

Factors Affecting the Sugar Content of Sugar Cane in the Wet Tropics of Queensland

-Statistical Analyses of C.C.S. Data at Babinda and Tully

By

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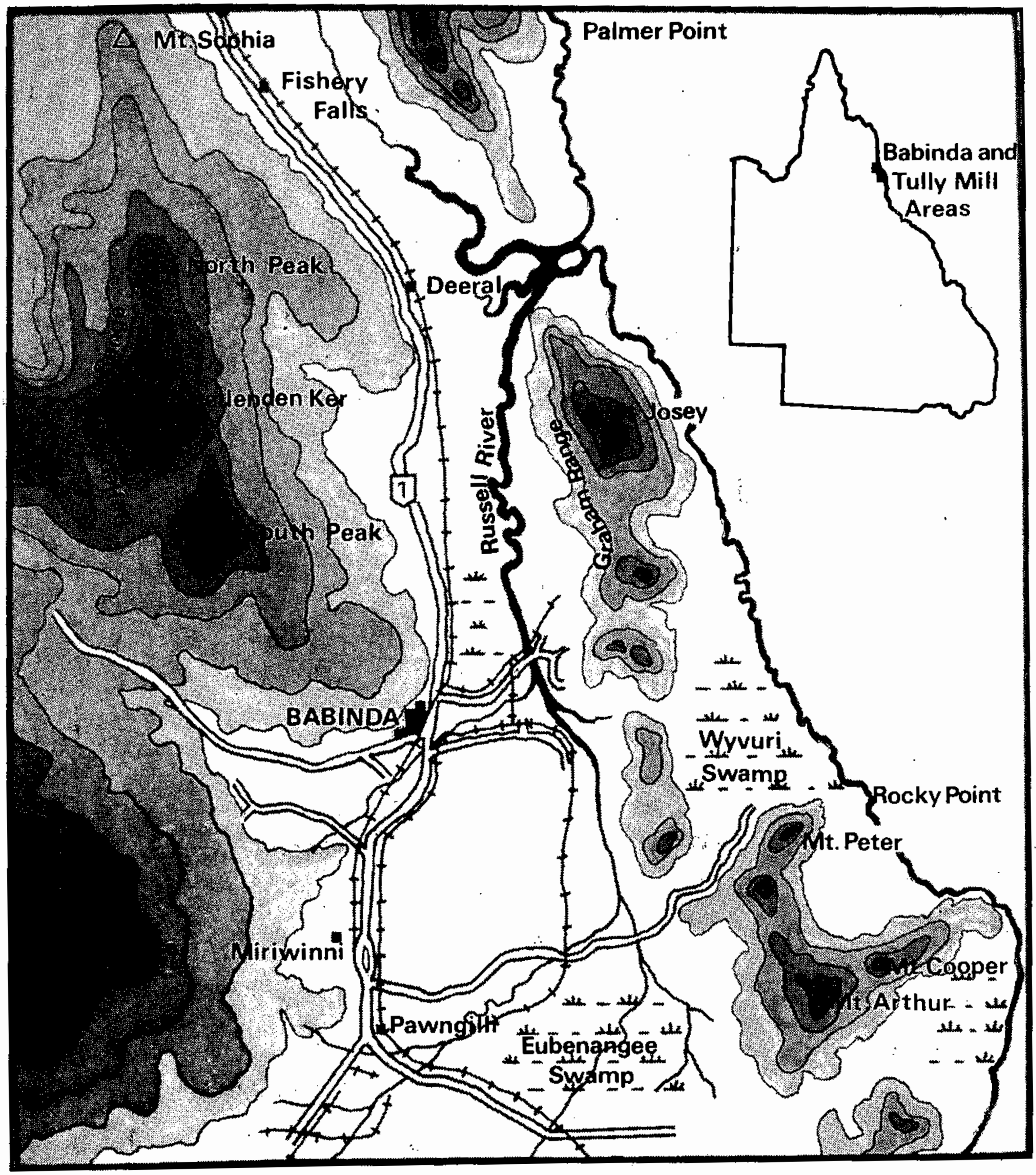


