THE IMPLICATIONS OF POOR CANE QUALITY

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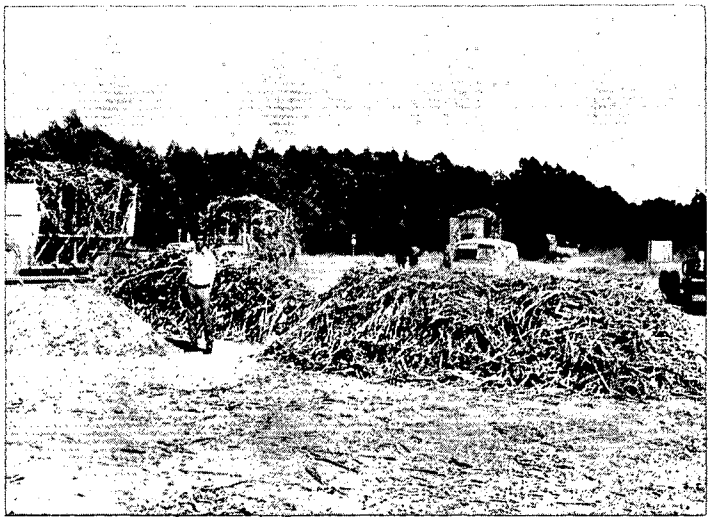
Abstract

In recent years the South African Sugar Industry has implemented a programme of large-scale expansion, in both the factories and agricultural sectors and it is possible that due to this expansion the emphasis has shifted from cane quality to quantity. An attempt is made to highlight some of the detrimental effects of poor cane quality and its effects on both the engineering and process sections of sugar factories. Certain statements and figures quoted are based on general observations, findings and trends in the South African industry and more particularly at Noodsberg Sugar Co. Ltd., and may vary from mill to mill.

Introduction

It is estimated that approximately 12 per cent of cane crushed in South Africa consists of tops, trash, sand and other extraneous materials, i.e. in excess of two million tons of extraneous matter was handled by mills in the 1975 season, the equivalent throughput of two large mills.

There has been a gradual decline in cane quality as can be clearly seen in the photographs below and by comparing the average figures for the South African industry over the past four seasons.



Is this cane?

Tops & Trash = 16.2 % Sand & Soil = 15.6 % Cane = 68.2 %

TABLE 1

Average figures for the S.A. Sugar Industry

Season	Pol % cane	Fibre % cane	M.J. purity	Ov. rec.	Cane/ sugar ratio
1972/73 . . .	13,26	14,82	86,66	85,50	8,77
1973/74 . . .	13,08	15,64	85,66	85,17	8,93
1974/75 . . .	13,08	15,59	85,01	84,76	8,97
1975/76 . . .	12,60	15,67	84,59	84,33	9,33

This downward trend for pol % cane and mixed juice purity has been prevalent from the 1955/56 season.

The quality of cane is dependent on many factors, the most important probably being

(i) delay between burning/cutting and crushing;
(ii) climatic conditions.

The most common excuse for bad cane is the climate, particularly drought (and frost in the Midlands). It could be claimed instead, however, that—

(i) pol % cane has been reduced primarily due to the ever-increasing amount of tops, trash, roots and soil;
(ii) mixed juice purity is reduced due to the gradually increasing delay between burning, cutting and crushing and an increase in the amount of tops;
(iii) *Factory overall recoveries*—Over the past years, most factories have installed more sophisticated and efficient equipment and technical and process technology is of a higher standard than ever before, yet factory recoveries continue to drop. This is again largely due to the constantly deteriorating quality of cane received.

With the increase in throughputs of most factories this influx of extraneous material is becoming an ever-increasing problem and should not be allowed to continue.

The seriousness of this low cane quality and its effect are separated into two sections:

(*a*) The effects of sand, soil and rocks on milling.
(*b*) The effects of cane quality on the boiling house.

The effects of sand, soil and rocks on milling

At this stage the only available measure of sand in cane is by means of the suspended solids in mixed juice expressed as a percentage, but this does not take into consideration the sand remaining in bagasse, or deposited in tanks, under feeder tables, etc. It is commonly accepted that for milling trains, the amount remaining in bagasse is approximately equal to that in mixed juice. However, this is not true for diffuser installations where the bagasse blanket acts as a filter medium.

