FOUR YEARS EXPERIENCE WITH MATURITY TESTING ON MHLUME SUGAR ESTATE

By R.D. TRUEN
Mhlume (Swaziland) Sugar Company Limited

Abstract

Pre-harvest sampling has proved to be a useful tool at Mhlume. Graphs are presented showing the improvement in the sucrose content of Mhlume's cane at the mill compared with that of the outgrowers over a 5-year period. The method of sampling and analysis is discussed in detail. The data from the 2 seasons when the 8-10 internode sample was used are presented and the different correlations between the various cane analyses and the tons cane: tons sucrose ratio are discussed. It is concluded that the 8 - 10 internode sample and the whole stalk sample taken together give the most satisfactory guide to harvest scheduling at Mhlume.

Introduction

The sucrose content of the cane stalk at harvest time is influenced by many factors. The main factor is the rate of growth in the preceding months. When the cane plant is growing rapidly the carbohydrates produced by photosynthesis are largely utilized for vegetative growth and only a portion is stored as sucrose. As the plant growth rate slows down more carbohydrates are available for storage. When rapid growth is resumed after a period of restricted growth the stored sucrose is inverted and metabolised, causing a drop in the sucrose content of the stalk.

With this in mind sugarcane farm managers aim at vigorous growth in the early and middle part of the growing cycle, with restricted growth in the latter part to ripen the cane. Therefore fertilizer must be adequate in the early stages but not enough to keep the plants growing vigorously as harvest time approaches. Similarly, irrigation should be restricted to reduce growth before harvest. A slightly different approach is to ensure that cane cut early in the harvest season, when the climate still favours growth, is cane carried over from the previous season. The age of this cane then ensures greater maturity than is possible with younger cane. The best method under Swaziland conditions is to delay harvest until the winter months, when the cane is ripened naturally by temperature effects. Unfortunately this is not feasible for the entire crop because the winter is not long enough to harvest and grind the tonnages produced.

A ripening programme is usually based on a harvest programme drawn up in advance and influenced by practical considerations such as replanting requirements, age of cane at harvest, variety, yield and local experience. Many farmers never go further than this and the preliminary harvest plan is used unchanged throughout the season. It is obvious that a knowledge of the relative maturities of the fields available for harvest must improve the effectiveness of the harvest programme and therefore the yield of sucrose. Many of the factors affecting maturity cannot be controlled. It is thus extremely useful to have some form of testing for maturity in routine operation.

Methods

When Mhlume started its central cane maturity testing service in 1968, the cane samples collected consisted of whole stalks taken from positions marked on a sampling map. Analyses were carried out on juice expressed by a 3 -roller Barron laboratory mill and the sucrose content of the cane was estimated by the Java ratio method. The stalks were cut in half before crushing and top and bottom halves were crushed separately. Thus comparisons could be made between the results for the two halves in addition to obtaining information about the whole stalk. At the end of the 1969 season it was decided that both the sampling method and the analytical method should be changed. The original sampling method, whilst adequate, was prone to occasional errors because there was no allowance for suckers. The percentage by weight of suckers in carry-over cane can be quite high (nearly 34% measured at Mhlume) and in view of the great difference in sucrose content between the suckers and the first season growth (4 - 6% just before harvest date) it is important that the analysis should reflect the presence of the suckers. An attempt was made to find a method which gave this information as well as an increase in accuracy. A suitable method seemed to be that used by Humbert et al[3] in Mexico. This offered a logical answer to the sampling problem in that the sample consisted of the whole stool. The 8 - 10 internode samples were processed for moisture, nitrogen, sucrose and reducing sugar content, while the rest of the sample was processed for "pol ratio" analysis. However, this method meant that a large number of stalks had to be collected and sub-sampled. It was felt that this could be avoided by taking only the 8 - 10 internodes from the sample stool *in situ*. It was considered desirable to have a whole stalk sample also, so whole stalk samples were taken from surrounding stools.

