IMPACT OF THE GREEN CANE HARVEST AND PRODUCTION SYSTEM ON THE AGRONOMY OF SUGARCANE

By

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Abstract

ECONOMIC, community, and environmental pressures are the major drivers for wider adoption of green-cane harvesting/production systems in most sugar industries. Agronomic implications of the green-cane trash blanket (GCTB) produced by residues from the harvesting of green cane are explored. Once implemented in suitable climatic and soil associations, the economic benefits of a GCTB system are enhanced by environmental and social benefits that include reduced: use of pre-emergent herbicides, tillage, and soil erosion and stream turbidity plus improved conservation of soil moisture, lower irrigation need, improved air quality and life style for farm managers and workers. Improvements in soil chemical, physical and biological fertility are associated with the recycling of carbon and nutrients in trash. Uncertainty about the economic benefits of the GCTB system is a constraint to adoption in areas with a current high reliance on manual harvest and in cool and wet environments where the trash layer retards development of ratios and yield, either because of extension of the period of low soil temperature in winter, allelopathic effects or enhancement of waterlogging and denitrification effects. The sheer bulk of trash in high biomass environments can be a constraint to ratooning, cultural operations and furrow irrigation. The change in significance of weed species is an emerging issue across sugar industries, resulting in need to focus on post-emergent control of large seeded vine weeds. We conclude that agronomic, socio-economic and environmental benefits associated with the GCTB system render it a more sustainable system in most tropical environments, but harvest and agronomic systems for implementation are not fully developed in some high biomass situations and in cooler and wetter sub-tropical environments.

Introduction

'Everything old is new again, Everything under the sun'—Stephen Page and Steven Duffy

The words of this lyric clearly reflect the cyclic interest across the international sugar industry in what is now called the green cane production system. This system is not a recent technology, but a re-introduction and modification of the production system under which the culture of sugarcane began in Southeast Asia prior to arrival of Europeans and for its introduction to the Americas in the 15th century (Earle, 1928). The green cane system includes retention of a full trash blanket (GCTB), or raking or lining of trash from rows to inter-rows, with tillage inputs ranging from zero tillage through strategic tillage of the inter-row or full incorporation of the residues at ratooning or for ploughout.

Adoption of green cane

Change from green to burnt systems

The early culture of sugarcane was based on a green cane system, without use of fire for reduction of non-commercial biomass, because productivity in a manual harvest system was not a high priority with slave or indentured labour, fire could not be managed within the relatively small daily harvest quotas from
individual suppliers and residues had value as animal food and domestic fuel. The latter two issues are still relevant in the 21st century in some sugar industries of the Asian sub-continent, Eastern Asia and Egypt or where sugarcane remains part of a mixed agricultural system involving large numbers of growers.

In these situations, individual cane areas sometimes have less than one hectare of cane and cane harvest and transport arrangements do not allow timely delivery of burnt cane to mills before occurrence of significant deterioration. Some cane burning was practised in Mauritius in the late 19th century, but this was proven disadvantageous by Boname in the late 1890s when he convinced the growers that burning eliminated predators of important pests (De Sornay, 1936).

Cane burning was introduced across most sugar industries over a 50 year period from the late 1930s (Table 1) largely to increase the efficiency of labour as sugar industries expanded, to improve safety of cutters from wild animals and diseases associated with animals, to reduce extraneous matter in the cane supply and to facilitate the introduction of mechanical harvesters.

**Table 1**—A summary of the periods for adoption of the burnt cane production system in five sugar industries and factors that influenced adoption.

<table>
<thead>
<tr>
<th>Country</th>
<th>Period for adoption of burnt cane system</th>
<th>Significant factors for the adoption</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Late 1930s–1940s</td>
<td>Control <em>Leptospirosis</em> disease from rats, Increased labour efficiency</td>
<td>Wood, 1987</td>
</tr>
<tr>
<td>South Africa</td>
<td>1950s</td>
<td>Increased labour efficiency, availability of chemical fertilisers</td>
<td>Meyer and Van Antwerpen, 2001</td>
</tr>
<tr>
<td>Brazil</td>
<td>1960s–1970s</td>
<td>Increased labour efficiency, removal of wild animals, increased scale of production, to reduce extraneous matter</td>
<td>Paixão, 2004</td>
</tr>
<tr>
<td>Mauritius</td>
<td>1970s–1980s</td>
<td>Increased labour efficiency, introduction of chopper harvesters</td>
<td>McIntyre and Hardy, 1989</td>
</tr>
<tr>
<td>Colombia</td>
<td>1970s</td>
<td>Increased labour efficiency, to reduce extraneous matter</td>
<td>Cock <em>et al.</em>, 1997</td>
</tr>
</tbody>
</table>

