

## EVALUATION OF THE ILLOVO MECHANICAL CANE CUTTER

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### Abstract

Labour for sugarcane cutting in South Africa is expected to become scarce as a result of growth in the manufacturing sector and the effect of HIV/AIDS on the available workforce. Manual harvesting is often favoured or unavoidable because of steep slopes and the high costs associated with mechanical harvesting. A brush-cutter with a redesigned blade configuration, named the Illovo mechanical cane cutter, was developed and evaluated during a series of field trials. A range of system properties were measured during testing at Isonti farm on the South Coast in 2005, where the dusty working environment affected the cutter adversely, and an improved filter system was recommended. Currently, the durability of the blade is the most limiting factor and contributes significantly to costs. Blade wear occurs rapidly when cane is cut close to the ground, and an economic break-even point is needed to balance cutting height and blade replacement costs. Although the system is efficient, several areas are highlighted for further research to help curb excessive costs.

*Keywords:* mechanical harvesting, brush-cutter, cutter performance, Illovo cutter

### Introduction

Labour availability for sugarcane cutting in South Africa is expected to decline. This is mainly attributed to rising aspirations because of growth in the industrial sector and the effect of HIV/AIDS. Sugarcane is often cultivated on steep slopes, which impedes the use of mechanical harvesters. It is therefore essential to move towards higher labour and harvesting efficiencies, but to concurrently utilise a system capable of harvesting sugarcane on steep slopes. One method used to increase harvesting efficiencies is ergonomics.

Ergonomics is the study and analysis of the working environment. Improved ergonomics benefits the employee by making the task easier, and the employer gains from the increased productivity (Scott *et al*, 2004). New harvesting systems are continuously being developed (Meyer and Fenwick, 2003) and may sometimes suggest improved productivity. These systems, however, can only be regarded as superior after thorough ergonomic evaluation has occurred (Scott *et al*, 2004), which should include resting times, energy consumption, physical sustainability and performance.

This short communication continues on from Langton and Paterson (2004), and reports on expanded evaluations of the Illovo mechanical cane cutter. Various performance measures were recorded and analysed to determine whether the system is feasible.

## Methods

A commercial brush-cutter was modified, which included designing a slicing blade and modifying the mounting of the blade to enable cutting the cane close to the ground. Mello and Harris (2000) found a blade angle of  $22.7^\circ$  to be the most efficient in cutting or slicing sugarcane. The slicing blade was found to be energy efficient and the least damaging to the cane. A  $22.7^\circ$  angle blade is based on 25% impact and 75% slicing mechanisms. A brush-cutter blade with a  $22^\circ$  angle to the cutting front was hence designed by Langton and Paterson (2004). The blade performed well, but required replacement within 20 minutes due to wear. Hence, a modified blade with replaceable edges was designed (see insert, Figure 1).



**Figure 1. The Illovo mechanical cane cutter used in conjunction with a crook to pull cane into windrows. The insert illustrates the blade with replaceable edges.**

The harvesting system involved one operator cutting the cane, while a second labourer pulled and aligned the cane in windrows using a crook (Figure 1). These two operators were trained in both tasks and changed places to allow for a recovery period when fatigue set in. Additional organisers (Figure 1, background) sorted the cane into bundles to enable subsequent topping and stacking.

Evaluations were conducted at Isonti farm (KZN South Coast) from July to November 2005. Recorded parameters included:

- cane yield and state (e.g. lodged)
- time taken to cut one ton of cane
- time taken to harvest an area
- total time in the field
- downtime
- fuel consumption
- different ergonomic properties of operators, such as heart rate and energy expenditure
- costs
- cane damage.

Also recorded were operating conditions, ease of use, hazards to workers, ability to operate on steep slopes of around 40°, and ability to cut cane at the correct height without including extraneous matter.

## Results and Discussion

Table 1 summarises the results obtained after 29 days of harvesting. The average cutting rate was 1.4 t/h, but with an alarming 42% downtime. The downtime was attributed to changing blades, refuelling and changing air filters. When the machine was operating, an average output of 2.5 t/h (maximum 4.4 t/h) was maintained. Downtime should therefore be a focus area to improve efficiency and cost.

**Table 1. Summary of the performance of the Illovo mechanical cane cutter.**

Performance	Harvesting rate		Downtime (%)	Cost (R/ton)
	tons/h	m <sup>2</sup> /h		
Average	1.4 (2.5)	311 (547)	42	38.10
Standard deviation	0.6 (0.8)	128 (174)	13	
Maximum/best	3.5 (4.4)	703 (929)	19	13.50

\*Values in brackets are actual rates when the system was operational (i.e. downtimes excluded).

Although the average cost was high at R38.10/t, the R13.50/t achieved on the best harvesting day makes the system attractive, and further improvements are warranted. The majority of the cost was made up of labour at R8/t (57%) and blades at R2/t (17%).

The mechanical cutter was tested in fields with low yields that averaged 47 t/ha. This affected the output, since higher yields require less area to cover. It is planned to harvest higher yielding fields during the 2006 season.

Cane was harvested at an acceptable height. The blade is sensitive to rocks and stones, but on average cut the cane at the same height as manual harvesting. A strong relationship exists between the cutting height and the amount of blade wear. An economic equilibrium is needed between the height of the cutting and the costs associated with blade wear.

Even with no previous experience in cane cutting, the mechanical cutter was easy to operate, and could be used on steep slopes with a slight reduction in output. Various safety measures, such as protective clothing, goggles, ear covers and a blade cover, were required to safeguard the cutter operator (Figure 1).

The extremely harsh working conditions resulted in engine seizure after 72 hours. To curb this, an adapted larger and more efficient air filter was installed. The gearbox and drive shaft did not deteriorate under normal routine service recommendations.

Further research will include ergonomic studies, system alterations and blade material and design modifications. Blades need to be more durable, and blade replacement times need to be reduced. A mechanical pre-topper is also currently being developed.

## Conclusions

The Illovo mechanical cane cutter system is still too expensive to be viable. However, work is under way to reduce costs, in particular those associated with downtime. Harvesting sugarcane using this system will increase the performance of cane cutters, reduce the variability between cutters, and the machine operator classification of the job more will be more attractive to labourers.

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