

FIBRE — ITS EFFECTS ON MILLING AND PROCESSING EFFICIENCY

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Abstract

This paper deals with the insoluble matter in the raw material delivered to a cane sugar factory, draws special attention to some specific constituents of fibre and discusses the effects that they have on milling and processing. Some preventive measures are included.

Fibre is defined in the Manual of Cane Sampling and Analysis for South African Sugar Factories as "the water insoluble matter of cane from which the brix-free water which it contains has been removed by drying", while cane is defined as "the raw material from which sugar is recovered. In the proposed cane evaluation for Estimated Recoverable Sugar fibre is one of the three factors used. Its importance in mill extraction is well appreciated by sugar technologists but some other effects of fibre deserve to be highlighted.

The ideal raw material for a cane sugar factory is obviously mature cane with no top growth or trash. In practice this ideal material is seldom received at the factory, the average consignment containing about 8% trash. The miller considers that trash up to a level of 3% is an acceptable compromise, and if this became the average for the future, it would have the following effects on the industry.

Present cane conditions:

Sucrose % cane	13,0%
Fibre % cane	15,5%
Trash % cane	8,0%
Fibre % trash	50,0%

Future cane conditions, after the removal of 5,0% of the trash which is considered to contain 50% by weight of fibre:

Sucrose % cane	13,7%
Fibre % cane	13,7%
Trash % cane	3,0%

As fibre is the controlling factor in milling capacity, the reduction of 5% trash will generate an increase in capacity of 13,1% without any alteration to mill settings. This would have the effect of decreasing the standard season from 40 weeks to 33,6 weeks and as wear and tear is partially related to length of season, it can be seen that there will be considerable savings in maintenance costs, the shut down period will be longer and the necessity of employing staff on heavy overtime rates will be reduced. Of course the grower will also benefit from a higher sucrose content of his cane since it will be harvested closer to the optimum period.

Assume that a factory has an overall recovery of 84,55% with an extraction of 95,0% with the cane in its present condition. The effect of removing 5% trash will give an overall recovery of 85,3% with

an extraction of 95,8%. The financial gain from these increases in efficiencies are known to all millers.

So far the effect of trash has been considered on the assumption that it consists of vegetable matter, such as dead cane leaves, and it has been shown that a not unrealistic reduction in trash brings a material benefit to the miller, provided he has sufficient bagasse to run his plant without recourse to burning any supplementary fuel. Not all fibre is vegetable matter, however. Some other insolubles associated with cane are sand, stones, rocks, boulders, chains, fencing standards, fertiliser bags and even the odd snake.

Sand is nearly always present in every consignment of cane. With the changes in harvesting practices there is a tendency for the amount of sand to increase. However, if it is assumed that 0,5% of the mass of average cane is sand (i.e. 5,0 kg per ton) then the removal of this sand prior to consigning the cane to the mill would increase the sucrose per cent cane from 13,0 to 13,07% and the fibre would decrease from 15,5 to 15,08%. If this same cane had been mechanically harvested to include say 15 kg per ton of sand, the sucrose percentage would change to 12,87% and the fibre would be 16,34%. This phenomenon was clearly demonstrated at Tongaat where a very high proportion of mechanically loaded cane was crushed predominantly on one of the two milling tandems. The cane on this tandem showed lower sucrose and higher fibre. The relative figures were:

Tandem No. 1 — Sucrose 13,05% Fibre 15,69%
Tandem No. 2 — Sucrose 12,87% Fibre 16,88%

Sand causes wear and polishing of mill rollers, wear of trash plates, chains, slats, intercarrier plates, pumps and piping. The most severe case experienced at Tongaat has been an accumulation of sand in a pressure fed mill that actually stalled the driving turbine. After the hydraulic load had been relieved, the mill eventually started with some severe strains on the headstocks which shook violently. A week later the top roller shaft broke. There is no doubt that the percentage of sand associated with cane is increasing. It may be coincidental that during the past season Tongaat had four shafts break and a further three rejected as a result of ultra sonic inspection.

Sand has an effect on processing as well as milling. Firstly, whatever sand is present in the mixed juice is assessed as a percentage of sucrose. For instance, if the whole 5 kg per ton of sand was included in the mixed juice, it would have the effect of increasing the apparent sucrose in cane from 13,0 to 13,06%. Increasing imbibition has the probable effect of ensuring that most of the sand is

washed off the bagasse and therefore is present in mixed juice.

