SURVEY OF CANE YARD EQUIPMENT AND OPERATION

By M. R. KEDIAN
Sugar Milling Research Institute

Abstract

The labour requirements and capital costs for the various cane yard layouts in the South African mills vary significantly. The various types of equipment available for cane handling and their effect on the capital and operating costs of the cane yard are discussed.

Introduction

The purpose of this survey was to compare the capital, maintenance and labour costs, together with power requirements, of the many different cane handling systems at present in use in Southern Africa.

Seven mills viz. UK, IL, ME, ML, UF, MH and PG were included in the survey, as these covered all the various types of handling equipment in use.

The capital costs used in the survey are present-day replacement costs from the 1977/78 assets register. The maintenance costs and labour costs are based on the 1977-78 budget and pay grades.

Initial observations

As the survey began a number of points were immediately obvious. These were : the extent of spare capacity in most cane yards, the expense and labour involved in the use of chain slings for bundling cane and the complications and difficulties caused in the cane yards by the present cane sampling system.

Capacity

During the visits to the various mills, cane yard managers and engineers were asked to give estimated design capacities, based on their experience, of each of their cane handling systems. This assumed that there was no delivery problem and that mill capacity was not a bottleneck. In this way the maximum continuous capacity was set for each handling system. The handling system was usually a combination of off-loading equipment and feeder table. Comparing this design capacity with the actual tonnage being handled by that equipment on an hourly basis gives a utilization factor for each handling system. Table I gives these utilisation factors for the mills studied.

It is accepted that a certain amount of spare capacity is required as a safety margin or to allow for future expansion. In addition most mills receive more cane during the day than during the night. Consequently during the day the off-loading equipment operates at a higher rate than the mill crushing rate. The extent of the reserve capacity at some mills, however, is far in excess of the above. It has in some cases reached the stage where the excess of spare capacity results in significant under-utilisation of labour and equipment. An example of this would be the SAR off-loading system at ML. This system in capital terms cost approximately half of the total cane yard cost but handles only 15% of the total cane tonnage. Based on the estimated design tonnage for the SAR system it operates at approximately 14% of its design capacity.

TABLE 1
Equipment utilisation factors

Mill	Actual tonnage (tch)	Design tonnage (tch)	Utilisation factor %
UK	233	500	47
IL	160	450	36
ME	210	450	46
ML	320	800	40
UF	300	300	100
MH	217	400	54
PG	210	240	88

Chain slings

The capital cost involved in using chain slings is considerable. From the mills studied it appears that the number of chains required by a mill is approximately 5 500. At a cost of ± R30 per sling this is a total cost of R165 000. The maintenance cost is also quite high and was given by the mills as being approximately R25 000 per annum. This figure seems to be conservative and could be considerably higher. Probably the biggest impact of the use of chains is in labour costs. Table 2 shows the total labour costs for each of the mills studied and the labour cost per ton cane handled; ME and MH are the two mills that handle essentially only bundled cane (MH has 93% bundled cane) and as can be seen the labour costs for these two mills are by far the highest. The labour costs have been based on the number of employees in each grade and the true cost for each grade. The same true cost for each grade has been used for all mills to ensure proper comparison.

TABLE 2
Labour costs

Mill	Total cost p.a. (Rand)	Cost per tch (Rand)	Employees per ton cane
UK	121 500	521	0,24
IL	73 430	459	0,19
ME	175 050	833	0,35
ML	112 110	350	0,14
MH	156 870	723	0,33
PG	112 770	537	0,26

Sampling

The present cane sampling system considerably complicates the handling of cane in the cane yard, particularly those yards receiving large percentages of cane in deliveries of less than 10 tons. For large deliveries that are loaded directly from truck to feeder table there is relatively no problem, but as soon as the cane needs to be stockpiled, the requirement that each farmer's cane be kept in discrete bundles until a minimum of 10 tons is received is a major source of problems. It considerably increases the area required for stockpiling and generally complicates the operation of the cane yard.

For those mills that receive a large number of small deliveries the use of some other sampling system such as grab sampling could be considered. This would allow the cane to be placed in one large common pile in the yard instead of a series of discrete bundles.

Off-loading systems

The off-loading systems in use at the mills studied include gantries, spillers, tippers and Cameco stackers. Each of these systems will be discussed below and an attempt will be made to highlight the advantages and disadvantages of each system. All costs are given in terms of Rand/tons cane hour (R/tch), so as to make cost figures more directly comparable.

