FIELD EFFICIENCY OF CHOPPER HARVESTERS

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Abstract

Time and motion studies on five chopper harvesters, operating on different estates, showed that actual cutting rates can be as high as 60 tons per hour. However, time lost to turning, servicing, waiting, etc reduces this figure to just over 20 tons per field hour. Even under ideal conditions, with long cane rows, 10% of the total field time is required for turning at headlands.

Introduction

The question of harvesting capacity is often raised when sugarcane producers discuss the pros and cons of mechanical harvesters. Manufacturers of chopper harvesters use phrases such as "a pour rate of over a ton a minute" and outputs of 50 or more tons per hour are mentioned. In practice, however, few machines seem to average more than 20 to 30 tons per hour, which indicates very low field efficiencies. Chopper harvesters are very expensive pieces of equipment and only high outputs and maximum utilization could, under present South African conditions, make them economically viable.

The Experiment Station conducted time and motion studies during 1975 and 1976 to determine the field efficiencies of chopper harvesters and to establish the influence of various factors on performance. Complete field records from one estate, where a chopper harvester had been operating for a number of years, were also available and some information from their records are included in this paper.

Method

Five machines from different estates were used in this study. Conditions were similar in that all fields were on flat ground and all cane was burnt before harvesting. Four machines operated on well laid out, well prepared and overhead irrigated fields, while one operated on un-irrigated fields not specially prepared for mechanical harvesting.

The recording official chose machines at random, and carefully noted times spent on various functions. Field particulars such as variety, age, ratoon number, extent of recumbancy, quality of burn, yield (when available), area being cut and average row length were recorded. Times noted included :

(i) Field time: the total time spent by the harvester in the field, excluding meal breaks.

(ii) Cutting time: the time utilized for cutting, i.e. the machine cutting and delivering sugarcane into containers.

(iii) Servicing: any servicing time which was required while the machine was in the field. This excludes normal servicing carried out before the machine moved to the field.

(iv) Repair and Maintenance: any time required to repair the machine and any maintenance while in the field.

(v) Waiting: time lost while waiting for infield transport, etc.

(vi) Turning: time required for turning around at headlands.

(vii) Others: any other time lost was also recorded.

Total time lost included items (iii) to (vii) and was the difference between (i) and (ii).

The field records available for one of the machines (machine E) for the 1976/1977 season gave the time spent per day on field time, repair and maintenance, servicing, machine engine hours and tons harvested. A check over 27 days showed that the engine hours of the machine corresponded fairly well with actual hours in service. Engine hours could thus be regarded as an indication of total time spent on cutting, travelling and turning.

TABLE 1

Results of time and motion studies on the field performance of five different chopper harvesters

Machine	A		B		C		D		E	
	Mins	%	Mins	%	Mins	%	Mins	%	Mins	%
Cutting	205,3	45,9	313,1	42,1	553,0	43,4	228,3	35,4	2 043,7	54,5
Turning	106,5	23,8	127,5	17,1	120,0	9,4	184,6	28,7	373,6	10,0
Waiting	23,6	5,3	228,3	30,7	318,4	25,0	20,5	3,2	844,4	22,5
Maintenance and repair	55,5	12,4	59,8	8,0	144,5	11,3	—	—	23,0	0,6
Other	56,0	12,6	15,8	2,1	139,9	10,9	210,5	32,7	465,4	12,4
Field time	447,0	100,0	744,5	100,0	1 275,8	100,0	643,9	100,0	3 750,1	100,0
Average row length	225		300		355		200		460	
Burn	Good		Good		Good		Good		Good	
Recumbency	80%		8%		25%		2%		40%	
Variety	N55/805		NCo 310		NCo 376		NCo 376		NCo 376	
Ratoon	—		—		2,4		2,1		2,3	
Yield	—		—		98 t/ha		95 t/ha		98 t/ha	
Tons cut	—		—		—		239		131	
Tons/field hour	—		—		—		22,3		21,0	
Tons/cutting hour	—		—		—		62,8		38,4	
Hectares cut	—		—		—		—		14,9	

This particular harvester had done 1 000 hours and had cut 27 557 tons before the start of the 1976/1977 cutting season. The cane was cut and delivered into five-ton bins on infield trailers, and transported to a loading zone. It was then transferred by forklift onto road trucks for transport to the mill, 54 km away. As only three road trucks were available for daily deliveries, these proved to be the limiting factor. Coupled to excessive mill breakdowns, this resulted in abnormal conditions with little infield pressure to improve daily output. Ample time for service and maintenance was experienced.

Results and discussion

Results of the time and motion study are shown in Table 1. The figures represent the total time each machine was observed over a extended time period. Particular observations might have been for periods as short as 30 minutes.

The actual time spent cutting varied from 35,5 to 54,5% of the total field time. In the worst case (machine D), machine output was reduced from 62,8 tons per cutting hour to 22,3 tons per field hour. In the best case (machine E) output was 38,4 and 21,0 tons per cutting and field hour respectively. Unfortunately the tonnages and areas cut by machines A, B and C could not be determined for the corresponding time and motion study periods. If their average cutting time of 43,8% is used with the average of 21,7 tons per field hour, obtained from machines D and E, we could assume that their output per cutting hour would have been as high as 49,6 tons.

