HARVESTING FREQUENCY AND ITS EFFECT ON YIELD, SUGAR RECOVERY AND THE FIBRE CONTENT OF CANE

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Summary

The significance of relating per acre yields of sugarcane and sucrose to the time taken for their production, is examined in a field trial carried out over a four year period. It is shown that 34% more cane and 31% more sucrose were derived by cutting cane four times at 12-month intervals, instead of twice at intervals of 24 months. Furthermore, by cutting at a young stage, the fibre % cane is considerably lower than in the older material. Growers are advised that, under normal conditions, highest yields are obtained by cutting the maximum acreage of their cane at 12-month intervals.

Introduction

"One of my fields has just given me 63 tons of cane per acre at 15.7% sucrose, following a plant cane crop of 60 tons at 15.6% sucrose". A claim such as this is not unusual among growers, but what does it mean in terms of real productivity? Very little in fact, for no indication has been given of how long the cane has been growing.

In 1963-64 a yield of 10,970,358 tons of cane was cut from 299,095 acres, with an average sucrose content of 13.55%. These figures show that last year the average yield per acre for the industry was 36.64 tons of cane and 4.36 tons of sugar. This is a little lower than the highest average yield which was achieved in 1961-62, when 39.43 tons cane or 4.774 tons sucrose were obtained per acre.

In 1963-64 the cane acreage harvested represented almost 48.5% of the total quota area, which implies that the crop was harvested at an average age of nearly 25 months. This estimation is based on the assumption that the total quota area was planted with cane, in which case a 50% cut per year would be equivalent to cutting every two years. Relating this age factor to yields, we find that in 1963-64 cane production averaged 1.47 tons per acre per month and sugar 0.175 tons per acre per month. If we compare these crops with the hypothetical yields referred to in the first paragraph, namely 60 tons for plant cane and 63 tons for 1st ratoon then, assuming the interval between harvests is 25 months, yields for successive crops are 2.4 and 2.5 tons cane per acre per month and 0.38 and 0.40 tons of sugar. This is substantially higher than the average industrial figure. However, an experiment recently concluded indicates that these yields can be even further improved upon, for a crop of 3.45 tons cane and 0.52 tons sucrose per acre per month was obtained by cutting four successive crops at intervals of about 12 months, instead of two at 24 months.

Harvesting dates were as follows:

Code	Treatment	Planted	Harvested			
			Plant Cane	1st Ratoon	2nd Ratoon	3rd Ratoon
T1 . . .	12 month harvests	August 1960	August 1961	August 1962	August 1963	August 1964
T2 . . .	16 month harvests	August 1960	December 1961	May 1963	August 1964	
T3 . . .	20 month harvests	August 1960	May 1962	December 1963	August 1964	
T4 . . .	24 month harvests	August 1960	August 1962	August 1964		

Experimental Data

In 1960 an experiment designed to compare the effects on the yield of cane of harvesting it at ages ranging from 12 to 24 months, was put down under dry land conditions. Four harvesting frequencies were compared using four different varieties and two fertilizer treatments. The trial was concluded in August, 1964, which meant that crops which were to have been cut at 20 month intervals were in fact under plant cane for 21 months, 1st ratoon for 19 months, but 2nd ratoon for only 8 months. All other crops were cut according to schedule and harvesting was completed within the 4 years devoted to the experiment.

Two fertiliser treatments were superimposed on each harvesting treatment, but in only two cases did they equal out over crops in the different harvesting treatments. Fertiliser treatments are as follows:

(F1) Cane planted with 800 lb. 3:15:3 and top dressed with 650 lb. 15:0:15.

Ratoons top dressed with:

T1 600 lb. 10.6.10 T3 800 lb. 10.6.10
T2 600 lb. 10.6.10 T4 1,200 lb. 10.6.10

(F2) Cane planted with 1,600 lb. 3:15:3 and top dressed with 1,300 lb. 15:0:15.

Ratoons top dressed with:

T1 1,200 lb. 10.6.10 T3 1,600 lb. 10.6.10
T2 1,200 lb. 10.6.10 T4 2,400 lb. 10.6.10

Four varieties were used, namely:

V1 N:Co.376 V3 N:Co.293
V2 N:Co.382 V4 N:Co.310

Yields

Fertiliser Effects

The inequality in the level of fertiliser application might, it was felt, mask differences in yield which were due to the frequency of harvesting. However, comparison of the two treatments, in which fertiliser dressings equal out, showed that the main yield trends are due to other than fertiliser effects. Details are given in Table 1.

