THE SUGARCANE CROPPING SYSTEM

Trevor Willcox, Alan Garside and Mike Braunack

THE most important and expensive operation in canegrowing is the establishment of a good plant crop, because this not only determines the yield of that crop but will also strongly influence the number of subsequent ratoons and their yield potential. For example, if acceptable yields can be produced from a plant and four ratoon crops, profitability is enhanced compared with having to re-plant after two ratoons. Soil conditions in terms of sett/soil contact, soil moisture and soil pathogens have a major influence on crop establishment.

Land preparation and planting must focus on providing conditions conducive to minimising the adverse effects of these factors. Further, current cropping practices are reliant on heavy machinery for land preparation, harvesting and hauling the crop. Heavy machinery induces compaction and a major aim of the cropping system must be to minimise compaction and the adverse effect it can have on crop growth.

SOIL PROPERTIES AND CULTIVATION

In general, the longer a soil is under cultivation, and the more frequently a soil is cultivated the greater the loss of its inherent properties of tilth and structure. Soil properties degrade under long-term cultivation; they do not improve. Soils in many canegrowing areas have been under continual cultivation for more than a century and many are clearly showing the signs of long-term exploitation. Although it is impossible to return them to their original fertile status under a cropping system, there is an urgent need to adopt strategies that will at least reduce the rate of degradation.

Inherent soil fertility has developed under natural processes over centuries, largely through the cycling of organic matter from original scrub, forest or grass cover. Intervention through practices used to grow crops disrupts these natural processes and increases the rate of organic matter decomposition (Table 1). Further, the shearing (ploughing) and pulverising (rotary hoe) effects of cultivation equipment destroy soil structure through reducing aggregate size. As soils lose their structure, they are more susceptible to slaking and dispersion, which reduces infiltration and provides greater resistance to root growth.

Table 1. The influence of clearing and cultivation on soil organic matter under tropical conditions.

System	% Carbon
Virgin rainforest	2.97
Rainforest cleared and grassed for 15 years	1.62
Rainforest cleared and cultivated for 15 years	1.14

In general, excessive cultivation provides a less hospitable environment for crop growth. Hence, the practices employed in growing the crop must attempt to balance short-term productivity considerations with long-term sustainability. More recent developments in understanding and managing soil properties can limit the degree of degradation and these are discussed in this chapter along with more traditional cropping strategies.

In discussing the cropping system, we restrict ourselves to a cropping cycle, starting from the end of the last ratoon in the current cycle and working through removal of the old crop, fallowing or plough-out/re-plant, land preparation, planting and subsequent ratooning.

REMOVAL OF THE OLD CROP AND FALLOW PERIOD

When the final ratoon is harvested, a grower has the option of removing the rootstock by tillage or herbicides. Tillage has been the traditional approach as it has always been assumed that cultivation is an essential component of any land preparation strategy.

However, in more recent times, rootstock removal through the use of the herbicide glyphosate is gaining popularity. The options open to growers are very much dictated by the cropping strategy adopted.

Plough-out/re-plant strategy

Growers operating a plough-out/re-plant strategy are dependent on a rapid turn-around between the harvest of the final ratoon and re-planting the new crop. The whole basis of the plough-out/re-plant strategy is to avoid missing out on harvesting a crop on a specific piece of land in any one year. Hence, to successfully practise a plough-out/re-plant strategy, the final ratoon must be harvested early in the crushing season (June–July), the land prepared quickly, and the new crop planted by early spring (September).

These time restrictions dictate the land preparation strategy. There is insufficient time to allow ratoon growth to provide enough foliage to use herbicides to effectively remove the old ratoon. Further, compaction from the previous cropping cycle must be removed to allow establishment of the next crop. This can only be done in a short time period with frequent aggressive tillage. This will work most effectively if the trash from the previous harvest is burnt and not incorporated, thus wasting valuable organic matter. Even so, frequent aggressive tillage is a very temporary answer to controlling compaction, as the effects of aggressive tillage, through soil structural degradation, lay the foundation for the rapid development of even more severe compaction in the next cycle. This aggressive tillage will almost invariably involve ploughing, ripping and rotary hoeing.