The areas of sampling blocks were as much as 40 hectares, but were more usually about 20 hectares. A map was drawn of the area on a 1:5000 scale, and the proposed sampling points were marked so that good coverage of the area was obtained. There was a minimum of one sampling point per 4 hectares.

When the sampler reached his sampling point he was required to judge whether or not the cane at the sampling point was representative of the

area. If it was not, he was required to move his sampling position to more representative cane. He did not mark this particular area as the sampling point for all future sampling, but was merely required to sample within the same general area on subsequent occasions. On arrival at his sampling point the sampler chose a representative stool of not less than ten stalks (this was to prevent a natural tendency to select the smallest stool possible). He then counted the stalks in the stool and entered this information in his sampling book. A note was also made of how many suckers and immature stalks were present. The 8 - 10 internode sample was then taken from all the stalks that would go to the mill at the time of harvest. Finally he selected two representative stalks, one each from stools on either side of the one from which he had taken the 8 - 10 internode samples. All the 8 - 10 internode samples from the different sampling points within a block were composited, and the same was done with the whole stalks.The two bulk samples were then analysed separately.

The analytical method adopted was the cold extraction method of direct cane analysis (Buchanan, 1966)[1]. On arrival in the laboratory the cane samples were chopped into pieces approximately 30 cm long and these were then disintegrated using a Jeffco cutter-grinder. Care was taken to ensure that the sub-samples taken for analysis were representative. The blender used for cold extraction was the "Ultra-Turrax" and not the SMRI blender. This necessitated a change in the cane to water ratio from a 1:2 to a 1:3 mixture. Brix was determined using a precision refractometer and a Dietert Moisture Teller dried the sample for moisture determination.

Reducing sugar analysis was done using Soxhlet's modification of Fehling's method on the filtered juice from the blender. The calculations necessary for the method are somewhat tedious but these were automated to an extent by the use of a calculator with programming facilities.

Results and Discussion

The seasonal sucrose graphs in Figure 1 show the mean weekly sucrose results from Mhlume mill for the Mhlume estate cane and the "outgrowers' " cane. The results in 1967 showed no tendency for Mhlume's sucrose percentage to be better or worse than the outgrowers.' 1968 was the first year the central cane maturity testing service operated and as can be seen from the graph there was little impact except at the beginning of the season. From 1969 there was a distinct improvement in performance and the sucrose content of Mhlume cane stayed higher than that of the outgrowers cane for the early and late parts of the season. The sudden improvement in sucrose levels in the outgrowers' cane in mid-season was mainly due to cutting a preponderance of NCo 310 at that stage. The best example of this was in 1969 when the sucrose percentage of the outgrowers' went up by more than 2% in one week as they moved into NCo 310 fields. The very marked difference between data for Mhlume and the outgrowers' in 1971 was thought to be due to some extent to the better drying off control achieved following recommendations published in the Rhodesian Sugar Association news bulletin (Gosnell, 1971)[2]. The drying off philosophy has changed over the last 5 years at Mhlume. During the first 4 years irrigation was discontinued some time before harvest, the period being longer in summer than in winter (6 to 8 weeks vs 3 to 4 weeks). The intention was to ripen the field as well as to facilitate vehicle movement. Irrigation was based on Class A pan evaporation and a factor of 100% of pan was used for fully canopied cane. Accuracy of control was made more difficult by the surface irrigation system used over much of the estate. Similar drying off programmes were used by the outgrowers' though some preferred a fairly short drying off period and one favoured a long drying off period with a final irrigation shortly before harvest. In 1971 Mhlume changed over to an extended drying off system as mentioned earlier. This system involved a 50% pan factor for cane harvested from April to September and a 67% pan factor for the October to January harvest period. The duration of drying off varied from 4 months in fields with deep top-soil to 2 months in fields with shallow top-soil.

