TRANSPORT OF WHOLE CANE FROM TRANSLOADING ZONES IN MAURITIUS

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Abstract

The centralisation of the Mauritian sugar industry, resulting from the closing down of mills of lower crushing capacity, involved the re-organisation of cane transport and the establishment of transloading zones. Cost effective transport systems and operating conditions had therefore to be identified. Different systems comprising lorries, agricultural tractors and one haulage tractor operating at three existing transloading zones were assessed technically and economically. Most transport systems are characterised by low payload to tare weight and high power to payload ratios. Factors affecting the transport cycles were also studied. The waiting times recorded both at transloading zones and mill yards were found to be of crucial importance. Their impact on costs predominated over technical aspects. Transport systems with 24 tonne payloads were found to be the most cost effective. Night transportation was less costly, mainly because of significant reductions in down time.

Key words: Transport systems, sugarcane, transloading zone, cost.

Introduction

Owing to the centralisation of the Mauritian sugar industry, the cranes at sugar factories which have closed down are utilised to operate transloading zones (Anon, 1984). Transport systems different from those which originally transported cane from the fields to the site are utilised to transfer cane to the factory where crushing is to be carried out. Transloading zones have also been created on sugar estates with fields in superhumid and/or sloping conditions where direct delivery in large consignments (>12 tonnes) is not practical. Cane from infield haulage units (5-12 tonnes) is transferred into larger units (15-24 tonnes). In the process of centralisation, more redundant factory sites will be converted into transloading zones.

Transport systems operating at three transloading zones were assessed technically and economically to identify the most cost effective and the factors involved in cost effectiveness. The aim was to make recommendations on systems to operate at the new transloading zones.

Materials and methods

Transport systems studied (transloading zone to mill)

The transport systems, as well as the distances between three transloading zones and their respective mills, are given below.

Solitude – Belle-Vue SE (8.8 km)

- Lorry (216 kW) + 24 tonne trailer on day shift
- Lorry (216 kW) + 24 tonne trailer on night shift
- Agricultural tractor (107 kW) + 15 tonne trailer.

Sans-Souci – FUEL SE (11.6 km)

- Agricultural tractor (112 kW) + 24 tonne trailer
- Agricultural tractor (90 kW) + 18 tonne trailer.

Henrietta – Medine SE (14.3 km)

- Haulage tractor (90 kW) + 24 tonne trailer
- Agricultural tractor (112 kW) + 24 tonne trailer
- Agricultural tractor (82 kW) + 12 tonne trailer
- Agricultural tractor (138 kW) + 24 tonne trailer.

The transport cycle

Figure 1 shows the different phases of a typical transport cycle between the transloading zone and the mill. Time and motion studies were conducted to obtain the duration of the different phases shown.

A survey was carried out at the transloading zones and weighbridges to obtain arrival and departure times for each trip. Loading, weighing and unloading times were measured and average values computed. Time lost due to breakdowns was not included in the calculated cycle times.

Cost analysis

The number of units required to transport the given quota was calculated for each system taking into consideration crop duration, cane quota to be transported, cycle time, average payload and effective working hours. The total cost of these transport units and the cost per tonne of cane transported were then computed.

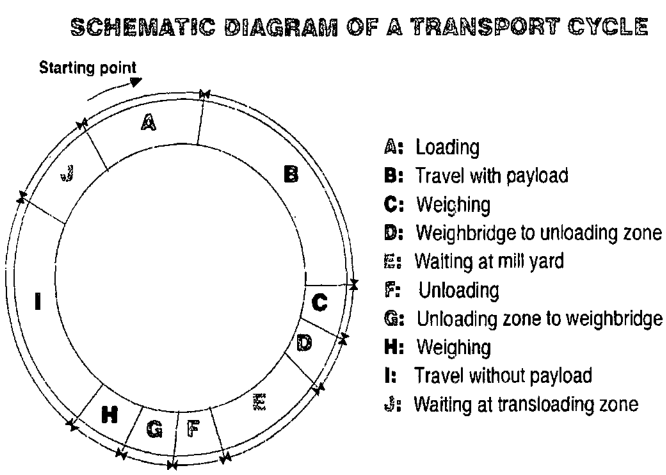

FIGURE 1: Schematic diagram of a transport cycle

The following costing procedures were adopted:

- depreciation was calculated using the straight line method
- interest on loans, insurance, licences, road taxes and shelter facilities were taken as fixed costs

- fuel, repairs, maintenance and labour were taken as variable costs.

The lifetime of prime movers was taken to be five years and that of trailers, seven years. Fixed costs were spread over the whole year for prime movers and over the crop season only for trailers. The present interest rate for agricultural loans in Mauritius (14%) was used. Fuel consumption was estimated to be 0,14 L/kW/h, which is a compromise between the values given by Lemoigne (1988) and the values obtained from records made at Belle Vue Sugar Estate (Bestel, personal communication). Repairs and maintenance costs were taken as 100% of annual depreciation (Lemoigne, 1988) and estimated at 120% for night shift.