The concept of controlled traffic, which is mainly about matching crop row spacing with equipment track width or multiples of equipment track widths, is gaining popularity in many cropping systems. Controlled traffic, in conjunction with minimum or zonal tillage, where only the crop row is removed using a narrow zone of tillage and the inter-row is left compacted with no attempt to remove it between crop cycles, offers real potential for rapid turn around in a plough-out/re-plant system. However, the controlled traffic/zonal tillage concept is still under development and all the ramifications of adopting such a strategy have not been fully evaluated. For example, there are concerns that root diseases may be promoted by planting into the same cropping line. Further, the compacted interspace may increase runoff and reduce effective rainfall, which may reduce yields in dry seasons. However, there is little doubt that the concept has enormous potential for both soil conservation and timeliness of operations. Growers should look to establishing at least small areas using the controlled traffic/zonal tillage strategy.

Fallow planting strategy

Fallow planting has traditionally been the practice in the Australian sugar industry. Basically, it involves the harvest of the final ratoon towards the end of the crushing period (October–November), and its removal through cultivation. For the following wet season or summer period, either a legume fallow crop is grown or the paddock is left as a bare or weedy fallow. Conventional cultivation is then used for land preparation and planting during the following autumn–winter period.

Until 1975, when assignment restrictions were lifted, fallow planting was basically forced on canegrowers because they were not allowed to harvest their full assigned area in any one year. However, with the lifting of restrictions, there was a general move towards more plough-out/re-plant over the next 20 years. In more recent times, fallow planting is regaining popularity, as growers become more concerned about declining productivity under the long-term monoculture system.

There is little doubt that many soil properties are improved by incorporating a legume fallow. Root diseases can be better managed through an extended break from sugarcane and organic nitrogen can be incorporated into the system for the next plant crop. In addition, soil structural improvement and a reduction in compaction can result from a non-grass crop being included in the system, and less aggressive tillage can be employed to establish the next plant crop because more time is available for land preparation. Growers also have the choice of removing root stock through tillage or herbicides as timeliness is not as critical compared with a plough-out/re-plant system.

In terms of crop production, the major difference between fallow planting and plough-out/re-plant is that, with the former, there is a year when no cane is harvested from part of the farm. Although yields are almost always higher following fallow plant than plough-out/re-plant, in both the plant and at least the early ratoon crops (Table 2), there has not been sufficient rigorous testing of the effect on long-term profitability, but results to date are very encouraging.

Table 2. Cane yields (t/ha) from crops planted with a plough-out/re-plant system and a fallow planting system. P represents plant crop and R ratoon crop. Data from Yield Decline Joint Venture rotation experiments.

Site and crop class	Plough-out/ re-plant	Legume fallow plant
Tully (P)	88	102
Ingham (P)	48	61
Mackay (P)	63	90
(R1)	92	116
Bundaberg (P)	107	124
(R1)	110	138
(R2)	107	125

The concept of controlled traffic/ minimum or zonal tillage can also fit into the fallow planting system. The old ratoon can be sprayed out, the legume direct seeded into the old mounds and then incorporated using a narrow zone of tillage prior to sugarcane planting. Considerable research is currently being conducted into the development of a sugarcane/legume rotation system based on controlled traffic/minimum tillage. Results to date are very encouraging.

Fallow management

Legume fallows have traditionally been established immediately prior to the wet season after the cane harvest has been completed. In general, input into legume establishment has been minimal. The traditional practice has been to broadcast seed onto the soil surface and incorporate it with a disc implement or rotary hoe. No other management has been applied. However, recent research has shown that management of the legume fallow, by planting on raised ridges to avoid wet season waterlogging and using a herbicide to control weeds, greatly enhances the growth of the legume. Ridges also facilitate irrigation if required. In addition, a change in species from the traditional cowpea to soybean is providing improved benefits, particularly in terms of increased nitrogen input. These aspects are covered in more detail in the Soil Health chapter.

Many farmers have traditionally left the fallow bare after the old stool has been destroyed. A fallow managed this way provides an opportunity to control difficult weeds such as nut grass, guinea grass and couch grass with glyphosate. However, with the development of more specific herbicides (e.g. Fusilade®), it is now becoming possible to control these weeds within a legume fallow. Other reasons for leaving a fallow bare include changing block layout, improving drainage and land levelling.

LAND PREPARATION

Many factors determine the timing and equipment used to prepare land for planting. Traditionally, the aim has been to achieve a fine tilth to around 300 mm to allow planting of the sett to a reasonable depth. However, two major questions emerge with traditional land preparation: is it necessary to work soil to the fine tilth often seen for planting sugarcane, and is it necessary to adopt such aggressive tillage practices to achieve such a fine tilth? From recent research, particularly involving controlled traffic/minimum tillage, the answer in both cases is clearly no. Land preparation should only be to provide a seedbed that will give the sett the best chance of germinating, emerging and developing into a healthy cane plant.