It will be noted that yields in the T4 treatment, which is cut every 24 months, are lower than those in the T2 treatment, where in the same period the cane is cut 3 times at intervals of 16 months. These yield losses at the single and double levels of fertiliser application are respectively 18.08 and 29.14 tons cane and 0.58 and 2.98 tons sucrose per acre. However, the higher level of fertiliser provides an increase in yield in the 16 month crop, but this response is reversed when the crop is cut at 24-month intervals.

This aspect of the results is pertinent only in relation to the differentiation of responses due to fertiliser and harvesting frequency. Nevertheless, it is of interest to note that in a burning and trashing experiment, where over a long period, harvesting had always taken place at intervals of 24 months, fertiliser effects became more marked when the age of cane at harvest was reduced to 12 months. In these circumstances fertilised plots gave very much higher yields than unfertilised, the difference being significant at a 0.1% level.

TABLE 1

	Total lb. Fertilizer	Total Cane Cut in 3rd and 4th Crops in Tons Per Acre	Total Tons Sucrose in 3rd and 4th Crops in Tons Per Acre
T2 F1	2650	144.00	21.08
T2 F2	5300	152.41	22.28
T4 F1	2650	125.92	20.50
T4 F2	5300	123.27	19.30

Growth Rates and Harvesting Intervals

The rate of growth of cane as depicted by yield data, is illustrated at Table 2. It can be seen from this that the growth rate slows down after the first 12 months. Indeed, over 4 years the cumulative yield of cane and sucrose, as quoted in Tables 2 and 3, are respectively about 34 and 31% less in the two year harvesting treatments than in the cane harvested at one year.

TABLE 2

Mean yields of cane in 48 months
(Tons per acre)

	Yields				Total Yield in 48 Months	Percentage Gain per 4 Months	Tons Cane Per Acre Per Month
Code	Plant	1st Ratoon	2nd Ratoon	3rd Ratoon			
T1 . . .	47.11	35.35	49.04	34.11	165.61	11.6	3.45
T2 . . .	54.06	59.08	35.21		148.35	13.8	3.09
T3 . . .	60.82	56.34	13.09		130.25	5.6	2.71
T4 . . .	60.10	63.17			123.27		2.56

$$\frac{T1 - T4}{T4} = 34.34\%$$

TABLE 3

Mean yields of sucrose in 48 months
(Tons per acre)

	Yields				Total Yield in 48 Months	Percentage Gain Per 4 Months	Tons Sucrose Per Acre Per Month
Code	Plant	1st Ratoon	2nd Ratoon	3rd Ratoon			
T1 . . .	6.80	5.57	7.19	5.75	25.31	11.6	0.52
T2 . . .	7.60	8.32	5.75		21.67	8.6	0.45
T3 . . .	8.67	9.47	1.80		19.94	3.3	0.41
T4 . . .	9 38	9.92			19.30		0.40

$$\frac{T1 - T4}{T4} = 31.13\%$$

It became clear from this data that total yields from individual plant cane or ratoon crops may be quite misleading in terms of true yield. Thus, while individual crop yields from the T4 treatments are much greater than the T1, it is the latter which give the highest yield per acre over a given period of time. In the same way the figures quoted at the beginning of the paper, viz. 60 tons plant cane and 63 tons in the 1st ratoon, are a meaningless ideal unless time is taken into account. It can be seen from Tables 2 and 3 that in terms of tons cane and tons sucrose per acre per month, the lowest overall production figure is obtained where the intervals between harvest are longest. If then one bears in mind that the average industrial yield is only 1.47 tons of cane per acre per month, and the average age at harvest is just under 25 months, then there is surely considerable scope for increasing the efficiency of production, merely by cutting cane much earlier than at present!

Varieties and their Influence

Having considered the effects of reducing harvest intervals, it is pertinent to ask how this is influenced by variety.

Four varieties were used in this trial. Two of these, N:Co.376 and N:Co.310 were thought to grow slowly in the first year and to develop most effectively during the period 18-24 months after planting. In contrast, N:Co.293 and N:Co.382 were known to grow vigorously in the first year and, in the case of the last named, to lodge badly in the second year. Yields of these varieties are quoted in Tables 4 and 5.