Excluding diffuser installations, the average suspended solids in mixed juice for South African factories increased from 0,56% in 1974/75 to 0,63% in 1975/76, i.e. an increase of 12,5% *under drought conditions*!! Converted, this is equivalent to 240 000 tons of sand which, mixed with juice and water, forms a wonderful grinding paste.

(i) *Cane preparation*

Damage by rocks, tramp-iron, etc., and excessive wear by sand on cane knives and hammers must have a detrimental effect on the cane preparation, which will affect the extraction. Furthermore, the damage and loss of production caused by rocks results in a further loss of sucrose.

(ii) *Milling*

Apart from mill settings, probably the two most important factors influencing extraction are—

(*a*) cane preparation;

(*b*) mill roll conditioning and peripheral speed;

both of which are heavily dependent on the amount of sand in cane.

For example—Average figures for the preparation index of cane and mill extraction are given for a 10-week period.

TABLE 2

Variation in P.I. and extraction at Jaagbaan due to wear

	Start of week	End of week	Difference
Preparation index .	91,2%	88,8%	2,4%
Extraction . . .	96,85%	96,6%	0,25%

These figures do not include the periods when, due to high sand content, the knives and hammers had to be changed midway through the week.

Further effects are a reluctance for the toproll to float, no mill lift, and a high moisture % bagasse. It has been repeatedly observed that during periods of high sand content the mills refuse to "lift", Donnelly chutes start filling, crushing rates are reduced or the peripheral speed has to be increased.

It is generally accepted that the volume of bagasse leaving the discharge opening of a mill is always greater than the volume between the two mill rolls. This expansion of bagasse results in "reabsorption" of the expressed juice. Tests carried out in Australia have shown clearly that this "reabsorption" increases with the degree of "squeeze", peripheral speed, and the amount of juice which has to be expressed per unit of time. When weighing up these facts it is easy to see why the effects of sand and soil has become so much more critical in recent years. For example, most factories have had to increase peripheral speed to some extent to cope with increased throughput and mill feeding devices have been improved to allow mills to work harder. Maceration levels have been maintained at a constant level relative to the quantity of cane crushed, which has in many cases resulted in quantities of fluid far greater than those previously handled.

It would therefore not be unreasonable to expect that for a given wear rate in the milling train the sand level should have been considerably reduced over the years: unfortunately the reverse is the case.

The above table shows clearly the decrease in roll wear due to switching from carbon arcing to welding and hardfacing, also a 20 per cent increase in wear for an 11% increase in suspend solids.

This 20 per cent increase in wear for an 18-roller mill is equivalent to an extra 3-roller reshells per season.

Boilers

Numerous mills have installed new boilers. Invariably these boilers are of a modern design with high thermal efficiencies

TABLE 3

Increased wear with increase in sand — at Jaagbaan

Season	Tons cane per hour	Moisture % bagasse	Solids % m.j.	Roll wear per 3 000 t	Roll conditioning
1971/72 .	177	53,79	1,04	1,41 mm	Carbon arc
1972/73 .	199	52,52	1,07	1,21 mm	Welding and Carbon arc
1973/74 .	207	52,11	1,02	1,17 mm	Welding only
1974/75 .	207	50,81	1,01	1,18 mm	Welding only
1975/76 .	218	52,48	1,13	1,42 mm	Welding only

and of the spreader stoker type, having a minimum of refractory and some form of alternative fuel system, usually coal.

Unfortunately these boilers require a well-controlled and very steady supply of fuel, which due to the very small thermal heat storage in the boiler may not be interrupted. Most of these boilers commissioned in the previous season have had serious steaming problems. It is still a debatable point whether this is due only to sand, or a combination of sand, high bagasse moistures and fuel supply to the boilers.

