SUGARCANE IN PAPUA NEW GUINEA

By J.H. Sumbak, Agronomist-in-charge,
Agriculture Research Centre, Bubia.

Plans to establish commercial sugar production in Papua New Guinea have been backed up by many years of field trials with sugar-cane. These trials have been carried out in the Markham Valley, by agronomists at the Bubia Agriculture Research Centre. The programme was directed by Mr Malcolm Hunter from 1965 to 1971, when he left Papua New Guinea. Subsequent work has been directed by Mr. J.H. Sumbak, Agronomist-in-charge at Bubia, who here reviews the programme and results to date, and assesses their practical implications for commercial sugar-cane growing, with particular reference to the Markham Valley.

Although sugar-cane grows well in almost every part of Papua New Guinea and it would be possible to make sugar from the cane at the village level, in most places the climate is not suitable for sugar to be stored in concentrations high enough to make commercial sugar production economic. The climate is too favourable for continuous growth, and therefore sugar is not stored.

Sucrose (sugar) is made in the leaves of the plant and moved to storage cells in the stalk. If conditions are warm and wet, the plant uses up the sugar for its growth. A period of less favourable conditions (either cool weather or shortage of water) will slow growth and allow sucrose to be stored.

The aim then is to get maximum growth at the beginning, and then eventually to have a period of very little growth.

A seasonal stress is needed to cause the plant to slow down its growth and store sugar.

In PNG the only areas with a great enough stress are those with a definite dry season. This is why places in the Markham and Ramu Valleys and in the Central Province were chosen for sugar-cane trials.

Experiments commenced in the Markham Valley in 1965 and by 1970 it was obvious that sugar-cane could be grown successfully. Many varieties of cane were tested, and the most suitable variety was found to be Pindar.

Problems of pests and diseases were not serious on the small areas of cane which were planted at that time. However, if large areas of of sugar-cane are planted it is possible that pests and diseases might build up over the years and become a problem.

A large, commercial-sized block of 16 ha was planted in 1971 to study this. This crop was harvested in 1972. The crop was then allowed to ratoon, that is, new canes were encouraged and allowed to grow again, and the ratoon crop was harvested in 1973. A further 12 ha were planted in 1972 and this was harvested in 1973.

Through this period there was no evidence of pest or disease build-up in either the first crops or the ratoon crops.

The following summarizes the work of the Department of Primary Industry to date. Recommendations are given for growing sugar-cane under Marham Valley conditions.

VARIETY TRIALS

A large number of varieties of sugar-cane were tried out, to find out which were most suitable.

The prime considerations in the Markham Valley were resistance to downy mildew (an air-borne fungal disease), and resistance to Fiji disease (a viral disease carried by insects).

Other important factors include pests, ratooning ability, size of the crop and sugar levels.

When some of the crop falls over, known as lodging, this makes harvesting difficult. This factor was looked at.

Flowering in sugar-cane is undesirable because it uses up energy which otherwise could have gone into sugar storage. Flowering time and intensity were also considered.

Different parts of the Markham Valley were tried out in 1965. These included Narakapor, Munum, Pyramid Hill and Sangan. The four Queensland varieties Pindar, Trojan, Q50 and Q57 were planted at each place.

Generally growth was satisfactory. The Pyramid Hill block yielded 100 tonnes/ha of cane after 12 months growth, with a fibre content of 12% and estimated commercial cane sugar (ccs) of 12%.

A first ratoon crop at Munum yielded over 63 tonnes/ha of millable and 38 to 50 tonnes/ha of immature and deteriorated cane.

Of these four varieties, Pindar appeared to be the best. It grew strongly, did not suffer much from downy mildew, and not many plants flowered before harvest time.

However, Pindar had two major drawbacks. It was not very resistant to Fiji disease, and it had a tendency to lodge badly, in places where good soil enabled the plants to grow tall. Pindar also had only moderate sugar levels.