Besides the above effect sand causes abnormal wear of pipes, juice heater tubes and end plates, and pumps. In addition it increases the mud load on the filter station, blocks filter screens, chokes mud troughs and in severe cases jams the mud trough agitators. Once there is a large accumulation of sand in the mud trough it is difficult to remove it by the normal hosing down process. Sand can also interfere with the closing action of large gate valves.

The sand associated with cane which does not appear in the mixed juice must leave the milling train with the bagasse or must fall through openings in the carriers in the cane handling yard. If the latter takes place, there will be an accumulation of dirt which will require some expensive labour to remove. If the sand is in the bagasse, it will cause excessive tube and fan wear, particularly with spreader stoker fired boilers. In the most severe cases, the sand could block the passage of forced draught air through the gate and cause a serious drop in steaming capacity thus seriously affecting the whole factory operation.

It can be seen that sand is a major problem. Under the present cane payment system, if it is removed from the mixed juice prior to weighing, it must either be weighed, sampled and analysed so that due allowance is made for sucrose associated with it, or it must be returned to the milling tandem and therefore leave with the bagasse and cause damage to the boilers. If it is not removed from the mixed juice it affects the determination of sucrose per cent cane. Under any system of direct testing of cane it is very important that an unbiased sample of shredder cane be used for analysis. In view of the irregular distribution of sand across side fed carriers, this may well require full carrier width sampling, though, in view of the very adverse effects of sand on the factory, a bias which augments the sand content of cane would tend towards greater equity in assessing the value of the cane.

It is not surprising that the Australians consider sand to be the worst constituent of fibre in the raw material delivered to the mill.

In connection with stones, rocks and boulders, depending on their size, some of them are found when cane is transferred from one carrier to another because they are heard. They are also heard going through the knives, but at this point it is usually too late because they have damaged the knives or the shredder. Frequently when the bigger boulders go through the knives there is also damage done to the main carrier slats. Boulders that eventually get into the mills themselves can cause roller and shaft damage.

A boulder in the cane supply will almost invariably cause a mill stoppage due to the mill staff searching for broken knives and for the boulder. In severe cases the cane knives will go out of balance and will require attention, causing a stoppage of up to three hours. Apart from the cost of the damage and lost time, further losses occur due to irregular flow of juices to the process section, causing disturbances of steady states and deteriora-

tion due to stoppage. Long stops may cause the expensive use of supplementary feed for the boilers.

Undetected load chains frequently wrap around the cane knife shafts and cause heavy damage to main carrier slats due to the flailing action of the chain. This causes lengthy stops while repairing the carrier, with the attendant losses to process. Undiscovered chain locks can cause heavy roller damage.

The odd fencing standard has been known to appear in an inter-carrier and become entangled with the slats, causing extensive damage and lengthy breakdowns.

Prevention of damage by "fibre"

At Tongaat for many years a reward system has been operating whereby any employee finding a chain, boulder or the like in the cane supply is rewarded R1,00. An analysis of the payouts for 1970/71 reveals the following:

Number of chains found	212
Number of boulders found	121
Number of chain locks found	13
Miscellaneous found	9

To facilitate the discovery of the offending article, the yard lighting has been considerably intensified and a metal detection alarm is being installed on one tandem.

In order to reduce the damage to plant and equipment, a sand removal system has been installed after the mixed juice scales. This consists of a slow moving scraper conveyor in a large rectangular tank, dragging the sand from the bottom, up a slope where it is sprayed with water, and then discharging into a trailer for removal.

For many years the trash and tops content of cane consignments have been assessed and the results have been fed back to growers. Whilst the data is interesting it is doubtful whether the growers take much notice of it. In an attempt to obtain cleaner cane, a Cane Supply Committee is usually formed each season in terms of paragraph 6 of Schedule "C" of the Sugar Industry Agreement.

However, the real place to clean the cane is in the fields, and it is hoped that a new cane evaluation system will encourage this to take place. In fact, if it is found that the new cane payment system does not result in a substantial reduction in the amount of trash delivered to the factories, the application of penalties more effectively motivate growers to remove trash would be fully warranted in the interests of the sugar industry as a whole.

Appendix

Basic assumption:

Standard cane comprises 13,0% sucrose and 15,5% fibre and moisture and non-sucrose.

