PRELIMINARY RESULTS OF THE CANETHUMPER® OPERATING ON THE LOWER SOUTH COAST OF SOUTH AFRICA

LANGTON MI[1], HARDING TR[2] and LYNE PWL[3]

[1]*Canestay Manufacturing cc, PO Box 393, Port Shepstone, 4240, South Africa*
[2]*Illovo Sugar Limited, PO Sezela, 4215, South Africa*
[3]*South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe, 4300, South Africa*
milangton@gmail.com *mailto:teharding@illovo.co.za* *peter.lyne@sugar.org.za*

Abstract

In South Africa there are two methods of harvesting sugarcane, manual and mechanical, of which manual harvesting is currently the dominant method. However, manual harvesting is by nature labour intensive and can be significantly influenced by issues such as HIV/AIDS infection, government grants and industrial projects (e.g. water and electricity reticulation, housing and '2010'). A significant proportion of South Africa's sugarcane is planted on steep topography where mechanical harvesters are unable to operate. It has therefore become important to re-evaluate and redesign manual cane cutting devices in an attempt to make sugarcane cutting easier, more economic and efficient. Mr J van Tichelen introduced the idea of using a small self-propelled sickle bar mower to harvest sugarcane under various conditions. In partnership with Ennepetaler Schneid- und Mahtechnik GmbH & Co. KG, a machine was developed that is semi-mechanised, uses unskilled labour and harvests sugarcane effectively and economically. This machine is called the CaneThumper®. Illovo Sugar Ltd, Sezela, on the South Coast of KwaZulu-Natal province, realised the severity of the problem caused by the shortage of cane cutters and were the first to implement a commercial CaneThumper® system. This paper outlines the results with regard to productivity, efficiency and economics of cutting, and the overall acceptance of the semi-mechanised harvester in the South African sugar industry.

Keywords: sugarcane, mechanical harvesting, semi-mechanised harvesting, manual harvesting, CaneThumper®, efficiency, economics

Introduction

Sugarcane is a major economic crop in many developing countries where there is ample labour for manual harvesting. However, with a combination of rising aspirations, the industrial sector providing higher paid jobs under more comfortable working conditions, and HIV/AIDS, the skilled labour required to harvest sugarcane is becoming limited. A shift toward mechanisation is required to increase productivity and efficiency and to make the job less strenuous. The problem has been partially solved by the increased use of chopper harvesters, although this accounts for only ±10% of the sugar crop harvested internationally (Meyer, 1997).

The South African sugar industry currently harvests in excess of 20 million tons of sugarcane annually. More than 90% of this is harvested manually and, with a large portion of sugarcane planted on steep slopes (>20%), this is unlikely to change significantly (Meyer and Fenwick, 2003). A semi-mechanised machine is thus needed in South Africa to harvest sugarcane effectively.

In 2006, Mr J van Tichelen, a contractor on the South Coast of KwaZulu-Natal, had the idea of harvesting sugarcane using a sickle bar, 2-wheel walk-behind tractor which is used extensively in the northern hemisphere for cutting grass. In partnership with Ennepetaler Schneid- und Mähtechnik GmbH & Co. KG (ESM), the first machines were developed between November 2006 and June 2007. After the development had been successfully completed, CSE Equipment were awarded the dealership rights.

This machine is called the CaneThumper®, and was introduced into the South African market in September 2007. Although acceptance of new machinery and methods in a long-established industry is difficult, the machine has become a viable unit for many farmers and contractors. The first company to implement the system was Illovo Sugar Ltd, Sezela, after which 15 units were sold and used during the remainder of the 2007 season.

The performance of the CaneThumper® varied between farms, farm managers and working conditions. Performance was analysed with respect to effective and efficient harvesting, and the best system was determined. The quality and height of the cane cut, the safety factors involved, productivity and costs were recorded to determine machine viability.

Methods

Machine

The machine has a 4-stroke single cylinder diesel engine rated at 5 kW at 3 200 rpm. It is equipped with a Donaldson air filter, a light and an hour meter. It has twin pneumatic wheels with an option of metal grid wheels for operating on very steep slopes, in lodged cane or under wet conditions (Figure 1). It has four forward and four reverse gears, and operates at speeds of 1, 1.5, 1.9 and 7 km/h. The fastest gear is used solely for moving between fields. The operator controls the machine by using levers situated on the handlebar. These include a clutch, reverse selector, throttle, differential lock and gear selector. There is an automatic 'kill' switch which comes into operation when the machine is left unattended. The initial service interval is 25 h, and thereafter every 250 h. It has an oil bath transmission that drives a double action sickle bar with a blade length sufficient to cut stool widths of up to 1 m. No blade sharpening is required, and the machine can be safely operated in fields with small rocks and stones.