Technical characteristics

The technical parameters adopted to compare the different transport systems were:

- ratio of power rating of prime mover to payload
- ratio of payload to tare weight.

Results

Waiting times

The waiting times both at transloading zones and mill yards were found to represent a high percentage of the total transport cycle.

Table 1

Waiting time

	Waiting at transloading zone		Waiting in mill yard	
	Time (h)	% of cycle	Time (h)	% of cycle
Minimum	0	0	0	0
Maximum	3,20	63,5	1,40	43,3
Mean	0,67	26,0	0,22	8,4

An irregular supply of cane from infield haulage units was the main cause for the high percentage of waiting time at the transloading zone. This value reached a peak of 3 hours and

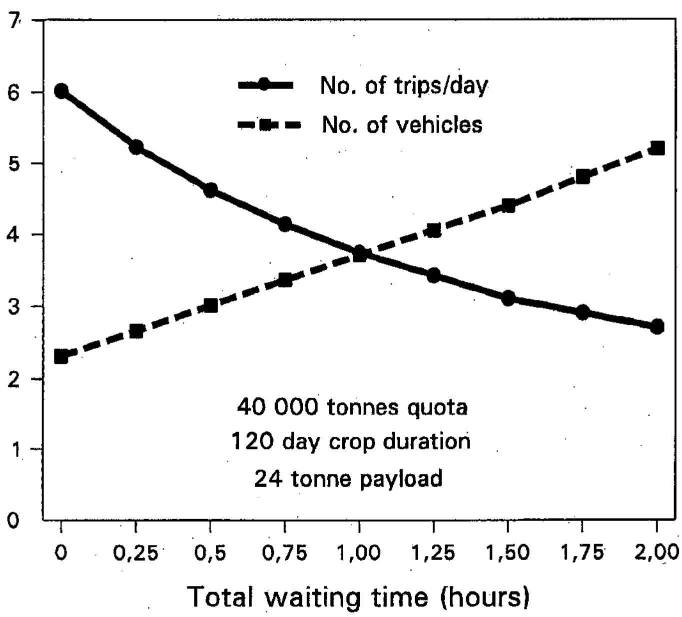

FIGURE 2: Influence of waiting time on number of transport units

12 minutes (Table 1) and represented 63,5% of the transport cycle at Medine. At the mill yard the waiting time before unloading depends on the crushing capacity of the mill, the traffic density in the mill yard, the space available for machine manoeuvrability and the number, type and capacity of unloading equipment. The maximum waiting time was recorded at Belle Vue (43,3% of cycle time) whereas at Medine it was only 17,3%. The unloading systems and traffic organisation at Belle Vue estate should be more closely studied.

As shown in Figure 2, vehicle availability and the number of trips per day are reduced due to waiting. The number of vehicles required to transport a given cane quota (40 000 tonnes, 120-day crop) subsequently increases.

Technical characteristics of transport systems

As shown in Table 2, the haulage tractor has the most efficient power to payload ratio. The other systems are characterised by an under-utilisation of available power. The worst case is the 107 kW tractor transporting only 15 tonnes of cane.

Table 2

Ratio of power to payload

Prime mover	Power (kW)	Payload (tonnes)	Power: payload (kW/tonne cane)
Haulage tractor	90	24	3,75
Agricultural tractor	138	24	5,75
Agricultural tractor	112	24	4,67
Agricultural tractor	90	18	5,00
Agricultural tractor	107	15	7,13

Efficient transport systems should have a payload to tare weight ratio of at least 1,5:1 (de Beer *et al.*, 1993). In other words, a transport unit should have a payload of at least one and a half its tare weight. A lower value means that the payload is too low or the tare weight too high, implying that more than 40% of fuel consumed or energy spent is used to transport dead weight. As during half of its life time the transport unit runs empty, the tare weight should be reduced to the optimum level. Poole (1989) claims a ratio of 2:1, allocating only 33% of energy to the transport of dead weight. The worst ratio (0,89 as shown in Table 3) is for the 107 kW agricultural tractor. This haulage unit is transporting less cane than its tare weight and 53% of the energy spent is used for hauling dead weight. The haulage tractor again shows the best ratio. This may be due to the Poole hitch system, which ensures the maximum weight transfer from the trailer to the tractor. The good performance of the same type of haulage tractor has been reported also by Ubombo Ranches in Swaziland (Anon, 1992).

Table 3

Ratio of payload to vehicle tare weight

Prime mover	Total tare weight (tonnes)	Ratio
Haulage tractor	11,76	2,04
Agricultural tractor (112 kW)	16,80	1,61
Agricultural tractor (107 kW)	16,77	0,89
Lorry	13,39	1,79

Economic aspects

Cost under actual operating conditions

The values obtained in Table 4 are highly influenced by waiting time. For Medine and FUEL, the haulage tractor and the 112 kW agricultural tractor respectively are the most cost-effective. At Belle Vue, the lorry operating on night shift is the most economical. All these systems haul payloads of 24 tonnes. However, comparisons between estates should not be made as distances and conditions are different.

