A STUDY OF COST EFFECTIVE TRANSPORT SYSTEMS FOR MECHANICALLY HARVESTED CHOPPED CANE IN MAURITIUS

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Abstract

The transport of sugarcane from the field to the mill represents a substantial proportion of the costs of cane production. With the introduction of chopper harvesters in Mauritius, a major change has been observed in the transport systems used to haul cane. Presently, cane received from chopper harvesters is hauled directly to the mill by infield transport of relatively small capacity, or is transloaded into truck-drawn or tractor-drawn trailers of larger capacity. Choice of transport system on various estates was originally based mainly on information obtained from other sugar producing countries, without an economic feasibility study being carried out.

The objective of this study was to determine the shortest distance below which direct delivery is more economical than transloading, and subsequently to identify which mode of transloading is more cost effective. Field surveys were conducted to monitor the cycle times associated with the harvesting and transport operations. After optimisation, these parameters were fed into a computer simulation model to generate the number of transport units required to haul the mechanically harvested cane, when the harvester idle time is either zero or 10% of a normal ten-hour working day. A cost analysis was used to establish a boundary, defined in kilometres, either side of which represents the economic feasibility of the respective methods. The results obtained using these parameters indicated that direct delivery of green chopped cane has a cost advantage over transloading into outfield transport for distances up to 8-9 kilometres.

Keywords: green chopped cane, direct delivery, transloading, cost effectiveness.

Introduction

In certain countries, the cost of cane transport can be as much as 30% of the total cost of cane production (Anon, 1991). With such a significant contribution to total production costs, it is important that transport systems should be as effective and efficient as possible if maximum profitability is to be attained. Too often a high level of management and investment is devoted to crop production and processing at the expense of transport. Yet it is the complex issue of transport which is the vital link in the production chain.

The Mauritian sugar industry is facing a severe shortage of labour and the available labour is becoming more and more expensive. These factors have led to the introduction of mechanisation of sugarcane harvesting, which is the most labour intensive cultural operation. When considering topography, cane lodging and cane yield, it seems that chopper harvesters are best suited to local conditions. Indeed, in 1994, 13 chopper harvesters were in operation, representing 68% of the cane harvested mechanically, compared with only five whole-stalk harvesters (Anon, 1994). Moreover, in view of possible legislation for banning cane burning prior to harvest, chopper harvesters will prove to be more appropriate because of their cleaning system. Mechanised harvesting is confined to sub-humid and humid zones (receiving less than 2 400 mm annual rainfall). In the super-humid regions, soil conditions are unsuitable for mechanical harvesters and infield transport (unless equipped with tracks) during most of the crop season. In addition, most of the cane varieties planted in these areas do not tolerate stubble shaving (McIntyre and Hardy, 1989).

Sugar estates have chosen their transport systems for chopped canes on the basis of information from other sugar producing countries without a feasibility study having been conducted under their own operating conditions. There arises a growing need to review the economics of the transport of chopped cane. Typically, the methods used include tractor-drawn trailers taking cane directly from the field to the mill, and truck-drawn or tractor-drawn trailers requiring a transloading operation. In the latter case, the trailers alone or the prime movers together with the trailers stand by before being loaded from the side- tipper bin of the infield transport. The objective of this study is to determine the cost effectiveness of the different transport systems of green chopped cane in order to identify the lowest cost system in relation to field-mill distance.

Method

The following haulage systems were studied:

Direct delivery

The harvester loads the chopped cane into an infield tractor (82 kW) equipped with a rear- tipper bin (12 tonnes). These haulage units then deliver the cane directly to the mill.

Indirect delivery

The infield haulage operation is performed using 60 kW tractors equipped with side-tipper bins (6,5 tonnes). The different sub-systems for delivering the cane to the mill are as follows:

(i) the infield haulage unit transfers the cane into 12 tonne bins parked near the field, which are then hydraulically hitched onto lorries (216 kW) for delivery to the mill.

(ii) the chopped cane is transferred into tractor-drawn 18 tonne bins equipped with a movable bed.

