MECHANISED HARVESTING OF SUGAR CANE IN THE SUPERHUMID ZONE OF MAURITIUS

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Abstract
Manual selective harvest followed by mechanised loading from the field edge is the normal practice in the super humid zone (>2500 mm of mean annual rainfall) of Mauritius. However, due to the increase in labour cost, harvest should be mechanised in this climatic zone to allow production to be competitive in the global arena. Three trials were laid down to compare manual selective harvesting with stubble shaving and mechanised harvesting with the objective of verifying if, over and above the effect of stubble shaving, mechanisation would further reduce yield and affect ratooning. Measurements included stalk height and number of shoots at monthly intervals as well as yield. Results have shown only an adverse effect of stubble shaving. Mechanised harvesting had no further effect provided that trash is cleared from the rows after harvest. Soil bulk density measured in two trials increased mainly at 10 cm depth in the interrows after harvest, without adversely affecting yield. Trafficability problems in humid soil conditions have been solved with the use of low-pressure tyres.

Introduction
Mauritius is divided into three agro-climatic zones depending on the mean annual rainfall. The sub humid zone receiving less than 1250 mm is limited to the coastal belt, while the super humid zone is found in the centre of the island and receives more than 2500 mm. An intermediate (humid) zone is situated between those two zones.

At the end of the 1980s, the sugar industry was faced with a severe labour shortage problem and the mechanisation of harvesting, the most labour intensive operation, was perceived as a vital step in maintaining the viability of the industry. A whole-stalk harvester was introduced in 1989 and a chopper harvester in 1990. Mechanised harvesting has extended rapidly in the sub humid and humid zones. At present, 23 harvesters reap about 10% (600 000 tonnes) of the total production.

However, mechanisation of harvest has yet to be practised on a large scale in the high rainfall zone because of two constraints: yield reduction reaching 10% (McIntyre and Hardy, 1989) due to stubble shaving, and poor trafficability. Thus, selective yield followed by mechanical loading at the field edge is the normal practice in the super humid zone, representing about 30% (22 000 ha) of the area under cane cultivation. With the rapid increase in labour cost, mechanisation of harvest will be the only means to reduce labour cost, allowing sugar production in this zone to be competitive in the global arena. In this context, trials were laid down to verify whether the use of heavy machinery for mechanised harvest would affect plant growth, yield and soil physical properties.

Material and methods
Stubble shaving (manual harvesting) and mechanised harvesting were compared with the control, selective harvest, in a Fisher randomised block design. In selective harvest, only millable canes are cut, whereas non-millable canes, consisting of water shoots and suckers, are left standing. Table 1 gives the characteristics of the trial sites.

<table>
<thead>
<tr>
<th>Table 1—Characteristics of trials sites.</th>
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<tr>
<td>Estate</td>
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<tr>
<td>Section</td>
</tr>
<tr>
<td>Harvest month</td>
</tr>
<tr>
<td>Soil type (USDA)</td>
</tr>
<tr>
<td>Mean annual rainfall (mm)</td>
</tr>
<tr>
<td>Altitude (m)</td>
</tr>
<tr>
<td>Cane variety</td>
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<tr>
<td>Harvesting equipment</td>
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</table>

KEYWORDS: Stubble Shaving, Soil Bulk Density, Gamma-Neutron Probe, Trafficability, Low-Pressure Tyres.
chopper harvester on tracks and infield units fitted with medium pressure tyres (280 kPa), it became possible to set a third trial during the wet months at the start of harvest. Stalk height and number of shoots were measured on 10 m strips at monthly intervals.

The compactibility of the top 10 cm of the Dystropeptic Gibbsiorthox in trial 3 to the maximum energy produced under cane harvesting conditions (140 kJ/m²) was determined through the Proctor test (Bradford and Gupta, 1986). Soil compaction was assessed in situ in trials 1 and 3 by measuring changes in bulk density with a gamma-neutron probe, model MC-S-24, (Campbell Pacific Nuclear Inc., USA). Measurements were made in the cane row and the interrow at depths of 10, 20 and 30 cm, with bulk density being monitored just before and after harvest, and at monthly intervals thereafter. By protecting the measurement holes with PVC tubes, all subsequent readings were taken at the same positions, to ensure that measurements were comparable over time.

In 1999, low-pressure tyres (550/60–22.5, 12 PR) inflated at 150 kPa were fitted to a 10 tonne payload upper trailer of Mon Désert Alma to test its ability to work in industrial conditions alongside the chopper harvester on tracks, under extremely humid soil conditions. If successful, this approach would avoid the use of 5–6 tonne capacity infield units to transfer cane to larger outfield units.

