SUGAR MILLING RESEARCH INSTITUTE

THE COST TO THE MILLER OF SOIL IN CANE

by

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SUMMARY

1.	Report No.	:	Technical Report No. 1745
2.	Title	:	The cost to the miller of soil in cane.
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4.	Date	:	30 October 1996
5.	Objectives	:	To examine and report on the typical cost to the sugar miller of crushing, separating, handling and disposal of soil being delivered to the sugar mill with sugar cane.

6. Summary :

The problem of soil entrainment with cane is discussed in general, and methods of measuring this are given.

The effect of this soil on the operation and maintenance of the sugar mill is described and the results of some previous research into wear of cane preparation equipment are given.

The cost to the milling sector of this soil in cane is estimated at about R50 000 000 per season.

Methods of reducing soil or removing it at the mill are discussed and some recommendations are given.

7. Distribution :

Full report:

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The librarian, Tongaat-Hulett TMD
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INTRODUCTION

In the 1995/96 season the total soil in cane delivered to sugar mills in the South African sugar industry was approximately 215000 tons, as measured by the total ash method and allowing for 0,55% of soluble ash in cane. Because this season was still marked by the tail end of the serious drought, it ought not to be considered as typical. Nevertheless, the tonnage handled was equivalent to 10750 journeys of a 20 ton transport vehicle to deliver the soil and a further 10750 journeys to discard it.

In the mill itself, the soil was a direct cause of severe wear on cane knives, shredder hammers, diffuser screens, mill rolls, trash plates, scrapers, conveyor chains, conveyor slats, conveyor troughs, chute liners, juice screens, pump impellers, juice piping, clarifier scrapers, mud filter components, bagasse feeders, boiler tubes, boiler grates, boiler fans, ash disposal equipment, and various parts of by-product plants.

This report discusses the soil in cane issue and brings together the results of several past SMRI projects which have reported on the effects of soil on component wear. After several visits to sugar mills to gather further information, an estimate is made of the costs to the sugar mill of replacement, maintenance and refurbishment of all of these components, and of lost time of production resulting from the corresponding stoppages.

THE SOURCE OF SOIL

The present harvesting practices in South Africa have evolved over many years, and are now considered to be the optimum for the present circumstances. All cutting is carried out manually, and the cut cane is usually laid on the ground in windrows where the tops are cut off. From here the cane must be picked up and deposited in the in-field trailer. This operation is usually carried out by a mobile hydraulic grab which often has to be driven along the row to pile the cane into a bundle ("push-piling"). There is also a fair proportion of cane trans-loaded from field trailers into road vehicles at loading zones. These methods tend to entrain soil with the cane, and this phenomenon is aggravated during wet weather.

SOIL MEASUREMENT

The present method of determining soil in cane at the mill is by measuring the ash in a sub-sample of the cane from the Cane Testing Service hatch sampling system by incineration in an oven. This evaporates all water and burns off all combustible material, leaving only the soil and any soluble ash in the cane juice. Since this method is rather time-consuming, most mills measure ash in a composite sample for each day, and in only occasional, random samples from individual consignments. The results of the daily composite are averaged and reported in the SMRI monthly reports.

The ash content thus obtained includes the soluble ash in the cane which should be subtracted from the reported figures if soil in cane is required. This soluble ash is usually of the order of 0,6% in cane, with the range being 0,4 to 0,7%. The soluble ash is regularly measured in mixed juice, and average figures for this are 0,45 for South African mills at present. A simple ash balance can be applied to this to calculate the soluble ash in cane. This calculation gives an average to-date soluble ash % cane of 0,55%.

The figures reported in the SMRI monthly reports would thus fairly accurately indicate soil in cane if 0,55% were to be subtracted from them, or, better still, if the soluble ash were to be calculated for each mill and subtracted from it.

The SMRI is also commencing a series of tests on cane of different varieties and growing conditions to measure this ash content directly and to compare it with the mass balance figure.

A current SMRI project is also investigating the feasibility of measuring soil in cane using a nuclear device which is presently being used in the coal industry to measure ash in coal. Early results of these tests are promising.