The Babinda mill area

Summary

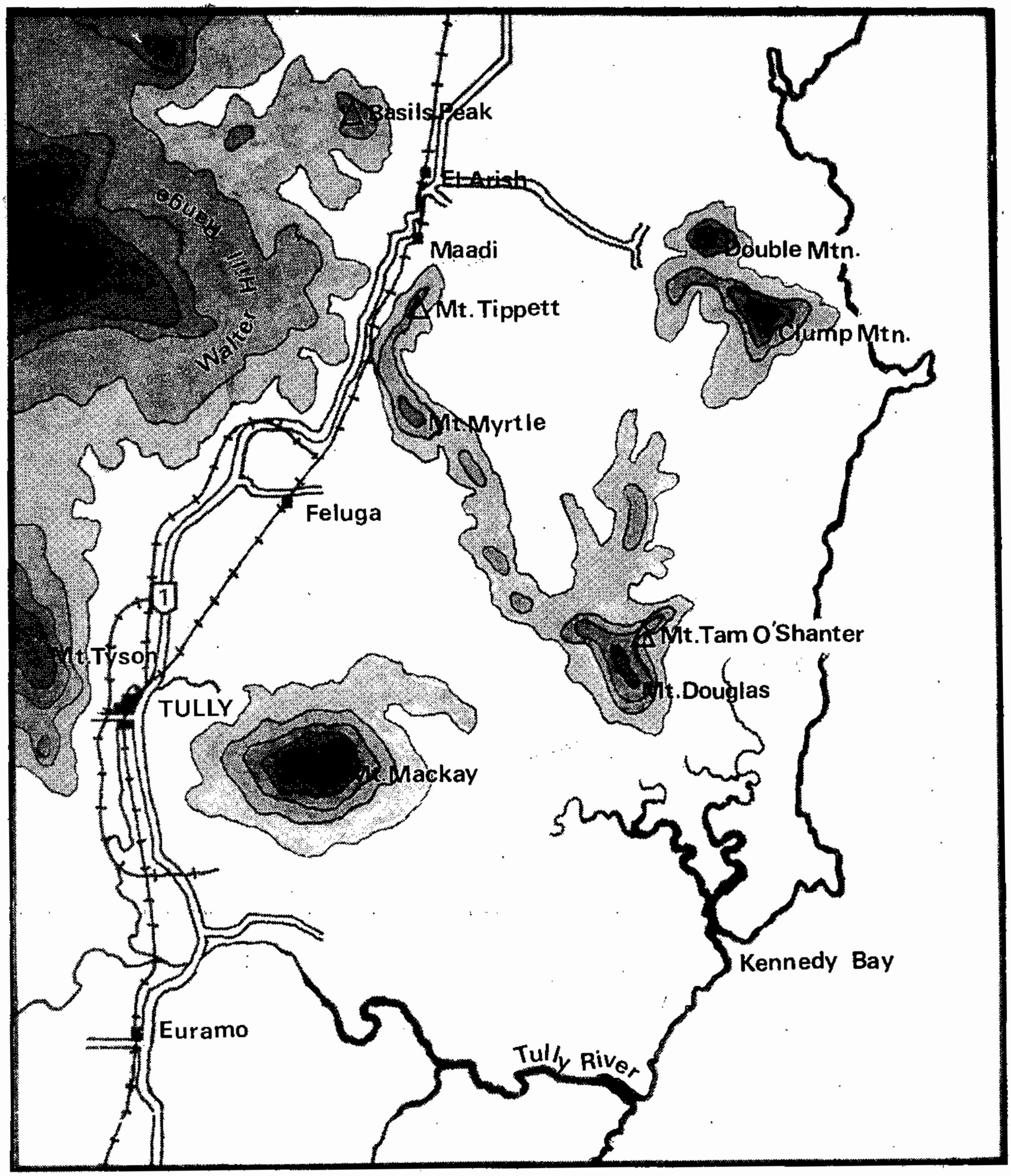
1. The method of analysis suffered from several statistical deficiencies. The most notable of these was the confounding of several factors in certain analyses.

2. C.c.s. tended to decline in later ratoons of Q.57, possibly because of heavier suckering and sprawling in these ratoons.

3. Cane cut by chopper harvesters had lower c.c.s. than cane cut manually or by whole-stalk harvesters. This difference was greatest in later ratoons and towards the end of the season.

4. Farms shaded either by mountains or clouds hanging on mountain ranges had lower c.c.s. than unshaded farms. That is, the amount of solar radiation received is an important factor influencing c.c.s.

5. Only limited evidence was found to associate c.c.s. with geographical location, soil type, and drainage.



The Tully mill area

Introduction

Sugar cane is grown in Queensland along a narrow, discontinuous belt of coastline extending from Rocky Point (lat. 28°S) t Mossman (lat. 16½°S), a distance of over 1,000 miles. The 31 mill areas of the State are grouped, for statistical and other reasons, into four major cane-growing districts, each being separated by sections of unreli rainfall or inferior soil types.

Three of these districts - northern, Burdekin and central lie within the tropics. The "wet-tropics" is defined as that part of th northern district where annual rainfall is in excess of 100 inches compared with a rainfall of the order of 80 inches in the other areas. Fiv mill areas, namely Babinda, Goondi, Mourilyan, South Johnstone and Tully are situated within the wet tropics.

Despite improved technology, the average sugar content of all crops throughout the State has remained fairly constant for many yea (Table 1). Table 1 shows the large differences in district c.c.s. betwe crops of the dry tropics (that is, the Burdekin district where flood irrigation is practised) and the northern district (which embraces the w tropics).

