JOINT SESSION ON CANE QUALITY

The Chairman, Dr PH Hewitt, welcomed delegates to the joint agricultural/milling session on cane quality which was the final session of the Congress. He noted that the opening speaker, Mr C Savage, had referred to the need for containing production costs and increasing productivity in order to make the industry more competitive. Dr Hewitt noted that the production costs could be reduced substantially if good quality cane is delivered to the mill. He then reminded delegates that Dr M Clarke, Managing Director, Sugar Processing Research Institute, Inc. was emphatic that the only way to improve cane quality was through the introduction of payment for cane quality.

The first speaker, Mr TL Culverwell, the SA Sugar Association Experiment Station (SASEX) extension officer at Umfolozi, delivered the following paper in which he traced the change in cane quality following the transfer of co-operative grower ownership of a mill to miller company ownership.

THE UMFOLOZI EXPERIENCE

TL CULVERWELL

SASA Experiment Station, PO Box 179, Mtubatuba, 3935

Introduction

This short, non-technical presentation

- Illustrates the changes in Umfolozi sugarcane quality during the past 15 years and discusses possible reasons.
- Supports Dr MA Clarke's statement made at the opening of the SASTA congress, that to improve cane quality, appropriate payment is required.
- Compares a 'total' cane value with a 'sucrose' value and an 'Estimated Recoverable Crystal' value.

History

During the period 1981 to 1995

- Umfolozi cane quality was certainly affected by extremes of devastating floods and droughts of varying intensities. However, another significant event occurred: Umfolozi growers sold their co-operative sugar mill.
- Consequently, in 1992 payment for sugarcane changed from an Umfolozi estimated recoverable sugar formula to the standard SA sucrose formula. I believe growers' perceptions of cane quality also changed at that time.

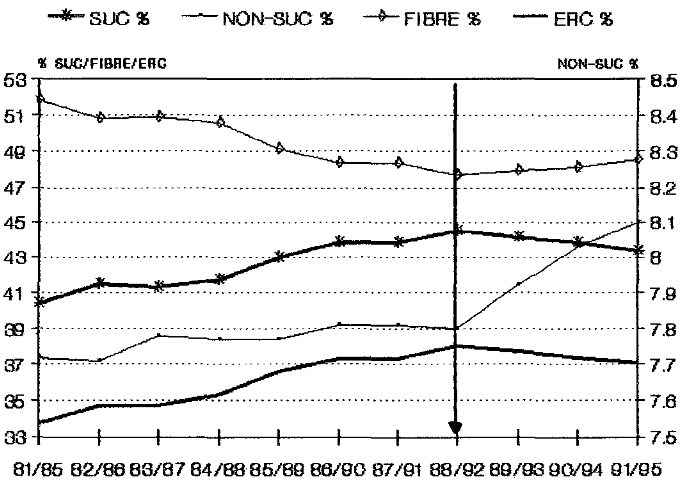

FIGURE 1: Umfolozi dry matter content – 5 year moving average

- They had enjoyed a greater Rand value per ton of cane when more sugar was recovered from a better prepared product delivered to the mill. Furthermore, less ash meant less damage and therefore less cost to their co-operative mill.
- Now the perception is to send the whole cane stalk to the mill to recover all the sucrose. If any other materials such as tops, trash and soil are also delivered to the mill, the growers no longer see it as their problem.
- Co-operation with the miller has tended to change to confrontation, which is probably detrimental to both parties.

Figure 1 shows dry matter (DM) composition changes in quota grower sugarcane as 5 year running averages from 1981-85 to 1991-95.

Comment

1981-85: Umfolozi cane quality near worst in South Africa. Massive damage suffered from two cyclones. A Cane Quality Campaign started. Growers' attention focussed on improving ERC%cane and reducing Ash%cane.

1988-92: Umfolozi cane quality competes with the best in South Africa. Umfolozi Co-operative Sugar Planters sell their mill. Payment based on ERC%cane stops.

Fibre % DM: Declined from 1981-85 until 1988-92, then increased.

Non-sucrose % DM: Remained approximately static until 1988-92, then increased significantly.

Sucrose % DM: Increased from 1981-85 until 1988-92, then decreased.

ERC % DM: Increased from 1981-85 until 1988-92, then decreased.

Declines per 1 million tons cane. 1988-92 compared with 1991-95:

Sucrose = 1 900 tons
ERC = 1 500 tons

Is this trend a mirror image of what could happen if a cane quality payment were reintroduced?

Perhaps, Mr Chairman, in the face of deregulation, increasing competition and rising costs, another serious evaluation of our cane payment system is needed. What are the merits of a future cane value including some or all of these principles?

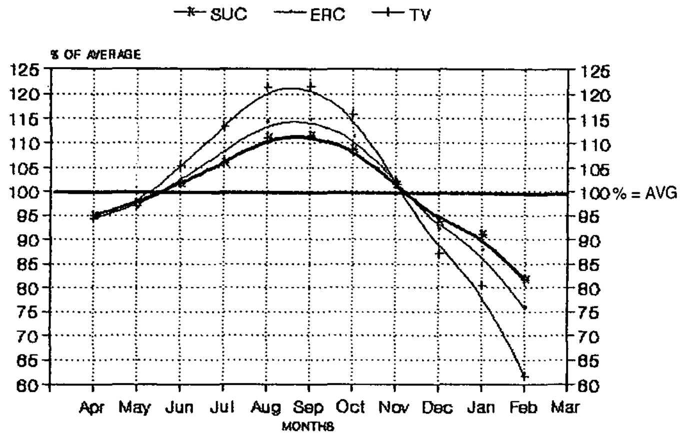

FIGURE 2: Umfolozi 10 year (1995-1994) average sugarcane analyses are compared in terms of sucrose value, ERC value and 'total' value per ton cane with a season average value of 100%.