(iii) the chopped cane is transloaded into truck-drawn 24 tonne rear-tipper bins.

For (ii) and (iii), the prime mover stands by hitched to its empty bin, while for (i) only the bins stand by.

Field surveys were carried out to monitor the above transport systems in order to obtain actual values for their loading rate, travel time, weighing and unloading time at the mill. The different variables identified in this study were as follows:

Harvester cutting rate

Green cane: cutting rate 40 t/hour (after allowing for turning at the end rows and bin change-over).

Unloading times

Transloading time at field edge	2 minutes
12 tonne rear-tipper bin at millyard	3 minutes
18 tonne movable bed bin at millyard	7 minutes
24 tonne rear-tipper bin at millyard	5 minutes.

The travel time of the infield tractor from the harvester to the transloading site and back is one minute. At the millyard, the time spent queuing is taken as seven minutes for any system.

Road speed

25 km/hour for tractors
40 km/hour for trucks.

These variables were used in a computer simulation model to simulate the harvesting and transportation operations. The main output was the determination of the optimum number of transport units required when the harvester idle time is either zero or 10% of a normal 10-hour working day (actual value observed due to breakdown and refuelling). It was assumed that the mill is working at full capacity without any breakdowns.

Costing method

In order to identify the most economic transport system in relation to field-mill distance, a cost analysis was carried out to calculate the cost of shifting one tonne of cane for each system. The procedure used included both fixed and variable costs. The following assumptions were made for developing the total cost of operating each haulage method under study:

- the expected lifetime of the prime movers and trailers was five and seven years respectively, both with a zero salvage value.
- the prime movers were considered to be in operation all year round and the cost due to the transport operation was calculated according to a 120-day milling season. The trailers were depreciated totally over the harvesting season.
- the straight line depreciation method was adopted.
- interest rate was calculated on 50% capital cost of the equipment based on the actual rate for agricultural loans (14%).
- insurance and shelter represented 1% of the capital cost of the equipment.
- road taxes were those actually paid by the estates.
- repairs and maintenance costs were assumed to be 100% of the annual depreciation (Lemoigne, 1988).
- fuel and lubricant consumption of the prime movers were obtained from various estates.
- labour charges were those stipulated by the National Remuneration Board.

The total cost associated with each transport system was derived by combining the fixed and variable costs of the number of transport units required to haul the chopped cane to the mill. The cost of transporting one tonne of chopped cane was then calculated for one kilometre increments from 1-15 kilometres. The results were then used in a comparative analysis to establish a least-cost method.

Results and discussion

The cost of transporting one tonne of cane by each hauling method is presented graphically in Figure 1, when the harvester is assumed to work at full capacity (zero idle time). Additional detail of the transport units required for each system is given in Table 1. Examination of the costs indicates that the direct delivery system with a payload of 12 tonnes has the greatest cost advantage up to about 8 km. Beyond this distance transloading into larger units is necessary.

Among the larger units, the truck and trailer (24 tonne payload) on standby is most cost effective. The tractor and trailer with a movable bed (18 tonne payload) is the least advantageous, irrespective of distance. This can be explained by the lower travelling speed of the prime mover and greater investment cost for the trailer. This highlights the necessity for sugar estates to make judicious investment in equipment.

The system with trucks transporting 12 tonne bins stacked at the field edge is less cost effective than 24 tonne bins on standby with truck, irrespective of distance. This indicates that, even when using a faster prime mover, greater payloads must be envisaged to offset the cost of the transloading operation.