TABLE 1 - District averages for seasonal c.c.s., 1956 to 1970

Five-year period	District c.c.s. averages				State averages
	Northern (1)	Burdekin	Central	Southern	
1956-60	14.01	15.03	14.67	13.79	14.32
1961-65	14.08	14.99	14.65	13.93	14.37
1966-70	13.96	15.31 (2)	14.75	13.71	14.41

(1) excludes C.S.R. mill data

(2) increase due to major changes in Invicta mill assignments

The average values of seasonal c.c.s. for crops harvested in each mill area of the northern district are listed in Table 2 for the five years 1966 to 1970. Here it is shown that, apart from Tully, the commercial cane sugar (c.c.s.) content of crops harvested in the wet tropics is below the average for the district and the State. An examination of five-year averages for the five mill areas in the wet tropics, over a period of 25 years (1946 - 1970) in Table 3, demonstrates the relatively high c.c.s. of Tully crops and the low c.c.s. of crops harvested at Babinda and Goondi for 20 years (1946 to 1965). It is also of importance to note that, during the last five years (Tables 2 and 3), the sugar content of Goondi crops has improved, relative to Babinda in particular and to all other mill areas in the wet tropics.

In mill areas where short-falls in sugar peaks occur, any improvement in the seasonal c.c.s. of crops may justify the retention of peaks and could lead to subsequent increases. Irrespective of mill peaks, when the seasonal c.c.s. is well below the average for the State, growers, in particular, have cause for concern, even though c.c.s. may seem to be relatively high by overseas comparisons. In fact, canegrowers have strong motives to increase c.c.s.; these stem from incentives in the formulae for cane price and for cane payment by giving financial rewards for relatively high c.c.s. In the wet tropics, the sugar content of crops is

TABLE 2 - Seasonal c.c.s. of mills in northern district, 1966 to 1970

Mill area	Seasonal c.c.s.					Five-year average
	1966	1967	1968	1969	1970	
Mossman	15.13	14.42	14.42	14.23	14.11	14.46
Hambledon	15.57	14.76	15.76	14.45	14.38	14.98
Mulgrave	14.93	14.08	14.66	13.75	14.00	14.28
Babinda	13.61	13.23	13.72	13.22	12.76	13.31
Goondi	14.61	13.91	14.37	13.50	13.19	13.92
Mourilyan	14.41	13.92	14.54	13.48	13.43	13.96
South Johnstone	14.10	13.50	14.17	13.45	13.35	13.71
Tully	14.58	14.34	14.66	13.71	13.59	14.18
Victoria	14.34	14.74	14.73	14.37	13.58	14.35
Macknade	13.98	14.33	14.31	13.71	13.18	13.90
Northern district	14.48	14.20	14.55	13.84	13.54	14.12
State	14.46	14.25	14.86	14.14	14.27	14.40

TABLE 3 - Five year averages for mill c.c.s. in the wet tropics, 1946 to 1970

Five-year period	Mill c.c.s.				
	Babinda	Goondi	Mourilyan	South Johnstone	Tully
1946-50	13.61	13.54	14.43	14.18	14.48
1951-55	12.85	13.04	13.50	13.44	13.48
1956-60	13.28	13.48	13.88	13.81	13.61
1961-65	13.56	13.58	13.77	13.52	13.98
1966-70	13.31	13.92	13.96	13.71	14.18

usually below the State's average and is a critical factor in the farm economy, particularly during years of low sugar prices. This aspect of sugar production has been the subject of detailed investigation.

King (1957) examined six factors that might contribute to low c.c.s. of Babinda crops. Four which were highlighted for attention included the selection of cane varieties, climatic factors, cane deterioration between burning and crushing and mechanical loading. Ten years later, at the request of Babinda growers, Sturgess (1968) investigated the factors contributing to the relative change in the average c.c.s. of crops at Babinda and Goondi for the years 1966 and 1967. An examination of c.c.s. data implicated cane varieties and mechanical harvesting. Briefly, the wide separation in the maturity curves for the same varieties, harvested in the neighbouring mill areas, related to a differential reduction in the transport and storage delays of chopped cane, after harvest, in each mill area.

During 1968, the Directors of the Babinda Co-operative Central Mill Society, acting on a suggestion from the Bureau, met with the Babinda Mill Suppliers' Committee and formed a Standing Committee to investigate low c.c.s. and allied problems (Sturgess and Ryder, 1971). This committee has kept the Babinda c.c.s. problem under review and defined, from time to time, agricultural and milling projects for investigation. One of these projects involved the statistical analyses of c.c.s. data from Babinda and Tully, and the results of this investigation are reported in this paper.

Methods and Materials

Collection of Data

C.c.s. data for Q.57 supplied by every farm in the Babinda mill area during the 1967 harvest season and for Q.57 and Q.83 from every farm in both the Babinda and Tully mill areas for the 1968 season were collated with the following information for statistical analysis:

1. *Crop class:* The data from each farm were categorized according to the crop harvested. For Babinda, the classes were plant (P), first ratoon (1R), second ratoon (2R) and other ratoons (OR - third ratoons or older). For Tully, the classes were P, 1R and OR with second ratoons being included in OR.

2. *Time of harvest:* For the 1967 data, the harvest season was divided into an early, mid and late harvest period, each period being approximately 6½ weeks. To enable more comparisons to be made on the data, the 1968 season was divided into weekly intervals for both Babinda and Tully.