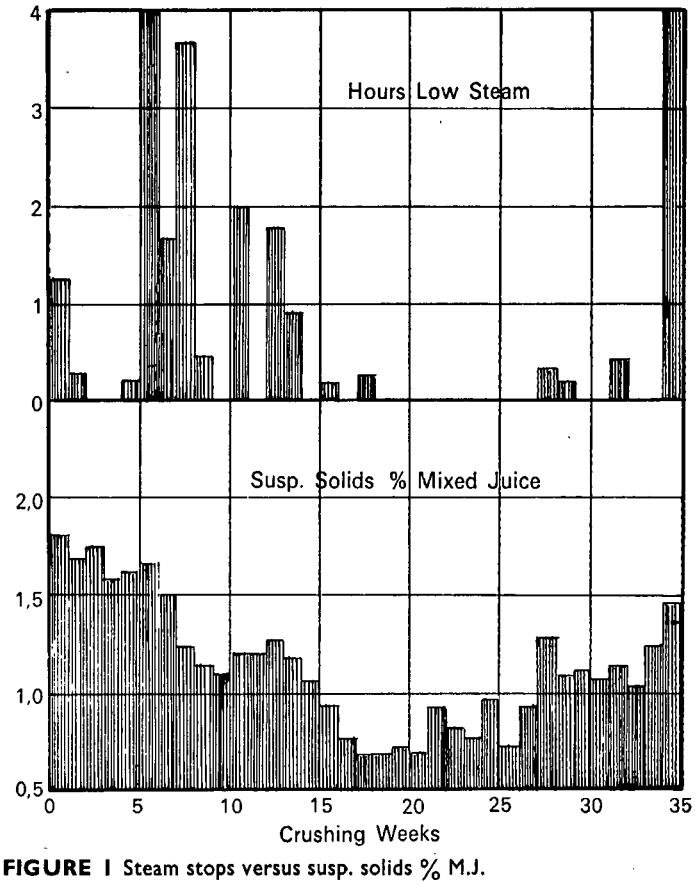


FIGURE 1 Steam stops versus susp. solids % M.J.

This graph shows clearly how the number of low steam stops increase with increase in sand content.

The effects of poor quality cane on the boiling house

There are two negative factors to consider, viz.:

(i) *The effects of sand, soil and foreign matter in cane*

These are easily definable, and are primarily limited to excessive wear in mixed juice pumps and piping, blocking of

tubes and bottom passes in vertical juice heaters. Excessive wear on doors and pass baffles of juice heaters has necessitated major rebuilding and modifications.

Heavy deposits of sand in the clarifier have resulted in the lower scraper arms being wrapped around the central shaft, requiring additional strengthening of the scraper arms. One of the most serious effects of sand is the resultant loss of sucrose in filter cake; at Jaagbaan the filter capacity is on the low side, and this is further aggravated by the ever-increasing amount of sand in mixed juice.

TABLE 4

Increase in the filter cake % cane with increased suspended solids, and resultant increase in pol lost in filter cake

Season	Suspended solids in mixed juice	Filter cake % cane	Pol in filter cake as a % mixed juice
1974/75	1,01	4,91	0,61
1975/76	1,13	5,64	0,72

Furthermore, blockage of filter drums screens and filtrate piping are not uncommon. It has been estimated that approximately 15 000 tons of sand were removed from the mixed juice in the 1975/76 season, an increase of 1 800 tons over the previous years.

Transportation of milo from the mill back to the farms has always been a troublesome and expensive undertaking, which is increasing yearly due to extra sand and soil.

(ii) *The effects of low mixed juice purity*

The quality of cane received at the mill plays a large part in maximising the amount of sucrose recovered.