Cane payment system

Market related. Includes the value of sugar, molasses and fuel fibre.

Common to miller and grower. Both parties can then focus on the same quality value to achieve greater proceeds before division.

Based on Estimated Recoverable Crystal (ERC) % in cane.

A 'total' value could consider some fixed costs:

- Processing of fibre to compensate the miller.
- Processing of molasses to compensate the miller.
- Costs of delivering cane low in sugar content during a prolonged milling season to compensate the grower.

The *sucrose* value varies the least throughout the milling season. This could be the reason why it is favoured by conservative growers with cane quality problems.

The *ERC* value indicates greater opportunity for profit during better cane quality months and greater penalties during poor quality months.

A 'total' cane value displays even greater opportunity for profit during high quality months and greater penalties for poor quality. If both miller and growers measured cane in 'total' value terms instead of in sucrose terms there would probably be more attention paid to cane quality in general, and to length of milling season in particular.

Chairman: It is obvious that there was a substantial change in attitude towards cane quality once the growers no longer had a vested interest in delivering high quality cane.

The following speaker was Mr Q Mann, SASEX extension officer in the Midlands, who discussed the problem of extraneous matter in cane.

EXTRANEOUS MATTER

QV MANN

SASA Experiment Station, PO Box 65, Dalton, 3470

When referring to millable sugarcane, 'extraneous matter' is a delightfully all-embracing term which refers to all the nasty things that find themselves mixed up with the cane stalks crossing the weighbridge at the various sugar mills.

Defining extraneous matter

In sugarcane, what are these 'nasties'? Let us try and list them. They include rocks, stones, building rubble, broken plough shares and discs, fence posts, the poles on the edge of the cane loads which are there to hold the load on the truck or trailer, barbed wire, wire snares, fencing standards, droppers and, of course, cane chains. Hoes, axes and cane knives are sometimes found – with or without their handles. Then there is soil – thousands and thousands of tons of it; cane roots, whole cane stools and other plant roots; woody weeds like wattles and bugweed; dry annual weeds, especially *Erigeron* or 'Mtitembili'; lush succulent weeds like *Convolvulus* or Morning Glory, 'Ubabe', 'Qangaport', and Napier Fodder. And we are not finished yet. Very occasionally there will be found items of clothing, plastic, paper, bottles, tins, and cartons, animals skins and even bones. None of these contain any sucrose and we still have not finished our list. Dead cane leaves are known as trash, and excessive cane trash is often regarded as part of the extraneous matter in millable cane, as are the unripe cane tops, the rolled leaf sheaths above the meristem and the green leaves. All of these also contain little or no sucrose.

Can anyone think of anything else that should be listed as part of the extraneous matter? How about *Eldana* larvae? We are fortunate in the cane industry that there are no toxic chemicals, like insecticides or nematicides, either in or on the cane stalks, which cause milling or marketing problems.

Effect of extraneous matter in the mill process

From this long list of extraneous substances, what causes the biggest problems to millers? Some may think it is the stones or the metal. Indeed stones can cause enormous problems, as can metal objects, if they are not detected before they reach the cane knives or the shredder. Recently one of the Midland mills found a dolerite boulder weighing 65 kg in a bundle of cane. It was more than 400 mm in diameter. If undetected, this would have caused tens of thousands of Rands worth of damage and many hours of delay. Rocks like this can usually be associated with individual consignments and millers often display them prominently or ask the culprits to reclaim their property. Iron and steel objects are usually picked up by powerful electrical magnets placed above the cane train, and are more difficult to associate with individual consignments.

Rocks and metal objects in cane consignments cause highly dramatic problems, but the biggest single 'baddie' in the long list of extraneous materials is unquestionably soil. Soil adhering to cane stalks is detected as ash in a complete cane analysis and, as it is insoluble, it is grouped with cane fibre in the routine Direct Analysis of Cane (DAC). The true ash content of clean mill cane is about 0,6%. Last season the average ash content of all the cane entering South African sugar mills was 1,78%. This means that about 1,18% (nearly 200 000 tons) of soil was delivered by the whole industry. The sand in the soil is very abrasive. It wears out cane knives, hammers, rollers, pump impellers, pipes and boiler tubes. All soil particles can clog up a diffuser. If the ash content of cane exceeds about 2% it causes severe problems with extraction at mills with diffusers. Ten per cent ash will clog the diffuser at once. Too much ash in the bagasse can literally put out the fires in the furnaces. If this happens they have to be allowed to cool before being cleaned out. Last year, as Raoul Lionnet told us in his summary of milling performance, the whole industry had problems with ash and Felixton had more problems than any other mill. At one stage they were running for six hours, then stopping for six hours because of excessive soil in both the diffuser and the furnaces.

Steps towards increasing cane quality by reducing ash content

Most mills do not run a routine ash analysis of cane consignments. It is a costly, time consuming procedure, requiring great precision and standard techniques. However, ash content can be greatly reduced by improved field management, and some mills monitor individual grower performance. To reduce the ash content of mill cane, the cane cutters should be trained to base-cut at ground level – never below; they should top the cane in the air rather than on the ground and they should be encouraged to make small bundles of cane rather than leaving it in a windrow. Mechanical loader operators need to be trained to do less push-piling and to learn to shake the dust and soil out of cane bundles before loading. The field surface needs to be flat and uniform or ridge planted. Infield roads should be free of dust. Poorly metaled or muddy loading zones, especially when the no-chain systems is used, also increases ash content. Cane haulage vehicles should have good mudguards and should preferably have a slatted base. Cane mills can also install fairly efficient dry rock and soil removers. There are already two working well in the industry. Mist, heavy dew, light drizzly rain and sticky cane caused by long burn to harvest delays, all increase the ash content of cane dramatically.