3. *Geographical location:* The Babinda area was divided into northern, central and southern sectors. The northern sector is a relatively long, narrow area of cane land north of Babinda township, bounded on the western side by the Bellenden Ker mountain range. The central sector is a flat, open area, not subject to the same degree of influence by mountains as the other districts, extending south of Babinda to Pawngilly. The southern sector includes both open and broken country south of Pawngilly and comes under the influence of the Bartle Frere range. The Tully area was divided into sectors described as El Arish, Feluga, Riversdale/ Syndicate and Lower Tully. The El Arish sector ranges from the northern part of the Tully mill area to the southern edge of the Walter Hill range;

Feluga covers the area from the southern edge of the Walter Hill range south to the Tully township; Riversdale/Syndicate covers the area south of Tully township and west of the North Coast rail line; Lower Tully covers the area south of Tully township and east of the North Coast rail line.

4. *Soil types:* Each farm was given a broad classification for soil type. In the Babinda area, there are three main soil types: volcanic (V), granitic gravel (G) and clay loam (L). Clay loams cover those soils with textures in the range sandy clay loam to clay loam and include both alluvial and forest soil types. Where a mixture occurred, the predominating soil type was listed first, e.g. V-L. In the Tully area, the soil types were loam (L), peat loam (P), alluvial (A), red residual granite (R), grey granite (G), schist (S), and mixed. The loams included clay loams with forest cover. The peat loams are found on the edges of the Tully River alluvials and are usually poorly drained.

5. *Method of harvest:* The categories for both mill areas were: mechanical chopper harvester (C) and manual cutter or mechanical wholestalk harvester (W). Most W farms were cut manually.

6. *Shading effects:* Shading is caused by either mountains or clouds hanging on mountain ranges. Three classifications were used: shaded in the morning (SM), shaded in the afternoon (SA), and unshaded (U). It should be noted that these classifications are not critical, since they are based on visual assessment and local knowledge. Furthermore, they do not take into account the degree of shading on a particular farm during the day nor the change in shading effects during the year due to differences in cloud cover and the angle of the sun.

7. *Drainage:* In the Tully mill area only, farms were classified as having excellent, medium, or poor drainage. Farms with either good natural drainage and/or good artificial drainage were classed as excellent. Farms that cause some concern, especially in the wet season, were

classed as medium. This class includes areas of poor natural drainage on which a reasonable attempt at improvement has been made. Farms which show prolonged waterlogging and apparent damage even though drains may have been constructed were classed as having poor drainage.

Statistical Analyses

The data collected were the total tons of cane and c.c.s. for each crop class for each period for each farm. The value analysed was the c.c.s. and, in all analyses of variance, these c.c.s. values were weighted by the tons of cane which produced the c.c.s. Thus, if crop classes were being analysed, for example, and there were more tons of plant cane than first ratoon cane harvested during the period being considered, more weight would be given to the plant cane c.c.s. than the first ratoon cane c.c.s. It would have been preferable to use area as the weighting factor but, unfortunately, area figures were not available. The use of tons of cane per acre assumes that there is no difference in yield per acre throughout the district. Obviously, this is not so, but the bias caused by this is not likely to affect the analysis greatly. However, if no weighting were used at all, completely misleading results could have been obtained. For example, if blocks with poor drainage were very small but produced very high c.c.s. values due to chance effects, poor drainage would be found to be desirable. However, by using a weighted analysis, these values would be given much less weight, and differences between drainage types would not be biased in favour of poor drainage.

Weighted one-way analyses of variance were conducted on all characters studied for each crop class. With the 1967 data, analyses were conducted for each of the three periods and for the whole season. With the 1968 data, analyses were conducted on each two-week period, each four-week period, and for the whole season. At each period, analyses were also combined over all crop classes.

In all, about 1,000 analyses of variance were completed using a Wang programmable desk calculator. Only the more interesting results from these analyses are reported in this paper.

Results and Discussion

Crop Class

The effect of crop class on c.c.s. at Babinda in 1967 and 1968 and at Tully in 1968 is shown in Tables 4, 5 and 6, respectively.

TABLE 4 - The effect of crop class on the c.c.s. of Q.57 at Babinda in 1967

Period	Crop class				All crops
	P	1R	2R	OR	
Early	12.40	11.99	12.01	11.96	12.08
Mid	13.52	13.28	13.36	13.36	13.38
Late	14.06	14.05	13.75	13.79	13.91
Season	13.23	13.12	12.99	12.71	13.04

Significant differences:

Early: P>>1R, 2R, OR

Season: P>>OR, >2R

1R, 2R>OR

For the 1968 data, four-week periods have been shown with the exception of the last period for Babinda, which was of six weeks' duration.