PRESENT LEVELS OF SOIL IN CANE

When soil is measured by the above method, it is believed that the average figures taken over a month will smooth out much of the daily variation, and will thus be fairly representative. The average monthly soil % cane is shown in Figure 1 for the past six seasons. This is obtained by subtracting 0,55 from the monthly ash % cane figures in the SMRI data base.

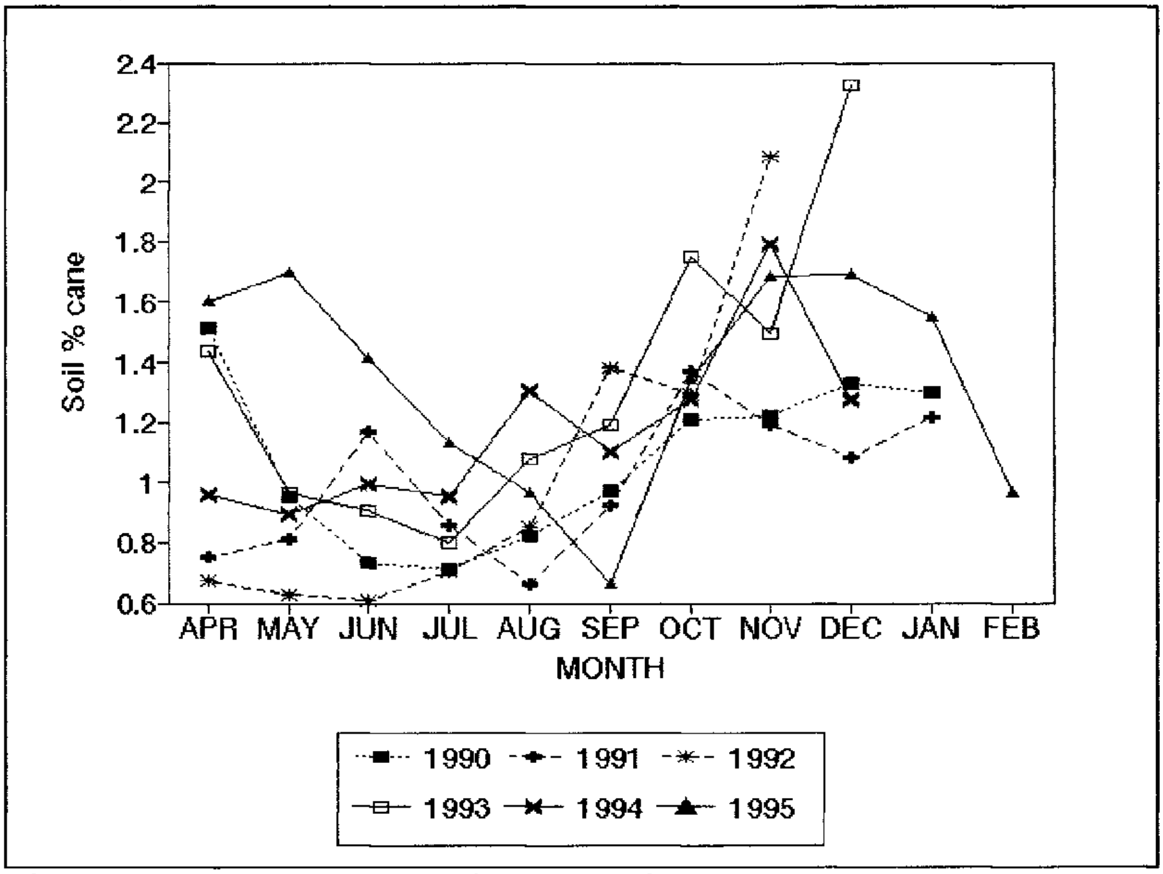

Figure 1 Monthly variation in soil % cane

It may be seen from this that the soil is higher during the rainy period, a fact which is well known and understood. However, this figure does not give the true picture of individual consignments. When such measurements are taken, it is usually because the cane reception staff suspect high levels of soil. And this suspicion is usually confirmed by measurements sometimes between 15 and 20% soil in cane. Every mill has its own story, but the writer has often heard of individual consignments with soil as high as 22%. It should be possible to avoid such high figures by careful harvesting and transloading practices.