In Figure 2 the average seasonal sucrose percentages for the 5 year period 1967 to 1971 are compared using the 1967 value as 100%. In these histograms the steady improvement in Mhlume's sucrose percentages over the last 5 years is apparent. In 1971 Mhlume's yield in tons Sucrose per hectare per month was the second highest ever obtained, showing that it is possible to increase sucrose percentages without sacrificing yield. The histograms for the outgrowers' data show a much more variable performance. Four of the six show a rise in sucrose from 1967 to 1968, and five of them show a decrease the next year. All six show a rise from 1969 to 1970 and they all drop the following year. It is obvious that a seasonal effect on sucrose content predominates. This is in contrast to Mhlume's results over the same period.

The data in Table 1 show the variety percentages by area for Mhlume and the outgrowers' over the period considered in Figures 1 and 2. Mhlume sugar estate delivers about 46% of the sucrose processed by the mill, the major outgrowers' producing approximately 45%. The general trend over the period was the replacement of the high sucrose variety N:Co 310 by the medium sucrose variety N:Co 376. Throughout the period Mhlume had proportionately less N:Co 310 than the outgrowers'. By 1971 12% of Mhlume's cane was of other varieties, the two main ones being N:Co 334 (6%) and N55/805 (3%). In spite of the general move away from N:Co 310 to N:Co 376, prompted by the former's susceptibility to smut, there was no general tendency for the sucrose percentages to drop. A study of the relationship between variety