From Tables 4, 5 and 6, it can be seen that the c.c.s. of Q.57 declines as the number of ratoons increases. This trend is not

TABLE 5 - The effect of crop class on the c.c.s. of Q.57 and Q.83 at Babinda in 1968

Period ending	Q.57					Q.83		
	P	1R	2R	OR	All crops	P	1R	All crops
20.7.68	12.87	13.03	12.91	12.92	12.93	12.55	12.72	12.62
17.8.68	13.67	13.36	13.32	13.36	13.40	14.03	14.06	14.04
14.9.68	14.26	14.13	13.70	13.84	14.01	14.12	14.20	14.14
12.10.68	14.03	13.89	13.10	13.18	13.58	14.34	14.32	14.34
23.11.68	13.76	12.86	12.80	12.49	12.82	14.48	14.13	14.39
Season	13.85	13.53	13.14	13.03	13.34	14.32	14.18	14.29

TABLE 6 - The effect of crop class on the c.c.s. of Q.57 and Q.83 at Tully in 1968

Period ending	Q.57				Q.83		
	P	1R	OR	All crops	P	1R	All crops
13.7.68	13.82	14.20	13.97	13.98	14.02	13.27	13.87
10.8.68	14.52	14.28	14.61	14.47	14.69	14.61	14.67
7.9.68	15.09	15.05	14.73	15.02	15.15	15.21	15.17
5.10.68	15.10	15.03	14.55	14.96	15.24	15.24	15.24
2.11.68	14.62	14.85	14.29	14.60	15.57	15.63	15.59
7.12.68	16.04	14.39	13.14	13.37	15.08	15.26	15.16
Season	14.55	14.59	14.07	14.39	15.25	15.34	15.28

evident for Q.83, but figures for Q.83 were only available for the plant and first ratoon crops. It is possible that Q.83 will show the same trend when second and later ratoons are harvested. With Q.57, the trend is most obvious with the second and other ratoons and, in Tully, there was actually no difference between plant and first ratoon (Table 6). However, if Q.83 can maintain its c.c.s. in later ratoons, this would help to improve the mill average c.c.s. It can also be seen from Tables

5 and 6 that Q.83 produced higher c.c.s. values than Q.57 for most of the harvesting season. The difference in c.c.s. values late in the season was substantial, although it must be remembered that there is very little Q.57 harvested at the end of the season and, therefore, the relevant c.c.s. values in Tables 5 and 6 are based on a small tonnage of cane.

The reason for the decline in c.c.s. in later ratoons is not clear but could be due to several factors. Firstly, Q.57 suckers badly in later ratoons and, with the advent of mechanical harvesters, many of these suckers would be milled. Secondly, Q.57 is inclined to sprawl more in ratoon crops than plant crops. Sprawling itself may have an adverse effect on c.c.s. but, possibly more seriously, the mechanical harvesters do not top the cane as efficiently in sprawled cane. A large number of tops with the cane would have an adverse effect on c.c.s.

Geographical Location

In Table 7, the locations effects, averaged over all crops, is shown for the 1967 Babinda data.

TABLE 7 - The effect of locations (averaged over all crops) on c.c.s. of Q.57 at Babinda in 1967

Period	Location			Mean
	Southern	Central	Northern	
Early	12.06	12.05	12.15	12.08
Mid	13.55	13.35	13.25	13.38
Late	14.02	14.10	13.50	13.90
Season	13.13	13.03	12.97	13.04

Significant differences:

Mid-season: Southern > northern

Late-season: Southern >> northern

Central > northern

Table 7 shows that the southern sector produced higher c.c.s. values than the northern sector in the mid- and late-season periods but, averaged over the whole season, there were no significant differences between sectors.

The results of the 1968 analyses at Babinda, when data from both Q.57 and Q.83 were available, also showed that location effects may exist. It was found that, in the northern sector, c.c.s. seems to decrease (relative to the other sectors) late in the season and also with number of ratoons.

In Table 8, the c.c.s. values averaged over the entire season are presented together with the F values from the analyses of variance. From Table 8, it may be observed that c.c.s. of Q.57 in each

TABLE 8 - C.c.s. values (averaged over the season) of Q.57 and Q.83 at Babinda in 1968 for three locations

Location	Q.57					Q.83		
	P	1R	2R	OR	All crops	P	1R	All crops
Northern	14.02	13.31	13.02	12.75	13.13	14.32	13.96	14.24
Central	13.91	13.55	13.13	13.02	13.34	14.36	14.40	14.37
Southern	13.74	13.64	13.34	13.21	13.48	14.29	14.18	14.27
F value	1.59	2.25	3.27*	5.42**	10.62**	0.30	4.74**	1.76

* Significant at 5% level ** Significant at 1% level

sector decreases with the number of ratoons but that the decrease in the northern sector is much more severe. With Q.83, it is only in the northern sector that there is any decrease in c.c.s. in the first ratoon crop compared with the plant crop. When these results were obtained, the 1967 data were re-examined to determine whether a similar trend was evident in that year. The trend was noticed but was not as well developed.

Table 9 shows the trend towards lower c.c.s. later in the season for the northern sector. It seems clear from this Table that the c.c.s. of Q.57 in the northern sector becomes relatively worse than for the other sectors as the season progresses. The situation with Q.83 is not clear, but the northern sector, which actually has the highest c.c.s. early in the season (when very little Q.83 is cut), does seem to decline later in the season.

The reason for the greater decline in c.c.s. in the northern sector could be associated with a greater preponderance of chopper harvesters in that sector. As discussed in the section on method of harvest, cane which is cut by chopper harvesters tends to have a lower c.c.s., and this effect is most noticeable in later ratoons and in the latter part of the harvesting season.