**Change from burnt to green cane systems**

Commercial interest in the mechanical harvest of green cane was stimulated by a series of wet harvest seasons between 1975 and 1980 in north Queensland, after severe losses from deterioration of un-harvested burnt cane in wet cane fields. Initial adoption of the green-cane harvest system was quite rapid in several districts (Figure 1).

![Graph](image-url)

**Fig. 1**—Adoption of the green cane system in the Herbert region, the State of Queensland, the Australian sugar industry and for the State of New South Wales (NSW).
By 2002, 60% of cane in Australia was harvested green, but adoption ranged from 100% in several districts in the tropics, to 1% to 9% in a dry tropical irrigated region and from 9% to 14% in cooler subtropical regions. The area of burnt cane in Mauritius has declined since the late 1980s in both manual and mechanically harvested systems (Seeruttun et al., 1992), where some 78% was harvested as green cane in 2002, but only 19% was cut mechanically (MSIRI, 2003).

The South African industry has approximately 15% of its production based on the green cane harvest in 2004 (authors' estimate) primarily to improve rainfall efficiency, as 90% of the dryland area in the South African sugar industry receives less than 1000 mm of rainfall and to improve soil quality (Graham et al., 1999) and yield (Van Antwerpen et al., 2001). Approximately 32% of the crop is harvested as green cane in São Paulo, with 90% of this being mechanically harvested (Paes et al., 2004).

Increased adoption of the green cane system is also driven by pressure from the community and regulators to reduce the impact of cane burning on air quality, where ash fallout creates a nuisance impact, or smoke from pre- and post-harvest fires aggravates personal comfort and some respiratory conditions (Small and Windle, 2001).

These issues result in various restrictions including exclusion zones around municipal areas, imposition of no-burn days based on unfavourable meteorological forecasts or model simulations, to planned programs for the cessation of burning (Brazil, Anon., 2002; Colombia, Cock et al., 1987; Mauritius, Seeruttun et al., 2003; Texas, Rozell and Crawford, 1980; Hawaii, Ashman, 1996 (pers. comm.); Florida, Anon., 2000 and Dunckelman and Bellamy, 2000).

The legislative schedule for the cessation of cane burning in Brazil is summarised in Table 2. Fire regulations in the Australian sugar industry maximise fire safety, rather than environmental aspects, and most burning takes place in the evening or early morning in the period of lowest wind speed but maximum impact of atmospheric inversion and burning is banned between 10:00 am and 2:00 pm.

In other industries (Hawaii, Florida, Louisiana and Brazil), fires are regulated mainly in daylight hours to maximise opportunity for convectional rise of smoke and ash.

The global warming potential of gases such as N₂O and CH₄ in addition to CO₂ and CO that are released during burning is another concern. N₂O is the most worrying emission because of its high global warming potential (300 times more damaging than CO₂).

### Table 2—Schedule for reducing cane burning in São Paulo, Brazil under state law No. 11,241 of 19<sup>th</sup> September 2002.

<table>
<thead>
<tr>
<th>Year</th>
<th>Areas suitable for mechanisation*</th>
<th>Areas not suitable for mechanisation **</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 (present)</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>2006 (6&lt;sup&gt;th&lt;/sup&gt; year)</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>2011 (10&lt;sup&gt;th&lt;/sup&gt; year)</td>
<td>50%</td>
<td>10%</td>
</tr>
<tr>
<td>2016 (15&lt;sup&gt;th&lt;/sup&gt; year)</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>2021 (20&lt;sup&gt;th&lt;/sup&gt; year)</td>
<td>100%</td>
<td>30%</td>
</tr>
<tr>
<td>2026 (25&lt;sup&gt;th&lt;/sup&gt; year)</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>2031 (30&lt;sup&gt;th&lt;/sup&gt; year)</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

* Areas suitable for mechanisation: slope <12%; area >150 ha and layout favourable for mechanised harvest.