Results and discussion

Trial 1

Stalks in selectively harvested plots were significantly longer than in the stubble shaven and mechanically harvested plots. The last two were comparable. The number of shoots was comparable for the three treatments. Uprooting of stubble by the harvester during the 1992 harvest resulted in 20.6% gaps between the last two being non-significant. Results from this study indicate that yield is not affected by mechanised harvest in super humid areas provided after harvest only at 10 cm and returned to a level model MC-S-24, (Campbell Pacific Nuclear Inc., difference between treatments, while the number of shoots was higher in mechanically harvested plots. At harvest in 1999, there was no significant difference in yield between manually stubble shaved plots (85.1 t/ha) and selective harvest (85.6 t/ha) but mechanically harvested plots yielded 7.7 t/ha less than the latter. This result does not reflect the tendency shown by stalk height and number of shoots. However, when the various losses associated with mechanised harvesting were considered, the yield gap was reduced to 2.2 t/ha, as shown in Table 3. The same tendency was observed the following year. Contrary to the two previous trials, yield was not affected by stubble shaving, indicating that variety M 52/78 can tolerate this practice as well as mechanised harvest.

Table 2—Yield after two years of mechanised harvest in trial 2.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Yield (t/ha)</th>
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<tbody>
<tr>
<td>Selective harvest</td>
<td>87.7</td>
</tr>
<tr>
<td>Manual stubble shaving</td>
<td>69.4</td>
</tr>
<tr>
<td>Mechanised harvest (trash blanket)</td>
<td>56.5</td>
</tr>
<tr>
<td>Mechanised harvest (trash lined)</td>
<td>67.1</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>7.4</td>
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</tbody>
</table>

Trial 3

Soil moisture at the outset of the trial in 1998 varied between 48.6% and 63.2% (dry weight basis). Subsequent measurements of stalk height showed no difference between treatments, while the number of shoots was higher in mechanically harvested plots. At harvest in 1999, there was no difference in yield between manually stubble shaved plots (55.1 t/ha) and selective harvest (55.6 t/ha) but mechanically harvested plots yielded 7.7 t/ha less than the latter. This result does not reflect the tendency shown by stalk height and number of shoots. However, when the various losses associated with mechanised harvesting were considered, the yield gap was reduced to 2.2 t/ha, as shown in Table 3. The same tendency was observed the following year. Contrary to the two previous trials, yield was not affected by stubble shaving, indicating that variety M 52/78 can tolerate this practice as well as mechanised harvest.

Table 3—Yield difference (t/ha) between manual and mechanised harvest in trial 3.

<table>
<thead>
<tr>
<th>Year</th>
<th>Manual</th>
<th>Mechanised</th>
<th>Manual</th>
<th>Mechanised</th>
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<tbody>
<tr>
<td>1999</td>
<td>86.6</td>
<td>77.9</td>
<td>1.9</td>
<td>3.4</td>
</tr>
<tr>
<td>2000</td>
<td>85.3</td>
<td>74.7</td>
<td>68.0</td>
<td></td>
</tr>
</tbody>
</table>

*1999 measurements

Soil physical properties

From the Proctor test, in trial 3, the maximum bulk density for the top 10 cm layer was found to be 1.26 g/cm³ at about 45% volumetric moisture content. Bulk density measured in the field increased after harvest only at 10 cm and returned to a level similar to pre-harvest conditions within 10 months or less. The evolution for mechanically harvested plots is shown in Figure 1. Harvesting was conducted in wet conditions with soil moisture varying between 48.6 and 63.2% (dry weight basis). Thus, the soil had gone beyond the optimum moisture condition for compaction. The bulk density of the topsoil reached 1.21 g/cm³, after mechanical harvest, and was still lower than the maximum possible value of 1.26 g/cm³. Furthermore, the use of the harvester on tracks has allowed the energy applied to be spread over a larger area, thereby reducing the risk of compaction. The same evolution of soil bulk density was observed in trial 1 (Ng Cheong et al., 1996).
Low-pressure tyres

Low-pressure tyres were successfully tested in 1999 allowing tractor and trailer traffic in and out of a field with soil moisture as high as 68% (dry weight basis). The same type of tyres have been used successfully in Australia (Anon., 2000). During the 2000 harvest, Mon Désert Alma decided to fit two other trailers with similar tyres for direct delivery of cane from the field to the mill, thus avoiding the use of small infield units. The cost of mechanised harvest was thus reduced by 15% (US$0.7 per tonne of cane). Measurement of tyre lug thickness since July 1999 indicated that about 20,000 tonnes of cane could be transported during the lifetime of a set of four tyres. This would represent an extra cost of only US$0.08 per tonne of cane compared with the cost of standard tyres.