Figure 1. The CaneThumper® with a single cylinder diesel engine and double action sickle bar cutter developed for harvesting sugarcane.

Labour and operation
The operation is still labour intensive but does not require skilled cane cutters. The requirements are, one driver, 5-7 sorters (huggers) and 1-2 toppers. The variance depends on local conditions such as steepness of slope, cane yield and degree of lodging. Generally eight labour units are used.

The driver operates the machine with the sorters standing in front pulling the cane over, as seen in Figure 2. The sorters lay the cut cane in a windrow, placing the cane from six lines onto the windrow, and then loop around to the front. Safety is a concern; it is therefore essential to supply the sorters with steel capped boots with rear guards to protect their feet. The blades cut at low speeds and do not scatter stones or debris as do conventional rotary cutters.

The toppers follow behind the machine and top the cane immediately after the windrow has been completed. This allows for quick extraction using a Bell loader. The toppers are also responsible for hand cutting the edges of areas that end on steep banks or in rocky outcrops, to allow for turning of the machine.

Figure 2. Operation of the CaneThumper®, showing the sorters pulling the cane forward in preparation for cutting.

Testing
Testing was carried out on the Lower South Coast on Bavaria Farm and Sezela farm during the 2007 season. The Bavaria Farm contract was for 10 000 tons and a daily rateable delivery of approximately 60 tons per day. The conditions varied from lodged carry-over cane to upright seasonal cane, and from flat undulating lands to steep slopes of more than 30 degrees. The following criteria were measured: area cut in a single day, machine operating hours, hours in-field, yield, cutting height, quality of base cut, slope, fuel consumption and labour units used.

The Sezela tests were the introduction of the CaneThumper® into the Sezela farm operations and in this case the productivity of the machine was measured.

Bavaria Farm results

Cutting height and quality

A limitation of the CaneThumper® is that cane planted in a furrow cannot be cut low to the ground. Where the ground was flat or the cane was planted on a ridge, the results averaged marginally lower than for manual cutting. The cutting quality was rated using the scale introduced by Kroes (1997), where a lower value indicates a higher quality cut. The results showed a cut quality of three, which is similar to manual harvesting (1.8) but far superior to chopper harvesting, which has an index of approximately five.

Productivity

Table 1 outlines the productivity for Bavaria Farm, where 10 000 tons of sugarcane were harvested during the 2007 season.

Table 1. Productivity throughout the 2007 season, including the development period, using the CaneThumper® semi-mechanical harvester,

Productivity	Area/day (ha)	Tons/day	Tons/h	Area/h (m^2)	Tons per labourer/day	Downtime (%)
Average	0.71	44	6.11	776	5.8	21
Maximum	1.18	82	10.20	1 208	10.25	

After evaluation under various conditions, a task table (Table 2) was determined for sugarcane grown at 1 m row spacing and various degrees of lodging and slope.

Table 2. Task table (ha/day) for cane yields of between 50 and 80 tons/ha.

Lodging	Slope			
	Flat (<5%)	Slight (5-15%)	Medium (15-30%)	Steep (>30%)
1 (upright)	0.8	0.75	0.7	0.65
2	0.75	0.7	0.65	0.6
3	0.7	0.65	0.6	0.55
4	0.65	0.6	0.55	0.5
5 (prone)	0.6	0.55	0.5	0.45

When operating in higher yielding cane, the area cut per day dropped by approximately 10%, and when cutting in green cane the area cut per day dropped by approximately 12%. No experiments were carried out to compare labour productivity with traditional manual operations, although qualitative comparisons can be made. A study by Meyer and Fenwick (2003) showed work rates varying from 5.27 t/man.day to as high as 14 t/man.day. However, the productivity level has shown a steady decline since 2003, and during the implementation phase of the ‘thumper’ was less than 6 t/man.day. It should nevertheless be borne in mind that operation of the ‘thumper’ does not require a skilled cane cutter and can be carried out with labourers less skilled than those required for traditional operations, therefore productivity is likely to increase with experience.