Gantries

With the exception of gantries used to off-load SAR trucks with grabs, gantries are always used in conjunction with chain slings. The combination is one of the most expensive methods of off-loading in terms of capital, maintenance and labour costs. The capital cost appears to be about R850/tch for the gantry and a further R700/tch for the chains. The maintenance cost per annum for a gantry would be about R50/tch and for the chains about R100/tch.

Gantries, whether handling bundled cane or off-loading loose cane from SAR trucks appear to be very labour intensive. The annual labour costs for a gantry and chain sling system are about R750/tch.

Direct truck unloading

There are two basic forms of direct truck unloading onto feeder tables. These are the fairly general Hilo spillers and the ML type hydraulic side tipper. The systems both work effectively and efficiently, allowing rapid unloading of large amounts of cane. Their major disadvantage is that they rely on the cane transporter to provide a very steady, continuous cane supply, as they have no ability to stockpile. At some mills an attempt at providing surge capacity has been made by increasing the size of the feeder tables so that these can hold three or more truckloads of cane. As will be shown later, this is an extremely expensive way of providing cane storage.

It has been shown at ML that some form of stockpiling is required even at a mill that has deliveries on a 24 hour a day basis. At a mill that has some period of time without deliveries the stockpile needs to be greater.

Once there is a stockpile then equipment is needed both to load into stockpile and to load from the stockpile onto the feeder table. At any mill with a definite break in deliveries for a period during the week, the system used to load cane from stockpile has to have sufficient capacity to maintain mill throughput.

Hilo spillers

The capital cost of Hilo spillers is relatively low, ranging from R150 — R280 per tch. The price depends on whether the spiller is fixed or on rails allowing lateral movement. The spiller requires one operator and perhaps one cleaner, giving an annual labour cost of about R16/tch. The maintenance costs are very low at about R5/tch.

A Hilo spiller can unload a truck in about 2 minutes 30 seconds. After discussions at various mills it was decided that, on a continuous basis, the Hilo spiller should be capable of unloading a truck every 4 minutes. At an average load of 20 tons, this would give a design capacity of 300 tch. The capital, maintenance and labour costs are based on this figure.

The trucks used with the Hilo spiller are of special design and in their present form they are unable to handle chopper harvested cane but could relatively easily be modified to do so.

Hydraulic side tipper

This system is cheaper than the Hilo spiller in terms of capital cost. The cost would be about R100/tch on a 300 tch basis. As with the Hilo spiller two operators are required. Maintenance costs would be about the same as for the spiller.

The side tipper has two main advantages over the spiller. The first is that the tipper takes 90 seconds to unload a truck and can, on a continuous basis, unload a truck every two minutes. At an average load of 20 tons this gives a maximum design capacity of 600 tch.

Secondly, the trucks used at ML are also of special design, but these can carry chopper harvested cane as they are. A further advantage is that these trucks require no further cleaning after tipping, unlike the Hilo type body which needs regular cleaning.

Tippers

Two tipper systems were studied. These were tippers for SAR trucks and for trams.

SAR tippers

This system was only in use at one of the mills studied viz. ML.

Capital cost appears to be extremely high and in the region of R1 500 to R2 000/tch. Because the system was only in use at one mill the maintenance figures are not known with any accuracy but are expected to be about R30/tch.

A problem with SAR systems is the use of wooden poles to increase the capacity of the trucks. ML has overcome this by using special trucks with increased side height.

Tramway tipper

Tramway tipper systems appear to be about the lowest in terms of capital cost, although they are fairly labour intensive. Whether or not to use a tramway system depends more

