Experience with high fibre cane in Barbados

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ABSTRACT

The Agronomy Research and Variety Testing Unit of Barbados Agricultural Management Co. Ltd has carried out a number of observations with high fibre sugar cane varieties in an effort to provide the Barbados sugar industry with material to allow an alternative to the production of sugar. Between 2003 and 2007, a total of 260 acres of high fibre varieties were established, and during the 2007 harvest 216 acres were harvested. In June 238 tonnes of molasses and between 321 and 336 litres of pure alcohol were produced per tonne of molasses at one factory. Information on cane and biomass yields, weight and quality of the cane is presented. Progress is reviewed and plans for the future are outlined.

Key words: high fibre cane, observation, yield, quality

INTRODUCTION

Barbados is among sugar industries globally with the highest cost of production, while it is faced with a 36% reduction in sugar prices by 2010. In addition, yields have declined and property values have increased to the point where it is no longer economically attractive to produce just sugar and molasses from the land. To a substantial degree this decline in yield is thought to be due to a decline in morale among the sugar industry employees. In turn, poor morale is mainly due to the perceived grim outlook for the traditional sugar industry. It is now accepted that continuation of the production of mainly raw sugar for export is no longer feasible for survival of an industry in Barbados. Consequently, in 2003 a start was made with the identification and expansion of higher-fibre sugar cane varieties from which electricity would ultimately be generated for sale to the national grid. The current plans are designed to be a morale booster and should result in a diversified and more profitable industry.

In 2002, the plan was to use bagasse from high fibre varieties for the production of electricity by means of co-generation in the existing sugar factories. This was subsequently amended, and in 2007 the plan was to construct an all-new sugar cane processing facility that would produce direct consumption sugar, molasses for the production of rum and fuel alcohol, as well as the generation of electricity throughout the year from bagasse and/or alternative fuels. In addition, other high-value products would be sought, identified and assessed for their economic feasibility.

In 2002, the then advisor to the Barbados sugar industry, Mr. Jacques Albert-Thenet and the Director of the West Indies Central Sugar Cane Breeding Station (CBS), Dr. Seshagiri Rao, identified some six varieties in the large germplasm collection available at the CBS. These were considered to be suitable for the production of bagasse to be used as a source of fuel in the generation of electricity. From the first trials and additional material subsequently identified at the CBS, three varieties were selected and planted on a larger scale.

DEVELOPMENTS

Yield and quality observations were done and eventually the three most promising varieties were expanded to a total area of 260 acres by 2007. These ranged in fibre content from 23.6 to 25.6% by traditional laboratory methods and 26.0 to 28.3% using Near Infra Red (NIR) technology, *Table 1*. Pol was relatively low, ranging from 9.0 to 9.5° (traditional) and 11.0 to 11.3º (NIR).

Table1 Average analyses of high-fibre cane, 1980-2007

	Variety	WI79460	WI79461	WI81456
Lab mean (traditional methods, CBS)	Fibre	25.6	24.0	23.6
	Pol	9.0	9.5	9.1
NIR (2007) analyses	Fibre	28.3	26.0	28.3
	Pol	11.0	11.2	11.3

The Near Infra Red (NIR) data are interesting, because for the first time it was possible to carry out many analyses in a short time with a new "SpectraCane" NIR analyser at the CBS. For this reason, the data from these analyses are probably a more reliable indication of relative quality of the cane analysed. Many samples were duplicated and analysed with both traditional and NIR methods. Results showed that, with proper calibration the NIR analyser produced comparable and reliable results.

In the factory it proved difficult to distinguish between varieties, but differences between the three main varieties were never found to be great, *Table 2*.

Table 2: Factory analyses of high fibre cane

	Tonnes	Fibre	Pol
Andrews, Apr 06	1,060	24.53	7.02
Andrews, Feb 07	1,781	27.33	4.74
Portvale, Jun 07	1,944	27.40	7.23

The low pol at Andrews in February was probably due to the fact that the cane was not processed until about a week after it was delivered. This was because of problems at the factory. The syrup that was produced from this batch also could not be processed because it had started to ferment.

Yield data

When the high fibre project was conceived, it was hoped that the biomass yields of the varieties selected would be very high: of the order of 150 tonnes per ha. The early variety trials did provide some promising data, but subsequent information was disappointing: see Table 3 for a summary of four crops for two of the initially selected varieties.