At Tully, there was no apparent location effect for Q.83. Averaged over the entire season and for both plant and first ratoon crops, the c.c.s. values were:

El Arish	15.30
Feluga	15.30
Riversdale	15.20
Lower Tully	15.29

There did appear to be a location effect for Q.57 and, in Table 10,c.c.s. values averaged over all crops (plant and ratoons) are presented for Q.57.

From Table 10, it may be seen that Lower Tully was consistently high throughout the season and that Feluga was generally lower than the other areas. In fact, Lower Tully produced significantly higher c.c.s. than Feluga in every period except the period ending 5.10.68. Over the whole season, Lower Tully's c.c.s. exceeded the c.c.s.

TABLE 9 - C.c.s. values (averaged over all crops) for three locations at Babinda in 1968 at various periods during the season

Location	Q.57						Q.83					
	Period ending						Period ending					
	20.7	17.8	14.9	12.10	23.11	Season	20.7	17.8	14.9	12.10	23.11	Season
Northern	12.90	13.37	13.70	13.56	12.17	13.13	13.71	14.33	14.36	14.26	14.15	14.24
Central	12.89	13.36	14.05	13.37	12.98	13.34	12.41	13.71	13.87	14.42	14.72	14.37
Southern	13.02	13.50	14.13	13.90	12.94	13.48	11.92	13.85	14.16	14.32	14.40	14.27
F value	1.08	1.19	4.70**	4.97**	9.49**	10.62**	1.19	5.55**	7.53**	0.77	10.07**	1.76

** Significant at 1% level

TABLE 10 - C.c.s. values of Q.57 (averaged over all crops) for four locations at Tully in 1968 at various periods during the season

Location	Period ending						Season
	13.7.68	10.8.68	7.9.68	5.10.68	2.11.68	7.12.68	
El Arish	14.06	14.78	15.30	14.64	14.18	12.88	14.31
Feluga	13.61	14.26	14.62	15.03	14.61	13.08	14.15
Riversdale	13.94	14.39	14.75	14.90	14.13	13.66	14.30
Lower Tully	14.33	14.64	15.34	15.15	15.14	14.37	14.77
F value	9.26**	3.78*	5.61**	1.27	7.19**	7.83**	16.34**

* Significant at 5% level   ** Significant at 1% level

in each other sector at the one per cent level of significance. The higher c.c.s. in Lower Tully may be related to lack of shading from mountain ranges or from cloud cover.

Soil Types

In Table 11, the mean c.c.s. values for different soil types at Babinda, averaged over all crops and the entire season, are presented for both 1967 and 1968. The same information is presented in Table 12 for the Tully data.

For Babinda, the results for Q.57 in 1967 and 1968 are fairly comparable. The granite gravels produced the best c.c.s. values in both years but no other soil type seems to be particularly good or particularly bad. With Q.83, the granite gravels performed well but the granite gravel-loam mixtures also produced high c.c.s. values. As Q.57 did not do very well on this soil type, the possibility of a variety x soil type interaction is suggested. It should be noted, however, that the gravel soils usually produce smaller crops, and perhaps this is the reason for higher c.c.s. values on these soils.

TABLE 11 - C.c.s. values (averaged over all crops and the entire season) for all soil types at Babinda in 1967 and 1968

Soil type	1967	1968	
	Q.57	Q.57	Q.83
Volcanic, V	13.14	13.33	14.22
V - L	13.15	13.31	14.20
L - V	12.74	13.37	14.34
Clay loam, L	13.04	13.35	14.14
Granite gravels, G	13.48	13.66	14.58
G - L	13.12	13.24	14.76
L - G	12.91	13.19	14.32
Others	12.96	13.28	14.22
Mean	13.04	13.34	14.29

TABLE 12 - C.c.s. values (averaged over all crops and the entire season) for all soil types at Tully in 1968

Soil type	Q.57	Q.83
Loam, L	14.28	15.27
Peat loam, P	14.62	15.03
Alluvial, A	14.55	15.23
Red residual granite, R	14.35	15.18
Grey granite, G	14.21	15.41
Schist, S	14.07	15.13
A - P	14.47	15.42
A - L	14.63	15.47
Mixed	14.31	15.12
Mean	14.39	15.28

A problem with an analysis of soil types at Babinda is that the clay loams are dominant on almost 50 per cent of the farms in the mill area. As a result, other soil types are represented by relatively few farms at each harvest period, and misleading results could arise by chance under these circumstances. However, it is reasonable to conclude on the evidence available that soil type is not a major factor influencing c.c.s. at Babinda.

Significant differences between soil types were found for both Q.57 and Q.83 at Tully, but the results (Table 12) are difficult to interpret. For example, peat soils gave the lowest c.c.s. for Q.83 but one of the highest for Q.57. The alluvial loams were high for both varieties and the schists were low for both, but there are many anomalies.

Classification of soil type for a particular farm is difficult because many farms have two or more soil types. Classification of each block would be more accurate but was impractical for this investigation. For this reason, the analysis of soil types is not considered very reliable.

Method of Harvest

In Table 13, c.c.s. values for chopped and whole-stalk cane, averaged over the entire season, are shown for both the 1967 and 1968 data from Babinda and the 1968 data from Tully. In Tables 14 and 15, c.c.s. values for Q.57, averaged over all crops, are presented for a number of periods during 1967 and 1968 respectively. In Table 16, c.c.s. values, averaged over all crops, are presented for the data from Tully.