A major problem with land preparation is the tendency to carry out tillage operations when soil is either too wet or too dry. Either condition can have adverse effects on soil properties. Cultivating when too wet can cause problems such as smearing and compaction producing large clods, which in turn require more aggressive tillage to break down. Tillage of soil that is too dry can result in soil pulverisation reducing soils to a powder. This can cause surface sealing and provide a substantial barrier to water infiltration. Of course, it is not always possible to carry out tillage at the ideal moisture content but, when preparing land, soil moisture content to the depth of tillage should be an important consideration.

As discussed above, in plough-out/re-plant systems using conventional cultivation, the grower has little option but to adopt aggressive tillage practices that will probably involve ploughing, deep ripping and several rotary hoeings. However, with conventional cultivation in the fallow plant system, several options exist. Firstly, the incorporation of the legume fallow is best achieved by either shallow discing or ploughing, not by rotary hoeing. After allowing some time for the incorporated organic matter to partially decompose, a deep ripping to disrupt any remaining compacted areas will probably be the next operation. Future workings should simply involve shallow tillage with tyned implements to create a suitable seedbed.

The potential for controlled traffic/ minimum tillage to totally change cultivation practices is enormous. Although still under development, all the results to date have been positive. Most importantly, crop yields have not been adversely affected (Figure 1). The only obvious negative is the potential for promoting root diseases by planting back into the same area. However, varietal rotation appears to offer a solution to this potential problem.

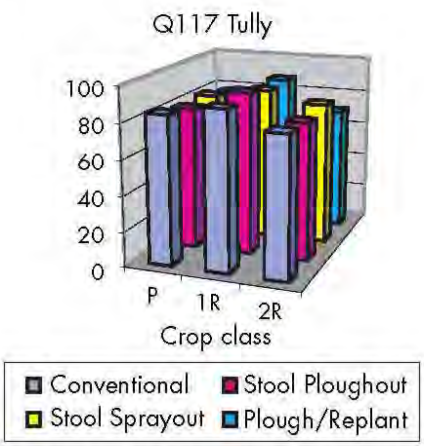

Figure 1. *Cane yield (t/ha) for plant, first and second ratoon crops grown with fallow plant prepared by conventional cultivation, stool ploughout and stool sprayout and conventional plough-out/re-plant. Data from Yield Decline Joint Venture strategic tillage experiments.*

Most importantly, controlled traffic divorces traffic and crop growth areas, which improves timeliness of operations through providing a compacted area for traction and a non-compacted zone for root development. This reduces the area that is disturbed and the number of operations required to produce a seedbed, resulting in substantial reductions in time (80%) and fuel usage (90%) (Figure 2).

The ultimate aim with controlled traffic/ minimum tillage is a system where the only soil disturbance is to the crop growth zone to provide a prepared area for planting. This could well be achieved with one pass of a tillage implement. If this can be achieved, without adverse effects on productivity, it should be encouraged, as improved timeliness of operations and improved soil properties are likely to result. In the final analysis, land is only tilled to ensure good crop establishment and weed control. If that can be achieved with minimum tillage, substantial benefits will result in terms of both sustainability and profitability.

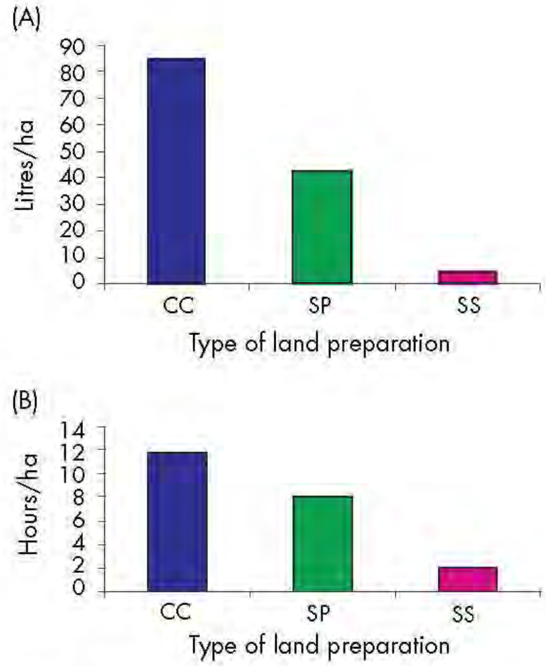

Figure 2. *Litres of fuel used per hectare (A) and hours to prepare a hectare (B) with conventional cultivation (CC), stool plough-out (SP) and stool spray-out (SS). Data are from Yield Decline Joint Venture strategic tillage experiments.*

