieves the allocated d.r.d, the system will not allow any further deliveries to be processed and the vehicle will be rejected from the weighbridge.

Communications systems

In order for the supply chain to be managed effectively, good communication systems are vital. To ascertain the anticipated cane deliveries for each day, hauliers are contacted telephonically in the morning and afternoon. Whilst some of this data is captured automatically via the optically marked consignment notes, not all hauliers have the latest communication technology and verbal communication is still the quickest and most accurate method. The anticipated cane deliveries are then passed onwards to the mill in order to set the crush rate.

Basic delivery performance is via a mass meter voucher issued to each vehicle before leaving the weighbridge after unloading. Other events such as planned mill stoppages; mill breakdowns or delivery problems are also communicated to growers by a message facility on the base of the voucher. Other methods of communication used in emergencies and at regular times of the day are:

- Daily mill performance radio broadcasts at a specified times
- E-mail communications to those growers/hauliers who have this facility
- SMS messages via email to cellular telephones.
- Cellular to cellular SMS messages.
- Hand deliveries via the Hilo's from the weighbridge pigeonhole letterboxes system.

The Transport Committee

To regulate the smooth running of the supply chain and to ensure that the supply chain is as adaptable as possible to the mill requirements, the ever-changing cane crop and the dynamics of road haulage, a transport committee was formed. The committee, comprised of miller, grower and haulier representatives as well as representatives of the Road Traffic Inspectorate and Maintenance Departments.

The committee reports indirectly to the Mill Group Board and is tasked with resolving problems regarding non-rateable cane deliveries, mill yard and queuing delays, cane spillage, vehicle and road safety issues. The committee is also tasked with allocating the number of transponders to be used by hauliers delivering cane to the Sezela Mill. The number of transponders issued to each haulier is based on the haulier's d.r.d, haulage distance to the mill and the average vehicle payload. The average payload is calculated from delivery data downloads from the CTS computer system. In limiting the number of transponders operating within the supply area, the number of trucks operating in the supply chain is kept to functional levels thus avoiding excessive delays or queuing at the mill.

Delivery information feed-back

While it is important for information regarding expected deliveries to be constantly fed into the supply chain, it equally important to be able to monitor the past performance of the chain in order to take timeous corrective action. For the automated weighbridge at Sezela to function, it was necessary to create a comprehensive database of every field of each large grower delivering cane to Sezela. Data such as field number, area of each field, ratoon, age of cane and variety was captured into the database. As each consignment of cane is delivered to the mill, the data pertaining to the field is logged and captured on the weighbridge and CTS file servers. This information has been down-loaded and converted into a comprehensive spreadsheet data base which can be interrogated using filters and pivot tables by age, variety, area, etc.

At the end of each week, the delivery and crush data is copied to the Cane Procurement Department data files where it is converted and saved as an Excel spreadsheet file. As the season progresses, a comprehensive database of cane deliveries is compiled. By using data filters and pivot tables, the delivery data can be manipulated in a fraction of a second in many different combinations. This has proved to be an enormously powerful management tool that is used to monitor the efficiency of the supply chain. The data is available to hauliers and growers so as to monitor their own efficiencies. At the end of the season this data is down-loaded from the spreadsheet files onto a compact disc and stored for future reference in the at the Cane Procurement Department. It must however be stated that the information is uncorrected from that passed on to Sugar Association for cane payment purposes. As our Industry develops user-friendly precision farming/management systems, this information can be downloaded to each stakeholder in the supply chain, allowing managers to make great improvements in their operating efficiencies.

Future developments

Vehicles operating within the Sezela supply chain are limited strictly according to d.r.d requirements and can be monitored from arrival at the mill yard staging area to departure once off-loaded. Further enhance this facility are being planned, by imbedding additional transponder readers at the unloading points within the mill yard. This will allow accurate records of travelling and vehicle delays such as vehicle standing and cleaning times, within the mill yard.

Other enhancements and systems in planning are;

- Linking data downloads to a digital mapping and data base program thus allowing for on-line precision farm management and estimating.
- Real-time data access by growers and hauliers to a dedicated website, will allow for better planning of deliveries and better vehicle utilization.

Conclusion

Compared to other agricultural industries in South Africa, the Sugar Industry is highly organized and extremely well controlled. The technology and information to manage the cane supply chain effectively, is available at most mills in South Africa, yet is not being used to its potential.

If the South African Sugar Industry is to remain in business in the face of declining profits, rising costs and increased global competitiveness, every facet of our inputs must examined and challenged. Second, to labour costs, cane haulage costs represent a major portion of any cane farmers budget. Any improvements in vehicle and farm efficiencies and especially at those mills where there is a long supply chain, such as Sezela, could be the difference survival and failure. All past delivery conventions must be challenged in order to ensure that the quality of our product is acceptable to our customers and globally competitive.