EVALUATION OF THE AUTOMATIC BASE-CUTTER CONTROL SYSTEM IN THE AUSTRALIAN SUGARCANE INDUSTRY

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Abstract

SUGAR CANE HARVESTING is one of the more costly operations in sugar production. The efficiency and quality of this process still relies very much on the skills of harvester operators. The height control of the base-cutter system requires a lot of concentration of effort from operators. Bad results not only have negative economic impacts, but also environmental impacts due to sucrose losses in the field. An automated base-cutter system, initially developed in Cuba and later intensively tested and widely adopted in Brazil by Techagro, has been also evaluated in the Australian sugarcane industry. It works on the basis of measuring the pressure on base-cutter disks several times a second with a pressure sensor, and then processing the signal with an on-board computer that automatically controls the base-cutter height according to settings previously defined by the operator. A total of 12 harvesters, including Austoff, Cameco and new John Deere, were fitted with the system during 2007 harvesting season. There were six at Tully, five at the Herbert and one in the Burdekin. Trials were conducted under several field conditions, which included light sandy soils to heavier alluvial soils; fields with dual and single rows; plant and ratoon crops; and different row profiles. Evaluations included field measurements of stool damage, stubble height and estimated losses. Quality data were measured at the mill when possible, as fibre content, CCS, juice purity and soil content. The results of the trials varied slightly with field conditions and operators, but in general showed several benefits with the use of the automated base-cutter control system. Average values showed reduced stool damage by 5.7%; similar soil levels; reduced stubble height by 22.5 mm; and reduced cane losses by 1.7 t/ha. Differences in fibre, CCS and juice purity were small (0.1%) and not statistically significant. Factors influencing the adoption of this technology are discussed. These include not only the economic and environmental impact, but also some social components such as the increasing lack of skilled operators.

Introduction

Sugarcane harvesting is one of the more costly operations in sugar production. The efficiency and quality of this process still relies very much on the skills of harvester operators. In particular, the height control of the base-cutter system requires a lot of concentration of effort from operators.
concentration of effort from operators. Bad results not only have negative economic impacts, but also environmental impacts due to sucrose losses in the field.

An automatic base-cutter system for sugarcane harvesters has been one of the aspirations of harvester operators because it is very demanding for them to keep the optimal base cut height, something which can vary considerably along the cane row. There have been many attempts to develop such a system (Wright and Simoneaux, 1998; Neves et al., 2001) but the difficulties in measuring effectively the base cut height in the varying surface of a cane row have meant that many of those systems remain as prototypes and/or only work under specific crop conditions.

An automated base-cutter system, initially developed in Cuba and later intensively tested and widely adopted in Brazil by Techagro, has been also evaluated in the Australian sugarcane industry (Esquivel et al., 2007). It works on the basis of measuring the pressure on base-cutter disks several times a second with a pressure sensor, and then processing the signal with an on-board computer that automatically controls the base-cutter height according to settings previously defined by the operator.

During the 2007 harvesting season the automatic base-cutter control system was made commercially available in Australia by Techagro Pacific, an Australian company that develops precision agriculture technologies for the sugarcane industry. Several harvesters were fitted with the system and evaluations made with participation of productivity services, mainly in the Tully and Herbert areas. The present paper discusses the results of the 2007 trials.

Materials and methods

Equipment

After fitting the equipment, simple in-service training was provided to operators on the simple menu driven software that allows setting up of operational parameters for the base-cutter system (Figure 1). Minimal and range of base-cutter pressures are initially set up for specific field characteristics (e.g. soil type, cane variety, crop type). Several settings can be saved for different field conditions, shifting from one to another with a single button touch.

Increasing the minimum base-cutter pressure setting (X1) drives the base-cutter height down. Conversely, decreasing the minimum base-cutter pressure setting (X1) drives the base-cutter height up. Pressures less than X1 will activate the automatic system to lower the cutting height until the base cut pressure is higher than the X1 setting. Similarly pressures
above X2 will activate the automatic system to lift up the cutting height until the base-cutter pressure is lower than X2.

When any of these variables are below threshold settings for several seconds while the system is working in automatic mode, control of base-cutter height is suspended. When both of these variables are over the minimum threshold settings, control of base-cutter height will automatically resume.

**Field trials**

A total of 12 harvesters, including Austoft, Cameco and new John Deere machines, were fitted with the system during 2007 harvesting season. There were six at Tully, five at the Herbert and one in the Burdekin. Figure 2 shows the on board computer that controls the automatic height of the base-cutter system.

![On board computer of the automatic base-cutter system.](image)

Trials were conducted under several field conditions, which included light sandy soils to heavier alluvial soils; fields with dual and single rows; plant and ratoon crops; and different row profiles.

Evaluations included field measurements of stool damages, stubble height and estimated losses (Figure 3). Replicated blocks of 10 m and two adjacent rows were randomly selected across the fields for stool damage assessment according to BSES methodology (Cam Whiteing, pers. Comm., 2007).

Trash was removed and stubble height measured in mm. A total of 20 cane stalks were randomly selected and hand cut from each treatment and weighed; stalk length was also recorded. This allowed an estimate to be made of the weight of 1 cm of cane and thus the weight of cane left behind after harvesting.

Each treatment (manual and automatic) was consigned in different rakes, to allow the collection of consignment quality data at the mill, such as fibre content, CCS, juice purity and soil content.
Results

Results of the field trials are summarised in Table 1.

