SUGARCANE VARIETY 2010

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Abstract

It takes about 15 years to develop a new variety of sugarcane to the stage where it is in significant commercial production. A minimum of 10 years is needed for the processes of breeding and selection, and a further five years for multiplication and planting. As a result, breeders must prognosticate how cane will be grown in 15 years' time if they are to ensure that their varieties will respond to the needs of the industry at the time the cane is commercially grown. This paper summarises the views of the Colombian sugar industry on future developments in cane growing, and how these changes will affect the variety of sugarcane that will be needed for the year 2010.

Mechanisation

In Colombia almost all cane is hand cut and then mechanically loaded. Manual cutting of cane is hard work and has limited appeal and, as the country develops, the availability of labour for hand harvesting is likely to decrease. With 150 000 hectares of cane and a production rate of 120 tons of cane per hectare, the industry requires about 10 000 cutters to harvest 15 million tons of cane. To sustain the historic rate of increase of sugar production (4% per year) and other things being equal, by the year 2010 the cane harvest would be about 30 million tons, grown on 225 000 hectares and cut by 20 000 cutters. However, if new varieties increase the sugar yield by one percentage point to about 12%, only 27 million tons of cane would be required.

At least one mill in the region has noted that with erect varieties, which permit greater efficiency by the cane cutters, the job of cutting cane becomes more attractive as they increase their incomes. On the other hand, commercial data indicate that as cane tonnage per hectare increases above 150 t/ha the efficiency of manual harvesting actually decreases, presumably due to lodging.

Because of uncertainties concerning the future development of the region, it is difficult to predict the extent of future labour scarcity for manual harvesting. It is nevertheless most unlikely that the industry will be able to attract a 100% increase in cane cutters in the next fifteen years. By the year 2010, it is probable that most of the cane crop will be mechanically harvested and the industry will therefore require varieties that can easily be cut by machine.

To facilitate mechanical harvesting, varieties with different characteristics are needed. For manual harvesting cutters prefer stalks to be thick, erect, long and heavy. However, the long, heavy cane may be more susceptible to lodging and thus may complicate mechanical harvesting. Furthermore, in the case of manual harvesting, uniformity of height is of little importance, whereas with mechanical harvesting it is essential for effective topping. For mechanical harvesting the varieties to be developed should be erect and resistant to lodging, and should have stalks that are shorter and thinner than those of the present varieties, with more tillering.

The importance of resistance to lodging is problematic as there is a close relationship between high tonnage and lodging. It is unlikely that erect cane varieties can be developed that will also have very high tonnage. Nevertheless it would be possible to maintain high levels of production of cane per hectare per month and of sugar per hectare per month by shortening the growth cycle between harvests, and hence to some extent it should be possible to obviate the problem of lodging while maintaining high levels of production. In the past ten years the age at harvest has been reduced substantially; in the period 1960-1979 harvest age remained relatively constant and increases in production were related to increased tonnage per hectare (Figure 1). However, from 1980 onwards the age at harvest dropped from around 19 months to less than 14 months (Figure 2), while tonnage per hectare was maintained. As a result production in terms of tons of cane per hectare per year or per month continued to increase (Figure 1). This change has been advantageous

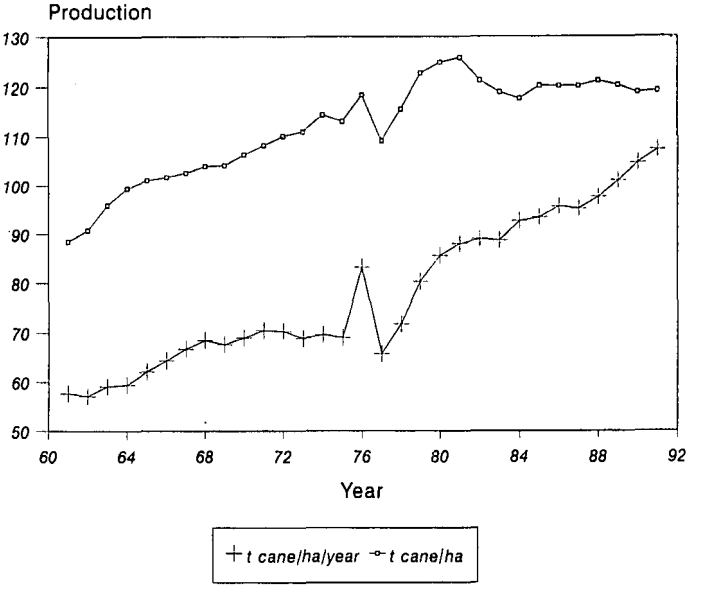

FIGURE 1 Cane production per harvest and per year (three point moving average).