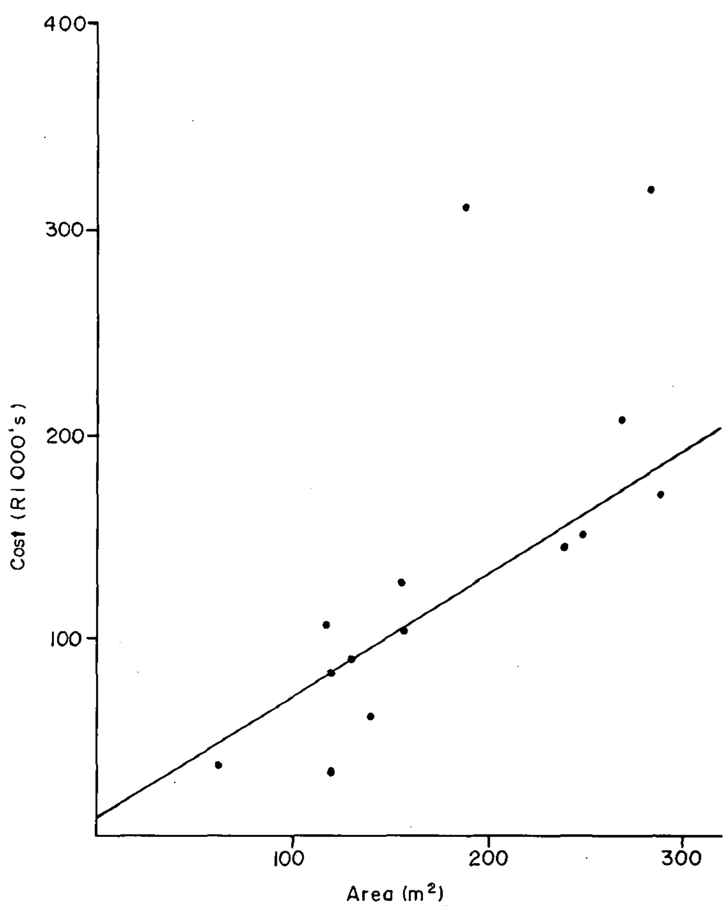

FIGURE 1 Variation in feeder table cost with table area.

on field considerations than the factory and hence applications are limited.

Cameco type stackers

The stacker capital cost is R70 000 and in terms of tons cane per hour this is about R300/tch. It should be noted that the stacker cannot itself unload trucks and has to work in conjunction with some other unloading system such as a spiller. A spiller/stacker combination would cost about the same as an equivalent gantry but would require a considerably smaller labour force. For example IL and ML have a labour requirement of 0,19 and 0,14 employees/tch while ME and MH have requirements of 0,35 and 0,33 employees/tch.

ML operates at 320 tch with a spiller/stacker combination and ME at approximately 210 tch with a gantry. The ML labour costs are 45% of those of ME and this represents a saving of about R90 000 per annum at present rates of pay.

The maintenance costs of stackers are about R10 000 per annum or R45/tch. The stackers have a relatively high fuel cost of R10 000 per annum and this has to be taken into account.

Feeder tables

From the mills studied, a graph was drawn showing capital cost of feeder tables as a function of their area. The graph is shown in Figure 1 and the correlation between cost and area can clearly be seen. It is for this reason that the use of the feeder table to supply surge capacity is a very expensive practice.

Table capacity

Some spiller tables appear to have sufficient capacity to hold up to 5 truck loads of cane. It is recommended that the area be based on the formula given by Hugot[1] which is A = tch x 0,6. This links the table size to throughput and should give sufficient capacity to level out minor irregularities in crushing rate and cane delivery. Any cane yard with a spiller discharging directly onto a feed table must have a backup stockpile system and it is from there that surge capacity is supplied.

For a factory handling 225 tch the Hugot formula would give a feed table area of 135 m². At the mills studied, feed tables being fed directly by spillers ranged from 190² to 295 m². It is interesting to note that the 190 m² table presently operates at the highest throughput of all the spiller tables studied.

Feed table drives

Figure 1 shows clearly that feeder table area has the most pronounced effect on cost, but other factors will influence cost as well. One of these will be the type of drive used. At the mills studied, the drives used ranged from simple on/off electric drives to complex hydraulic drive systems. There appears to be no evidence that variable speed drives are a necessity. Many operators apparently operate the tables in an on/off mode, even when variable speed is available. One of the mills is presently considering replacing a variable speed controller with an on/off button. It appears therefore that some savings can be realised by avoiding variable speed drives and at most having some system that gives a stepped increase in power to the motor to avoid the impact loads of a truly on/off system.

Slat or drag type conveyers

Drag type tables have one disadvantage and that is an inability to cope with chopper harvested cane.

Drag type tables have many advantages however, the first being that they are lower in capital cost. Because a chain failure on a drag type table does not stop operation these tables can use old chain downgraded from more critical services instead of having to use new chain, and maintenance costs are therefore considerably lower. Maintenance costs for drag type tables are in the range of R10 000 to R20 000 per year.