PLANTING, ESTABLISHMENT AND PLANT CROP MANAGEMENT

The procedures employed in planting and establishing the plant cane crop will have a major effect on crop productivity in both the plant crop and subsequent ratoons. Growers need to carefully consider such factors as variety, row spacing, sett quality, planting depth, fertiliser placement, sett treatment with fungicides and insecticides, and planting time. All of these have an effect on crop growth and development.

Row spacing

Row spacing for sugarcane production has developed as a compromise between crop agronomy and machinery track width. The current row spacing used in the industry is single rows spaced between 1.40 and 1.65 m apart. Unfortunately, the track width of most harvesting and haulout equipment is 1.8 m. Therefore, at 1.5 m row spacing, the machinery compacts 90% of the total area in a block. If the row spacing is less than 1.45 m, the harvester wheel or track is on the side of the stool and knocks down and squashes cane before it is cut. Where soil is moist, this also causes soil compaction in the stool area. All of these traffic issues greatly reduce the potential yield of later ratoons. Additionally, growers do not always pay attention to ensuring that the row spacing they use is consistent. Quite often the spacing of rows within a field can vary from 1.35 to 1.65 m. Such variation increases the potential for stool damage.

Using single 1.8 m rows is an option to allow matching of track width and row spacing. However, as 1.8 m rows generally yield less than 1.5 m rows, there has been reluctance in the industry to move to the wider row spacing to avoid crop damage. In order to address this problem, there has, more recently, been a trend towards dual-row planting where drills are spaced 1.8 m apart but contain two rows spaced 0.5 m apart (Figure 3). Research is also currently underway to develop a high-density, close-row system where four rows are spaced 0.5 m apart on a 2.1 m bed with controlled traffic areas between. Regardless of whether dual or close-rows are adopted by the industry, both systems are ideally suited to the emerging controlled traffic/minimum tillage system (Figure 4).

Yield potential is directly related to the extent of ground cover or radiation interception. The faster the crop achieves full ground cover, the higher the yield potential.

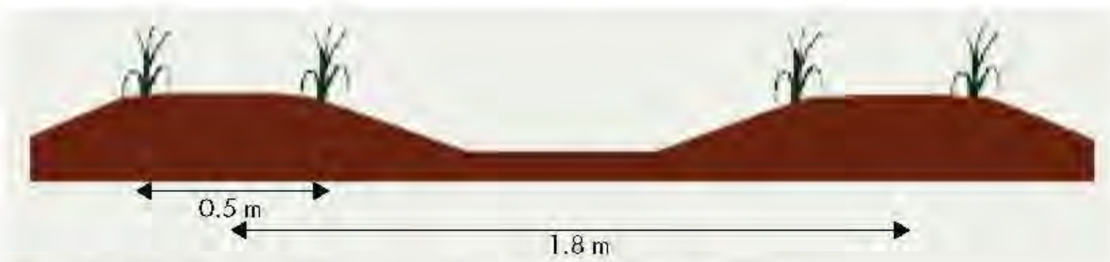

Figure 3. *Schematic view of dual rows 0.5 m apart on 1.8 m in centres.*

Figure 4. *Schematic view of dual rows in a controlled traffic/minimum tillage system.*

However, the realisation of high yields is also dependent on subsequent stalk losses, which can be substantial in current varieties and this can negate much of the advantage obtained with early ground cover. The time taken to achieve full ground cover depends on the planting time, variety and row spacing. Current varieties were selected from variety trials with row spacing of 1.4 to 1.5 m and produce good yields at this spacing. For similar planting times, dual-row and close-row systems achieve full ground cover earlier and therefore have the potential for higher yields.

Planting

Planting is an important and costly operation. Good germination and emergence with no gaps are essential for high yields and provide a sound foundation for future ratoon crops. A successful planting operation depends on the machinery used, the quality of the planting material, and the way the equipment is operated.