It will be seen from these that N:Co.376 is superior to the other three varieties at all harvesting intervals, both in terms of tons cane and tons sucrose per acre. It is also apparent that in the case of N:Co.382 the yields of both cane and sucrose for the plant cane crop fall away after 20 months, while in the 1st ratoon crop it puts on only 0.47 tons cane per acre in the same period.

N:Co.293 as plant cane, maintains a regular increment of growth in successive four month periods. However, in its 1st ratoon, there is a marked drop in yield between cane of this variety cut at 16 months and at 20 months. This probably occurs because the harvest date for T3 plant cane falls in May and winter regrowth of this variety is notoriously bad. It is also worth noting that in the 24 month crop cut in August each year the increase in yield over the last 8 months of growth is only 1.97 tons.

The yield of sucrose per acre falls in N:Co.382 plant cane when it is between the age of 20 and 24 months. In contrast N:Co.293 which, in the same period shows a drop in cane yield, produces an increased yield of sucrose between 20 and 24 months.

Yields, expressed as tons cane produced per acre per month, are illustrated in a histogram in Figure 1.

It can be seen from this that the varieties N:Co.376 and N:Co.293 benefit from cutting at 12 months, while N:Co.382 seems to yield best when it is cut at 16 months. N:Co.310 maintains its yield at a fairly constant level between 12 and 24 months, the mean yields at 12, 16, 20 and 24 months being respectively 3.14, 2.90, 2.43 and 2.42 t.c.a.m. Even in this case, however, the yield from the cane harvested at 12 months is clearly superior to the yield of cane harvested at all other periods of maturity.

Yield Fluctuations

Fluctuations in yield are most marked in the T1 treatment and least obvious in the T4 treatment. That these fluctuations are caused by variation in annual rainfall is demonstrated in Table 6, where the total rainwater falling on the crop is shown alongside the mean yields expressed as tons cane per acre. It can also be seen that despite the fluctuations in yield per crop, there is a consistent figure for tons cane produced per inch of rainwater. This figure drops consistently with increasing age at harvest and indicates that the younger the crop is when it is harvested, the greater the use that it makes of available water.

TABLE 6

	Mean Tons Cane per Acre	Total Rain on Crop	Tons Cane per 1 Inch Water
T1 P	47.11	44.34	1.1
R1	35.35	29.90	1.2
R2	49.04	45.75	1.7
R3	34.11	28.26	1.2
T2 P	54.06	55.51	1.0
R1	59.08	55.57	1.1
R2	35.21	37.18	1.0
T3 P	60.82	73.86	0.9
R1	56.34	65.62	0.9
R2	13.09	8.68	1.5
T4 P	60.10	74.47	0.8
R1	63.17	74.02	0.9

This trend towards more efficient use of water by younger crops is illustrated at Figure 2. Indeed, it is apparent even in the 2nd ratoon crop of the T3 treatment, which was harvested prematurely at the age of 8 months.

This trend is confirmed in another experiment in which the effect on yields of varying the age of the crop at harvest, is compared under irrigated conditions. In this experiment the periods of crop maturity compared were not so great as those in the rainfed trial. Plant cane was cut at 14, 16 and at 18 months and ratoons at 12, 14 and 16 months. Yields expressed as tons cane and tons sucrose per acre and per month, together with the total water used and the tons cane produced per inch of water, are all given in Table 7.

It can be seen from this data that, except for the 1st ratoon T3 treatment cut at 16 months, the yields of cane per inch of water decrease the older the crop becomes. The exceptional crop, namely the 1st ratoon of the T3 treatment, was harvested in June, 1963. The

TABLE 4

YIELDS: Varieties at differing ages in tons cane per acre

	T1 12 Month Cutting					T2 16 Month Cutting				T3 20 Month Cutting				T4 24 Month Cutting		
	P (12)	R1 (12)	R2 (12)	R3 (12)	Total T1	P (16)	R1 (15)	R2 (17)	Total T2	P (21)	R1 (19)	R2 (S)	Total T3	P (24)	R1 (24)	Total T4
N:Co.376	54.76	38.03	55.35	37.65	185.79	57.24	62.60	41.86	161.65	69.44	60.64	15.28	145.36	69.12	73.48	142.60
N:Co.382	41.38	33.78	42.53	33.64	151.15	54.74	58.58	33.54	146.86	60.09	57.25	12.91	130.25	56.94	57.72	114.66
N:Co.293	47.11	38.58	51.70	33.93	171.32	53.18	60.62	31.86	145.66	56.63	56.80	15.21	128.64	57.27	62.59	119.86
N:Co.310	45.18	31.02	43.56	31.24	151.00	51.07	54.51	33.58	139.16	57.12	50.66	8.98	116.76	57.08	58.89	115.97