From Table 13, it may be seen that the difference between the c.c.s. values of whole-stalk and chopped cane tends to increase in later ratoons. This statement applies chiefly to Q.57 because there were insufficient data to detect a definite trend for Q.83. In plant cane, there is little difference between chopped and whole-stalk cane and, in fact, chopped plant Q.57 gave significantly higher c.c.s. than whole-stalk

TABLE 13 - C.c.s. values (averaged over the entire season) for two methods of harvest at Babinda in 1967 and 1968 and Tully in 1968

Method of harvest	Q.57					Q.83		
	P	1R	2R	OR	All crops	P	1R	All crops
1967 *Babinda*								
Chopped	13.15	12.91	12.72	12.52	12.84			
Whole-stalk	13.33	13.43	13.27	12.92	13.29			
F value	2.14	27.35**	26.76**	11.35**	37.58**			
1968 *Babinda*								
Chopped	14.00	13.45	13.00	12.86	13.21	14.39	14.09	14.32
Whole-stalk	13.78	13.75	13.50	13.34	13.59	14.26	14.39	14.29
F value	3.87*	6.66**	30.41**	20.25**	47.45**	2.83	4.30*	0.18
1968 *Tully*								
Chopped	14.34	14.36		13.81	14.12	15.26	15.26	15.26
Whole-stalk	14.69	14.74		14.29	14.59	15.25	15.45	15.31
F value	6.95**	13.78**		14.09**	40.35**	0	6.07*	0.96

* Significant at 5% level ** Significant at 1% level

TABLE 14 - C.c.s. values (averaged over all crops) for two methods of harvest at Babinda in 1967

Method of harvest	Period ending			Season
	Early	Mid	Late	
Chopped	12.01	13.24	13.65	12.84
Whole-stalk	12.16	13.51	14.35	13.29
F value	2.94	8.38**	37.06**	37.58**

** Significant at 1% level

TABLE 15 - C.c.s. values of Q.57 (averaged over all crops) for two methods of harvest at Babinda in 1968

Method of harvest	Period ending					Season
	20.7.68	17.8.68	14.9.68	12.10.68	23.11.68	
Chopped	12.85	13.33	13.94	13.32	12.64	13.21
Whole-stalk	13.08	13.53	14.19	13.97	13.31	13.59
F value	8.05**	5.06*	5.87*	18.13**	17.24**	47.45**

* Significant at 5% level   ** Significant at 1% level

TABLE 16 - C.c.s. values of Q.57 (averaged over all crops) for two methods of harvest at Tully in 1968

Method of harvest	Period ending						Season
	13.7.68	10.8.68	7.9.68	5.10.68	2.11.68	7.12.68	
Chopped	13.87	14.20	14.75	14.66	14.22	12.84	14.12
Whole-stalk	14.08	14.60	15.17	15.14	15.20	13.69	14.59
F value	3.85*	11.10**	6.08*	6.50*	40.10**	9.16**	40.35**

* Significant at 5% level   ** Significant at 1% level

plant Q.57 at Babinda in 1968. In ratoons, however, it is apparent that chopped cane gives significantly lower c.c.s. than whole-stalk cane for both Q.57 and Q.83. The decrease in c.c.s. as the ratoons get older (noted in an earlier section) is less pronounced with whole-stalk cane than with chopped cane. As most of the whole-stalk cane was cut manually, it seems very likely that mechanical harvesting is a major factor causing the decrease in c.c.s. in later ratoons.

It is interesting to note that the difference between chopped and whole-stalk cane is approximately the same at Babinda and Tully for both Q.57 and Q.83. Thus, the effect of chopper harvesting is not the reason for lower c.c.s. at Babinda than Tully.

Tables 14, 15 and 16 show that the difference between chopped and whole-stalk cane increases as the season progresses. This effect which is apparent at both Babinda and Tully, is probably caused by greater deterioration of chopped cane later in the season when the temperature is higher. Q.57 seemed to be much more affected than Q.83 and the Q.83 results are not reported for that reason.

That Q.57 is more affected could be due to the lack of any ratoons of Q.83 older than first ratoon. A study of the results for each crop class during the season revealed only small differences between chopped and whole-stalk cane in the plant crops of both Q.57 and Q.83 but showed much greater differences in all ratoon crops as the season progressed. This was true for both Q.57 and Q.83 and at both Babinda and Tully. This suggests the possibility of greater deterioration in ratoon crops than plant crops.

This could be related to greater amounts of extraneous matter in the sprawled ratoon crops. At Tully, preferential crushing of chopped cane was carried out to reduce time between harvest and milling. Nevertheless, the difference in c.c.s. between whole-stalk and chopped cane was still obvious.

Shading Effects

In Table 17, the effect of shading on c.c.s. is presented for Q.57 for both 1967 and 1968 and for Q.83 in 1968. Figures for both Babinda and Tully are given and the c.c.s. values are averaged over all crop classes and the entire season. With the 1967 Babinda data, the farms classified as having any shading were grouped for analysis whereas, with the 1968 data, the different classifications of shading (shaded in a.m., p.m., or a.m. and p.m.) were analysed separately. With the Tully data, no farms were classified as having shading in both morning and afternoon.