Cane yard cost comparisons

The two systems that appear at present to be the best are a spiller/stacker combination and a gantry.

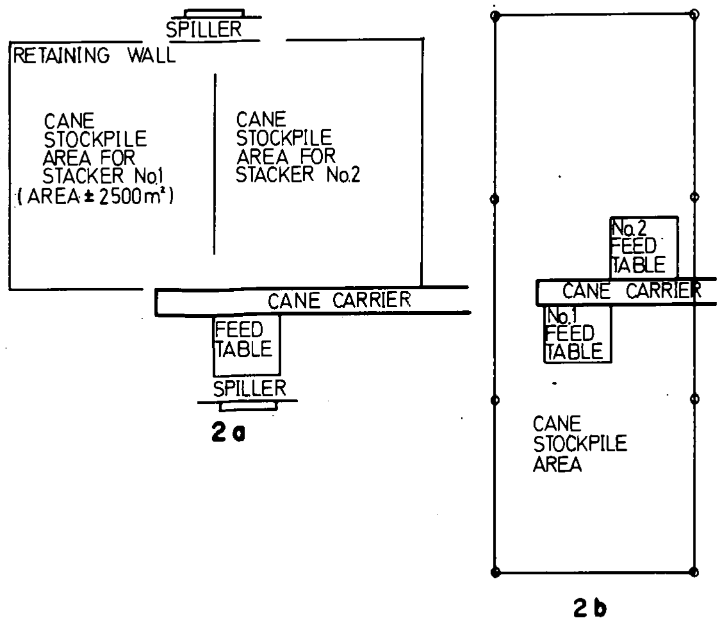

FIGURE 2 Proposed cane yard layouts.

TABLE 3

Item	Figure 2a	Figure 2b
Capital:		
Spillers	80 000	—
Stackers	130 000	—
Paving	60 000	25 000
Gantry	—	190 000
Chains	—	150 000
Table (135 m²)	100 000	100 000
Weighbridges	30 000	30 000
TOTAL	400 000	495 000
COST/tch	R1 778	R2 200
Maintenance:		
Spillers	3 000	—
Stackers	20 000	—
Paving	2 000	1 000
Gantry	—	10 000
Chains	—	25 000
Tables	10 000	10 000
Weighbridge	3 000	3 000
TOTAL	38 000	49 000
COST/tch	R169	R218
Labour:		
Total requirements	32	60
Estimated Cost	at 2 400 = 76 800	at 2 180 = 130 800
COST/tch	R341	R581
Power:		
Annual fuel/power cost	20 000	2 000
Cost/tch	R90	R9

In an effort to compare these, a mill size of 225 tch was assumed and the cane yard requirements for each of the two systems estimated.

Figure 2 shows sketches of possible layouts using these two systems. Figure 2a shows a yard with two spillers, one feeding directly onto a feeder table, and two stackers loading from stockpile. Figure 2b shows a gantry system with two feeder tables and using chain slings.

Table 3 shows a cost comparison of the three systems.

It should be noted that the system shown in Figure 2a would allow the mill to operate without cane deliveries for a period of time over the weekend. If deliveries were continuous throughout the week except for the shutdown period, then one stacker would suffice.

Conclusions

The survey confirmed the initial observations. Most mills do have excess capacity and this seems to stem from the use of two or more handling systems e.g. gantry and spiller or spiller and SAR tipper. The most effective use of equipment is made by a yard receiving cane on a continuous basis and using only one system of cane handling.

The use of chain slings is very labour intensive and consequently the costs are high. Added to this, the capital and maintenance costs for chain slings are also high. It appears that, at cane yards where the cane has to be delivered in chained bundles, ways of minimising the use of chains inside the yard itself would be worth investigating.

The present cane sampling system does complicate the operation of the cane yard. The degree of complication caused by sampling seems to be dependent on the percentage of small deliveries and the size of cane stockpile required. An alternative sampling method would be worth considering at some mills.

Acknowledgements

The assistance given by cane yard managers and engineers at the mills surveyed is greatly appreciated, as is the assistance given by Smithtech.

REFERENCES

1. Hugot, E. (1960). Handbook of cane sugar engineering. Elsevier, Amsterdam, p.15.