Table 3: Yields in tonnes biomass per hectare; cut by hand

Variety	PC, 2004	R1, 2005	R2, 2006	R3, 2007	mean
WI79460	152.7	160.9	123.2	106.1	135.7
WI79461	161.4	152.5	116.7	114.6	136.3
Mean	**157.0**	**156.7**	**120.0**	**110.4**	**136.0**

In Barbados, harvesting by hand on a scale other than small trial plots is out of the question nowadays: labour costs are too high, and cutting high fibre cane is more problematic than cutting sugar cane because of the hardness of the stalks. At the research unit where these trials were located, workers are paid a premium to cut the high fibre cane. Under commercial conditions this would not be practical, and so cutting by standard chopper harvesters was attempted. This turned out to be possible, as long as the toppers and extractor fans were used to remove tops and trash. If the toppers and extractors were turned off the machines quickly choked. In 2007, two new John Deere harvesters were purchased. These appeared to be more competent in handling the total flow of biomass (which may be used when the new processing facility becomes operational).

Between 2004 and 2006, yield data were collected from hand cut and chopper harvested fields, *Table 4*.

Table 4: Some examples of yields obtained with hand and machine harvest

Harvest method	tonnes per ha	Location, year, crop, age
Hand cut: "total" biomass including tops, trash and leaves	88.9	Warleigh, 04, PC, 13months
	161.0	CBS 05, R1, 11m
	177.0	Golden Ridge 06, PC, 15m
	181.5	Golden Ridge 06, PC, 17m
Machine cut: mainly stalks; some trash and pieces of cane	44.5	Mt. Pleasant 05, PC, 13m
	53.6	Castle Grant 05, PC, 14m
	63.2	Spring Garden 05, PC, 18m
	63.2	Golden Ridge 06, R1, 10m
	65.9	Warleigh 05, PC, 14m
	96.7	Golden Ridge 05, PC, 12m

The data in *Table 4* are not a scientific comparison, because different fields and different varieties were harvested, but they provide an indication of the magnitude of differences observed. They clearly show that there is a large disparity between yields obtained with hand cutting and with machine harvest.

Efforts were made to obtain more accurate data on the quantity of cane left in the field after mechanical harvest, and comparing it with hand cutting in the same varieties in the same field, *Table 5*.

Table 5: Cane harvest and losses. Average of three varieties (WI79460, WI79461 and WI81456)

Mechanical harvest					Hand harvest
Cut mechanically three strips, 2,222 m^2 average	Retrieved after harvest, t/ha Three strips, 113m^2 average			Mechanical harvest plus retrieved material	Three strips, 780m^2 average
tc/ha	Trash	Cane pieces	Total	Total tonnes biomass per ha	Total tonnes biomass per ha
55.1	35.7	15.3	51.0	106.1	119.6

All this work was done in one field, the strips in close proximity to each other. The strips cut by hand were harvested first, and then the rest of the field was harvested by machine. Finally, virtually all biomass left in plots of an average of approximately 113m^2 in the mechanically harvested area was collected and weighed. This exercise showed that the unmodified harvester used in this experiment was able to harvest only about 50% of the total biomass available in the field. The difference (about 13 tonnes per ha) between mechanical harvest and hand harvest is thought to be mainly due to the fact that the mechanical harvester pulverises some cane with the unrecoverable loss of very small fragments of cane and juice from the chopping knives and extractor fans. Some differences may also be due to yield variations within the field harvested.

An earlier observation in 2006 in four one-metre square quadrants in the same field yielded very similar results, and therefore it would appear to be safe to conclude that approximately half of the total quantity of biomass is not recovered by reaping with unmodified sugar cane harvesters. It was now possible to estimate the amount of total biomass from cane harvested mechanically by multiplying the tonnes of "clean" cane by a factor of 1.9.

Using this factor, the total biomass yields obtained in 2007 was estimated at 90.6 t/ha, *Table 6*:

Table 6 Yields of cane and biomass per ha, 2007

Hectares harvested	tonnes harvested	Tonnes cane per ha	Estimated tonnes biomass per ha
87.8	4,144.1	47.2	90.6

This is, of course, still not good enough, and much work will be needed to improve yields through more careful field management and the breeding, selection and introduction of better varieties.

Weight of cane

High fibre cane tends to contain less water than conventional sugar cane. It was therefore anticipated that stalks would tend to be lighter. By how much was not known. Data were collected to determine the difference in weight of a given volume, *Table 7*.