TABLE 5

YIELDS: Varieties at different ages in tons sucrose per acre

	T1 12 Month Cutting					T2 16 Month Cutting				T3 20 Month Cutting				T4 24 Month Cutting		
	P (12)	R1 (12)	R2 (12)	R3 (12)	Total T1	P (16)	R1 (15)	R2 (17)	Total T2	P (21)	R1 (19)	R2 (8)	Total T3	P (24)	R1 (24)	Total T4
N:Co.376	7.79	5.85	8.46	6.29	28.39	8.06	8.96	7.17	24.19	9.60	10.24	2.10	21.94	10.30	11.56	21.86
N:Co.382	5.32	4.97	5.83	4.87	20.99	7.32	7.89	5.25	20.46	8.69	9.16	1.56	19.41	8.66	8.36	17.02
N:Co.293	6.81	5.96	7.32	5.44	25.53	7.25	8.15	4.97	20.37	7.58	9.33	2.01	18.92	8.70	9.55	18.25
N:Co.310	7.28	5.50	7.14	5.79	25.71	7.77	8.28	5.66	21.71	8.80	9.14	1.44	19.38	9.84	10.26	20.10

FIG. 1. YIELD IN TONS CANE/ACRE/MONTH

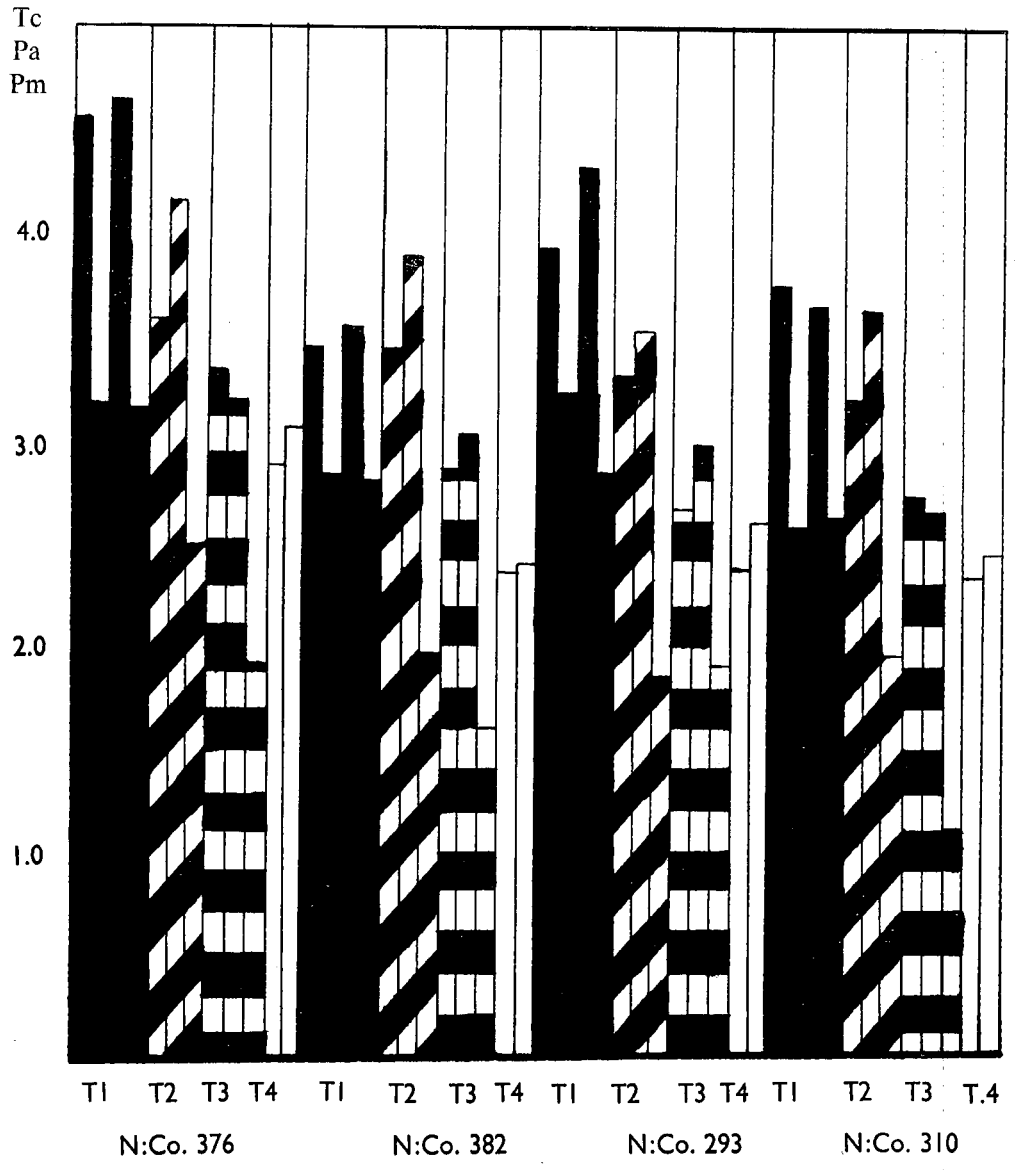


TABLE 7

Time of Cutting in Months	Tons Cane per Acre	Tons Sugar per Acre	Tons Cane per Acre per Month	Tons Sucrose per Acre per Month	Total Water (Rain and irrigation) in Inch/Acre	Tons Cane per Inch Water
Plant Cane						
T1 14	68.2	10.31	4.87	0.74	56.23	1.2
T2 16	67.5	9.91	4.22	0.62	64.29	1.1
T3 18	76.6	10.68	4.25	0.59	74.83	1.0
1st Ratoon						
T1 12	54.2	7.60	4.52	0.63	43.74	1.2
T2 14	62.6	8.89	4.47	0.63	55.39	1.1
T3 16	81.4	11.94	5.09	0.75	61.52	1.3
2nd Ratoon						
T1 12	55.3	8.12	4.61	0.68	52.37	1.1
T2 14	57.4	7.85	4.10	0.56	63.15	0.9

previous plant cane crop had been cut in February, 1962, and it may well be that this timing and growth period in relation to season, may have combined to affect yields in a manner as yet unknown.