In 1967, 14 more varieties were tried out. These varieties, all from the approved list for north Queensland, were: Eros, Cato, Ragnar, Q59, Q64, Q66, Q67, Q68, Q77, Q78, Q80, SJ4, HQ426 and Vidar.

In 1969, 13 more varieties were grown. They were: Q44, Q58, Q74, Q75, Q82, Q83, Q84, Q85, Cadmus, Comus, Damon, Luna and Sirus.

The variety Q44 was completely resistant to Fiji disease, and Damon was highly resistant. They were, however, deficient in other characteristics.

The best 16 of the above varieties (selected mainly on their resistance to disease) were planted at Pyramid Hill in October, 1970.

From the results of these trials, Pindar and Ragnar were selected as the best varieties for the Markham Valley.

Pindar was found to have fast early growth. This is useful because weeds are controlled early through shading. (It was shown that depending on variety,and also on weather, maximum growth rate is attained 120 to 160 days after planting).

Pindar was unfortunately relatively susceptible to Fiji disease, but it is not yet known whether this is important in the Markham Valley. It is still not known whether the leaf hoppers which spread Fiji disease are sufficiently active in the Markham Valley.

It is also susceptible to lodging, but none of the other varieties that did not have this problem was as good as Pindar in other ways.

The sugar levels in some other varieties are considerably better than Pindar, but again, they are not so good in other ways.

Ragnar was unfortunately not tested for resistance to Fiji Disease, but results from 14 trials overseas classify it as extremely resistant to this disease. For this reason, stocks of Ragnar are being grown, so that they can be used instead of Pindar, if Fiji disease becomes serious in the Markham Valley.

Some of the other good varieties chosen include Cato, Q84, SJ4, and Q78. Crops of these are being grown to supply planting material.

Recommended varieties are likely to change. New varieties are still being brought from Queensland, and varieties with higher yields may be found. If pests and diseases become a problem with one variety, another variety may have to be used.

PLANTING MATERIAL

Holding period. - Holding planting material for three days before planting seemed to give the fastest germination. (The best germination rate was 90 %). The buds still germinated if the material was held up to two weeks (76% germination), but if conditions were humid the setts started shooting before planting, and this made the shoots and roots vulnerable to damage.

Fungicide. - An organism (Ceratocystis paradoxa) may infect the bud and prevent germination in cool, dry weather and under such conditions it is essential to dip the planting material in a fungicide. The Department has found that under the hot, moist conditions in the Markham Valley dipping is not essential with commercial-sized plantings.

Planting pieces. - It was found that the best planting method was to cut off the tops of the stalks, and cut the remainder of the stalk into setts with three nodes each. These setts gave more even germination than uncut stalks, which germinated very unevenly.

Plant establishment. - In the experiment, 3-node setts of Pindar were planted in rows 145 cm apart with cane laid end to end in the rows. (The weight of planting material used was 5 000 to 7 000 kg/ha. The weight of planting material will naturally vary with the thickness of the cane. This will be different in different varieties).

Setts were covered with 5, 10, 15 and 20 cm of soil, and the number of shoots in a 7.6 m row counted over 12 months. There were big differences in the number of shoots at three months (111 for 5 cm, 83 for 20 cm) but by harvest time the variation was 45 for 5 cm and 41 for 15 cm. Lodging increased between 15 and 5 cm from a figure of 2.3% to 15%.

As moisture conservation is likely to be important at the time of planting it is recommended that setts be covered with 15 cm of soil.

Weed control. - On new land weeds would be unlikely to be a real problem. Where control is needed, hand-weeding, mechanical weeding or chemical control can be carried out. Mechanical methods would probably be the cheapest.

A number of chemicals, including atrazine and paraquat (Gramoxone) would be suitable. Sugar-cane tolerates paraquat fairly well. It gives an immediate kill of broadleaf and grass weeds.