Conclusions

The use of harvesting equipment in the super humid zone does not affect crop development and soil physical properties. However, long-term effects of traffic on soil bulk density should be monitored. Stubble shaving is the predominant factor in yield reduction. Variety M 52/78 appears to tolerate stubble shaving and mechanised harvesting despite the extremely humid conditions prevailing. Low-pressure tyres have solved the trafficability problem in the super humid zone by allowing transport units to haul 10 tonne payloads from the field in extremely humid conditions. The search for varieties able to withstand stubble shaving should be pursued, and is considered a priority for the super humid zone of Mauritius where, unless mechanical harvest is carried out, cane production is likely to be significantly reduced by the scarcity of labour and its high cost, which affect the viability of the sugar industry.

Acknowledgments

The authors are grateful to the management and personnel of Mon Désert Alma, and Beau Champ for having taken the risk of mechanised harvest under unfavourable conditions and to the Manager of MECOM for having imported and contracted out the chopper harvester on tracks. Thanks go also to the Manager of Belle Vue for the loan of the whole-stalk harvester for trial 1 at Mon Désert Alma, and to the management of the MSRI for the opportunity to publish this paper.

REFERENCES

LA RECOLTE MECANIQUE DE LA CANNE A SUCRE DANS LA ZONE PERHUMIDE DE MAURICE

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Résumé
La récolte sélective de la canne à sucre suivi du chargement mécanique au bord des champs est la pratique courante dans la zone perhumide (>2500 mm de pluviométrie moyenne annuelle) de Maurice. Toutefois, avec la hausse des coûts de la main-d’œuvre, la récolte devrait être mécanisée afin de rendre la production compétitive dans le contexte de la globalisation. Trois essais ont été mis en place pour comparer la récolte sélective à la coupe rase et à la récolte mécanique afin de vérifier si au-delà des effets de la coupe rase, la mécanisation affecterait encore plus le rendement et la repousse. Les paramètres mesurés comprenaient la hauteur des tiges, le tallage et le rendement de la canne. La récolte mécanique n’a pas eu d’effets dépressifs à condition que la paille soit enlevée des lignes de canne après la récolte. La densité apparente du sol après la récolte a augmenté dans l’interligne à une profondeur de 10 cm, sans pour autant affecter le rendement dans deux essais. Les problèmes de traficabilité dans des conditions humides ont été résolus grâce à l’utilisation de pneus basse pression.

Mots clés: coupe rase, densité apparente du sol, sonde gamma-neutronique, traficabilité, pneus basse pression.

COSECHA MECANIZADA DE CANA DE AZUCAR EN LA ZONA PERHÚMEDA DE MAURICIO

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Resumen
La cosecha manual selectiva de la caña de azúcar seguida por el cargado mecánico desde el límite del lote cosechado, constituye el procedimiento habitual de cosecha en la zona perhúmeda de Mauricio (>2500 mm de precipitación media anual). Sin embargo, dado el alto costo de la mano de obra, la cosecha en esa zona climática debe mecanizarse si se desea obtener una producción competitiva en el mercado global. Se llevaron a cabo tres ensayos para comparar la cosecha manual selectiva, la cosecha manual y la cosecha mecanizada, con el objeto de verificar si la mecanización podría reducir en mayor grado la producción y el retome, que la cosecha manual. Las estimaciones, hechas a intervalos mensuales, incluyeron la altura del tallo y el número de brotes, como así también la producción. Los resultados mostraron sólo un efecto adverso en la cosecha manual. La cosecha mecanizada no mostró efecto alguno siempre y cuando los residuos fueran removidos de los surcos luego de la cosecha. La densidad aparente del suelo medida en dos ensayos aumentó principalmente a 10 cm de profundidad en los intersurcos luego de la cosecha, sin afectar en forma adversa la producción. Los problemas de tránsito en condiciones de suelo húmedo se solucionaron utilizando cubiertas de baja presión.

Palabras claves: cosecha manual, densidad aparente del suelo, tránsito, cubiertas de baja presión, análisis gamma-neutrón.