EXTRANEOUS MATTER VERSUS CANE LOSS: FINDING A BALANCE IN CHOPPER HARVESTERED GREEN CANE

By

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Abstract

Green cane harvesting and trash blanketing are important agronomic production techniques in the northern sugar producing areas of Australia. Cane losses are accepted to be higher with green-cane harvesting and extraneous matter levels can be high, especially in difficult conditions. Harvester trials were conducted throughout the north in an effort to quantify the performance characteristics of current harvesters. Samples taken in the field and at the mill were assessed to determine the effect of harvester pour rate and extractor fanspeed on extraneous matter. Yield data and collection of scrap cane from the extractor systems were used to assist in the determination of cane loss. Results indicate that current harvester designs are limited in their ability to effectively clean cane, whilst minimising cane loss, at high harvesting rates. The results of trials at commercial pour rates imply that significant sugar losses are occurring in the harvesting process. From the work, harvester operator guidelines were developed to produce good quality cane without sustaining excessive cane losses in the process.

Introduction

The move to green-cane harvesting in Australia has been driven by a range of factors, including cane freshness and agronomic and financial benefits of trash retention. Steady improvements in the capacity of successive newer machines to process large green crops has facilitated the swing to green-cane harvesting. More than 90% of the Northern Region crop and over 80% of the Central Region crop is now cut green (Anon., 1996). Apart from the obvious constraints of the ability of a harvester to gather and feed a non-burnt crop, the most significant machine related factor impacting on green-cane harvesting is the ability of the machine to produce a product of acceptable quality (extraneous matter (EM) levels) at acceptable levels of cane loss. Performance characteristics of current harvesters must, therefore, be understood.

In their 1984 report, Hurney et al. stated that, ‘Over the past decade, harvester cleaning systems have been increased considerably in power in an endeavour to cope with extraneous matter entering the harvester from sprawled or uneven crops.’ They went on to observe that, ‘Mill data indicate that harvester modifications have not been effective in counteracting the effect of adverse field conditions on extraneous matter levels.’

Shaw and Brotherton (1992), reporting on their 1991 survey in the Mulgrave mill area, had sought to, ‘Establish whether an optimum cleaning level was available where both loss (cane) and extraneous matter levels were minimised.’ Tarpaulins were placed on the ground beside the path of the harvester to collect cane scrap and trash coming out of the extractor (the ‘blue tarp’ method of cane loss determination). They noted that, although there is a lack of precision with this method, the ‘cane collected is a visible definite loss and is thus a firm minimum value.’ The work found that trash was the most readily removable form of extraneous matter but, as the extractor works to remove heavy trash loads, billets are drawn out the extractor. In one case, ‘reducing EM by one per cent, cane loss was increased by 4.2 t/ha in Q120,’ and this led the investigators to the conclusion that ‘there is little evidence of an optimum harvester setting which minimises both loss and EM.’

Since these trials, manufacturers have significantly increased installed engine power on harvesters, so increasing the power available to key feed components. The primary goal has been to increase harvesting rates. Cleaning systems have typically increased marginally in size and installed power has increased. Throughout this time, EM levels in cane arriving at the mills have increased steadily (Cargnello and Fuelling, 1998).

To quantify the effect of these changes and characterise the performance of modern harvesters, trials were undertaken on recent model harvesters in the 1997–2000 harvesting seasons.

Methodology

The trial program aimed to define the performance of late model machines with respect to extraneous matter and cane loss under a range of operational settings and field conditions. Key attributes of the trial program were:

- Trials were conducted at commercial cutting rates for the field and crop conditions.
- Trials focused on one operator controlled variable, such as fanspeed or pour rate (harvesting rate calculated from nominal cane yield *
Results and discussion

Over 50 extensive field trials were carried out on late model machines over four crushing seasons under a wide range of field conditions and operating parameters. The three main factors affecting extraneous matter levels and cane loss were found to be field conditions, harvester pour rate and fanspeed. Whilst no attempt was made to undertake comparative testing between the two harvester makes sold in Australia (Cameco CH2500 and Austoft 7000/7700), results of the machines demonstrated very similar characteristics.

Harvester pour rate

Under given field and crop conditions, harvester pour rate was the primary determinate of final trash levels in the harvested product. Figure 3 gives the data for two trials, whereas Figure 4 gives the generalised representation when all data are included, including data also collected on dirt in cane levels for all trials. Currently, dirt in cane levels averages 1–2% in most harvesting conditions.