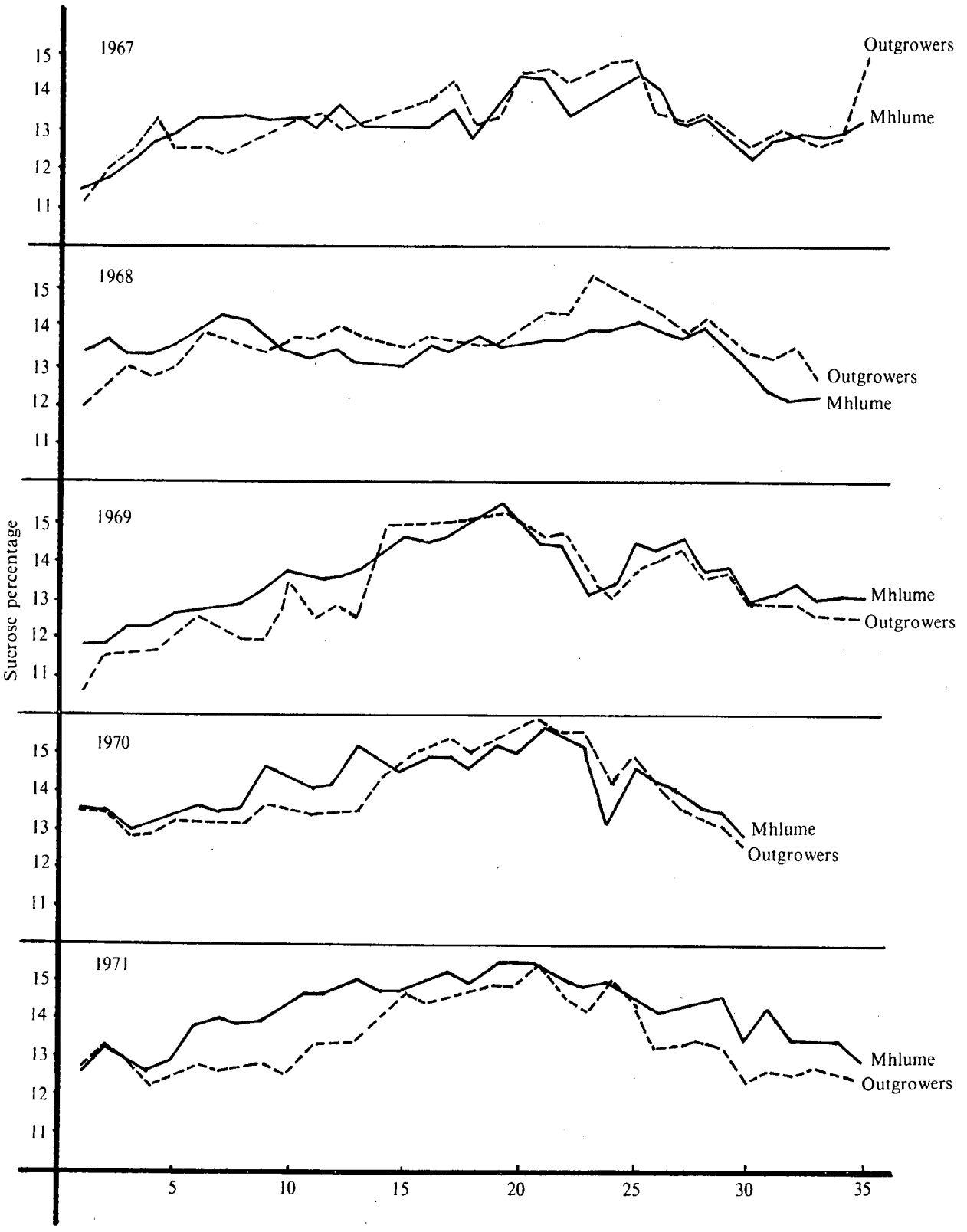

Figure 1 Seasonal Mill Sucrose Results 1967-1971

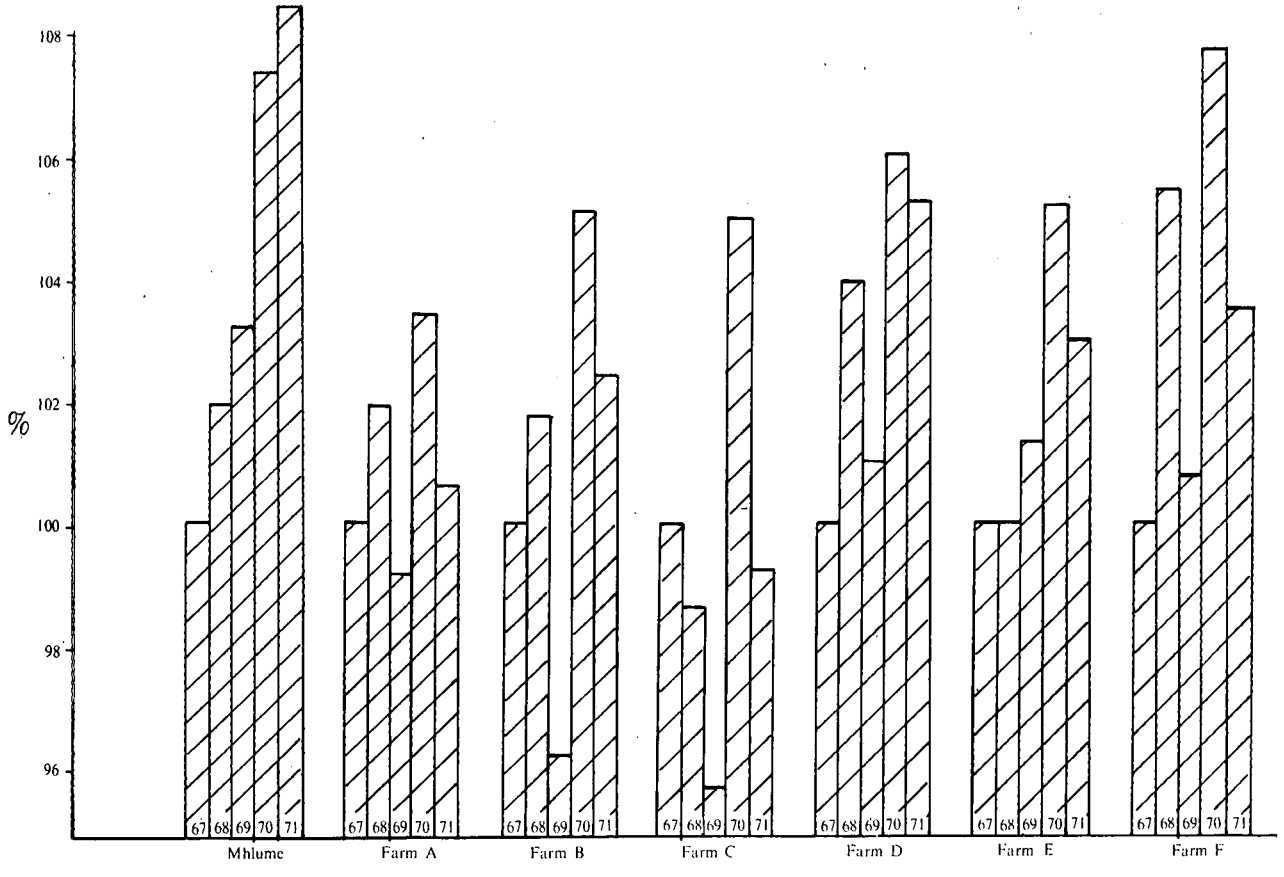

Figure II Histograms showing the variation from the 1967 value (expressed as 100%) of the seasonal sucrose percentages obtained by the major suppliers to the Mhlume mill in the period 1967 - 1971

composition of the major outgrowers' farms and their seasonal sucrose percentages mainly reveals the existence of a seasonal effect on sucrose content. Mhlume's sucrose percentages did not appear to exhibit these seasonal effects. It is therefore inferred that the changes in cultural practices, particularly maturity testing and pre-harvest management, contributed to the improvement in sucrose content.

The data in Table II show the correlation obtained between the various analyses performed on the pre-harvest sample and the tons cane : tons sucrose (TC/TS) ratio in the harvested cane for the 1970 and 1971 harvests. All the variables were significantly correlated at the 1% level with the TC/TS ratio. The correlation coefficients show the 8 - 10 moisture, 8 - 10 sucrose and whole stalk sucrose to be particularly useful in establishing priorities for harvest.

A more detailed breakdown of the 1971 results into 2 month periods as shown in Table III, demonstrates that there was a marked seasonal effect on the correlation between the different variables and the TC/TS ratio at harvest. The 8 - 10 moisture percentage and 8 - 10 sucrose percentage gave strong correlations during the May - August period, but during the September - October period correlations were low. This is probably because in the May - August period the differences between 8 - 10 samples from various fields were large (reflecting the wide range of cane maturity at that time), but as winter progressed and the cane ripened naturally, these differences became smaller and the 8 - 10 analysis lost significance. The whole stalk sucrose percentage was strongly correlated with the TC/TS ratio from May to October.