Conclusion

If the industry is really committed to improving its cane quality, reducing milling costs and keeping the soil where it belongs (in the cane fields), then it simply must reduce the ash content of cane entering the mills. Ash content could possibly be introduced into the cane payment formula.

Chairman: Thank you, Mr Mann, for an interesting and informative presentation.

Discussion from the floor focused on the problem of sand in the cane. It was noted that the high ash content is attributable to the presence of sand or soil adhering to the stalk as well as soil which is picked up during collection, particularly by push-piling of cane in the field or on loading zones. Furthermore, it was noted that with the present system of payment for total sucrose based on sucrose % cane, mass contributed by sand contributes to grower income. This was regarded as unacceptable. It was pointed out that high levels of ash and sand cause serious damage to moving parts in the mill, flooding of diffusers and extinguishing of bagasse fired boiler fires. It was noted that as much as 75 tons of sand per week was being removed from one mill.

It was also noted that some factors such as heavy dew, mist, rain and flooding which resulted in more soil adhering to cane could not be controlled. The possibility of pre-delivery cleaning of cane was raised but it was pointed out that this could result in difficulty in meeting rateable deliveries which could ultimately result in a longer milling season. The possibility of cleaning after the weighbridge was raised. Since sucrose content is determined after weighing, it was suggested that this could be conducive to delivery of cane with an even greater extraneous matter content.

Mr GRE Lionnet, head of Processing Research at the Sugar Milling Research Institute, delivered the next paper which dealt with the subject of harvest to crush delays.

CANE DETERIORATION

GRE LIONNET

Sugar Milling Research Institute, University of Natal, King George V Avenue, Durban, 4001

Introduction

Post-harvest deterioration affects all crops and is studied extensively all over the world. Sugarcane is no exception and post-harvest deterioration has been investigated by many technologists, particularly in Australia and in South Africa.

It is generally accepted that cane stalks start deteriorating immediately after burning and/or cutting. The deterioration is caused firstly by the enzymes present naturally in the stalks and, more importantly, by micro-organisms which rapidly enter the sucrose-bearing tissues of the cane. These organisms invert the sucrose, consume glucose and form downstream products such as alcohols, acids and gums.

Sucrose losses through deterioration

Cane deterioration causes sucrose losses both directly and indirectly. The direct loss is caused by the inversion of sucrose into glucose by enzymes and by micro-organisms. This type of loss has been investigated extensively, through controlled experiments. Pol % cane, purity and estimated recoverable crystal (ERC), have been used.

Microbiological activity also results in the formation of impurities, most of which impact negatively on sucrose recovery in the factory. Although this aspect is more difficult to measure, attempts have been made to investigate it. The following points have been well established:

- Lactic acid is highly melassigenic and will thus result in higher sucrose losses in final molasses.
- Gums and polysaccharides increase the viscosity of sugar liquors. This will make massecuite exhaustion more difficult and losses in molasses will increase.
- Oligosaccharides, although formed in relatively low concentrations, have a marked impact on the shape of the sugar crystal. Deformed crystals tend to be smaller, to break easily and to pass through the centrifugal screens. Again, the loss of sucrose in molasses will increase.
- Acids are formed as a result of microbiological activity. This increases the possibility of acid catalysed sucrose inversion in juices.
- Finally, cane deterioration can increase the colour of juices. This has obvious implications as far as sugar colour and thus refining costs are concerned.

Factors which affect deterioration

Several factors affect the rate at which cane deteriorates. Some of the most important are:

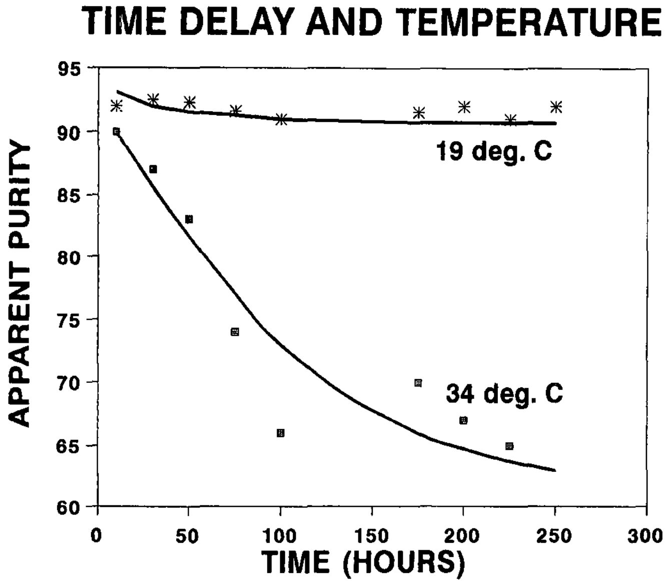

FIGURE 1: The effect of temperature on the purity drop as whole stalk cane deteriorates.

- Time: Obviously the longer the post-harvest delay, the more the deterioration.
- Temperature: This is a major factor, with deterioration increasing exponentially with temperature. An example of the effect of temperature is shown in Figure 1, for a controlled test with whole stalk cane.
- Burning/trashing: Burning generally speeds up the rate of deterioration. Controlled experiments have shown measurable sucrose losses only eight hours after burning and cutting. Burning also seems to have a marked effect on the formation of gums, as shown in Figure 2.