Table 7 Weight of high fibre and sugar cane in standard cane bins*

	"5-tonne bins"			**"20-tonne bins"**		
	# of bins	**total tonnes**	**mean tonnes per bin**	**# of bins**	**total tonnes**	**mean tonnes per bin**
High fibre cane '06	206	764.33	3.7	23	263.15	12.0
Sugar cane '01	170	983.94	5.8	31	599.96	19.4
High fibre cane as % of sugar cane			**64.1**			**61.8**

*** Source: summarised from various commercial and experiment yield data. Weights determined at factory weighbridges**.

The 5-tonne bins are the standard size used for tractor haulage, while the 20-tonne bins are used for haulage with road tractor trucks.

Processing

A first attempt at processing fuel cane was made in July 2005 at Andrews Factory, when 241 tonnes of high fibre cane were delivered and ground. After some adjustments to the mills in order to accommodate the higher level of fibre, it went through the mill smoothly, albeit at a lower grinding rate than for sugar cane (about 75 instead of 100 tonnes cane/hour). Plenty of good bagasse was produced which helped the factory to grind some poor quality sugar cane. Steam pressure went up and it was also noticed that there was noticeably less dust from bagacillo in the factory. However, no molasses or sugar was made, due to the small quantity of syrup produced.

In April 2006, Andrews Factory ground a total of 1,060 tonnes of high fibre cane and made syrup, which could not be used for tests by a rum refinery because of the long delay between harvesting and grinding. This delay was not due to the qualities of the fibre cane, but due to other factory problems.

In 2007, both Andrews and Portvale factories ground substantial quantities of high fibre cane, and from the cane processed at Portvale 238.5 tonnes of good-quality syrup was produced and tested by a rum refinery, *Table 8*.

Table 8: Processing of high fibre cane, 2005-2007

	tonnes cane processed	tonnes syrup produced	average grinding rate (tonnes cane/h)	% Fibre (cane)
Andrews Factory, July 2005	241.2	-	75	19.2
Andrews Factory, April 2006	1,060.1	80.3	86.4	23.0
Andrews Factory, February 2007	1,780.6	198.4	67.6	27.3
Portvale factory, June 2007	1,974.7	238.5	60.1	31.3

Since this paper is mainly dealing with the field aspects of high fibre cane production, and because factory experience so far is limited, this aspect is only dealt with in a cursory manner here.

Future plans

Based on the experience to date, it may be said that yield of high fibre cane has been very disappointing, especially in the more marginal cane growing areas. However, reasonable yields, especially of total biomass cut by hand (over 160 tonnes per ha) have been obtained in the higher rainfall areas. The question remains whether or not the newly planned processing plant will be able to convert total biomass into a profitable marketable product. Meanwhile, the Cane Breeding Station and the Variety Testing Unit are working on developing higher-fibre **sugar** cane varieties. A few varieties of this type are already under observation on a limited scale, but others are expected shortly from the Cane Breeding Station.

Since it is considered highly unlikely that the production of raw sugar for export will be a profitable enterprise in Barbados again, the search for other, high-value products such as precursors to medicinal compounds, is essential and needs to be continued and intensified. When it has been decided what exactly will be the most promising and profitable product(s), the breeding and testing programmes can be more focussed than they currently are.

SUMMARY and CONCLUSION

Between 2003 and 2007 Barbados has expanded its area under high fibre cane from small research plots to a total of approximately 104 ha in 2007. Based on the information collected from the harvest and growth pattern of this cane so far, it may now be concluded that the high fibre varieties that have been grown have disappointed as far as yields are concerned. However, they have other qualities that may be useful for a future sugar cane processing industry, such as the fact that they produce large quantities of a very good quality bagasse. The syrup that was produced also had qualities such as an interesting smell and flavour that may be exploited if marketed carefully and imaginatively. In the meantime, a full-scale variety selection programme has been started. The main objective of this is to search for varieties with higher sucrose content and higher yields.

One major success of the high fibre work has been to show that a slightly adjusted standard factory can handle sugar cane with higher fibre and lower sugar content. The grinding rate of high fibre cane that has been harvested mechanically using toppers and extractors is inevitably reduced, but no major problems are encountered otherwise. Grinding of total biomass has not yet been attempted, and it may be better to delay such experimentation until the new processing plant has become operational. The production of good quality bagasse is an invaluable asset to the factories, especially during wet weather or at the start of the crop. This may be a major use for high fibre cane until it can be processed by dedicated equipment. It is unfortunate that the existing sugar factories in Barbados are currently not able to sell electricity to the national grid so that the commercial potential of the project could be properly assessed. Also, the storage of bagasse is problematic.