Planting machinery falls into two groups, billet and whole stalk. In both groups, there is a range of equipment from several manufacturers. Both types of planters open a furrow, apply fungicide to the sett, drop the sett in the ground, and apply fertiliser and insecticide, if needed, to the soil. Whole-stalk planters also have a cutting mechanism to cut the stalk into billets approximately 300 mm long. For billet planters, the stalks are cut into billets with a cane harvester before they are loaded into the planter.

Whole-stalk planters generally produce better germination than billet planters but are more labour intensive. The results with billet planters are generally inferior, due to damage to billets by the cane harvester. Best results with billet planting are achieved using harvesters that have been modified to cut plants. Modifications normally increase the billet length to about 300 mm and reduce feed roller damage by using worn or rubber-coated rollers. Extra care should also be taken to keep basecutter blades and chopper knives sharp to avoid splitting billets.

Traditionally, sugarcane has been planted in a furrow 120 to 200 mm below the soil surface (Figure 5). Initially, setts are covered with 50 to 100 mm of soil to promote germination and tillering. Later, the drill is filled-in and the row area raised above the interspace (or the depth of cover increased for mound planted blocks) and shaped into a profile to aid harvesting (Figure 5). While this is still the most common practice, there is now a trend towards planting into a raised mound, particularly in wet areas.

Improving crop establishment

Erratic or failed germination and poor emergence can result from a combination of factors. These include sugarcane variety, poor growth in the crop used for plants, harvester damage to billets, poor sett coverage with

Figure 5. *Schematic view of sett placement in conventional and mound planting systems.*

fungicides, insect damage, dry soil in contact with the cane sett, and cool and wet soil conditions.

Variety

Speed of germination is a varietal characteristic. Some varieties such as Q124 are slow to germinate while others such as Q151 and Q170[Φ] are fast to germinate. While the speed of germination is not normally considered in variety selection, extra care must be taken with varieties that are slow to germinate. With slow germinating varieties, it is best to avoid planting in cool weather and the depth of soil cover should be kept to a minimum.

Plant source

Planting material should be sourced from cane that is actively growing as evident by the green colour of the leaf. Well-nourished younger cane germinates faster and in general produces better plant stands than poorly grown cane. An application of nitrogen (125 kg ammonium sulfate/ha) four to six weeks prior to cutting plants improves the speed of germination, particularly where fertiliser was restricted initially to obtain erect plants or where wet conditions were experienced during the growing period. Irrigation also improves the vigour of the plant source if conditions are dry.

Growers should choose an erect plant source if possible, as this will provide sound and healthy stalks. This is particularly important with billet planting, as the billet damage from the harvester will be less in erect cane. Erect plant crops of 75-100 t/ha usually provide excellent planting material.

Setts may have hollow centres, commonly called pipes. This is a varietal characteristic that is accentuated when sugarcane is grown under stress conditions (too wet or too dry). Where pipes are present, extra care will be required with fungicide application and in timing planting to avoid cool weather slowing down germination and providing greater opportunity for disease development.

Cane selected for use as planting material should have been long-hot-water-treated or obtained from a Cane Protection and Productivity Board (CPPB) plot within the past three years.

Hot-water treatment is a process where cane is immersed in water heated to 50°C for three hours. This process kills any ratoon stunting disease (RSD) bacteria present in the plant. (See Disease Management chapter for more detail).

Where possible, plant sources should be grown in a special nursery block which is well-drained and where special care is taken to prevent introduction of disease from machinery contamination. Plant sources should be inspected for RSD as the cane may have been re-infected by harvesting or planting equipment during propagation on the farm.

At inspection, checks should also be made for other diseases such as Fiji, chlorotic streak or leaf scald disease and for damage from insects such as moth borer and weevil borer. This service is available from Cane Protection and Productivity Board staff.

Sett quality

Growers should aim for a sett that has two to three nodes. Single node setts should be avoided. The node is a natural barrier to disease infection and movement; setts with two or three nodes are less susceptible to sett rots. However, sett rots may also enter through damaged rind caused by the harvester used to cut plants. To minimise sett damage, the harvester should be modified to cut plants. Modifications include reducing pressure from feed rollers to stop splitting and cracking of billets, using worn or rubber coated feed rollers to reduce rind damage to billets, and modifying the chopping mechanism to increase billet length. Also, it is important to keep chopper and basecutter blades sharp and correctly adjusted. The condition of billets should be monitored for splitting, cracking, rind damage and billet length.