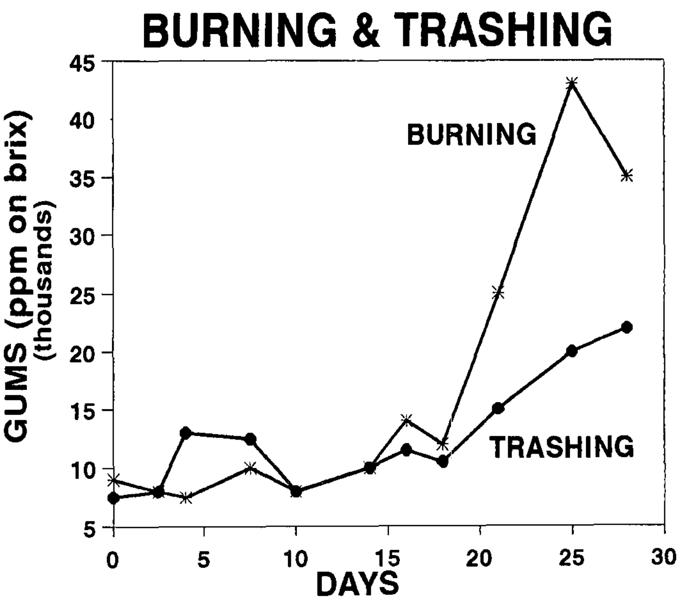

FIGURE 2: Gum formation as burnt and trashed cane deteriorates.

- Whole stalk/billets: Deterioration is speeded up if more of the internal sections of the cane are exposed. Mutilating cuts, instead of clean cuts, have a similar effect.
- Variety, age and other agricultural factors have smaller effects.

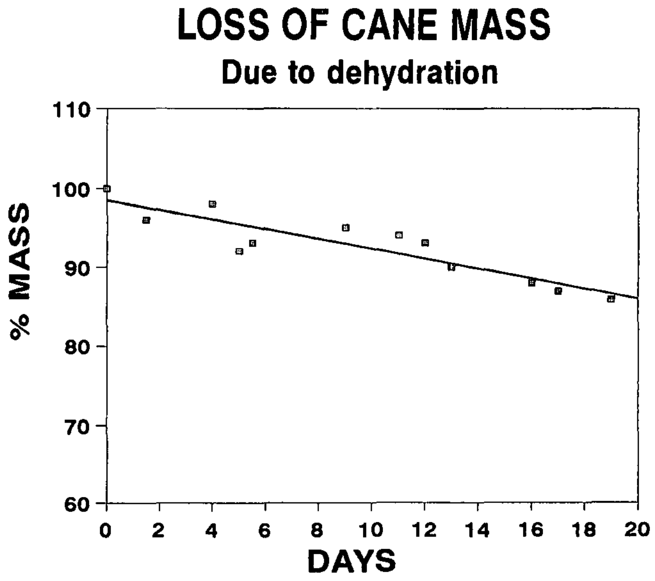

FIGURE 3: The mass loss for whole stalk cane laid in windrows.

Quantification of the sucrose loss

Much work has been done to measure the loss of sucrose due to cane deterioration. Loss of mass, sucrose loss and the effects of impurities on factory recovery are usually required to obtain a complete picture. An example of the loss in mass of whole stalk cane laid in windrows is shown in Figure 3. The loss in mass, which is due mostly to dehydration, averages about 1% per day.

In South Africa the formation of ethanol as the cane deteriorates has been used to estimate the loss of sucrose. The relationship between the sucrose lost and the formation of ethanol depends on the conditions under which the cane deteriorates, for example burnt or trashed, in windrows or in bundles. For burnt cane in windrows and under normal conditions, about 1% of the sucrose is lost for every 1 000 ppm (on brix) of ethanol formed. An ethanol profile, in burnt cane, over one season, is shown in Figure 4. The climatic (winter/summer) effect is clearly evident.

Finally, the delays between burning, cutting and crushing can be measured by a tagging system. This is, however, difficult in practice. Ethanol levels, temperatures, variety and other factors can be used to estimate the delay, after establishing a relationship for the conditions investigated. This approach is not absolutely precise, giving at best an uncertainty of ±24 hours.

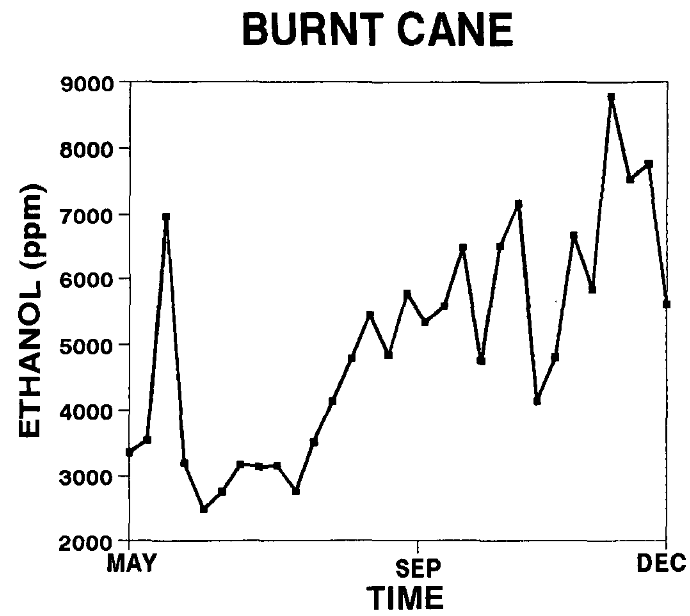

FIGURE 4: Ethanol (ppm on brix) in burnt, windrowed cane.

Chairman: The results confirm once again that harvest to crush delays, particularly when dealing with burnt cane, result in substantial sucrose losses which frequently go hand in hand with production of undesirable impurities.