** Areas not suitable for mechanised harvest: Future schedule adjustments should be in terms of machinery availability to allow economic mechanical harvesting.

**Benefits of the green cane system**

**Economic and social**

Economic benefits flow from the GCTB system, as cultivation costs are reduced by US$47 to US$51/ha with adoption of zero- or minimum-tillage strategies (Hardman et al., 1985; Wynne and Van Antwerpen, 2004).

Minimum tillage may involve ripping the centre of the interspace with a tyne behind a coulter to cut through the trash, or a similar arrangement for subsurface placement of fertiliser beside the cane row. Some growers prefer subsurface placement of fertiliser in the stool, also using a coulter disc, while others
broadcast fertiliser onto the surface of the stool. The latter system can result in significant losses of nitrogen by volatilisation of ammonia from urea (Freney et al., 1994).

Additional economic benefits flow from the GCTB system with improved weed control (Makepeace and Williams, 1988) and reduced use of herbicides, because the residue layer inhibits emergence of most weeds in ratoon crops; allelopathic effects were implicated (Lorenzi et al., 1982).

However, the GCTB system results in a change in significance of weed species with large-seeded vines; *Ipomea* spp. in Australia, Mauritius and Brazil; *Cajanus scarabaeoides, Paederia foetida* and *Passiflora suberosa* in Mauritius (Makepeace and Williams, 1988; MSIRI, 2004; Manechini et al., 2005). The vines are capable of emerging through trash blankets and post-emergent herbicides are still required in such situations.

The economic benefits of the GCTB system are matched by significant social benefits, where cane growers or farm managers have improved life style and lower stress levels by not having to manage pre-harvest burning of cane or post-harvest burning of trash (Small and Windle, 2001).

However, Australian experience has shown need for greater focus on fire fighting capacity at farm or harvest group level in the early stages of GCTB adoption where there is still significant use of fire in regions. Concern about trash fires was a constraint to adoption of GCTB in Mauritius (Seeruttun et al., 2000).

Farm managers have more time to devote to other productive activities and leisure time because of reduced requirements for tillage operations (Hardman et al., 1985).

**Improved rainfall use efficiency**

The residue layer assists with conservation of soil moisture and results in an additional 100 to 200 mm of moisture for crop growth than in burnt-cane systems (Van Antwerpen et al., 2001; unpublished BSES data).

Moisture conservation aspects of the GCTB system up to canopy closure can result in improved yield in rain-limiting environments (Thompson, 1966; Malein, 1994; Smith, 1993) and reduced irrigation input (Gosnell, 1970).

Reported yield benefits of 7–11 tonnes cane/ha (Smith, 1993; Van Antwerpen et al., 2001) are consistent with the above values for conserved moisture with commercial water use efficiencies of approximately 7 tonnes cane/100 mm of crop water use.

**Soil quality**

Progressive loss of soil organic matter, microbial biomass and microbial activity is a major factor leading to soil degradation in pre-harvest burnt sugarcane systems (Dominy and Haynes, 2002; Dominy et al., 2002).

The GCTB system improves the accumulation of organic carbon in the surface 2–5 cm of soil relative to burnt systems (Thompson, 1966; Robertson and Thorburn, 2000; Thorburn and Kingston, 2003), and the size and activity of the soil microbial community, dehydrogenase activity and arginine ammonification rate in the top 100 mm of soil (Graham et al., 2002a, b).

Wet aggregate stability (associated with organic matter) increased in the surface 76 mm of trash treatments on a vertisol soil in a long-term trashing experiment, while resistance to penetration of a steel probe to 400 mm was less under trash than burnt conditions (Thompson, 1966; Van Antwerpen and Meyer, 1998) and water runoff was reduced by 88% in the presence of trash under a rainfall simulator at another site in South Africa (Dewey and Meyer, 1989).

These effects will result in increased infiltration. Reduction in soil strength after several cycles of GCTB results in reduced power requirements for plough-out tillage in Australia (authors' observations). However, data from Brazil show that soil strength increases in the GCTB system from compaction during wet harvest conditions early in the season, and tillage is required to manage compaction and improve water infiltration (CTC, 2004).