Of the November - January data the 8 - 10 moisture percentage and the whole stalk sucrose percentage showed slight correlation with the TC/TS ratio. This low correlation of the November - January data may be explained by the seasonal rain in that period which caused a drop in the sucrose content of some of the harvested cane. This drop occurs not only in cane harvested during rain but also in cane harvested shortly afterwards.

The data presented in Table III would seem to indicate that under the conditions prevailing at Mhlume, a simple whole stalk sample would be an adequate guide for harvest scheduling. However there are several factors to consider. Firstly, the presence of suckers in the carry-over cane reduces the accuracy of whole stalk sampling. Secondly, the 8-10 sample comprises more units than the whole stalk sample, and is more representative of the whole stool. Thirdly, the moisture content of the 8 - 10 sample is a valuable guide for drying off control, and finally, the 8 - 10 sample provides a guide to the point at which the cane should be topped.

In the future the 8 - 10 sample may also yield useful information regarding nitrogen status of the plant at harvest. As mentioned earlier, Humbert et al[3] used the 8 - 10 sample in Mexico where they found the nitrogen level in the stalk to be positively correlated to the TC/TS ratio at harvest. This would therefore serve as a useful guide to the optimum nitrogen fertilization of cane that is scheduled to be cut during the early and latter parts of the season when temperatures are high enough to encourage growth.