A question from the floor asked why, in some cases, the levels of ethanol were the same but the sucrose losses different. Mr Lionnet pointed out that ethanol was only one of the possible end products of sucrose degradation. Depending on conditions, sucrose loss in one case could be the result of the action of a yeast which produces ethanol. In another case, a yeast and another organism which produces a degradation product other than ethanol could also be involved. The end result could be the same levels of ethanol but differing sucrose levels.

One of the delegates from the Natal midlands, where winter temperatures seldom rise above 20°C, was of the opinion that the rate of deterioration of burnt cut cane was not a significant factor. He suggested that the harvest to crush delay was a smokescreen which was being used to divert growers' attention away from other more important issues.

The Chairman pointed out that reaction rate, including sucrose deterioration rate, will be reduced at lower temperatures. One of the delegates agreed that deterioration was slower in the midlands but was nevertheless approximately half of that measured under coastal conditions. He pointed out that in spite of decreasing sucrose levels the purity could be artificially maintained due to the loss of the solubles in volatile form. He cautioned against using purity alone as a measure of sucrose content.

In the following paper, Dr BS Purchase, Director of the Sugar Milling Research Institute, discussed the influence of cane composition on processing.

THE EFFECT OF CANE QUALITY ON FACTORY OPERATIONS

BS PURCHASE

Sugar Milling Research Institute, University of Natal, King George V Avenue, Durban, 4001

Sugar recovery

The major objective of cane processing is to produce as much sugar as is economically possible from the sucrose in cane. This takes place in two main stages, the first involving extraction of juice from the cane and the second involving crystallisation of sugar and subsequent recovery of the crystals from the surrounding liquor (Figure 1).

Extraction

The extraction process produces two streams – juice and bagasse. Some sucrose remains in the bagasse and is therefore never recovered as sugar. High levels of recovery are therefore facilitated by low quantities of bagasse, i.e. by low fibre content in cane, which in turn is strongly influenced by the amount of tops, trash and sand on the cane.

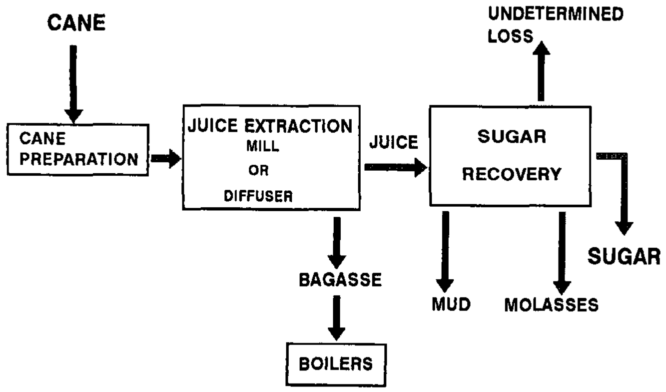

FIGURE 1: Flow diagram for a sugar factory

South African factories have particularly efficient extraction systems that enable them to produce bagasse containing only about 1,8% sucrose when expressed on a dry mass basis. This means that for every ton of fibre delivered 0,018 t of sugar is lost because it remains on the fibre in the bagasse. This knowledge enables one to quantify the effects of fibre on sugar recovery and hence to quantify cane quality in terms of its fibre content.

Crystallisation

In the crystallisation process it is not possible to crystallise all of the sucrose because some of it remains dissolved in the soluble non-sucrose components of the juice. These non-sucrose components are analogous to fibre in that they 'capture' some of the sucrose and divert it to molasses, thereby reducing recovery as crystal sugar. Their effect is much greater than that of fibre in that each ton of soluble non-sucrose takes with it approximately 0,5 t of sucrose into the molasses stream. As with fibre, this knowledge enables one to quantify cane quality in terms of its non-sucrose content or purity.

Direct and undetermined losses

Cane deterioration causes sucrose to be converted to non-sucrose thus causing direct loss of sucrose as well as a subsequent diversion of some sucrose to molasses due to the increased amount of non-sucrose in the system.

The sucrose content of cane is an obvious determinant of quality and is a fundamental indicator of how much sugar can be made from the cane. A portion of this sucrose is, however, unavoidably lost due to degradation during the high temperature phases of processing. The exact mechanisms of such loss are not always clear but the amount involved is equivalent to about 2% of the sucrose in cane. This so-called undetermined loss must be taken into account when estimating the quantity of sugar that can be made from cane.

Cane quality

The foregoing explanations can be encapsulated into a formula which describes cane quality in terms of sucrose content (S), soluble non-sucrose content (N) and fibre (F), and which expresses the effect of these parameters on factory recovery thus enabling a calculation of estimated recoverable crystal (ERC) in cane:

$$ERC = aS - bN - cF$$

The factor 'a' (approximately 0,98) expresses the portion of sucrose which is recoverable after accounting for undetermined losses. Factors 'b' and 'c' reflect the amount of sucrose which is trapped by the soluble non-sucrose (N) and fibre (F) respectively. The three factors are derived from actual results achieved by factories. Industrial average values are calculated at the end of each season and are generally close to 0,98, 0,51 and 0,018 for 'a', 'b' and 'c' respectively.

Other cane quality effects

Apart from affecting recovery, cane quality has distinct effects on factory throughput, sugar quality and factory maintenance costs. The ERC formula does not account for these other effects and it therefore gives an incomplete description of cane quality.

Throughput

Although throughput is expressed in terms of tons cane per hour it is usually limited by tons fibre per hour. Good quality cane of low fibre content will therefore enable a relatively high throughput in terms of sugar. This was well illustrated in experiments at Maidstone (Purchase *et al.*, 1990) in which cane from a common source, but with various amounts of tops and trash, was crushed. The extreme results were as follows:

	t fibre/h	t cane/h	t pol/h
Clean cane	26	181	24
Cane with all tops & trash	27	127	13

The factory's productive capacity was almost halved when no tops or trash were removed from the cane.