Richard (2004) drew attention to the difficulties associated with trash and necessary tillage operations. Tyne and coulter equipment is used in Australia for tillage and fertiliser application in ratoon crops.

**Soil conservation**

The GCTB system results in reduced soil erosion because the soil surface is protected from raindrop impact and lower intensity overland flow (Prove et al., 1986). More recently, it has been shown that adoption of the GCTB system has a dramatic effect on the intensity and nature of earthworks for soil
conservation in Brazil where erosion can be managed on slopes of <6% without contour banks and by introduction of 50% fewer, but straight banks for slopes of 6 to 9% in the presence of trash (Manechini et al., 2004).

Similar efficiencies have been employed in the Australian industry to facilitate field design for irrigation and mechanical harvest (authors’ observation).

This resource conservation benefit has the additional off-site environmental benefit of reducing turbidity in streams and the associated loadings of particulate nitrogen and phosphorus.

**Nutrient cycling**

Data from Thompson (1966) and Kingston et al. (1984) show that residue dry matter : fresh cane ratios vary between 0.17 and 0.25, depending on variety, but most data are around 0.17.

This provides between 14 and 22 t/ha of dry residues for cane yields between 80 and 130 t/ha. Torres and Villegas (1995) indicate residue yields of 20–40 dry t/ha (40% dry matter) in Colombia.

Deposition and decomposition of this large amount of crop residues in the GCTB system provides significant opportunity for recycling of organic matter and nutrients (Mitchell and Larsen, 2000; Robertson and Thorburn, 2000; Wagner et al., 2002), whereas there is a major loss of nutrients from a field in burnt systems (Table 3).

Potassium is readily leached from sugarcane residues and 85% to 95% of potassium in residues can be leached over 12 months (Spain and Hogden, 1994; Wagner et al., 2002). That this potassium has value as a nutrient is demonstrated by nutrient balance studies (Maule et al., 1998; Klok and Kingston, 2002b).

Comparison of burnt and GCTB systems, by the latter authors showed the burnt system extracted 159% of potassium applied as fertiliser and residue, whereas the GCTB system was balanced with 100% extraction of applied fertiliser and residue potassium; soil potassium levels showed a greater decline in the burnt system.

**Table 3**—Comparison of dry matter inputs from sugarcane residues and nutrient yield for the GCTB system, the traditional burnt cane system and for burning of residues after green-cane harvest (Mitchell and Larsen, 2000).

<table>
<thead>
<tr>
<th>Component</th>
<th>GCTB system</th>
<th>Green harvest / burn residues</th>
<th>Full burnt cane system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (t/ha)</td>
<td>12.7</td>
<td>2.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Nutrients (kg/ha)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>65</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>70</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Potassium</td>
<td>9</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Calcium</td>
<td>39</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Magnesium</td>
<td>22</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Sulfur</td>
<td>9</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

The increase in total nitrogen levels in soil under the GCTB system is generally restricted to the surface 2–5 cm of soil, as for the increase in organic carbon (Graham et al., 1999; Robertson and Thorburn, 2000; Thorburn and Kingston, 2003).

The high C:N ratio in sugarcane residues can lead to immobilisation of mineral nitrogen (Ng Kee Kwong et al., 1987; Basanta et al., 2003), and there is a period of disequilibrium within which decomposing residues are net sinks for mineral nitrogen and that contained in residues (Robertson and Thorburn, 2000).

The period of disequilibrium and potential for impact on cane yield upon conversion of burnt to green systems was affected by the level of N applied to the system (Figure 2), with cane under a GCTB system out-yielding burnt cane after about 5 years with 180 kg N/ha, and 12–15 years with 150 kg N/ha (Thorburn and Kingston, 2003).
Fig. 2—Simulated change in cumulative difference in sugarcane yield between GCTB (at three different rates of N fertiliser) and trash burnt (at 150 kg/ha application of N fertiliser) systems with increasing time after changing from the burnt to the GCTB system for (a) Bundaberg climate and Red Kandosol soil and (b) Mackay climate and Brown Chromosol soil (Thorburn and Kingston, 2003).

The fact that there were no large scale reports of lower yields soon after the adoption of the GCTB system in Australia may be a function of the widespread use of above recommended levels of nitrogen in the decade after the introduction of GCTB.