For estate purposes it is felt that harvest schedules based on both samples are substantially less prone to error than schedules based on either whole stalk or 8 - 10 samples alone. This is particularly true when, as at Mhlume, cane growth is uneven within fields due to the varying depth of

TABLE I

Variety composition (expressed as a percentage of the area) of the fields harvested by the major suppliers to the Mhlume Mill, 1967—1971.

Year	Variety	Mhlume Estate	Major Outgrowers						All Outgrowers Combined
			Farm A	Farm B	Farm C	Farm D	Farm E	Farm F	
1967	NCo 310	35	61	72	78	70	73	69	70
	NCo 376	58	39	28	22	30	27	31	30
	Other	7	—	—	—	—	—	—	Trace
1968	NCo 310	23	68	61	45	79	62	71	66
	NCo 376	72	32	39	55	21	38	28	34
	Other	5	—	—	—	—	—	1	Trace
1969	NCo 310	17	61	53	66	42	59	65	64
	NCo 376	76	39	47	34	58	41	35	36
	Other	7	—	—	—	—	—	—	Trace
1970	NCo 310	17	50	63	55	43	57	54	56
	NCo 376	73	50	37	45	57	43	46	44
	Other	10	—	—	—	—	—	—	Trace
1971	NCo 310	16	32	36	33	29	48	32	42
	NCo 376	72	68	64	67	71	52	68	58
	Other	12	—	—	—	—	—	—	Trace