Sett placement and soil cover

Planters should be adjusted such that setts are placed on firm, moist soil. With billet planters, the amount of plants should be reduced or chutes widened if setts lie on each other. Normally with billet planting, 7.5 t cane/ha of cane plants is sufficient if damage to setts is minimised. With whole stick planters, 3–5 t cane/ha, depending on stalk diameter, will provide excellent stands.

The amount of soil cover over the sett influences the temperature and moisture content of the soil adjacent to the sett and, therefore, the speed of germination. When soil moisture is the limiting factor, setts should be covered well and no press-wheel used. When temperature is the limiting factor, a light cover should be applied and a press-wheel used. With good soil moisture 25 to 50 mm of firmed soil is sufficient cover. Under dry soil conditions and with no access to irrigation, it is recommended that the cover be increased to 75 to 100 mm of loose soil. Where suSCon® Blue is applied at planting, granules should be covered with 50 mm of compacted soil or 100 mm of loose soil.

Soil conditions

Good soil moisture and tilth are important to achieve good germination and emergence. Soil that is too wet or too dry slows germination and may lead to failures. As distinct from germination, soil that forms a surface crust can impede emergence.

Good drainage is essential for good plant establishment on wet soils. If waterlogging occurs after planting, young shoots may rot before emerging. In situations where waterlogging occurs frequently, many growers now plant cane in mounds to improve drainage.

If the soil is too dry, it is best to irrigate prior to planting. If irrigation is carried out after planting under cool conditions, the wet soil conditions result in lower soil temperatures that slow germination. If irrigation is not available, it is best to restrict planting to fallow fields to ensure good soil moisture and/or wait until a good profile of soil water is available.

Where soil tilth is cloddy, it is difficult to obtain good contact between the cane sett and the soil. Good soil contact is necessary to ensure that buds and root primodia contact moist soil to initiate germination and root growth. Press wheels on planters are recommended to firm the soil around the sett and improve soil/sett contact. The press-wheel loading should be between 3.0 and 4.5 kg per centimetre width of the press wheel.

Temperature

The major factor affecting the speed of germination is temperature. Soil temperature must be greater than 17°C for successful germination. Germination is greatly reduced by soil temperatures below 22°C and is optimal at soil temperatures of 28–32°C. The speed of germination increases with soil temperature, although this can vary with cane variety.

To avoid cool soil temperature, growers in southern (Bundaberg south) and central (Mackay) districts do not plant from early May to early August, and June and July, respectively. In the Burdekin, restricted planting may be carried out in June–July, but this varies in line with prevailing air temperatures and the duration of cold periods. In northern areas, planting continues throughout the winter months.

Control of pineapple disease

Fungicides are applied to the setts during the planting operation to protect the cut ends from infection with pineapple disease. It is important to use a clean source of water as a carrier for fungicides and insecticides. Ensure that fungicide spray (whole-stick planters) and dip systems (billet planters) function correctly and that spray systems operate at a minimum of 200 to 250 kPa pressure. Solid cone nozzles are preferred and should be replaced each year. Sett coverage from the spray or dip system should be checked with a dye prior to planting. The volume of water used is not critical, provided there is good coverage and the correct amount of fungicide is added to tanks to achieve the dilution rate specified on the label. The solution in dip systems should be cleaned out and replaced regularly, at least twice per day.

Wireworm control

Wireworms burrow into germinating buds and young shoots causing poor emergence that results in gappy stands. In severe cases, very poor emergence can result. Insecticides are applied at planting to protect setts from wireworm damage in areas prone to wireworm attack.

In southern districts, application of suSCon® Blue at planting for the control of canegrubs also controls wireworms. However, in the tropics, insecticides containing chlorpyrifos (many product names) or bifenthrin (Talstar®) should be applied as well as suSCon® Blue. Where suSCon® Blue is not required for grub control and the area is subject to wireworm damage, chlorpyrifos or bifenthrin should be applied. The recommended application method for insecticides is by a gravity-feed applicator through a nozzle located at the rear of the planter boards. The amount to be applied is stated on the label. Further information is available in the chapter on Pest Management.