Table 1—Comparison of the effect on six attributes of sugarcane of harvesting with automatic and manual modes for control of base-cutter height. Data are the means of 12 harvesters in three districts. Standard errors of the means are given in brackets.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Automatic</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage* (%)</td>
<td>64.5</td>
<td>70.3</td>
</tr>
<tr>
<td>Stubble height (mm)</td>
<td>11.3 (4.63)</td>
<td>33.8 (15.59)</td>
</tr>
<tr>
<td>Cane losses (t/ha)</td>
<td>1.2 (0.30 )</td>
<td>2.9 (0.55 )</td>
</tr>
<tr>
<td>Fibre (%)</td>
<td>15.6 (0.46)</td>
<td>15.7 (0.59)</td>
</tr>
<tr>
<td>Juice purity (%)</td>
<td>89.1 (1.04 )</td>
<td>89.2 (0.70 )</td>
</tr>
<tr>
<td>CCS</td>
<td>13.6 (0.68 )</td>
<td>13.5 (0.56 )</td>
</tr>
</tbody>
</table>

*Data available from only one site

Stool damage was assessed in one trial only. Using the automatic base-cutter system reduced the percentage of damage by 5.7%, i.e. from 70.3% for manual to 64.6% for automatic mode. The base-cutter system is one of the main causes of stool damage and has the potential to reduce stand in subsequent ratoons. The average speed during the trial was relatively high at 8.2 km/h, with a maximum of 12.0 km/h.
One of the most important advantages of the automatic base-cutter system is to reduce the stubble height to the desired level defined by the operator. The average stubble height in manual mode was 33.8 mm, while for the automatic mode it was 11.3 mm, a reduction of 22.5 mm for the trials. The stubble height target may vary between regions, as well as between farmers. Generally, most farmers prefer to cut a little above the soil surface in Tully, at ground level in the Herbert, and just below ground level in the Burdekin. However, the advantages of cutting closer to the ground are generally recognised in the industry. These include a generally cleaner cut of the stubble and, more importantly, a greater recovery of cane from the field.

Average cane losses in manual mode were estimated at 2.9 t/ha, ranging from 2.5 to 4.3 t/ha, while in the automatic mode the average losses were estimated at 1.2 t/ha, ranging from 0.9 to 2.0 t/ha. The average reduction due to automatic mode was 1.7 t/ha and was statistically significant. This reduction in cane loss occurs in the lower part of the cane stool, which has higher juice purity and sucrose content.

The difference between the mean values for soil in cane supply from automatic and manual modes was not significant (data not presented).

The fibre content measured at the mill was 15.7% in the manual mode and 15.6% in the automatic mode. This difference of 0.1% was not statistically significant.

Similarly, the difference in average juice purity (0.1%) was not significant.

The most important benefits are a reduction in cane loss and the potential to increase CCS. The average CCS in cane harvested in manual mode was 13.5%, while in cane harvested with the automatic system it was 13.6%, a 0.1% increase which was not statistically significant.

Discussion

Apart from the economic benefits of reducing the loss of high sucrose cane in the field there is also an important environmental benefit. Sucrose in the field is considered a contaminant, due to the possibility of its runoff into wetlands and streams where it decreases dissolved oxygen.

The automatic base-cutter system also has an important social component. To date, the automatic base-cutter height control depended very much on the skill of the operator, making a distinction between skilled and novice operators. Once the operator has learned how to change settings of the automatic base-cutter system and how to recognise the appropriate setting for specific field conditions, the system can do the job in most cases, making it possible for the operator to concentrate on other activities.

These results agree with those obtained by Hernández et al. (2000) with a Cuban KTP-3S harvester, later adapted to CASE IH, CAMECO and SANTAL TANDEM harvesters in Brazil. An evaluation of the automatic base-cutter system in 2002 at São Martinho Mill, demonstrated a reduction in harvest base-cutter losses of 88% (equivalent to an additional 0.99 tons cane per hectare) (TechAgro, 2002).

Despite the results reported here, the Australian sugarcane industry has several peculiarities that could slow down the progress of adoption of this technology. Among them, the structure of the industry is the most important. In Brazil, the milling, harvesting and farming responsibilities are usually operated the same organisation, while in Australia they are split between the farmer, the harvesting contractor and the milling group.
All of them will benefit from the automatic base-cutter system, but who will pay for it? Some progress was made this season, mainly in the Herbert area, and as the benefits are quantified the awareness of benefits to each party should increase. The harvester payment system based on cane quantity and does not provide incentives for the adoption of this technology.

The shortage of skilled labour for harvesting may have an impact in the adoption of this technology. The automatic base-cutter height control creates more possibilities for less skilled operators, minimising the differences in the quality of the work done in comparison to more skilled operators. It also reduces the fatigue of the operators, allowing concentration on other demanding activities. Some skilled operators have opposed the introduction of this technology as they see the system as a threat to the advantage they have over less skilled operators.

Conclusions

The results of the trials of the automatic base-cutter control system commercially available from Techagro in the 2007 season have shown it to offer economic, environmental and social benefits to the Australian sugarcane industry.

The various stakeholders in the sugarcane industry need to realise the respective benefits to be obtained from the adoption of this technology in order to reach agreement on how to fund its adoption.

More in depth studies should be conducted on the environmental impact of the adoption of this technology and that may facilitate more rapid adoption.

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REFERENCES