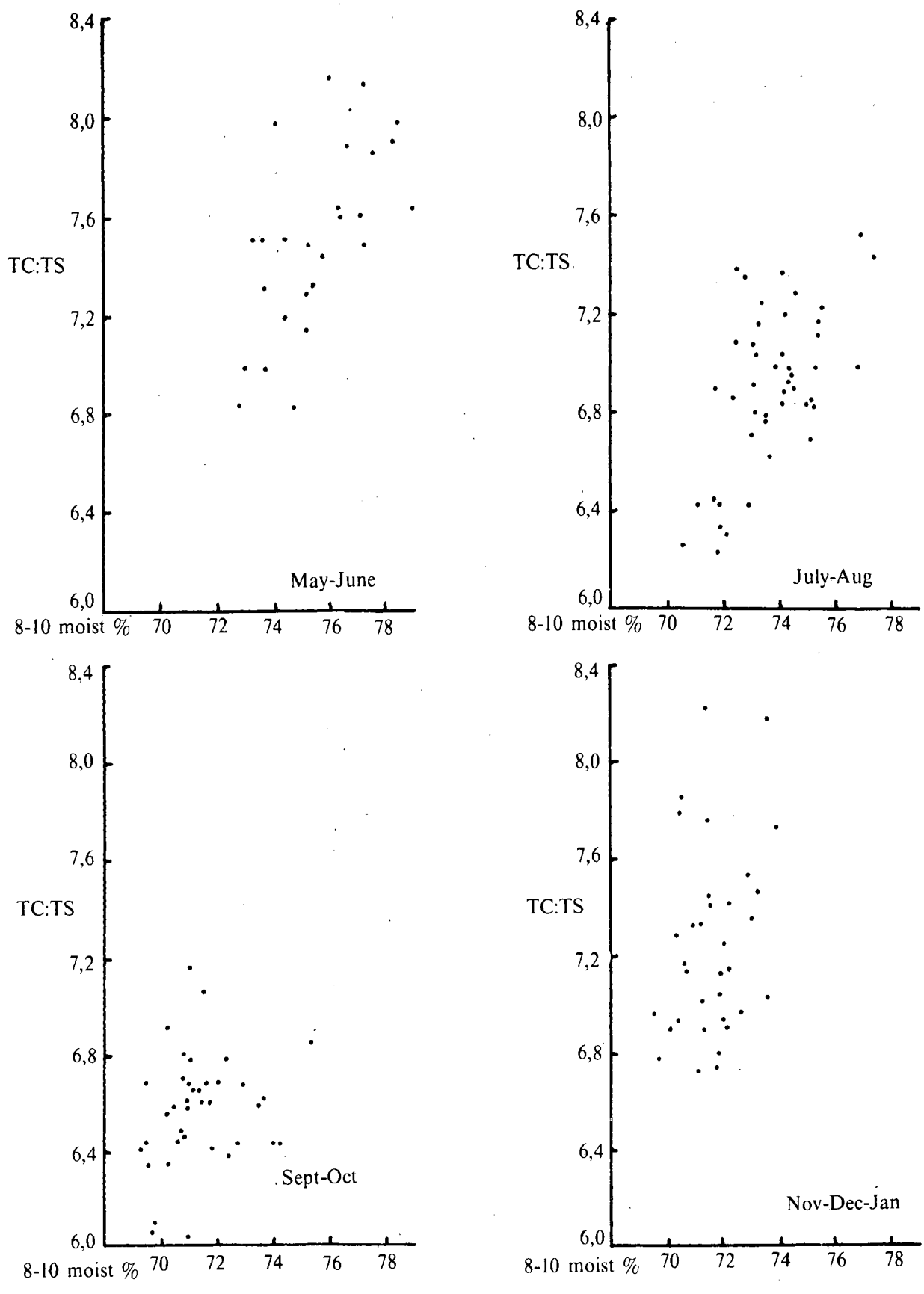

Figure III The relationship between 8 - 10 moisture percentage in the pre-harvest sample and the TC/TS ratio at harvest during successive periods in 1971

TABLE II

Correlation coefficients between the pre-harvest analyses and the TC/TS ratio in harvested cane in 1970 and 1971

Year	8 — 10 moisture %	8 — 10 *$\frac{RS}{S}$%	8 — 10 sucrose %	whole stalk $\frac{RS}{S}$%	whole stalk sucrose %
1970	0,41**	0,30**	-0,47**	0,29**	-0,48**
1971	0,52**	0,39**	-0,56**	0,22**	-0,47**

*($\frac{RS}{S}$% is the reducing sugar to sucrose ratio expressed as a percentage)

top-soil over the estate. Under such conditions sampling error can be considerable. The 8 - 10 sample has been a useful guide in the prevention of excessive drying off. This has been the case even in the September - October period when its value in relation to maturity assessment seems doubtful. For these reasons Mhlume will continue to take the 8 - 10 sample and will continue to take it over the entire season.

Figure 3 shows the 8 - 10 moisture data as they were related to the TC/TS ratio through the 1971 season. Average 8 - 10 moisture percentages for the different periods were; 75,5% for May - June, 73,5% for July - August, 71,0% for September - October and 71,5% for November - December - January.

The whole stalk sucrose figures have proved most useful for forecasting the average sucrose for Mhlume estate each month. It was often possible to get within ± 0,1% of the actual figure. Changes in harvest schedules and adverse weather can upset the accuracy of the forecasts. It would seem likely that this type of forecasting will always be more of an art than a science both early and late in the season when rain can be expected.

TABLE III

Correlation coefficients between the pre-harvest analyses and the TC/TS ratio in the harvested cane during successive periods in 1971

period	8 — 10 moisture %	8 — 10 $\frac{RS}{S}$%	8 — 10 sucrose %	whole stalk $\frac{RS}{S}$%	whole stalk sucrose %
May - June	0,63**	0,20	-0,72**	0,25	-0,62**
July - August	0,60**	0,29	-0,67**	0,40**	-0,62**
Sept. - Oct.	0,19	0,05	- 0,17	0,09	-0,65**
Nov. - Jan.	0,24	- 0,16	0,01	0,06	- 0,28

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