Sugar quality

Tops and trash are major sources of colour in the juice and ultimately in the crystal. Once this colour is in the factory it is expensive to remove and it diminishes the value of the sugar made. In the Maidstone trials mentioned above the juice colour was more than doubled when moving from clean cane to 'whole plant' cane containing all the tops and trash.

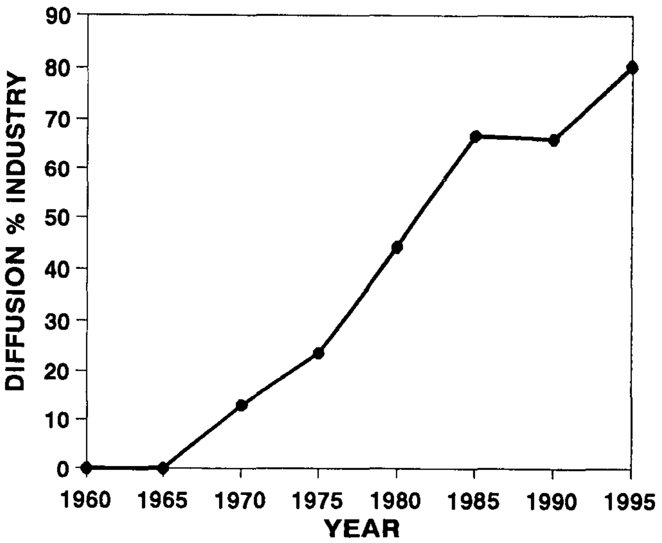

FIGURE 2: Historical trend in the conversion from milling to diffusion in South Africa

Factory maintenance

Sand in cane has severe abrasive effects on factory equipment, particularly shredder hammers, knives and boiler tubes. This effect is especially serious where diffusers are used for extraction, because the sand is filtered out of the juice by the bed of bagasse in the diffuser and is then carried in the bagasse to the boilers. The amount of sand conveyed to the boilers after wet weather is often sufficient to extinguish the fires and cause factory stoppages while the boilers are cooled and the sand is removed manually.

With the steady trend towards the use of diffusers in South Africa (Figure 2) the sensitivity to sand has increased. Unfortunately, there is also a recent trend towards the use of mechanical push-piling and loading of cane and this increases sand levels. Great care is needed to ensure that the sand content of cane is given due regard as a quality parameter.

REFERENCES

Purchase, BS, Lionnet, GRE, Reid, MJ, Wienese, A and de Beer, AG (1991). Options for and implications of increasing the supply of bagasse by including tops and trash with cane. Proceedings of the 1990 Sugar Processing Research Conference, San Francisco. pp 229-243.

Chairman: Thank you, Dr Purchase, for your paper and the observation that cane quality is an issue which affects both millers and growers.

Responding to a question on the effects of various components of processing, Dr Purchase indicated that ash had a major negative effect. This is reflected by the exponentially increasing financial penalty imposed by at least one mill on increasing ash content. It was pointed out that high ash content in bagasse can lead to extinguishing of boiler fires resulting in substantial losses.

One of the delegates noted that it could be useful to compare miller-cum-planter cane where both pre-millyard and factory activities are controlled by the same body with private grower cane where these activities were separated. Dr Purchase pointed out that, in many cases, the miller-cum-planter cane was of very poor quality. He ascribed this to the fact that the growing and milling activities were still regarded as mutually independent and there was not a holistic approach to the entire operation. He noted that in the case of a genuine co-operative, the situation improves dramatically.

The next paper dealt with payment for quality and was presented by Mr Arnold Brokensha, head of the Cane Testing Service of the South African Sugar Association.

INCENTIVES FOR CANE QUALITY

MA BROKENSHA

SA Sugar Association Cane Testing Service, PO Box 507, Durban, 4000

Current cane payment system

In the South African sugar industry, sucrose content is the quality measure used for cane payment purposes and it is assumed that the proportion of sugar recovered per unit of sucrose is the same for all deliveries.

In practice, however, recovery of sucrose as sugar is influenced by the amounts of non-sucrose and fibre in the cane – the greater the amounts the lower the sucrose recovery. Thus, two cane consignments having the same amounts of sucrose could yield quite different amounts of sugar because of different levels of non-sucrose and fibre.

The current cane payment system makes no differentiation on the basis of potential sugar yield and provides no incentive for the individual grower to try and increase the amount of sugar that can be recovered from his cane – it merely provides incentive for maximising sucrose content.

Proposed method of evaluating the quality of cane

As sugar is by far the most valuable product that is currently obtained from cane, any scheme which is designed to lead to an improvement in cane quality should give a strong signal in terms of the recoverable sugar content of the cane.

The estimated recoverable crystal (ERC) formula is appropriate – the various sugars produced in the industry are reduced to a common crystal basis, hence the term estimated recoverable 'crystal' rather than 'sugar'.

Why ERC is recommended:

- It gives a clear indication of the cane constituents which detract from better sugar recovery.
- It is uncomplicated.
- It has a sound, practical technological basis.

Cane payment incorporating an ERC quality evaluation

If ERC % cane is substituted for sucrose % cane in the present cane payment formula, the grower will be paid for the ERC content of his cane, with the result that efforts will now be directed towards maximising the yield of recoverable sugar (measured as ERC) rather than sucrose, i.e. the ERC system with its incentives provides for a more focused system and as a consequence improved productivity.