Provided growth is satisfactory, the leaf canopy is usually complete after about three months, so weed growth is unlikely to be a problem after that.

FERTILIZER USE

A considerable amount of work on sugar-cane nutrition has been carried out in the Markham Valley. More work will be needed for specific soil types and areas.

Nitrogen

Nitrogen is almost certain to be necessary with sugar-cane, except perhaps after a leguminous crop.

However, too much nitrogen can cause problems, such as increased lodging. Lodging can lead to rat damage.

In the wetter areas of Munum, nitrogen increased dry matter production but the increase was in fact made up of deteriorated and immature cane, which spoils crop quality. A lot of the deterioration was due to rat damage. If rats had been controlled effectively, this deterioration could have been avoided, and there would have been a 30% increase in yield.

In view of this, it is recommended that on fertile, uncropped or lightly cropped soils only 65 kg/ha of nitrogen should be used. Higher rates can be used on poorer or lighter soils.

Urea can be sprinkled on to setts lying at the bottom of 20 cm deep furrows at rates of up to 212 kg N per ha without affecting germination or growth adversely.

Potassium

As levels of calcium and magnesium are high in most Markham Valley soils the possibility of antagonism with potassium was looked at. No yield increases were found. As sugar-cane removes large amounts of potassium it may be necessary to add potassium after cropping has been carried on for some time.

Trace elements

The alkaline soils of the Markham Valley can be expected to lead to deficiencies of zinc, copper and manganese. Tissue analyses of sugar-cane have indicated that these elements may be insufficient. Addition of trace elements to the soil gave greater mature stalk weights, sugar levels, crop yield and percentage moisture.

Further work on the need for trace elements will be needed if an industry develops.

COVER-CROPS AND ROTATIONS

As sugar-cane takes a lot of nutrient from the soil it will need to be rotated with other crops. Fertilizers would make up what the crops have taken out but it is likely that pests and diseases would build up with continuous sugar-cane crops.

A number of leguminous cover-crops have been looked at. *Dolichos lablab* proved to be the most promising. It unfortunately will not set seed in the Markham Valley but should serve as a suitable short-term rotation, provided seed can be obtained cheaply. Cowpea and possibly mung bean show promise.

CROPPING SEQUENCE

Times of planting and harvesting would be determined by the climate. With large-scale milling the longer the machinery is worked the more economical the operation is. Planting and harvesting schedules need to be worked out to give the longest possible harvesting period, provided that adequate sugar levels in the cane are achieved.

One suggested schedule for the Markham Valley was that planting be carried out in April to June. The crop would then be harvested in August to September of the following year, 14 to 15 months later.

The first ratoon would probably be ready to harvest between August and October the following year. Subsequent ratoon crops would then be harvested on an 11 to 12 month basis as the mill required.

While possibly adequate this system may not be the best. Planting in April to June would not achieve maximum early growth followed by sugar storage; conditions are generally dry in the Markham Valley from May onwards. What in fact would happen is that the crop would establish and then grow very slowly until the wet season, usually beginning in December. Vigorous growth would then occur. The lower and middle Markham also generally has a minor "wet" during July and August and this could in some years hinder harvest.

One crop which was planted in January, 1972, on an area with a high water table, was ready for harvest in October to November of the same year. The crop obviously benefited from the early planting and then grew vigorously until July to August. This suggests that early planting (possibly November to December) would allow maximum early growth and shorten the period to harvest.

The following system is suggested based on "typical" weather conditions.

At the top end of the Markham Valley and perhaps the Ramu Valley planting could normally be carried out in October to November. The wet north-west season commences early in this region, and good rainfall conditions occur until at least June or July. The crop should be ready for harvest in September to December. Early rains in October or November could impede harvest a little but should not be a major problem in normal years.

In the lower and middle parts of the Markham Valley, a late November to early January planting could be aimed at with harvesting in October to November of the following year. If the rains do not come early, planting could be delayed until March to April. In this case the growing season would be prolonged and harvesting could commence in June (depending on the season, the soil type etc.) and continue until September. This would give a milling season of June to December.