Fertiliser at planting

Fertiliser is normally applied at planting to encourage early root development and plant growth. The most common fertilisers applied at planting are di-ammonium phosphate (DAP) or planting mixtures containing 11-17% N, 11-18% P, and 15-33% K. Direct contact between the sett and fertiliser should be avoided particularly if the mixture contains potash. Recent evidence suggests that there is no need to apply nitrogen fertiliser after a good legume fallow. Refer to the chapter on Nutrition for more detail.

Cultivating plant cane

After the cane is planted, subsequent operations are aimed at controlling weeds, promoting tillering, and assisting emergence through the breaking of surface crusts.

Weed control in plant cane is critical and trials have shown large reductions in crop yield when weeds are not controlled. Weeds are controlled mechanically by cultivation or chemically with herbicides (see chapter on Weed Management).

Herbicides are widely used to control weeds in plant cane. The most common herbicides are knockdowns such as paraquat or ametryn and residuals such as trifluralin, atrazine or diuron.

Cultivation is effective on small broadleaf and grass weeds. The sides of the plant cane drill are cultivated with discs or boards by a practice termed cutting-away. The implement used should also incorporate small rakes or tines which pass through the stool area to remove weeds. If weeds are too large to remove with rakes, they may be removed with spinners or smothered by covering with soil.

Where cane is planted in mounds, cultivation is carried out with the inter-row cultivators normally used in ratoon crops.

To promote tillering close to the original sett, the depth of soil cover over the setts should be minimised. In the early stages of crop establishment, it is important to keep the drill open until tillering is well advanced and several are established from each primary shoot. Once tillering is well advanced, the drill should be filled in and the row mounded to facilitate harvest. The recommended row profile is a slightly rounded mound 100-150 mm above a flat inter-row. Where surface irrigation is practiced, this may need to be increased to 200-250 mm to control water flow, particularly if a side slope exists across the rows or trash blanketing is to be practiced following plant cane harvest.

After the final cultivation, just before the passage of a tractor will break the developing cane stalks, pre-emergent herbicides are normally applied to the soil surface to provide control of subsequently emerging weeds. Virtually no specific management operations are required after this stage until after harvest, when it is time to focus on ratoon establishment.

RATOONING

Growth of ratoon crops

Ratoon growth occurs from buds on the stubble stalks below ground. As indicated for plant crops, factors such as soil moisture (excess or deficit), stalk damage, disease and insect damage are all factors that can influence germination and emergence of ratoon crops.

Whether a successful ratoon is established is not only dependent on post harvest management, but is also dependent on the condition of the cane stool after harvest. Careful harvesting and haul-out to avoid stool damage form the basis of a good ratoon. Stalk damage during harvesting allows fungal rots to colonise the damaged stalk, inhibiting ratooning. This is one of the most common contributing factors to ratoon germination failures and results in gaps which affect both yield and longevity of the ratoon cycle. These aspects are discussed in more detail in the chapter on Harvesting and Transport. Once the ratoon has emerged, its productivity is largely dependent on weed control, adequate radiation, water and nutrition.

Management of ratoon crops

Management of the ratoon crop is partly dependent on the type of harvesting systems employed, a burnt-cane system (BC) or green-cane trash-blanket (GCTB). Traditionally, pre-harvest burning was the major harvesting system used in the sugar industry. Although being rapidly replaced by the GCTB system (Figure 6), burning is still practised in some areas, for example, in areas with large crops (Burdekin and two-year cane in northern New South Wales), furrow irigation areas (Burdekin), and in southern cane areas with early harvesting as low temperatures can restrict ratooning under a GCTB. Under a BC system, cultivation is still used to a reasonable extent to incorporate remaining trash, apply fertiliser, and clean out furrows under furrow irrigation. However, the number of cultivations continues to be reduced.

With the advent of a wide spectrum of herbicides and the adoption of green-cane trash-blanketing (GCTB) in many cane growing areas, ratoon management has