The cane payment formula (incorporating ERC) can be modified from its present structure to one which provides much stronger incentive for high ERC % cane. This is the so-called AY-C system, in which C is the milling margin in units of ERC % cane which is fixed for the season and is the same for all mills. The milling margin (a constant for the season) is subtracted from the ERC % cane determined for a delivery to give the ERC % share accruing to the growers. This has the effect of accentuating the value of high ERC % cane and, conversely, detracting more severely from low ERC % cane.

The advantage of the AY-C system must be weighed against the potentially harsh impact it will have on areas where ERC % cane levels are depressed, for one reason or another, in comparison with the industry average.

Soil (ash) % cane

The ERC formula categorises soil as fibre. However, the damaging effect of soil on mill machinery and processes is far in excess of the value of the sucrose loss attributed to it in the ERC formula. It is therefore necessary and generally accepted that special incentives have to be put in place for minimising the soil content of the cane.

Such incentive schemes are best developed locally, having regard to local circumstances.

Chairman: Thank you, Mr Brokensha, for giving a very lucid overview of the criteria which can be taken into account when attempting to arrive at a formula that reflects the quality of the cane delivered to the mill.

One of the delegates inquired why ash was not determined as standard practice by the Cane Testing Service. Mr Brokensha pointed out that ash is not taken into account in the present payment system and was therefore not determined. If required, ash could be determined but this would increase analysis costs. It was noted that ash is determined at one of the mills – at the mill's expense. The validity of this test was questioned by one of the grower delegates.

The following speaker was Dr NG Inman-Bamber, leader of the Canegro modelling group at SASEX.

FACTORS AFFECTING DRY MATTER AND SUCROSE CONTENT OF SUGARCANE

NG INMAN-BAMBER

South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300

Sugarcane, like many other crops, offers little scope for yield improvement by increasing the inherent rate of canopy photosynthesis, at least with conventional breeding and husbandry practices. The conversion of radiant energy intercepted by leaves appears to be maximum at approximately 1,8 MJ/g dry matter (DM) in well adapted varieties. There is more scope for yield improvement in the interception of radiation by leaves, but this is limited to conditions where there is adequate water. The scope for improving DM allocation to the economically important components of the crop could be assessed by considering the large body of data available for South African genotypes. In this study the results of direct cane analysis (DAC) from over 400 released variety trials (RVTs) were collated in order to establish genotypic differences in the way dry matter is partitioned in the stalk. The presence of NCo376 in all RVTs provided a paired data set for each variety and a convenient way of determining how the varieties compared in regard to DM allocation within the stalk. Age and seasonal effects on partitioning were determined by conducting DAC on stalk segments of eight crops of NCo376 ratooned at two month intervals and sampled 8, 10, 12, 14 and 16 months after ratooning.

Varieties

Sucrose % cane (S%) of the varieties tested in RVTs since N12 was released in 1978, varied from -2 to +35% of the S% for NCo376 (Figure 1). The varieties differed substantially in the way S% depended on dry matter % cane (DM%) and sucrose % DM (S%DM). S% of N17 was 7% greater than that of NCo376 because of increased DM%, and S% of N15 was 9% higher than that of NCo376 because of improved S%DM (Figure 1). The large improvement in quality in CP66/1043 depended equally on increased DM% and S%DM. This variety and others (N15, N19, N24) with considerably enhanced S%DM have the inherent potential of producing greater sucrose yields than NCo376 because they allocate DM more efficiently in the stalks, although many other factors may override the performance of these varieties in the field. The t-test on all paired data sets except those for N24 were significant (p = 0,01).

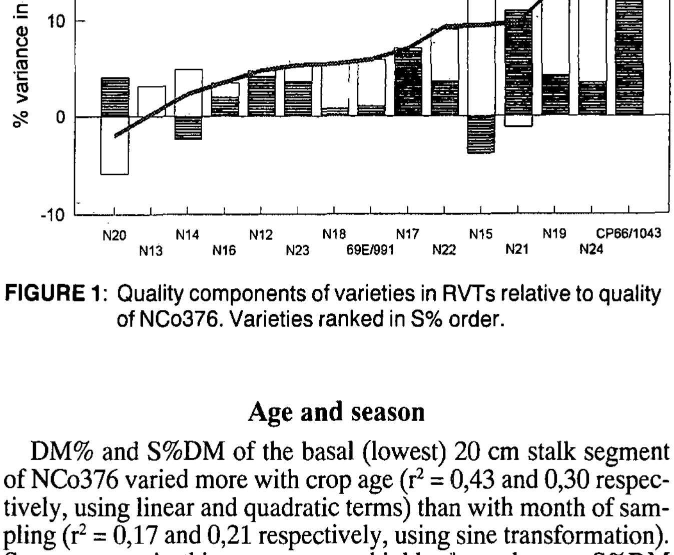

FIGURE 1: Quality components of varieties in RVTs relative to quality of NCo376. Varieties ranked in S% order.

Age and season

DM% and S%DM of the basal (lowest) 20 cm stalk segment of NCo376 varied more with crop age (r^2 = 0,43 and 0,30 respectively, using linear and quadratic terms) than with month of sampling (r^2 = 0,17 and 0,21 respectively, using sine transformation). Sucrose mass in this segment was highly dependent on S%DM (r^2 = 0,79, n = 39). This segment quickly attained high S%DM (>40% DM) and then accumulated additional sucrose in winter

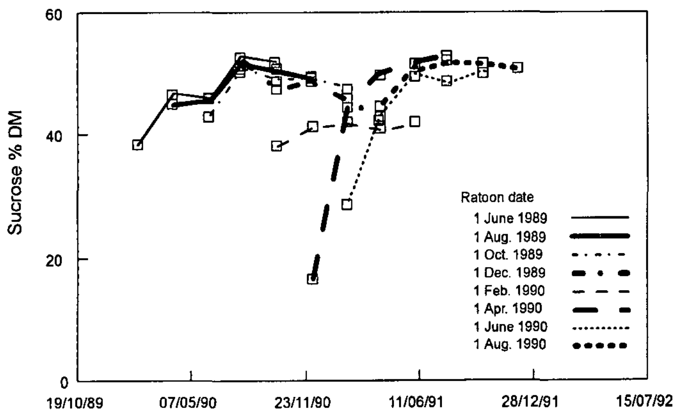

FIGURE 2: Sucrose % DM of the basal 20 cm segment of cane stalks of NCo376 ratooned at two month intervals and sampled 8, 10, 12, 14 and 16 months after ratooning.