The 'Brazil data' are the results of tests undertaken by Copersucar staff on an Austoft 7700 machine in Brazil (Neves, pers. comm.). The effect of pour rate on final product quality is clearly evident, with trash levels increasing at high pour rates. The trash and dirt levels of 10–12% indicated at pour rates of 120 t/h are consistent with current industry practice. It is interesting to note the relativity of the Brazilian figures, again confirming the effect of typical harvester pour rates on trash levels.

The relative ineffectiveness of extractor fan speed at reducing trash levels, except at high fan speeds is highly significant.

**Cane loss**

The trial data demonstrate that cane loss from extractor systems is primarily determined by fan speed, with parameters such as pour rate and crop conditions demonstrating a relatively minor effect.

The magnitude of cane loss was determined at all sites by the ‘blue tarp’ method whereby cane pieces are collected from a pre-placed tarpaulin on the ground after the harvester has passed. The cane loss that occurred in the cleaning process was then estimated by multiplying the mass of collected scrap cane pieces by a predetermined factor (Linedale et al., 1993). In many trials, ‘no fan’ or ‘low fan’ treatments were used to determine the recoverable cane, without cane loss. The ‘mass balance’ cane loss was then determined by the difference between yield of clean cane (gross yield corrected for trash and other EM levels) in the relevant treatment and the yield of clean cane in the ‘fans off’ treatment. Typically the ‘mass balance’ cane loss gave a cane loss indication considerably higher than the ‘blue tarp’ estimate, with ‘mass balance’ cane loss data indicating cane losses as high as 30 t/ha in some conditions, particularly in heavy crops, and at high pour rates. Errors and field variability meant that mass balance results
tended to be erratic under conditions of low cane loss, but were robust in conditions of high cane loss. Data on the results are presented in Figure 5. The lower boundary represents typical cane loss figures determined by the lower ‘blue tarp’ estimations for the various trials, with the upper limit generally being the boundary defined by the upper limit of the mass balance estimations. Extractor cane loss is primarily determined by fanspeed; however, under adverse harvesting conditions, operators almost universally increase fanspeed in an attempt to reduce EM levels. In heavy lodged crops, the unevenness of feed through the machine causes cyclic overloading and underloading of the extractor chamber, resulting in excessive cane loss (Figure 6). Typical fanspeed trial data, indicating the magnitude of extractor losses and the impact on grower returns, are shown in Table 1. Cane fragments collected on the tarp did not account for the large yield decrease as fanspeed increased. The slightly higher CCS at maximum fanspeed does not compensate for the excessive loss incurred. Note that fanspeed has very little impact on trash and CCS except at maximum fanspeed, where losses are alarming.

Results of trials conducted over three seasons have highlighted the limitations of the current extractor system to perform, especially in heavy, uneven crops. Clearly, current machines perform very well in ideal conditions but, as crop conditions deteriorate, cleaning performance decreases very badly, irrespective of fanspeed. With crop condition having such a marked impact on cleaning ability, operators should not be pressured into producing a clean product in adverse field conditions where high fanspeeds can only result in reduced sugar recovery.

Overloading of the current extractor system in trashy green-cane conditions creates a dilemma for operators seeking to produce a quality product with minimal losses, often in difficult field conditions.
Table 1—Typical fanspeed trial results following full mill analysis of separate rakes. Average results from replicated trial in a badly lodged, first ratoon block of variety Q152. (Different letters indicate statistically significant differences.)

<table>
<thead>
<tr>
<th>Pour rate (t/h)</th>
<th>Fan speed (rpm)</th>
<th>Total yield (t/ha)</th>
<th>‘Blue tarp’ cane loss (t/ha)</th>
<th>Mass balance cane loss (t/ha)</th>
<th>Trash+salt (%)</th>
<th>Clean cane yield (t/ha)</th>
<th>CCS (actual)</th>
<th>Actual net income ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>131</td>
<td>1400</td>
<td>146.2a</td>
<td>8.8a</td>
<td>25.0a</td>
<td>8.0a</td>
<td>134.6</td>
<td>11.68</td>
<td>2 481</td>
</tr>
<tr>
<td>145</td>
<td>1300</td>
<td>163.8b</td>
<td>7.8a</td>
<td>13.1b</td>
<td>10.6b</td>
<td>146.4</td>
<td>10.96</td>
<td>2 446</td>
</tr>
<tr>
<td>151</td>
<td>1150</td>
<td>174.2c</td>
<td>4.2b</td>
<td>4.9c</td>
<td>10.6b</td>
<td>155.8</td>
<td>10.82</td>
<td>2 536</td>
</tr>
<tr>
<td>151</td>
<td>1000</td>
<td>175.7c</td>
<td>2.9b</td>
<td>2.9c</td>
<td>10.6b</td>
<td>156.8</td>
<td>10.82</td>
<td>2 554</td>
</tr>
</tbody>
</table>
Conclusions

