CANE SAMPLING AND ITS EFFECT ON CANEYARD DESIGN AND OPERATION

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Abstract

The introduction of weighbridge sampling or modification of the existing sampling procedure would simplify the operation of most cane yards. The cost advantages may be difficult to assess quantitatively as mills would need to modify both operations and equipment. It appears from recent studies that core sampling is a feasible alternative to the present hatch system.

Introduction

The fact that all cane has to be sampled after it has passed through the cane yard adds to the operating and capital costs of most yards in the industry. It is also important to note that there is no direct benefit to the miller from cane sampling as these figures are used purely for the distribution of pol payment and not for the payment itself, which is based on the mixed juice analysis and mass. There has been a considerable amount said about other methods of sampling such as weighbridge sampling or reduced frequency sampling, but there is little or no quantitative information available on the actual economic and operational advantages that a new sampling method would bring. Part of the difficulty is due to the fact that factories have cane yards that are specifically designed to operate with the existing system and simply changing the sampling method is unlikely to affect significantly yard costs or operation. Benefiting from the advantages offered by other sampling methods will, in most cases, require changes to the operation of the yard and to the yard equipment. Prior to discussing the advantages of weighbridge sampling and reduced frequency sampling, it is perhaps as well to discuss briefly the sampling methods themselves.

Weighbridge Sampling

It is necessary to define what is meant by weighbridge sampling in this context viz a sampling system that gives ownership of the cane to the miller from the time the cane crosses the weighbridge. The result of this is that the miller is free to mix, store or sort the cane in the way that best suits his crushing programme and yard equipment. This entirely removes from the miller the onus of having to keep the cane in discrete loads until such time as the cane passes the shredder, as is presently the case.

In talking about weighbridge sampling and the possibility of using it in South Africa, both core sampling and grab sampling are often offered as alternatives. It is unlikely that grab sampling can be considered as a feasible alternative because the sample needs to be taken once the cane is unloaded. If it is in the form of a bundle, the bundle has to be broken as well. This immediately puts restrictions on the yard; either a grab and sample handling system has to be installed at each possible unloading point or the unloading has to be limited to one or two points within the yard. This means in effect that the most flexible form of weighbridge sampling that is available is core sampling.

The industry is very fortunate in having a factory, UF, operating on core sampling and hence has an ideal opportunity to assess this method of sampling. There are two factors that need to be considered; one is the precision and accuracy of core sampling and the other is its cost in comparison with the hatch system.

Core Sampling Costs

From their experience at UF the SICB has estimated the capital, operating and maintenance costs for a core sampler. Table 1 summarises the costs for both hatch and core samplers. Many mills would require two core samplers and at one mill possibly a third would be needed, whereas at present only those factories with two milling streams require two sampling systems. This means that the Central Board Cane Testing Services (CTS) operating costs would increase slightly, but the change would not be significant when compared with the potential for savings within the yard.

TABLE 1
Costs of Sampling Systems

Item	Hatch	Core
Capital cost	R87 000	R119 000
Maintenance cost (pa)	R8 800	R14 350
Labour (pa)	R45 000	R25 000

Table 1 shows that the cost of installing and maintaining a core sampling system is in general going to be higher than for the hatch system, while the operating cost will be lower due to the smaller labour requirement. It should be noted that these figures apply to a single installation. It must be emphasised that these are very rough prices as the cost is dependent on the mill layout.

Core Sampling Accuracy

The CTS has stated that, with the present forms of delivery and sampling equipment at UF, the core sampling system is producing good results. There appears to be no statistically significant bias in core sampling although there is an increase in the standard error of individual samples.

Tables 2 and 3 show the results of comparative tests performed by The Sugar Industry Central Board at UF and reported by Brokensha[1].