FIGURE 2 Age at harvest (1960-1992).

not only in terms of tonnage of cane but also in terms of sugar; the production of sugar per hectare per month increases with reduced age at harvest, reaching an optimum at close to one year and then declining as the harvest interval is further reduced (Figure 3). A reduction of the harvesting interval to one year opens up the possibility of synchronising harvesting with the climatic parameters in the different ecological niches, which would be a further advantage. It is therefore likely that future varieties with a cycle of one year will become the norm for the industry.

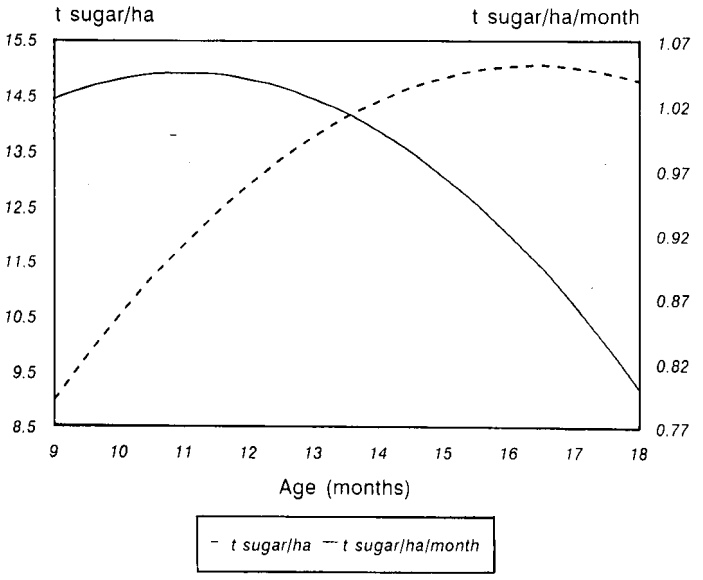

FIGURE 3 Maturity of sugarcane (variety MZC 74-275).

Green Cane

Burning the cane before harvest is a relatively new practice in the valley of the Cauca river. The mills began to burn cane in the middle 1970s. Initially the cutters and particularly the cane lifters or loaders were against the new system and resisted the change; however, with the introduction of mechanical loading, cane burning was rapidly accepted and adopted. Today the cane cutters are aware of the advantages of burning cane and, with the predominant present day varieties, it would be extremely difficult to return to the old green cane system, without making substantial bonus payments for cutting unburnt cane. From the point of view of the mills, which in Colombia are responsible for cutting, loading and transporting the cane, burnt cane has several advantages: cutting costs are reduced, less trash means that loading and transport costs are less, milling operations are facilitated and sugar yields are higher.

However, cane burning causes pollution, and may possibly cause health problems in the long term. This effect has yet to be demonstrated. The ash carried up by the burning that later falls on the local urban centres is a major annoyance to the public, and as a result political pressure is increasing to reduce or eliminate burning. Moreover the presence of colloidal smoke particles in the air could possibly reduce the total solar radiation reaching the cane crop, and hence the overall productivity of the region. Although this has not yet been quantified, it is another aspect that suggests that the permitted level of burning will diminish in the future.

Green cane harvesting presents serious problems with existing varieties due to the high levels of residue in the fields after harvest, increases in the costs of cutting, loading and transport, high levels of trash in the factory and reduced extraction of sugar. Commercial data from Ingenio Riopaila indicate that the efficiency of cane cutters was reduced by 24% in green cane with the most widely grown variety, MZC 74-275. However, these data also show that certain other varieties, such as V 71-52, can be cut green with much less problem, and indicate a potential for developing varieties for green harvesting.

What are the characteristics of varieties that are suitable for green harvesting and mechanical harvesting? The negative effects of increased levels of trash can be partly obviated by using varieties with high sugar content, and the amount of trash can be reduced by obtaining self trashing varieties which lose their leaves before harvest. Under Colombian conditions there is little evidence for or against the hypothesis that natural self trashing will reduce photosynthetic area and hence cane production and sugar yield. However, in the Burdekin area of Australia similar levels of production of sugar per hectare per year are obtained to those of Colombia, with varieties that are self trashing; hence the possibility of obtaining self trashing varieties with good productivity would seem real.