EQUIPMENT REFURBISHMENT PRACTICES

In a sugar mill the main components which require constant refurbishment due to serious wear are cane knives, shredder hammers, mill rolls, trash plates and scrapers.

Cane knives and shredder hammers are replaced regularly with refurbished components, during a stop period which takes place usually once per week and varies in duration from 10 to 20 hours. (The duration of the stop depends on the need to clean evaporator tubes, because the knives and shredder hammers can usually be changed in about two to three hours.)

During periods of high soil in cane, the frequency of this stop can increase to twice per week, depending on the amount of cane being crushed.

The worn hammers and knives are taken to the welding shop where their wearing surfaces are built up with carbon steel and hard facing welding material to their original shape. This operation requires semi-skilled or skilled labour and moderately expensive equipment. These consumables cost R200 000 per season for a typical sugar mill at present levels of soil in cane. If the hammers and knives can be made to last longer by cutting down the soil levels in cane, these costs can be considerably reduced.

The mill rolls suffer continuous wear of their hard rough surfaces due to the extremely abrasive conditions in which they are required to work. These surfaces are continuously refurbished by welding, using a specially-developed electrode which can be used in wet conditions. The cost of electrodes for a typical diffuser dewatering mill is R64 000 per season.

Other components mentioned in the introduction have to be replaced or repaired regularly, thus adding to maintenance costs.

RESEARCH INTO WEAR OF SUGAR MILL EQUIPMENT

For many years the SMRI has been concerned about the high cost of wear of sugar mill equipment, particularly the cane preparation equipment and mill rolls. For about five years, ending in 1983, three engineers at the Institute carried out a series of research projects in which various materials, welding consumables, replaceable blocks and other techniques were tested for their wear resistance in shredders and knives. The general conclusion of this and related research in other countries was that the wear problem could not be overcome easily, and that present methods of component refurbishment were the most economical to use.

A comparison with similar work in Australia has generally revealed that the wear rates in South Africa are very much higher than those in Australia. A typical shredder hammer replaceable tip was found to last up to 14 weeks in Australia, but at NB the same block did not last one week. Similar experiments at FX, MS and SZ have had the same results. The explanation for this is that the chopper harvesting method universally adopted in Australia is far less liable to entrain soil with the cane.

A list of relevant literature is given in the Appendix for interest.

ESTIMATED COSTS DUE TO SOIL IN CANE

The information on maintenance costs which could be attributed to soil in cane is not easy to gather. Sugar mills usually do not differentiate their maintenance costs on this basis. It has therefore been necessary to extract those costs which include component wear from a typical cost listing, and then to estimate the proportion of these costs which could be attributed to soil. The major contributors to these maintenance costs are cane knives, shredders, mills and boilers. In the case of boilers, major refurbishment such as retubing or grate replacement may take place only once every ten years.

For a typical sugar mill these costs work out to about R2 per ton of cane crushed, varying from R1 to R3 for different sugar mills.

In addition to the maintenance costs, the cost of unnecessary mill stops should be added to the above figure. This is also not a simple calculation, because time lost during the season can be made up by lengthening the season by a corresponding time. Allowing for this, it has been estimated that every hour of stoppage time costs the miller about R5000. The time lost due to soil in cane is estimated at 50 hours for the season. The cost therefore works out to about R0,25 per ton of cane for the season. The costs to the grower must also be significant, but at this stage they are unknown.

The presence of soil in the cane also causes a deterioration in sugar recovery because of the sucrose taken up by the soil, and also the degradation losses during the times that the mill is stopped. These losses are also very difficult to estimate, and will therefore by disregarded.

The total of maintenance and stoppage costs thus works out to about R2,25 per ton of cane, which in a good season could cost the industry more than R50 000 000.