TABLE 2
Core Sampler Bias Evaluation

	Pol % Cane	Brix % Cane	Fibre % Cane
Core	12,02	15,01	17,15
Hatch (reference)	12,04	15,10	17,20
Difference	−0,02	−0,09	−0,05
Standard deviation	±0,66	±0,59	±1,33
Standard error	±0,09	±0,08	±0,18
n	52	52	52

As can be seen from Table 3, the standard deviation of pol in one consignment for hatch samples is ± 0,30% and this increases to ± 0,55% with core sampling. However, cane payment is based on a monthly average and over that

TABLE 3
Precision (Standard Deviation of a Test)

	Pol % Cane	Brix % Cane	Fibre % Cane
Core sampler	±0,54	±0,41	±0,90
Hatch sampler	±0,30	±0,23	±0,62

period the errors average out. In fact, even on a weekly basis, as could be used for field control, the error averages out to give similar accuracy to that achieved by hatch sampling.

It must be noted that UF receives all of its cane in SAR trucks or tram trucks and hence the industry has no practical experience of the core sampling of road vehicles. As the majority of cane supplied to local mills is delivered by various forms of road transport, it is important that practical industrial scale tests be performed to ensure the acceptability of this form of sampling for road vehicles. Core sampling is used in other countries, e.g. Reunion and Mauritius, with road vehicles and hence the necessary technical expertise is available. The tests therefore would in essence be to determine the analytical accuracy of core sampling within South Africa and not to prove mechanical or operational acceptability, as this has already been proved overseas.

Reduced Frequency Sampling

At present virtually 100% of the cane shipments delivered to South African yards are sampled. At most mills there are two possibilities for any particular shipment of cane that enters the yard; it can either be unloaded directly on to a feeder table for immediate crushing or it can be off-loaded into storage for later processing. The cane that goes directly into the mill carriers obviously does not cause any problems within the yard as it passes straight through. The difficulties are caused by the cane that goes into storage. It is here that all the elaborate precautions have to be taken to maintain the cane in discrete deliveries. Reduced frequency sampling attempts to overcome this difficulty by sampling only the cane that is crushed immediately after delivery and waives the sampling of any cane that has to go into storage.

Statistical studies can be done to determine just how much the sampling rate can be dropped before the average analysis from the reduced number of samples begins to deviate significantly from the overall average analysis. This will depend to some extent on the particular mill but it appears that sampling can be reduced to somewhere in the region of 50% of any particular grower's deliveries depending on the number of deliveries from that grower. Reduced frequency sampling is done on a random basis, but there have to be limits built into the system to ensure that each grower's cane is sampled at least as often as the statistically required minimum number of times in the specified period.

This means that situations could arise where it would be most convenient to place a certain delivery into stock, but sampling requirements would dictate that it must be crushed.

Reduced Frequency vs Core Sampling

Considering the present sampling system and the two suggested alternatives a definite progression can be seen. The present system requires the miller to keep each delivery of cane as a discrete unit and to maintain the identity of that delivery until it is crushed. This is necessary whether the cane is crushed almost immediately or after a day or days. Reduced frequency sampling requires the miller to maintain as discrete units only a portion of the total delivery. This makes it possible to arrange that only the cane which is crushed immediately needs to maintain its identity as a delivery, whereas cane going into storage loses its identity and becomes part of a common storage pool. However reduced frequency sampling is only a step towards the full autonomy within the yard that is provided by weighbridge sampling.

Looking at the South African mills it is soon obvious that for some there would be little or no advantage in moving away from hatch sampling. For other mills reduced frequency sampling would give the necessary freedom and nothing would be gained by going further, and there are mills where weighbridge sampling would be necessary. This will be discussed in more detail with reference to particular mills.

Advantages and Disadvantages

Reduced frequency sampling offers the major advantage of not requiring any alteration to the present sampling equipment or methods. By the same token, the effects are not as great as a switch to weighbridge sampling and hence the major disadvantage is that the operation of the cane yard is still in many ways governed by the sampling requirements.