The latter authors also suggest that N application rates could be reduced in GCTB systems after the disequilibrium period if yield does not change; however, rates should not be reduced if trash retention results in a yield increase as a result of improved moisture conservation.

Limitations of the green cane system

Cane quality and yield

Some of the cane quality issues at harvest of green cane have implications for crop agronomy. Increased suckering (water shoots or lalas) has been reported in the wet tropics of Australia in the 1990s in the GCTB system (A. Hurney, pers. comm.; Klok and Kingston, 2002a). In manual harvest systems, the cutters can discriminate against suckers, but this is not possible with mechanised harvest.

Increased suckering was interpreted as a function of selection of genotypes with tendency to sucker (Berding and Hurney, 2000) and interactions between the latter factor with warm and wet winters in the late 1990s (Kingston, 2002) and increased release of nitrogen from the GCTB system after the wet season (Klok and Kingston, 2002b).

Growers in cool and wet subtropical and some wet tropical regions have not adopted the GCTB system because of concern with adverse effects of trash retention on productivity (Torres and Villegas, 1995; Seeruttun et al., 1998; Richard, 1999; Kingston et al., 2002). Here, moisture conservation benefits are valued because of generally adequate rainfall and particularly for soils with moderate to poor drainage characteristics.

Further, trash was seen to be an impediment to ratooning in winter months as insulation from trash contributes to soil temperatures that are 1–3.4°C cooler at approximately 10 cm depth than in burnt systems.
in late winter-spring months (Beater and Maud, 1962; Seeruttun et al., 1998; Kingston et al., 2002; Viator et al., 2005). Viator et al. (2005) showed the insulating effects of a trash blanket resulted in higher soil temperatures than where trash was removed under winter conditions in Louisiana, but absolute temperatures in both systems precluded winter development of ratoon shoots.

Lower soil temperature slows development of the ratoon shoot population in GCTB systems around the world, relative to burnt systems, but yield effects vary with site and season. The GCTB system had a significant and negative impact on cane yield for winter harvest under the subtropical conditions in New South Wales, Australia (latitude 28°S), where impact of trash retention after winter harvest was reduced by raking the stool zone (Kingston et al., 2002).

Effects of the GCTB system on yield of cane ratooned from mid-spring and summer harvests ranged from not significantly negative to slightly positive, over three ratoon crops and benefits were attributed to moisture conservation. While mature stalk populations generally equalised across trash management treatments from the winter harvests as the growing season progressed, the negative effect of trash on yield was caused by a relatively high proportion of small stalks associated with late developing secondary shoots in the GCTB treatment.

Allelopathy has been implicated in poor ratooning in GCTB systems (Lorenzi et al., 1982; Lovett and Hurney, 1992; Cock et al., 1987). Wet conditions within two weeks of harvest are thought to cause most damage from allelopathic effects under tropical conditions in Colombia (authors’ observation). Kingston et al. (2002) interpreted the different response to soil thermal time of plant populations under three trash managements (Figure 3) as an interaction with allelopathic effects of trash, as data should have formed a single distribution for temperature effects alone.

Tillage, irrigation and drainage

Management of the trash blanket presents greatest challenges in preparing land for succession planting, where incorporation and sufficient decomposition of trash can be achieved with large off-set disc tandems and rotary hoes if there is a gap of four to six weeks between ploughout and planting; square ploughs can be used to bury the trash layer.

Trash is removed in bales for sale as domestic garden mulch in some areas of Australia, or burnt on the ground for rapid re-planting. The latter strategy is not permitted on muck soils in Florida (Anon., 2000) and experiments are underway in Louisiana evaluating the use of baled residue in coastal restoration projects (Johnson and Richard, 2003).

The option of total biomass harvest and separation of cane and residues at the factory is proposed for a sugar / electricity co-generation industry in NSW in Australia (Schembri et al., 2002). The concept of controlled traffic and reduced or zonal tillage at planting is being advanced in the Australian sugar industry as components of a new farming system (Garside, pers. comm.). Within this system, trash may only need to be raked from the row area after stool destruction with glyphosate if succession planting must be employed.

Fig. 3—Effect of thermal time under three trash-management strategies on emergence of shoots in second-ratoon Q124 in New South Wales, Australia in 1997 (Kingston et al., 2002).
Presence of trash in the inter-row is regarded as a major difficulty for furrow irrigation of the more permeable soils (Holden and McMahon, 1997). Some growers in this dry tropical area in Australia rake trash from the inter-row onto the cane row to provide a relatively clear passage for irrigation water, while other growers' soils achieve a similar result by raking trash from every second inter-space and running water in the cleared furrows.