Seasonality of the harvest period

The Colombian sugar industry traditionally mills cane throughout the year. However, historic data indicate that there is a certain seasonality in the harvest pattern, with about 30% more cane being milled per month from July to September than during April and May (Figure 4). In addition the sugar yield displays a seasonal pattern, being greater in the second semester (Figure 5) when most cane is milled. The high sugar yields correlate positively with rainfall in the two months before harvest, and with the average minimum temperature in the month before harvest (more than 60% of the variation in sugar yield over an eight year period was explained by these two factors and a dummy variable for technological improvement).

The sugar yield in the second semester is greater than in the first semester, although similar rainfall and temperature patterns before harvest indicate that there may be other effects, such as photoperiod, which have not yet been quantified.

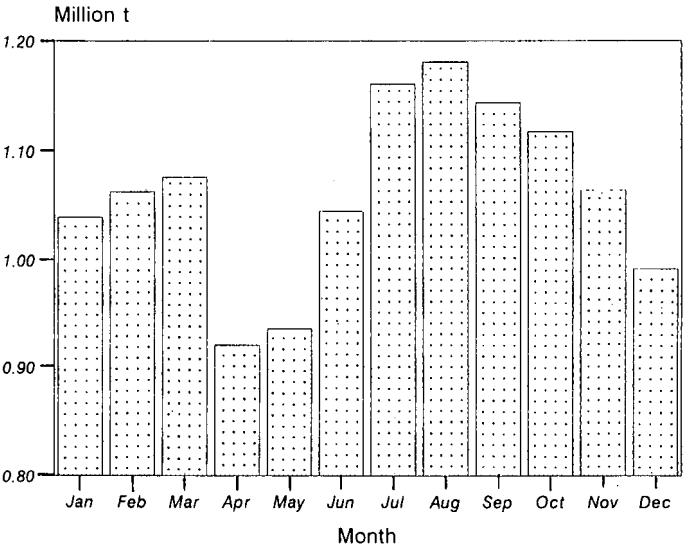

FIGURE 4 Monthly series of sugarcane milled in Colombia (1982-1992).

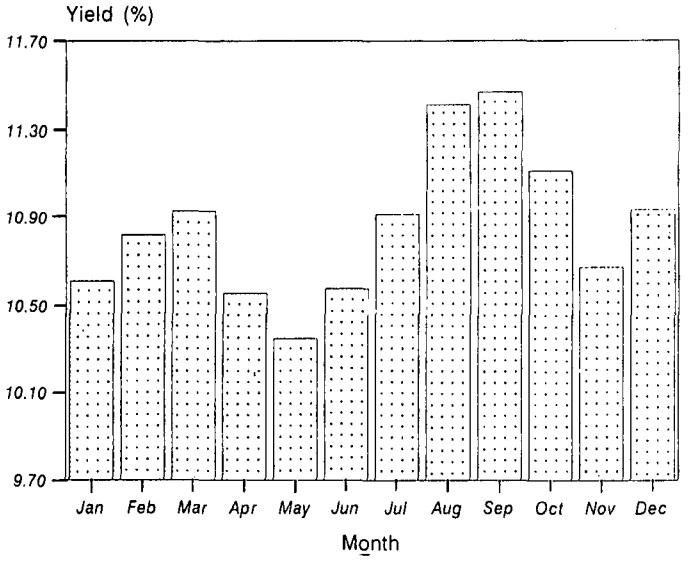

FIGURE 5 Monthly series of sugar yield (1982-1992).

At present about half the cane is produced by independent growers and the remainder by the mills. Most of the cane from independent producers is paid for on a tonnage basis; it is probable that, over the next few years, payment on the basis of quality will occur. At present it makes little difference to the producer, in terms of payment, when his cane is harvested, as cane tonnage shows little seasonal variation; however as payment for quality becomes the norm producers will try to programme their harvests for the periods when sugar yield tends to be highest, unless the mills instigate differential payments according to the harvest month. The producer will also tend to seek harvest periods where high yields coincide with dry periods, because he will maximise his income and minimise damage to stools and soil compaction, both of which reduce the productivity of ratoon crops.

With the present varieties that have a harvest interval of more than one year the independent producer cannot programme his harvest for the same time each year. It is probable in the future that cane producers will increasingly demand varieties that have a one year cycle so that they can take advantage of those months where sugar yield is high and soil conditions are best for harvest. If this occurs the mills are likely either to move towards greater seasonality of the harvest period, or will implement payment systems that guarantee a constant supply of cane throughout the year. Whichever of these scenarios proves correct, varieties will be needed that have a one year cycle and characteristics that make them appropriate for the season in which they are to be harvested. The most likely option is that of harvesting throughout the year, with peaks in the milling rate in those dry months when yield is highest. In order to maintain sugar production without excessive new investment in milling capacity it becomes important to have varieties with high sugar content.