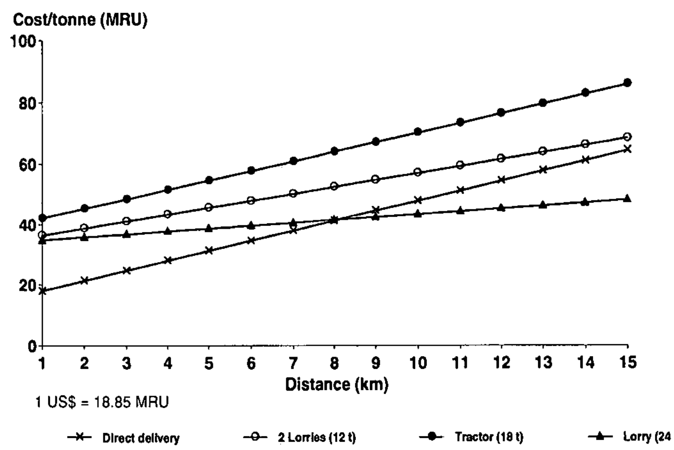

FIGURE 1: Transport costs for different systems (harvester idle time 0%)

Table 1
Number of transport units required for each transport system (zero idle time)

Distance (km)	Direct (km)	Indirect delivery		
		2 lorries (12 t) + n parked bins	Tractor (18 t)	Lorry (24 t)
1	2	2	2	2
2	3	2	2	2
3	3	2	2	2
4	3	2	2	2
5	3	2	2	2
6	4	3	3	2
7	4	3	3	2
8	4	4	3	2
9	5	6	3	2
10	5	8	3	2
11	5	9	3	2
12	5	10	4	2
13	6	11	4	3
14	6	12	4	3
15	6	13	4	3

Figure 2 shows the transport costs of unit tonne cane for the different systems studied when harvester idle time is 10% of a normal 10-hour working day. Detail of the transport units required for each system is shown in Table 2. The same trend is observed as when harvester idle time is zero. The direct delivery system now exhibits a cost advantage up to about 9 km. After this distance, transloading is necessary. In this case, the truck with a 24 tonne bin on standby again has a greater cost advantage.

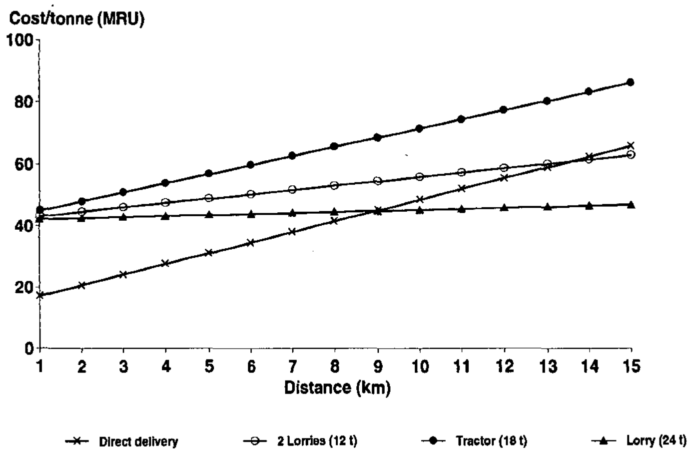

FIGURE 2: Transport costs for different systems (harvester idle time 10%)

Conclusion

Results show that direct delivery of green chopped cane has a cost advantage over transloading into an outfield transport for distances up to 8 or 9 kilometres, depending on whether the harvester is working at full or reduced (90%) capacity. This pattern of relative cost advantage occurs because of the additional cost associated with the transloading operation. Beyond these distances, transloading becomes more cost effective when performed into 24 tonne bins with the use of trucks, which have a greater hauling efficiency than tractors because of their higher travelling speed.

If mechanical harvesting is extended to the super-humid regions of Mauritius, direct delivery from the fields of 12 tonne payloads might not be possible, irrespective of the distance from the mill. Transport accompanying the chopper harvester should then consist of track tractors and side-tipper bins which would transfer the cane into larger capacity road haulage units.

Table 2
Number of transport units required for each transport system (10% idle time)

Distance (km)	Direct (km)	Indirect delivery		
		2 lorries (12 t) + n parked bins	Tractor (18 t)	Lorry (24 t)
1	2	2	2	2
2	2	2	2	2
3	2	2	2	2
4	3	2	2	2
5	3	2	2	2
6	3	2	2	2
7	4	2	2	2
8	4	3	2	2
9	4	3	3	2
10	4	5	3	2
11	4	6	3	2
12	4	8	3	2
13	5	9	3	2
14	5	10	4	2
15	5	12	4	2

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