Fibre % Cane

The percentage of fibre in cane is yet another factor influenced by age of the crop at harvest. The mean percentages of fibre in cane for various varieties harvested at different ages, are shown in Table 8.

TABLE 8
Fibre % Cane

Means for Times	N:Co.376	N:Co.382	N:Co.293	N:Co.310	Mean
T1 . .	10.68	13.99	11.34	10.58	11.66
T2 . .	11.34	14.65	11.33	11.44	12.19
T3 . .	12.15	15.88	12.80	12.38	13.30
T4 . .	12.25	16.30	12.91	12.59	13.54

These figures indicate that the older the crop is when it is cut, the greater the fibre content of the cane, regardless of variety. However, when comparing cane cut at 12 and 24 months, the increase in fibre content for the varieties N:Co.376, N:Co.382, N:Co.293 and N:Co.310 is respectively 1.57%, 2.31%, 1.57% and 2.01%. Despite this variation, it is clear that from the factory viewpoint there is an advantage in milling young cane.

Conclusions

(*a*) The older the crop the lower the yield of cane and sugar per acre, per unit of time.

(*b*) Cane should be harvested earlier than at present whenever the resultant increase in yield more than compensates for the additional cost of handling two crops.

(*c*) To make best use of the maximum growth period each year, harvesting at 12 month intervals is most desirable. This harvesting can be carried out at time of peak sucrose which, conveniently, is also the best time for development of ratoons.