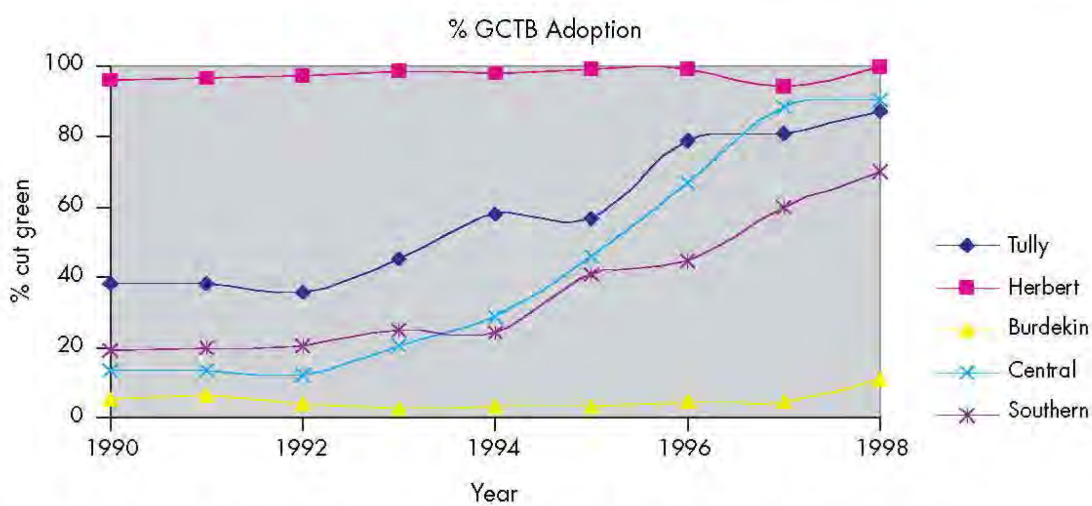

Figure 6. *Temporal change in the percentage of cane cut green for different mill areas.*

changed from a highly mechanised, labour-intensive operation to a quite simple time-conserving process. In line with these changes has been a trend to grow more ratoons than in the past, particularly as the varieties available today have been selected for their ability to ratoon.

In many areas, ratoons are no longer cultivated. They are managed on a zero or minimum tillage system in a GCTB. Herbicides are used to control weeds. Many mechanical operations formally employed, such as stubble shaving, interrow cultivating, and sub-soiling, are now rarely used as their benefits have been widely questioned.

More benefits of GCTB are emerging as the system is better developed and understood by canegrowers. In dry areas, GCTB has been shown to conserve soil moisture and so provide a more reliable water supply to emerging ratoons. Further, in areas such as the wet tropical coast, GCTB is playing an important role in erosion control and soil conservation. However, in very wet areas, growers need to be careful that the soil under the trash blanket does not remain too wet and impede ratoon establishment. The raking of trash from the immediate area of the stool needs to be considered in wet areas. In addition, ripping the centre of the interrow to remove compaction and allow better drainage is often practised. However, it is doubtful whether this last operation is actually beneficial. Regardless, a GCTB system still requires good management practices and will not be successful if insufficient attention is paid to drainage and weed control.

Weed control

As for plant crops, weed growth needs to be controlled during the early stages of the ratoon crop's development to ensure weeds do not smother the developing cane shoots and reduce yield. The GCTB can give effective weed control but herbicide application may be required where there is a thin surface mulch or bare areas to ensure weeds do not get out of control. It is also important to minimise weed growth throughout the crop as these can encourage rat infestations by providing a protein source for the rats during breeding.

Vines can become a problem under the GCTB system. However, effective control during a fallow should eliminate or minimise the problem during the cropping cycle. Management of weeds is critical as failures can destroy the effectiveness and economics of the GCTB system.

Fertilising ratoons

Fertilisers are generally applied as NPK or NK mixtures in ratoon crops. These aspects are discussed in more detail in the chapter on Nutrition. In both the burnt or green-cane system, fertiliser is applied sub-surface to the ratoon crop by stool splitting or slotted alongside the stool. Surface applications can also be used, but to avoid gaseous losses (for example with urea-based fertilisers), should only be applied after the canopy is well developed. It has been suggested that benefits will be gained from a GCTB by the recycling of nutrients from the trash. This process is still being researched but information to date suggests that it may be possible to reduce nitrogen rates in the second cycle of a GCTB system.

CONCLUSIONS

Careful attention to crop management is the key to high crop yields. In sugarcane, it is particularly important that the establishment period of both the plant and ratoon crops is well managed, as this will determine the yield potential of the crop.

Good crop establishment is critical, but it must be supported by disease, pest and weed control, adequate nutrition and an environment that will promote crop growth. Careful attention to fallowing, land preparation, sett quality, planting, and harvesting are essential if high yielding cane crops are to be produced.

The major factors that should be taken into consideration in managing a sugarcane crop have been outlined. Of course, seasonal conditions will probably play the most important part in determining crop yield. However, if the best possible management is applied, the best results will be obtained for any set of seasonal circumstances.

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