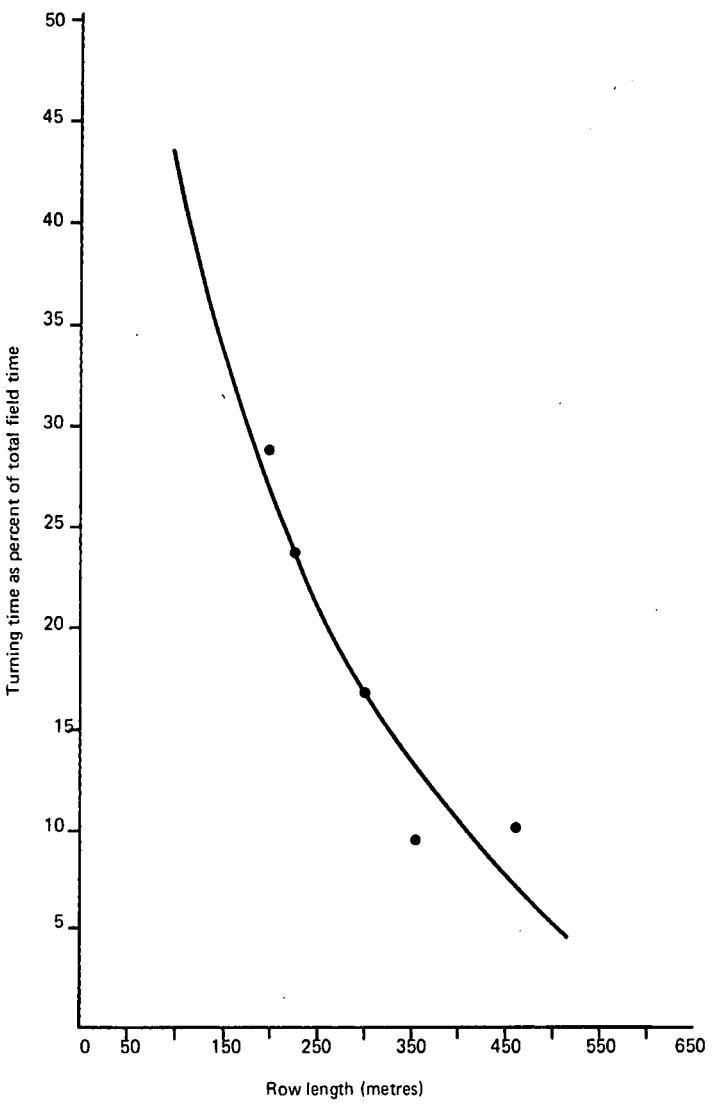

FIGURE 1 Relationship between row length and turning times for chopper harvesters.

From the above it is obvious that, while actively cutting, rates of chopper harvesters can very well be as high as 60 tons per hour or 1 ton per minute.

A relationship between row length and time spent on turning can be established from theoretical considerations. This relationship is also clearly demonstrated in Figure 1 which is plotted from the data in Table I. Note that shorter row lengths affect turning time much more significantly than longer row lengths. Row lengths of 350 to 450 m are apparently close to the ideal. It must be expected that at least 10% of the total field time will be spent on turning, even if fields are laid out and well prepared for mechanical harvesting.

Waiting time is simply a matter of availability and control of back-up services. This is one area where management could make a substantial contribution to more effective field utilization of chopper harvesters, which would result in far lower figures for cost per ton.

Repair and maintenance for the five machines studied are remarkably low. This is, however, explained by the fact that only machine A was utilized to its maximum for most of the day. By comparison, the other machines were parked extensively for various reasons, thus working for short periods of time only, and often only a few hours a day. This allowed adequate opportunity for service and repair outside actual field time. It can be expected that repair and maintenance requirements will increase considerably with an increase in the daily harvesting hours.

The field record of machine E is shown in Table 2. The 41,5 tons per engine hour corresponds well with the figure of 38,4 tons per cutting hour found during the time and motion study, even allowing for the inclusion of turning time. Field efficiency seems very low at 15,4 tons per hour but the hours available should be reduced by 206 to allow for meal breaks. Output per adjusted field hour would then increase to 18,5 tons, again showing a good correspondence with the 21,0 tons per field hour found in the time and motion study (Table 1) where meal breaks were excluded from field time. The small discrepancies between the time and motion figures and those from the field record could be due to variations in yield from different fields.

The good correspondence between the time and motion figures and the field record of machine E, stretching over 138 days, support the applicability of the results of the time and motion study of the other chopper harvesters.

TABLE 2
Field record for harvester E for the 1976/1977 season

Harvest days	138
Total tons cut	19 358
Average tons per day	140,3
Hours available for harvesting	1 258
Hours on daily service	42
Hours on repairs	109
Engine hours	466
Tons per available hour	15,4
Tons per engine hour	41,5

Conclusions

This study showed that chopper harvesters can deliver cane at rates of 60 tons per operating hour. Time lost in turning, waiting for transport, repair and maintenance, etc could reduce this figure to just over 20 tons per field hour. Management could reduce downtime by providing back-up facilities in the form of adequate infield transport and maintenance. Turning time is inversely proportional to row length, but rows of 350 to 450 m still require 10% of the total field time, even in fields with adequate headlands specially prepared for mechanical cutting.