- Under given field conditions, EM is predominantly controlled by harvester pour rate.
- As pour rate increases, fan speed becomes relatively ineffective in reducing EM.
- Field conditions significantly impact on the final EM a harvester can achieve. Reducing pour rate in difficult conditions will give a better result, in cane loss, with minimal reduction in trash levels.
- Significant cane loss (>20 t/ha) can occur at more extreme fanspeeds. At low fanspeeds, the extractor removes a fair portion of the total EM with minimal losses. As fanspeed is increased further, the inefficiency of the primary extractor leads to excessive losses, with no significant impact on cleaning.
- The challenge for operators is to select a fanspeed that minimises losses, then operate at a pour rate that gives acceptable cleaning and still remain viable as a business.

REFERENCES


MATERIES ETRANGERES ET PERTES DE CANNE: TROUVER L'EQUILIBRE POUR LA CANNE TRONCONNEE EN VERT

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Résumé

La récolte de la canne en vert et le paillis complet sont des techniques agronomiques importantes dans la zone de production de sucre au nord de l'Australie. Il est reconnu que les pertes en canne sont plus importantes lors de la récolte en vert et le niveau de matières étrangères peut être élevé, surtout dans des conditions difficiles. Une série d’essais fut mise en place dans la zone nord dans le but de quantifier la performance de coupeuses actuellement en service. Les échantillons prélevés au champ et à l’usine furent analysés pour déterminer l’effet du rendement horaire de la coupeuse et de la vitesse de l’extracteur sur la matière étrangère. Les données de rendement et la récupération des débris de canne dans les systèmes d’extraction furent utilisées pour la détermination des pertes.

Les résultats indiquent la limitation des coupeuses actuellement en service à éliminer la matière étrangère, tout en minimisant les pertes, à des vitesses de récolte élevées. Les résultats d’essais à des rendements horaires industriels tentent à indiquer que des pertes significatives de sucre sont encourees pendant récolte. Les travaux ont permis d’émettre un guide d’instructions aux opérateurs afin d’obtenir des cargaisons de canne de bonne qualité sans pour autant subir des pertes excessives.

Mots clés: rendement horaire, vitesse d’extracteur, conditions de champ.

MATERIAS EXTRAÑAS VERSUS PERDIDA DE CAÑA: BUSCANDO UN BALANCE EN LA COSECHA MECANIZADA DE CAÑA VERDE

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Resumen

La cosecha de caña verde y el cultivo con cobertura son importantes técnicas de producción en el Norte del área azucarera de Australia. Se reconoce que las pérdidas de caña son mayores cuando se cosecha caña en verde y también que los niveles de materia extrañas pueden ser mayores,
especialmente en condiciones difíciles de operación. Una serie de ensayos fueron conducidos a través de la región Norte, en un esfuerzo por cuantificar el desempeño de las actuales cosechadoras. Se tomaron muestras en el campo y en el ingenio para determinar el efecto de la velocidad de trabajo de la cosechadora y la velocidad del extractor, sobre el contenido de materias extrañas. Los datos de rendimiento del cañaveral y la recolección de la caña dejada en el suelo por el sistema de extractores, fue empleada para ayudar a determinar la pérdida de caña.

Los resultados indican que los diseños de cosechadoras actuales son limitados en su capacidad para limpiar efectivamente la caña y al mismo tiempo minimizar las pérdidas de caña operando a altas capacidades de trabajo. De los resultados de ensayos realizados a velocidades comerciales de trabajo, se infiere que significativa pérdidas de azúcar están ocurriendo en el proceso de cosecha. A partir de este trabajo se confeccionó una guía para los operadores de cosechadoras con el propósito de producir buenas calidad de materia prima y evitar excesivas y sostenidas pérdidas de caña durante la cosecha.

*Palabras claves:* velocidad de trabajo, velocidad del ventilador, condiciones de campo.