A one year cutting cycle and cane payments based on quality will necessitate that new varieties be specifically adapted for the different harvest seasons. Furthermore, these new varieties will have to perform reasonably whenever they are harvested to give the mills a certain flexibility in the management of the total stock of cane that they possess, especially in periods when there is plenty of cane and stocks are held in the field.

To date the breeding programme at Cenicaña has emphasised selection for harvest in the second semester. This was planned, and is the result of logistical convenience. The programme is now being re-organised to permit selection for the different semesters, emphasising high sugar content in the first semester when this tends to be low, and in the second semester a balance between sugar and tonnage.

Edaplo-climatic conditions

The valley of the Cauca river has in the past been considered a relatively homogenous zone. However, Cenicaña has demonstrated that there is considerable interaction between different varieties and the edaplo-climatic conditions. As varietal improvement and selection has progressed it has become evident that producers are willing and able to exploit different ecological niches by using different varieties. The days when varieties such as POJ 2878 were grown on more than 80% of the area are probably gone. This view is reinforced by the fact that, whereas POJ 2878 was widely grown on over 80% of the area, its successor, CP 57-603, reached only slightly more than 60% and the current predominant variety, MZC 74-275, appears to be at its peak with less than 50% of the area planted. In more saline soil conditions MZC 74-275 has never gained a hold and this niche has been occupied in the last few years by Co 421, which is rapidly being replaced by V 71-51. These site-specific varieties have permitted more aggressive development of this ecological niche and, as the industry moves into the Piedmonte area, which has soils with excellent drainage but that tend to be more acid it will demand specific lines or clones for these conditions. In addition the results of trials undertaken by Cenicaña indicate that in the Udic (wet) soils of the valley, sugar yield tends to be greater and tonnage less, while in the Ustic (dry) soils the reverse is true, indicating the need for different emphasis in varietal selection for these two distinct conditions.

In the areas of heavy soils (e.g. vertisols) harvesting during the wet period is difficult and damage to the ratoon crop can be severe. Various mills attempt to harvest on these soils in the dry period. However, it is impossible to do so effectively with varieties with growth seasons of more than a year and less than two years, without drastically reducing sugar content with very early harvests before the cane has ripened. Harvesting of one year cycle varieties on the heavy Udic soils will have to be confined to the dry months, and on the lighter Ustic soils to the rainy periods, thereby creating the demand for specialised varieties for these two conditions. The situation is complicated by the inverse relationship between sugar content and precipitation in the two months preceding the harvest.

Water

Water is a resource that becomes scarcer and more costly every day. In some areas of Colombia, where deep wells are the only source of water, irrigation accounts for about half the total variable costs of producing a ton of standing cane. The cane growers affirm that certain varieties are much more tolerant of a reduction in irrigation than others. Observations by Cenicaña and the mills indicate that several of the newer selections required less water to produce the same tonnage than has traditionally been used in the region. These observations indicate that in the future producers will demand varieties that use water efficiently.

Conclusions

Selection of the present generation of varieties has emphasised disease tolerance and high levels of sugar production per month. In addition to maintaining the desirable

properties of existing varieties the following characteristics will be emphasised in varieties bred for the twenty-first century:

- High sugar contents, especially in varieties for the first semester
- Uniform height
- Resistance to lodging
- Limited flowering
- Self trashing stalks
- Short, thin stalks with high tillering
- Lower water requirement.

The tendency will be towards specific varieties for specific conditions in the sugar growing region rather than varieties of broad adaptability. In both wet and dry soils different varieties will be selected for the first and second semester.

The specific characteristics of the varieties for differing soil conditions will be as follows:

- **Wet (Udic) soils.** The varieties will be tolerant of wet soils and their associated high water tables. They will be harvested mainly in the drier months of June, July, August, December, January and February. As sugar yields in these soils tend to be high this will at least partially counteract the lower yields of the first semester without major emphasis on selection for this period.

- **Dry (Ustic) soils.** The selection of these varieties will emphasise sugar content as this tends to be low in these soils, especially in the first semester. Selection will be for harvest in March-April and September-November.

- **Saline soils.** Selection for these varieties will emphasise tolerance of saline conditions above all else. As these soils tend to be concentrated in areas of low rainfall where harvesting throughout the year is not a major problem, they will not be selected for specific harvest periods.

- **Piedmonte.** In these areas, where irrigation is often difficult and the water-holding capacity of the soil is low, the selection process will emphasise drought tolerance. Soil fertility is low and the ability to produce well under less fertile conditions will be emphasised also.