(up to 55% DM) or lost a little (<5% DM) during summer or with ageing (Figure 2). S%DM increased more rapidly and was conserved better in young than in old segments (data not shown). There was no indication of substantial re-mobilisation of sucrose to support renewed growth. S%DM of segments was highly dependent on their distance from the natural breaking point and green leaf number per stalk (r^2 = 0,77, n = 260). Green leaf number is an index of water stress which has a profound effect on leaf and stalk elongation. These data suggest that sucrose is well conserved in stalks of NCo376 and that the seasonal variation in S% arises because of fluctuations in the proportion of expanding to expanded stalk tissue and, to a lesser extent, because of seasonal variations in DM%. The mass and/or quality of the expanding portion can be manipulated by topping, by ripener application and by withholding irrigation water. A mechanistic model of DM partitioning needs to be developed to help advise growers how best to use these management options.

Conclusions

Options available to growers for increasing the proportion and amount of dry matter ending up as stored sucrose include choice of variety, topping height, ripener application and irrigation scheduling. Stored sucrose is not readily re-mobilised and reductions in sucrose % cane should not be regarded as reductions in sucrose yield.

Chairman: Thank you for your contribution and illustrating how the model can be utilised to answer 'what if' questions, such as 'what is the optimum harvest age?' and, 'how should my irrigation be scheduled?' and many others.

The question of enhancing sucrose content in irrigated cane by ripener application or drying off was raised.

Dr Bamber responded by saying that results of the drying-off trials conducted at SASEX and in Zimbabwe and Swaziland have been summarised recently. They show that drying off mostly leads to a reduction in sucrose yield in spite of enhanced sucrose content. It is a good practice but is hard to do well, so it is better to apply ripeners and not to attempt drying off.

The Chairman invited further discussion from the floor.

One of the delegates stated that the systemic ash content of cane – that is excluding all sand or soil adhering to the cane, could vary between 2 and 4%. In response, it was pointed out that the systemic ash content on a wet matter basis was in the order of 0,2% in juice and that the total inorganic content in whole stick seldom rose above 0,8%. These figures were confirmed by numerous assays conducted by the SMRI, which showed that systemic ash content on a wet matter basis varied between 0,5 and 0,6%.

Another delegate, quoting results from El Salvador, stated that the ash content could be as high as 4,13% in bullshoots. It was not clear whether this was on a dry or wet matter basis. Several delegates expressed concern on the reliability of these figures.

One of the delegates was of the opinion that the whole ash content debate was biased, represented a miller's point of view and was based on the incorrect assumption that it is easy to deliver sandless cane to the mills. He stated that growers are aware of negative disruptive effects of sand but noted that there are costs involved in cleaning cane – costs which the industry should share.

Another question raised from the floor concerned sucrose losses arising during the period between delivery and processing. The view was expressed that these losses should be for the millers' account. As an alternative, it was suggested that sucrose content should be determined on delivery and that payment should be based on delivered sucrose. Mr Brokensha pointed out that this would require installation of costly core sampling equipment and would increase costs. He was of the opinion that the present system is functioning very efficiently and replacement of this equipment with that required to conduct core sampling would not be cost effective.

Another delegate pointed out that only those items which are grower 'influenced' and which effect cane quality had been discussed. However, items such as the length of the milling season, which was largely under miller control, could have a significant effect on cane quality. He asked for a more complete inventory of factors which affect cane quality. The problem of low quality miller-cum-planter cane, where there is the opportunity for a holistic management approach was raised – why was quality of this cane not the best in the industry?

Mr TL Culverwell pointed out that the small scale cane growers seldom have the opportunity of using ripeners and that they are dependent on contractors for harvesting and transport – transport is often unreliable and delays in delivery frequent. This often results in quality loss which the small grower cannot control.

One of the grower delegates stated that the Experiment Station is releasing a range of varieties which have higher sucrose levels, which are suited to various ecological conditions and which offer a choice of early, mid or late season harvesting. In addition, South African mills are highly efficient. However, all this was being negated by extraneous matter – particularly sand and soil in consignments. He was concerned that growers do not seem to recognise that the loading techniques, particularly push-piling, are a major cause of high sand and soil levels and even rocks in the cane.

The point was made on several occasions, that both growers and millers are dependent on the size of the sugar cake and should co-operate in making it larger.

Mr Q Mann proposed that SASTA write a formal letter to the South African Sugar Association requesting that a system which pays for cane quality be accepted. A grower member of the SA Sugar Association Council responded by saying that this was unnecessary since this was being considered by an industry task group and that he was confident that an appropriate system would be adopted.

The Chairman concluded by saying that we can grow a bigger sugar cake and that payment for cane quality can make a significant contribution to the larger cake. He expressed the hope that the growing and milling communities would reach an agreement on this issue and adopt an appropriate and relevant system. He expressed the hope that in 25 years' time a similar SASTA panel would not still be discussing the introduction of payment for cane quality.

He thanked the speakers and all delegates for their participation and commented on the success of the SASTA congress.