Core Sampling

In looking at the advantages and disadavantages of core sampling there are two areas that need to be considered. The first is the effect of the sampling system on the yard equipment and operation, the second is in the sampling equipment and the sampling operation itself. It is in the yard where the major benefits are to be gained and these are as follows :

1. Common storage for all cane in the yard would eliminate the need for chain bundles there and this in turn would reduce labour levels in the yard.
2. The savings in replacement and maintenance of the chains are also quite significant and have been estimated to be ±R35 000 per annum for a typical mill.
3. Common storage of cane would allow far better control of first in/first out.
4. For mills with high throughputs, the facility of being able to mix cane on the tables makes it far easier to get a steady flow of cane to the mill.
5. Having the cane sampled as it comes into the yard will make it possible for the millers to consider such actions as the dry-cleaning of cane.

To give an indication of the extent of the economic benefits that are available, one mill in SA has considered the possible savings if they were to redesign their yard assuming the use of weighbridge sampling. It is estimated that they would reduce their labour complement in the yard by 42 and would also be able to eliminate chains from the yard. The estimated annual savings from this would be R150 000 per annum.

At the same time however, this study illustrates one of the major barriers to the industry receiving the full benefit of weighbridge sampling, namely, the expense involved in modifying a yard to take advantage of a new sampling system. In the above study it was estimated that the capital cost of altering the yard would be R1,4 million. It is therefore fairly obvious that a switch to core sampling cannot in general be justified for an existing yard.

According to Crisp[2] the advantages, purely in terms of the sampling system, are as follows :

1. No identification or tracking of cane is required and this obviously reduces the labour requirements.
2. No ticket and/or sample carriers or conveyors would be needed as the laboratory could be adjacent to the weighbridge.
3. There is no interference with the milling tandem.
4. Cane can be sampled whether the mill is crushing or not, thereby avoiding hold-up of vehicles.
5. It is possible to have spare equipment so that samples are not lost in the event of a breakdown.
6. Equipment can be maintained whether the mill is operating or not.
7. There is no alteration to the sampling equipment when the factory alters the milling tandem and or yard.
8. Easier maintenance of the sampling equipment.
9. As crushing rates increase it becomes more difficult to prevent mixing of the cane deliveries on the feeder tables and cane carriers. With core sampling this does not matter.

In the same report a number of disadvantages were also discussed and the main ones were seen to be the following:

1. The sampling precision, while being acceptable, is not as good as hatch sampling for individual samples. As previously stated, this has no effect on the monthly average.
2. There is a high initial cost to convert a mill to core sampling.
3. There is a certain amount of development that would need to be done before core sampling could be introduced.
4. As the cane is sampled prior to the preparation equipment, further equipment is required to prepare the core samples.
5. The number of samples will probably increase as smaller loads are sampled.

While the purpose of this paper is to consider the effects of sampling on the yard operation, the above are included to show that there are many benefits that accrue to the sampling operation in addition to the benefits the miller would experience.

The Benefits

In looking at the mills in South Africa it is immediately obvious that there are some mills which would not benefit significantly from weighbridge sampling. One example is PG where all cane is delivered in trams and is unloaded onto a single feeder table. One small advantage is that during a mill stop cane could be dumped to ground storage so that trucks would not be held up in the yard, causing no-cane stops the next day. Effectively however, there is little advantage to PG in going to the effort and expense of changing the sampling system.

There are other mills such as NB where the economic pressures are far greater. While these pressures are not sufficient justification to spend the capital required to alter the yard, the pressures are sufficient that any additional motivation will tip the scale. If for example NB should decide to expand and capital would need to be spent anyway to increase the capacity of the yard, it is likely that it would pay to go all the way and modify the yard to weighbridge sampling.

Following in from this is the case of new mills such as FX II where the obvious economic choice is to go directly for weighbridge sampling in a yard that is designed for it from the outset. It is perhaps worth looking in a little more detail at the technical and economic reasons that require the use of weighbridge sampling.