METHODS OF REDUCING SOIL IN CANE

There are two different sources of soil related to the way in which it is entrained with the cane. The first is caused by fine soil and silt adhering to the cane stalk after rain or flooding and is almost impossible to avoid, and it is likely that this soil makes up perhaps 10 to 20% of the total soil in cane at certain times.

The second is the loose soil which comes in with the cane and is to some extent avoidable. The harvesting practices can be suitably modified to reduce this soil, as may be deduced from the experience of Union Co-op and other mills where efforts in the field to reduce soil were intensified. Data on the effect of different loading methods is not readily available, but a short table was quoted by Dr G D Thompson at a colloquium at the SMRI (Pillay, 1988) and is shown here in Table 1. It is understood that at UC the present loading system which starts with topping while standing, careful laying down of the cane in piles, using a Bell loader and other precautions, is achieving about 1,1 ash % cane.

Rainfall increases both types of soil entrainment to a greater or lesser extent in different regions. If high levels of soil are to be avoided during rain the precautions need to be intensified, and transhipment at muddy loading zones should be minimised wherever possible. Several loading zones in the industry have been provided with a hard layer of either tar or concrete with very good results.

Table 1. Effect of loading system on ash % cane

LOADING SYSTEM	ASH % CANE
(Clean cane)	0,6
Hand	1,3
Bell	1,7
Buck	1,9
Front end	2,0
Slewing	2,1

METHODS OF REMOVING SOIL

It is fully appreciated that by far the best method of reducing the soil problem is to avoid entraining soil with the cane during harvesting and loading, i.e. by leaving the soil in the field. However, it is necessary to consider various methods which may be available to remove the soil from the cane after delivery to the mill.

DRY CLEANING. At some locations in other cane growing countries, notably Cuba, the dry cleaning of cane is practiced. This involves some means of spreading the flow of cane stalks and dropping them through a stream of air at high velocity. The cane is thrown at a fairly shallow angle through a limited opening onto the cane conveyor, while rocks and heavier sand fall vertically past a splitter plate onto another conveyor for removal. Trash and tops are blown over a further splitter plate at a shallower angle from where they can be removed. This process may be repeated once or twice, depending on design. Further research and experimentation is continuing on this principle, mainly in Latin American countries, and it is expected that it could eventually become quite efficient. It is now possible to purchase a commercial plant from Cuba.

One major problem with dry cleaning is that it does not work well in wet weather, when the soil content is at its maximum.

KOMATI ROCK REMOVAL PLANT. It has been found that the KM system is able to remove a fair amount of soil from the cane (du Plooy, 1994). This is said to be the main reason for the very efficient clarification at KM and also at Union Co-op where a similar plant has been installed. It is suggested that both the KM and UC plants should be evaluated for their soil removal capability in wet as well as dry weather.

WET CLEANING. The principle of wet cleaning is the washing of the cane stalks to remove all extraneous matter in two or more stages. The efficiency of this process is very high, but there are two major problems. The first is that the large amounts of water required inevitably remove a fair amount of sucrose which is a major loss. The second problem is that the water becomes a serious source of pollution because the sugar and other contaminants make water treatment very difficult. However, in wet weather, this may be the only way to clean the cane.

CONCLUSIONS AND RECOMMENDATIONS

- The best solution to the soil problem is to reduce the entrainment of soil in field operations. A cane quality bonus scheme could provide the incentive for this.
- If it is found to be impossible to reduce the soil arriving at the mill, it is suggested that a combined wet and dry cleaning plant be considered. This would consist basically of a rock and sand remover developed from the KM plant, and a trash remover using air blowers, as in Cuban plants. The plant would be fitted with appropriate water sprays which would come into operation only during wet weather. The relatively small water volume required for this would be run into a settling dam, and stored there for further use, where it would only require minimal treatment to prevent gross biological activity.
- Research into alternative materials to reduce the costs of wear of preparation and milling equipment should be continued.
- Further investigation should also take place into instrumentation to measure the soil content of cane more accurately.

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APPENDIX
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