The large trash yield in Colombia is seen as an impediment to ratooning, cultural operations and efficient irrigation, and several systems operate for trash lining in interspaces and mechanical methods are being developed to reduce the size of trash pieces to facilitate compaction and decomposition (Cock et al., 1987; Torres and Villegas, 1995).

In the GCTB system is best suited to soils and fields with good surface and internal drainage, because of adverse effect of trash on surface hydrology. Shallow ponded water containing crop residues rapidly becomes anoxic and has a severe effect on establishment of ratoon crops (author's observations). The effect is more severe in warm climates and increases the potential for loss of nitrogen fertiliser by denitrification with elevated regimes for water and soluble carbon. Therefore, the GCTB system may not be successfully applied to some areas until surface drainage has been improved.

Insect pests

Alcohol from decomposing sugarcane pieces and protection afforded by a trash blanket makes the GCTB system more attractive than a burnt cane field for egg laying by female armyworm moths (Mythimna spp.) and development of populations of armyworms in Australia (Liu and Allsopp, 1996) and in Mauritius (Ganeshan and Rajabalee, 1996). This pest can inflict severe damage to emerging and developed shoots in some seasons.

Sustained attack on early harvested cane may affect yield (Liu and Allsopp, 1996), and some growers choose to spray with chlorpyrifos insecticide, while others rely on population control by natural predators. Adoption of the GCTB system in São Paulo led to concerns about increased damage from Mahanarva frimbriolata (spittle bug or frog hopper), but this has been managed by a biological control program where the fungus Metaharizium anisopliae is sprayed onto trash (Sanguino, 2002).

Varieties

Difficulty in achieving economic harvest rate and recovery of cane in high yielding lodged crops in the GCTB system (Cock et al., 1987; Holden and McMahon, 1997; Davis and Norris, 2002) has led to a change in focus in selection programs for varieties to be used in the GCTB system in Colombia and Brazil (Cock et al., 1987; CTC, 2004).

Cultivar ideotypes include high sugar content and erect habit and ability to ratoon through trash blankets in both programs but the Brazilians are also focusing on resistance to traffic damage and cultivars with lower losses in harvesters (thicker stalks), while the Colombians seek self trashing varieties with smaller tops. There is no overt selection program for GCTB varieties in Australia, as the high level of adoption of the GCTB system means that many final variety assessment trials are conducted on commercial farms, where varieties are selected on the basis of overall agronomic and harvesting performance under the GCTB system. However, losses associated with lodging in the wet tropics in the 1990s has led to a higher demerit index for this character in the selection index (Berding, pers. comm.).

Conclusions

The re-adoption of the GCTB production system by many sugar industries across the world is possibly the most significant change to sugarcane agriculture since the introduction of chemical fertilisers and herbicides to the burnt cane system in the decades after World War II. Economic, community and environmental issues are the drivers for wider adoption of the GCTB system in most countries. Once implemented in suitable climatic and soil associations, the economic benefits are enhanced by environmental and social benefits that include reduced use of pre-emergent herbicides, reduced tillage, soil erosion and stream turbidity plus improved conservation of soil moisture with lower irrigation need up to canopy closure, improved air quality and life style for farm managers and workers. Improvements in soil chemical, physical and biological fertility are associated with the recycling of carbon and nutrients in trash.

Significant productivity constraints are associated with retention of green cane residues in cooler and wetter sub-tropical environments unless specific and timely management is employed to remove trash from rows in late winter to early spring prior to the start of another production year.

It is concluded that agronomic, socio-economic and environmental benefits associated with the GCTB system render it a more sustainable system in most tropical environments, but harvest and agronomic systems for implementation are not fully developed in some high biomass situations.
REFERENCES


L’EFFET D’UN SYSTEME DE PRODUCTION POUR LA RECOLTE EN VERT SUR L’AGRONOMIE DE LA CANNE A SUCRE

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MOTS CLÉS: Système de Production pour la Récolte en Vert, Paillis, Brûlis, Résidus, Érosion, Labour Réduit, Qualité du Sol.