Felixton II

At this new mill it has been decided that each feeder table will be fitted with a billeter at the end of the table to chop the cane prior to dropping it onto the main carrier. The billeter needs to get a relatively steady supply of cane and this will be provided by using a steep feeder table which is intended to carry a fairly constant thickness layer of cane as it operates. Should any blocks of cane be lifted by the table a reverse kicker half way up the table will throw the excess cane back down the table. This will obviously cause mixing of the cane.

A second consideration is that the useful space on a feeder table fed by Hilos tends to be limited because a load cannot be dumped until the previous load has been moved forward. If the table has a load at the front the table cannot be moved until there is room on the carrier. This means that a table with two loads on it, one at each end, cannot take more cane even though it might have a large empty space in the centre. Therefore, live storage capacity in the yard cannot efficiently be increased simply by increasing table length. At FX II an attempt has been made to overcome this by moving away from the normal geometry of a flat feeder table with the Hilo roadway and the feeder table on the same level. With the steep angle of the feeder tables and the fact that the roadway will be raised, a well will be formed at the foot of the table and this will be able to take two full Hilo loads. This means that even if the table cannot move after the first load is dumped, a second load can be spilled. Again it is obviously not possible to prevent the mixing of cane that will occur in the well.

Turn-around times of the Hilo vehicles at the mills are a significant proportion of the total operating time. Studies at one mill showed that the time spent waiting to unload in the yard accounted for 27,6% of available vehicle time and any design features in the feeder tables that can help to reduce these non-productive waiting periods are worth considerable money in terms of reduced fleet size.

In addition to these operational benefits, there are capital benefits as well. The inclusion of a hatch system after the shredder will require an increase in the length of the main carriers of about 15 m. This has the effect of lengthening the whole site and the capital cost of this has been estimated to be R150 000.

Noodsberg

A study done at NB during 1980 illustrates the benefits that can be obtained from reduced frequency sampling. The purpose of the study was to to determine the percentage of deliveries that could be sampled assuming that only cane which was unloaded directly on to the feeder table was sampled and that all stored cane went into common pools. It should be noted that the conveyor speed and layout at NB allowed bundles of 5 tons to be tracked and sampled. This meant that it was possible to sample a single small delivery and it was not necessary to stockpile a particular grower's cane until a larger amount of cane was available.

NB designed a new yard which allowed for ground storage in common pools of both bundled and Hilo cane. This proposed yard was simulated using the GPSS programme on the University of Natal Univac Computer and the simulation was able to indicate the percentage of deliveries that could be sampled for both Hilo and small lorries and trailers.

Obviously the percentage of arrivals that could go directly to the feeder tables was dependent on the arrival rate and it was found that the percentage of cane sampled ranged from 44% of Hilo deliveries and 63% of bundles in the peak delivery period to 100% during slack periods. On the average 72,6% of all cane deliveries could be sampled. On this basis it was found that the yard could in fact be operated with common loose storage of cane resulting in the elimination of chains in the yard and the possibility of a significant labour reduction. Again however, it was found that the capital costs involved in the yard modifications were such that the projected savings did not give an acceptable payback rate. This seems to confirm that it is not at present economically viable to modify a yard to take advantage of an alternative sampling method purely on the basis of operational savings.

Conclusions

There is no doubt that the present sampling system does place restrictions on the operation of mill yards. The economic effect of these restrictions varies from insignificant at some mills to very significant capital and operational costs at other mills.

Because the costs involved in modifying an existing yard to take advantage of weighbridge sampling are so high, it is unlikely that acceptance of core sampling would cause a rush away from hatch sampling. It is most probable that core sampling would only be used by new mills and by mills which have to perform major modifications to their yards for other reasons e.g. expansion. Reduced frequency sampling could be considered as an intermediate step by some millers to provide limited freedom within the yard.

It would appear that the ideal situation for the South African industry would be the acceptance of various methods of cane sampling, perhaps hatch, core and reduced frequency sampling. This would then allow the millers some flexibility and each miller could choose the sampling system that best suits his particular requirements.

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