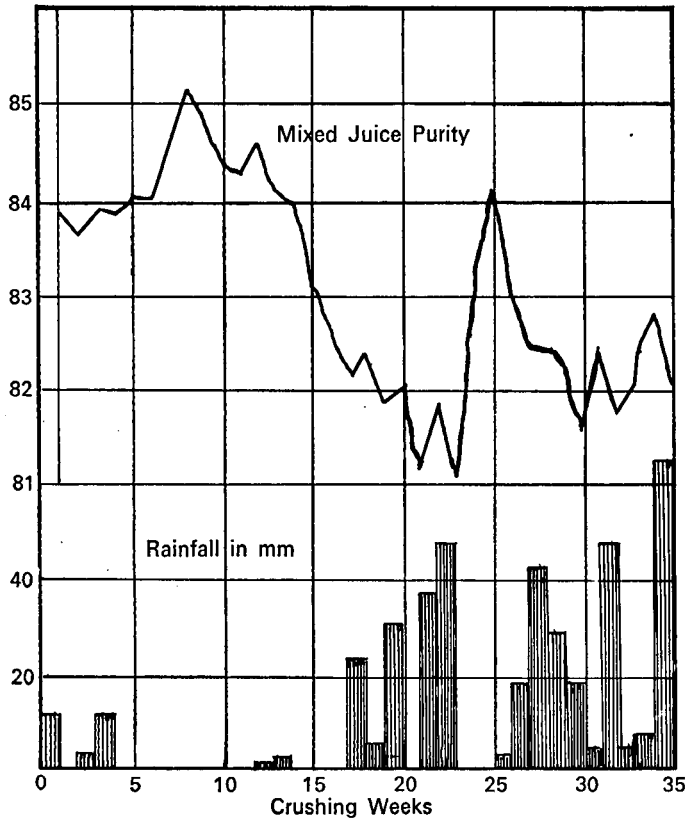


FIGURE 2 Mixed juice purity versus rainfall.

It is commonly accepted that the mixed juice purity is directly related to the boiling house recovery, as a general rule a 2 per cent drop in mixed juice purity is equivalent to a 1 per cent drop in boiling house recovery.

The primary causes of low mixed juice purities are:

(i) delays between burning/cutting and milling;
(ii) tops;
(iii) effects of climatic conditions, e.g. drought, frost, etc.

From week 8 to 23 there was a steady decline in mixed juice purity; the first rains of the season started at week 18, resulting in transport, burning and cutting difficulties. This condition deteriorated to such an extent that during week 23 the mill crushing rate far exceeded the farmers' delivery rate, and resulted in fresh unburnt cane being supplied to the mill, which resulted in a 2 per cent increase in mixed juice purity.

However, as the weather conditions improved, farmers again started burning and cutting areas far in excess of their daily quotas, and the mixed juice purity plummeted to its previous low value.

Low mixed juice purity has a detrimental effect on sucrose crystallization. Distortion of sugar crystals, i.e. elongated and needle grains, is very common, resulting in poor molasses exhaustion, and difficulties are frequently experienced with sugar qualities being below the specifications required for export sugar.

The large increase in tops supplied with the cane has resulted in an excessive increase in non-sugars, gums, etc., being processed, which (i) causes increased massequite viscosities, (ii) have a detrimental effect on the boiling and crystallization process, (iii) cause more rapid blinding of centrifugal screens, and (iv) reduce molasses exhaustion.

The estimated expenditure due to extraneous matter in cane (Jaagbaan 1975/76 season)

(*a*) *Cane preparation*

Costs to repair damage caused by rocks, etc., to knives	R19 500
Hardfacing and steel costs for knives and shredder hammers	R16 000
Lost time due to: (at R30/ton sugar):	
(i) Changing of knives and hammers mid-week: 21 hours @ 220 tons cane/hour	R13 800
(ii) Damages caused by rocks, etc.: 49 hours @ 220 tons cane/hour	R32 300

(*b*) *Milling*

Increase in mill roll wear (+12% or 3 reshells)	R15 000
Trashplate and scrapers	R2 500
Imbibition pumps and piping	R13 000
Mill roller hardfacing	R8 000
Intercarriers, chains, etc.	R5 000
Loss in extraction due to wear, etc. (0,3% @ R100 per ton sugar)	R33 120

(*c*) *Boilers*

Superheater to be replacement (3 boilers @ R30 000/boiler/6 years	R15 000
ID fans and ducting	R4 000
Ash handling and sluicing	R1 000

(*d*) *Labour*

Extra labour to clear excess sand from below carriers, boilers, etc.	R4 000

(*e*) *Transport costs*

12% tops, trash and sand in cane is equivalent to 126 600 tons/year, @ R0,80 tons/15 km R101 280

(*f*) *Boiling house losses*

Two units drop in mixed juice purity resulting in a 1% drop in boiling house recovery, i.e. 1 300 tons sugar @ R100/ton R130 000

TOTAL R413 500

Being very conservative and reducing this by 50%, the total cost to the South African industry is in the region of R3,3 million per year, or R1,65 per ton sugar. This excludes the cost of running two factories which crush 2 million tons of rubbish.

Conclusion

The cane received by the mill does not have to conform to any specifications or quality. It is therefore rather amazing that from this raw product a sugar is expected to be produced to conform to certain strict specifications, e.g.:

Purity: Colour, Grain size, Starch.

Ash: Reducing Sugars, etc.

Over the past few seasons more and more mills have experienced difficulties meeting these requirements, and paying penalties due to the gradually decreasing quality of cane received at the mills.