Table 4

Transport cost under actual conditions

Estate	Prime mover	Payload (tonnes)	Cost/tonne (Rs)
Belle-Vue SE	Agricultural tractor (109 kW)	15	65
	Lorry, day shift (216 kW)	24	57
	Lorry, night shift (216 kW)	24	46
FUEL SE	Agricultural tractor (112 kW)	24	48
	Agricultural tractor (90 kW)	18	50
Medine SE	Haulage tractor (90 kW)	24	63
	Agricultural tractor (138 kW)	24	91
	Agricultural tractor (112 kW)	24	75
	Agricultural tractor (82 kW)	12	66

R1 = Rs 4,26 (April 1996)

Influence of waiting time

The impact of waiting time on the number of transport units was shown in Figure 2. A simulation was done to obtain the influence of waiting time on costs, and the results are given in Table 5. When the transport unit is waiting either at the transloading zone or mill yard, the engine of the prime mover can be turned off so that variable costs such as fuel and oil are reduced. Fixed costs will, however, remain the same and the number of effective working hours will decrease with increased waiting time. If waiting time were reduced to zero, a reduction of up to 30% in transport costs could be expected.

Table 5

Influence of waiting time on costs

Prime mover	Payload (tonnes)	Cost/tonne (Rs)		% reduction
		Actual	No waiting time	
Agricultural tractor (107 kW)	15	65	57	12
Lorry, day shift (216 kW)	24	57	40	30
Lorry, night shift (216 kW)	24	46	32	30
Agricultural tractor (112 kW)	24	48	39	19
Agricultural tractor (90 kW)	18	50	41	18
Haulage tractor (90 kW)	24	63	47	25
Agricultural tractor (138 kW)	24	91	69	24
Agricultural tractor (112 kW)	24	75	56	25
Agricultural tractor (82 kW)	12	66	55	17

R1 = Rs 4,26 (April 1996)

Night transport

At Belle Vue, where a lorry operates a night as well as a day shift, the average waiting time fell from 17,4% during the day to 4,3% at night. Conditions for night shift have been simulated for the other transport systems with the following assumptions:

- there is no waiting time at mill yard and transloading zone
- vehicles operate on a 24-hour basis
- fixed costs are reduced whereas variable costs increase.

As shown in Table 6, a reduction of up to 31% in costs can be obtained by using night transport as compared with ideal conditions for the day (minimum waiting time, optimum number of trailers per prime mover).

Table 6

Comparative costs of operation during night and day

Prime mover	Payload (tonnes)	Cost/tonne (Rs)		% reduction
		Actual	No waiting time	
Agricultural tractor (109 kW)	15	57	40	30
Agricultural tractor (112 kW)	24	44	32	27
Agricultural tractor (90 kW)	18	45	31	31
Haulage tractor (90 kW)	24	43	35	19
Agricultural tractor (138 kW)	24	59	44	25
Agricultural tractor (112 kW)	24	52	42	19
Agricultural tractor (82 kW)	12	57	46	19

R1 = Rs 4,26 (April 1996)

Conclusions

An under-utilisation of rated power of prime movers with respect to payload was observed. Tare weight is often very high with respect to payload. For these two parameters, the haulage tractor had the best characteristics. However, there is only one such unit operating in Mauritius and the performance of new units in different conditions must be monitored before recommendations can be made.

Transport systems with 24 tonne payloads were the most cost effective between transloading zones and the mill.

The time factor had a greater influence on costs than did technical characteristics. Waiting time should thus be minimised: at transloading zones this can be achieved by improved scheduling of delivery of cane from the fields; at the mill yard, traffic should be better organized. Transloading zones can contribute to reduced traffic intensity and subsequent waiting time at the mill yard by allowing the use of bigger transport units.

Night transport is an important option, as it enables a reduction in waiting time and costs. Moreover, night transport would lead to reduced traffic congestion and waiting times during the day, and would subsequently reduce costs. However, the implications of night transport should be studied further. For example, teams of mechanics would need to be on standby for repairs, and the weighbridges and cane analysis laboratories would have to operate at night as well as during the day.

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REFERENCES

Anon (1984). *Master plan for the modernization and rehabilitation of the sugar industry.* Port Louis. The Mauritius Chamber of Agriculture. 255 pp.

Anon (1992). Bell haulers transport Ubombo's cane crop. *S Afr Sug J* 76(8): 260.

de Beer, AG, Hudson, JC, Meyer, E and Torres, J (1993). Cost effective mechanization. *Sug Cane* (4): 11-14.

Lemoigne, M (1988). Gestion du Materiel, CIRAD-SAR (ex CEEMAT), Montpellier, CIRAD-SAR (ex CEEMAT) France. 54 pp.

Poole, H (1989). Cost effective sugar cane transport. *Sug Cane* (1): 4-6.