HARVESTING

Harvesting can be carried out by hand or mechanically. Hand-cutting would probably be preferable in Papua New Guinea as adequate labour is available.

Hand-cutting assessments were carried out in 1972 and 1973. In 1972 work was carried out on an incentive basis while in 1973 labourers worked on an hourly basis (8 hours/day).

The amount harvested varied with the tonnage and degree of lodging of the crop, and of course varied tremendously between individual workers.

Lodging was quite bad in some areas in 1972 and this adversely affected the harvesting rate.

In both cases the cane had been fired before harvest. The cane was simply cut and stacked every 4 or 5 metres and not carried to a truck.

Allowance for this should be made when looking at the cutting averages.

It would appear that, on an incentive basis (this would be the obvious way of tackling harvesting), labourers should be able to cut and cart at least five tonnes of cane a day.

Burning is beneficial in removing insects, snakes and rats as well as making harvesting easier. A drawback with burning is that is is critical that the burnt cane be cut and rapidly transported to the mill to avoid deterioration.

The amount of organization involved and fire risks are also drawbacks.

Green cane can be stored for a considerable time before any major loss in sugar occurs.

RATOONING

As ground preparation and planting are an expensive aspect of sugar production it is desirable to grow as many economical ratoon crops as possible.

After harvesting it is necessary to shave the stubble back to ground level to ensure that shoots emerge from underground and not from old stalks above ground level.

Provided hand harvesting is carried out properly (that is, canes are cut to ground level) mechanical shaving may not be necessary.

New shoots come up much more quickly from the old stools than from freshly planted cane, and early growth is faster.

Ratoon crops should be ready for harvest a maximum of 12 months after the crop is harvested. First ratoon crops have been quite successful in the Markham Valley but the one second ratoon observed grew very poorly. In this case the first two crops were unfertilized while the second ratoon only received a single application of nitrogen after the first ratoon was cut.

While there are records of 11 and 12 ratoons in some Central American countries we cannot rely on more than one with certainty at this stage.

LARGE AREA PLANTINGS

In order to see if major pest or disease build-up occurred on commercial-size plantings a 16 ha block was established between April and August, 1971.

The crop was harvested in August to September, 1972, and sample yields varied considerably. (23 to 86 tonnes/ha). Problems had occured with soil types and weeds. Better cultural techniques and more selectiveness in choice of planting areas would have improved yield considerably.

Some of the crop was badly lodged - this is tied up with the vigorous growth of Pindar, as well as planting depth and soil type. The very strong Markham winds are also obviously an influence.

Fiji disease was evident but its incidence was very low.

A number of species of stem borer were noted but build-up of numbers was not noted and it is doubtful whether they were of any real significance.

An outbreak of aphids occurred but this was put down to unusually dry conditions. With the onset of more normal weather the outbreak decreased.

The planting ratooned quite well despite the dry weather and it was harvested in August to September, 1973. The ratoon crop showed very little lodging and yields were from 25 to 58 tonnes/ha.

A further 12 ha were planted in January to May, 1972 and harvested in August to September, 1973. It was well overdue for cutting. Much of it was badly lodged and a lot had died. Yields varied from 50 to 58 tonnes/ha. Most of the area appeared to be ratooning quite well.

Again there was no evidence of pest or disease build-up in either plant crop or ratoon.

The second ratoon of the April to August, 1971, planting performed poorly and was eventually ploughed in.

TABLE 1.

Date	Sample	Amount cut/worker/day tonnes	Estimated yield tonnes/ha
1972	1	16.4	69.5
	2	11.7	56.7
	3	9.7	49.4
1973	1	7.1	54.7
	2	5.8	45.3

Note: Incentive workers (1972) worked an unrestricted time while hourly rate workers (1973) worked an 8-hour day.