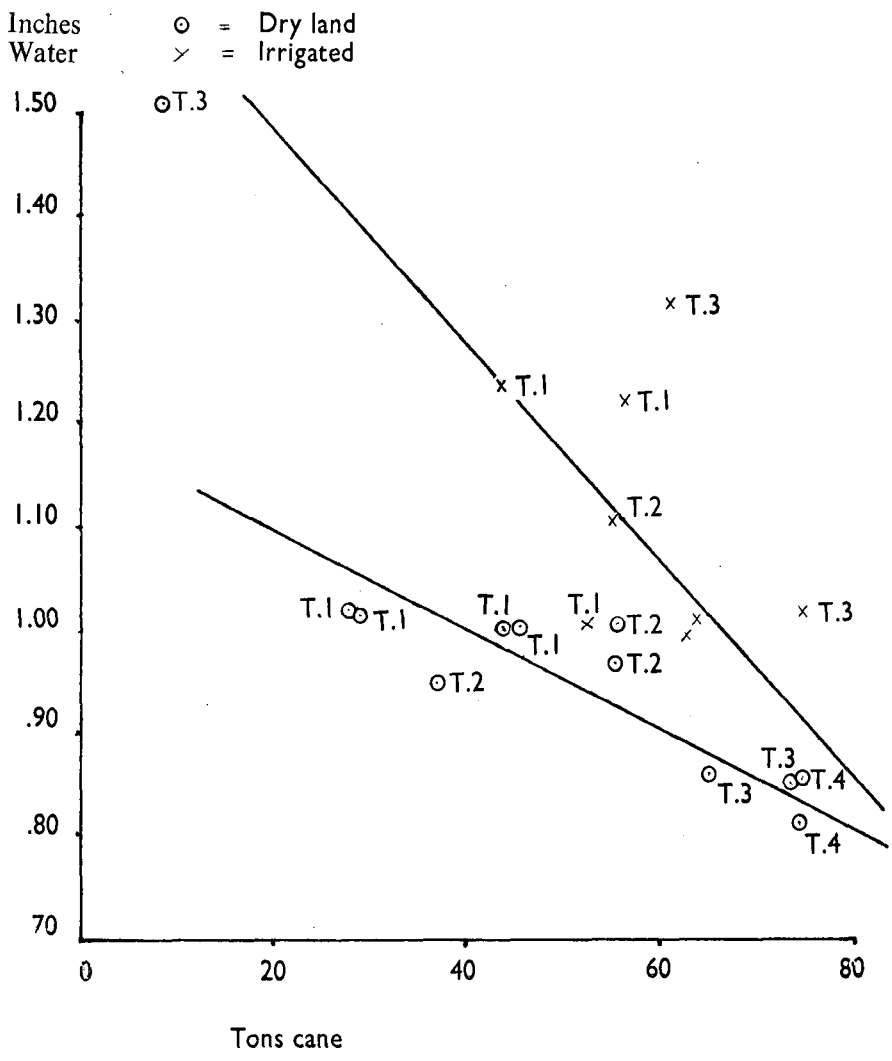
(*d*) Lodging of cane should not be tolerated as not only does it cost more to harvest and transport, but yields of both cane and sucrose are reduced.

(*e*) The younger the cane the easier it is to mill, as fibre % cane increases sharply with age.

Recommendations

Growers should strive to grow the bulk of their cane as a 12 month crop. In practice this means that the largest possible area that can be cut on any farm between August and November, should be harvested when the cane is about 12 months old. Of the remainder, cane due to be ploughed out is best harvested in June and July. The balance, consisting of cane which is more than 12 months old, but still as young as possible, should be cut to meet mill requirements earlier or later than the August-November season.

FIGURE 2: TONS CANE PER I IN. WATER FOR DRYLAND AND IRRIGATED CROPS



Mr. Hempson: It is only possible to cut at twelve months if the crop is cut at the best time of the year. Harvesting in December, January and February, even where growing conditions are good, is out of the question for twelve month cane.

At other times of the year we have found that cutting at twelve to fourteen months gives the best profit per acre per annum.

Some years ago, cutting at twenty-four months, we got up to 139 tons of cane per acre. In this last season we cut at between thirteen and fourteen months and averaged 52 tons per acre but with a much better sucrose content.

Mr. Pearson: I made certain recommendations at the end of my paper which are in accordance with your remarks.

Mr. du Toit: This question of harvesting frequency has been argued for many years.

I remember some time back that we were cutting Co.290 every year to 10th ratoon and getting about 30 tons to the acre.

If cane is cut annually at about September/October it is likely that its sucrose content will be as high, if not higher, than cane of eighteen months or two years being cut in September/October. But if the cane is cut in say May or February the sucrose content will be very poor.

Mr. Pearson's observation about trash is quite correct. Millers may not thank planters for growing a short crop as it might make them short of fuel.

If we accept that the weight of crop increases per unit of time as the age of the harvest decreases, we must not go beyond the optimum period.