Effect of reducing leafy trash from 8,0% to 3,0%:

Raw material (standard)	= 100
Sucrose (standard)	= 13,0
Fibre (standard)	= 15,5
Raw material (5,0% trash deducted)	= 95 or 100%
Sucrose	= 13,0 or 13,7%
Fibre (15,5 - 2,5*)	= 13,0 or 13,7%

*Trash is assumed to be 50% fibre.

Increase in milling capacity:

Fibre rate of mill = 15,5 tons per hour, or 100 tons standard cane per hour.

Reduced trash cane throughput will be $100 \times 15,5/13,7$ or 113,1 tons/hour.

Increase in capacity is 13,1%.

Reduced length of milling season:

Assumption. As only the 5,0% trash is removed from the cane, the total crop of cane will be reduced to 95,0% of untrashed crop. Because milling capacity has been increased by 13,1%, the standard season of 40 weeks will be reduced to $40 \times 0,95 \times 100/113,1$ or 33,6 weeks.

Gain in overall recovery:

(a) Boiling house recovery will remain constant at 89,0%.

(b) Reducing trash content by 5,0% will increase extraction from 95,0 to 95,8%.

Initial input:

100 tons cane 13 tons sucrose 15,5 tons fibre

$$\text{Extraction} = 95,0 = \frac{13 - x}{13} \times 100\%$$

$x = 0,65$ tons sucrose.

New input:

113,1 tons cane 1,131 \times 13,7 tons sucrose 15,5 tons fibre

Sucrose loss $x = 0,65$

$$\text{Extraction} = \frac{1,131 \times 13,7 - 0,65}{1,131 \times 13,7} \times 100 = 95,8\%$$

Removal of 0,5% of sand from standard cane:

New condition:

Mass of cane 99,5 or 100%

Mass of sucrose 13,0 or 13,07%

Mass of fibre 15,0 or 15,08%.

Discussion

Mr. du Toit: When the paper refers to 8% trash is it dry, does it contain green leaves and does it include the immature nodes at the top of the cane?

Mr. Gunn: The 8% refers to dry leaves. This year the trash is less than normal as stick weight is heavier than normal.

The figure for green tops is about $1\frac{1}{2}$ %.

Dr. Graham: The leaves would not necessarily be bone dry.

Mr. Rault: Tests were carried out 12 years ago on trash at Mount Edgecombe and the figure was found to be from 6 to 8% with a humidity of about 30%.

It is not true to say that loss of sugar is proportionate to fibre in cane—this statement must be qualified because the cane variety and the amount of trash in bagasse must also be considered. The trash in bagasse did not previously contain sugar.

Mr. Gunn: It is not correct to say that a decrease in fibre must mean an increase in extraction but it does give an indication.

We have done tests this year on bagasse and there is a large difference in amount of sucrose depending on particle size. The smaller the particle size of bagasse the less sucrose it has, and trash would break up into small particles.

Mr. Buchanan: There are several papers in QSSCT Proceedings and a thesis by John Seip which indicates negative correlations between fibre content and sucrose losses, which are difficult to explain.

This paper would be more complete if it gave percentages for cane growers' and miller-cum-planters' cane and described the type of mechanical harvesting used by Tongaat.

Mr. Gunn: The percentage of miller-cum-planter cane is 34% and three types of grab harvester are used.

Mr. Renton: EM has paid a lot of attention to trash because of its effect on diffuser operation. Total extraneous matter is regularly determined and averages about 13%, of which the immature tops would be about 3%, leaving a balance of 10% comprising green leaves and dry leaves.

Mr. du Toit: If there is a new cane payment system the composition of extraneous matter will be important because there will be a penalty for non-sugars, which are mainly in the top part of the cane.

Mr. Alexander: Does not the reward system at Tongaat encourage employees to 'salt' chains etc, in the cane?

Mr. Carter: I had an experience of this over a period of two weeks but when I asked for production of evidence the reports ceased. Apart from this one experience, the system does not seem to have been abused.

Mr. Ashe: It has been said that a new cane payment system might improve the trash position. Umfolozi is a co-op and penalises its farmers for trash, tops and extraneous matter. But this makes no difference at all. One grower was penalised on three successive days 5, 10 and 15% but was quite happy to accept the penalties as long as his cane was crushed.