Costing

Table 3 gives costs determined during the 2007 season for Bavaria Farm. The costs assume a machine depreciation over three years at 13% pa, a fuel price of R6.20/litre, a consumption of 0.6 litres/h, a blade life of 100 h, a labour rate of R60/day for the driver and R45/day for the sorters and toppers, and an average yield of 62 tons/ha. Included are a supervision cost, labour overhead costs and safety equipment costs.

Table 3. Cost of harvesting during the 2007 season at a rate of 0.71 ha/day at 6.11 t/h.

Harvesting costs	Cost/hour (R)	Cost/ton (R)	%
Ownership	23.23	3.80	24.6
Operating	22.77	3.72	24.1
Labour	48.47	7.93	51.3
Total	**94.47**	**15.45**	**100.0**
Detailed operating costs			
Maintenance	8.95	1.46	39.3
Fuel	3.72	0.61	16.3
Oil	0.60	0.10	2.6
Tyres	2.00	0.33	8.8
Blades	7.50	1.23	32.9
Total	**22.77**	**3.72**	**100.0**

Costs vary between areas and conditions and are sensitive to cane yield, with the higher yields reducing the costs significantly. Towards the end of the season the team averaged 0.85 ha/day and harvested up to 78 tons cane. This dropped the total cost per ton to R10.26. Other areas that have higher yields and wider row spacing are averaging a cost of below R10/ton. Costs for traditional operations change considerably, but generally vary from R12.50/ton to over R20/ton.

Illovo Sugar Ltd – Sezela Farm results

The results given in Table 4 include productivity during the implementation stage.

Table 4. Average productivity in burnt cane (19/8/07 to 23/12/07) and in trashed cane (30/9/07 to 23/10/07).

Productivity	Area/day (ha)	Tons/day	Tons/hour	Area/h (m^2)	Tons per labourer/day	Downtime (%)
Burnt	0.50	31	5.7	909	3.9	20
Trashed	0.36	25	4.3	525	3.1	40

For burnt cane the yield was 62 t/ha. This low yield decreased the productivity, and there was also a low value for machine operating hours of approximately 5.5 h/day. The downtime of 20% includes rain delays, mill stoppages, labour issues and machine breakdowns.

Harvest productivity in green (trashed) cane was 30% lower than in burnt cane; however, the trash cane team had six weeks' less experience on the machine. The green harvesting was carried out in 69 t/ha cane and shows how higher yields contribute to improved cost effectiveness. A 30% decrease in area amounted to only a 20% decrease in tons cut. The downtime in green cane included rain days, mill stoppages, labour issues and machine breakdowns. The machine breakdowns were higher compared to operating in burnt cane, and were due mainly to the operator not seeing large rocks in the field which caused higher blade breakages.

Ergonomics

At this stage no ergonomic studies have been carried out to compare the 'thumper' system with traditional manual cutting systems. Feedback from operators indicated that the semi-mechanised cutting operation is easier than hand cutting; however, this has not been quantified.

Conclusion

The CaneThumper® offers a cost effective solution to the harvesting problems currently being faced by many growers. The biggest advantage is that it is a useful management tool for ensuring a regular supply of cane to the mill. A disadvantage is that the harvest operation remains labour intensive. This disadvantage is offset by the grower being able to use any available unskilled labourers and not having to rely on the traditional but scarce cane cutters. During the implementation phase, the total system costs of manual cutting and use of the CaneThumper® were similar. The CaneThumper® costs are expected to decrease with further use and experience.

Acknowledgements

JC van Tichelen, TP McBean and W Blamey of Canestay Manufacturing cc; KR Strohn and W Oehler of ESM; K Orth, M Beerbaum and J Speckmaier of AGRIA; M Futter of Bavaria Farm; Illovo Sugar Ltd – Sezela Management; B Anderson of CSE Equipment; G Joyce and K Potgieter of Barloworld Armstrong.

REFERENCES

Kroes S (1997). The cutting of sugarcane. PhD Thesis, University of Southern Queensland, Australia.

Meyer E (1997). Factors to consider when implementing a fully mechanised harvesting system. South African Sugar Association Experiment Station Internal Report, Mount Edgecombe, South Africa.

Meyer E and Fenwick LJ (2003). Manual sugarcane cutter performances in the southern African region. *Proc S Afr Sug Technol Ass* 77: 150-157.