Résumé

Les pressions d’ordre économique, communautaire et environnemental sont les raisons majeures qui ont poussé la plupart des industries sucrières à l’adoption de la récolte en vert et des systèmes de production associés. Les implications agronomiques du paillis provenant des résidus de la récolte en vert sont étudiées. Sous des conditions climatiques appropriées et dans les sols associés, le paillis vert apporte, en sus des bénéfices économiques, des avantages tant pour l’environnement que pour la société, en permettant des réductions de l’utilisation des herbicides de pré-émergence, du labour, de l’érosion du sol et de la pollution des cours d’eau. Par ailleurs, la conservation de l’humidité du sol est améliorée, d’où un besoin moindre d’irrigation, la qualité de l’eau ainsi que le mode de vie des exploitants et des travailleurs sont rehausssés. Les améliorations de la fertilité chimique, physique et biologique du sol sont associées au recyclage du carbone et des nutriments dans la paille. Là où la rentabilité du paillis vert pose un doute, c’est surtout dans les régions qui dépendent largement d’une récolte manuelle et dans les environnements froids et humides où le paillis retarderait le développement des repousses et le rendement. Ceci serait dû soit à l’extension de la période de basse température du sol en hiver, aux effets allélopathiques ou à une amplification des effets de l’accumulation de l’eau dans le sol et de la dénitrification. Dans les zones à forte biomasse, la grande quantité de paille peut représenter une contrainte aux repousses, aux opérations culturales et à l’irrigation des sillons. Le changement dans l’importance des espèces d’herbes est un problème nouveau qui touche toute l’industrie de la canne et qui nécessite une attention particulière sur un contrôle de post-émergence des lianes. En conclusion, le système de paillis vert offre une meilleure durabilité dans la plupart des régions tropicales de par les avantages agronomiques, socio-économiques et environnementaux qui y sont associés. Toutefois, dans les environnements à forte biomasse et dans les régions plus froides et humides des sous-tropiques, les aspects agronomiques et la récolte doivent encore être étudiés avant que le paillis vert ne soit adopté.
IMPACTO DEL SISTEMA DE PRODUCCIÓN Y COSECHA DE CAÑA EN VERDE EN LA AGRONOMÍA DE LA CAÑA DE AZÚCAR

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Resumen

Presiones económicas, comunitarias y ambientales son los principales encausadores para una mayor adopción de los sistemas de producción/cosecha de caña en verde en muchas industrias azucareras. Se exploran las implicaciones ambientales del manto de rastrojos de caña en verde (GCTB, por sus siglas en inglés) producidas por los residuos de la cosecha en verde. Luego de ser implementado en adecuadas condiciones climáticas y edáficas, aumentan los beneficios económicos de un sistema GCTB con beneficios sociales y ambientales que incluyen una reducción en: el uso de herbicidas pre emergentes, macollamiento, erosión edáfica y turbidez de arroyos más una mejor conservación de la humedad del suelo, menores necesidades de riego, mejor calidad del aire y del estilo de vida para los administradores de fincas y sus trabajadores. Una mejora en la fertilidad física, biológica y química del suelo está asociada con el reciclaje del carbono y los nutrientes del rastrojo. La incertidumbre sobre los beneficios económicos del sistema GCTB es una limitación a la adopción en áreas que actualmente tienen altos porcentajes de cosecha manual y en ambientes fisiográficos, donde la capa de rastrojos retrasa el desarrollo de las socas y el rendimiento, ya sea por una prolongación del periodo de bajas temperaturas en el suelo en invierno, efectos alelopáticos, o aumentos en retención de agua y efectos desnitrificantes. La gran cantidad de rastrojos en ambientes con alta biomasa puede ser un obstáculo para el soqueo, las prácticas culturales o el riego por surcos. El cambio de importancia de las especies de malezas es un aspecto de creciente importancia en las industrias azucareras, necesitando enfocarse en el control post-emergente de guías de malezas de semillas grandes. Concluimos que los beneficios agronómicos, socio-económicos y ambientales asociados al sistema GCTB lo convierten en un sistema más sostenible en ambientes más tropicales, pues la implementación de los sistemas agronómicos y de cosecha no están completamente desarrollados para situaciones de alta biomasa y para ambientes subtropicales más frescos y húmedos.