If we decide to cut annually it will be essential to make better use of moisture.

Mr. Thompson (in the chair): Shorter cropping should also give greater benefit from trashing.

Mr. Grice: The matter of economics again comes into this. The amount of extra weeding required before a canopy forms must be considered and also the extra cost of labour for more harvestings.

Mr. Pearson: We did not go into costs because this was carried out in small replicated plots.

Weeds should only be a problem with plant cane as trashing should take care of the weeds later.

Mr. Hill: Tongaat carried out a cost investigation on annual cutting of cane, taking into account such factors as double acreage, weeding, increased fertilizer, easier cutting of young cane, bundling, etc. and found that it would pay handsomely when compared with cutting at two years.

Cutting N:52/11 at twelve months Tongaat got a better yield increase than for any other variety. In fact all our figures for twelve month cane were better than Mr. Pearson's.

We have had as much as 50% increase of two twelve months cuts over a twenty-four month cut.

However, our experiments were in small blocks which in many cases were isolated in a field of cane that had been harvested in a period of hot dry winds, so that the older cane deteriorated rather badly and had dried out.

Mr. Wilson: We have recently conducted an industrial survey at the request of the S.A. Sugar Association. One farmer about 40 miles from here, with a quota of 181 acres, on Dwyka soil has a sucrose quota of 821 tons. He cuts all of his cane at twelve to fourteen months, under dryland conditions.

Mr. du Toit: Under irrigation it is possible to cut a crop at twelve or fourteen months but it is not easily done under dryland conditions. Yet according to Mr. Pearson the percentage gain, cutting annually over a two year period, is greater for dryland than for irrigated cane, which seems strange.

Mr. Pearson: Table 7 gives times for cutting under irrigation, and it shows that growth is fairly similar in both the first and second year whereas under dryland conditions there is far less growth in the second year. This seems to be the wrong way round. If you cut from August to October, as you would with a twelve month crop, for two months there is very little canopy and very little transpiration, but usually rain is falling and therefore the soil profile is built up with water. The crop can therefore take off from a full profile right through its growing period. A two year crop has been transpiring all through the second year of growth and the water status is only the water falling on the soil — there is no accumulation for the two or three months of no transpiration. The twelve month crop has more water to produce cane than the second year of the twenty four month crop.

Mr. Hempson: Some varieties do not come into Mr. Pearson's category at all. We have found N:Co. 382 on our porous soil responds extraordinarily well. As Mr. Pearson pointed out, twenty or twenty-four month crops often contain dead cane, with a consequent loss in weight, money and growing time. Had the crop been cut younger there would be a considerable gain. In N:Co.382 grown on porous soil, the percentage weight per stick of twelve month cane is considerably better than for older cane. It is also easier to cut and therefore requires a smaller labour force. Sucrose per ton of cane is better because the older cane tends to lodge, with a consequent drop in sucrose.

Mr. Pearson: We showed in figures produced a few years ago a drop of 2% in sucrose in lodged cane.

Mr. Johnson: In India we found a direct ratio between cane deterioration in the interval between harvesting and milling and the age of the crop, i.e. older cane deteriorated much more rapidly. If there was any delay between harvesting and milling, due maybe to transport delays, cane more than eighteen months old was barely worth milling.

Mr. Gosnell: I have checked the results of the growth experiments and see they very largely confirm Mr. Pearson's current results. For the first eighteen months there was good uniform growth in the dryland section of the experiment, but from eighteen to twenty four months the increment in growth was very small.

The irrigated section did not show such clear trends, possibly because of inadequate replication, but it did appear that from about sixteen months, when lodging occurred, there was no effective further growth whereas in the period twelve to sixteen months the increment was as good as the dryland section.

Dr. Cleasby: Harvesting cane at a younger age will almost certainly become the practice in the foreseeable future. The advantage regarding yield has been realised for quite a long time. But the industry will be faced with major yield fluctuations. If we harvest at about eighteen months we will be cutting about two thirds of our land every year. In times of drought we could go from a very large crop to a very small crop. At 100% twelve month cutting, taking into consideration that rainfall can vary from 25 inches to 50 inches, the crop could vary by 100% from one year to another.

Mr. Thompson: As has been pointed out, all cane cannot be cut at twelve months as there must be flexibility of harvesting age. There is no doubt, however, that if the average at present is twenty-five months it should be considerably less.