TABLE 17 - The effect of shading on the c.c.s. of Q.57 and Q.83 at Babinda and Tully

	1967	1968			
	Babinda	Babinda		Tully	
	Q.57	Q.57	Q.83	Q.57	Q.83
Unshaded, U	13.07	13.39	14.35	14.44	15.31
Shaded, S	12.86	12.92	14.06	14.17	15.07
(a) Shaded in a.m., SM		12.03	13.57	14.20	14.95
(b) Shaded in p.m., SA		13.25	14.36	14.16	15.10
(c) Shaded in a.m. and p.m., SMA		12.93	13.85		
Mean	13.04	13.34	14.29	14.39	15.28

Significant differences:

1. 1967 Babinda Q.57 - Nil
2. 1968 Babinda Q.57 - U >> S, SM, SMA; SA >> SM; SMA >> SM
3. 1968 Babinda Q.83 - U >> S, SM, SMA; SA >> SM, SMA
4. 1968 Tully Q.57 - U >> S, > SA
5. 1968 Tully Q.83 - U >> S, > SA, SM

In 1967, a significant difference between unshaded and shaded farms was found early in the season but, when the entire season was analysed, the difference of 0.21 (Table 17) was not significant. In 1968, however, the differences between the classes for both Q.57 and Q.83 were highly significant. For both Q.57 and Q.83, the unshaded farms produced c.c.s. values which were highly significantly superior to farms shaded in the morning or shaded in both the morning and the afternoon. For both varieties, but particularly for Q.57, the difference between unshaded farms and farms shaded in the morning was very substantial. Farms shaded in both the morning and the afternoon apparently receive less severe shading than those shaded in the morning only, and the c.c.s. on these farms is not so adversely affected. Farms shaded in the afternoon only are not badly affected at all.

At Tully, for both Q.57 and Q.83, the unshaded farms obtained significantly higher c.c.s. values than the shaded farms, but the difference in c.c.s. was somewhat lower than at Babinda (Table 17). At Tully, there was no evidence to suggest that farms shaded in the morning had lower c.c.s. values than those shaded in the afternoon.

About 15 per cent of Babinda farms and 20 per cent of the Tully farms were classified as shaded but, of the Babinda farms, only about five per cent were classified as being shaded in the morning. Therefore, the effect of shading on mill average in both mill areas is slight as can be seen by the difference between the average of unshaded farms and mill average in Table 17. The effect on individual farms, however, is considerable.

The importance of these results is not the effect on mill average c.c.s. but the demonstration that the amount of solar radiation received is an important factor influencing c.c.s. If mills in the wet belt receive appreciably less radiation than mills in drier areas, c.c.s. is likely to be lower. Since these analyses were conducted, solarimeters have been located at Babinda and Tully, and it has been found that Tully receives more radiation than Babinda, which could account for the difference in c.c.s. between Babinda and Tully.

Drainage

The effect of drainage on c.c.s. at Tully is shown in Table 18. None of the differences shown in Table 18 was statistically significant. It is interesting to note that land with poor drainage actually produced crops of Q.57 with slightly higher c.c.s. than land with excellent drainage.

It was extremely difficult to classify a farm as having poor drainage because most farms so classified had only problem blocks or patches rather than poor drainage over their entire area. Farms classified as having poor drainage occurred mainly in the peat soils which are not

TABLE 18 - The effect of drainage on the c.c.s. of Q.57 and Q.83 at Tully in 1968

Drainage	Q.57	Q.83
Excellent	14.37	15.28
Medium	14.43	15.29
Poor	14.65	15.01
Mean	14.39	15.28

hard to drain. The problem is to remove the excess water from the drains, and this problem is gradually being overcome. In fact, very few farms were classified as having poor drainage.

Since excellent drainage was not found to be an advantage, this could indicate that mostly peat soils were classified as having poor drainage. That is, drainage may not be unimportant as suggested by these results. It is possible that poorly drained clay soils, for example, would produce crops with a lower c.c.s. than well drained clay soils.

Other studies in the Babinda area have also shown better c.c.s. values in wet peat soils than in wet clay soils.

General Considerations

Although this study has suggested some lines for further investigation, deficiencies in this approach to defining the factors responsible for the problem of low c.c.s. have become obvious. Before any further studies of this nature are contemplated, a considerable amount of work would be necessary to devise means of overcoming these deficiencies.

Perhaps the most notable deficiency is the confounding of several factors in the analyses which were performed. This difficulty could largely be overcome if it were practicable to carry out analyses of several factors simulatneously instead of only one. This would obviously require the use of a computer programme as the manual assessment of the data would become impracticable. These more complex analyses may, however, suffer from insufficient data in certain "cells" in the multiway classification of data and certain restraints would have to be programmed into the analyses.

When the study was initiated, it was realized that weighting factors for c.c.s. would be required. It was reasoned that for factors such as location, soil type, shading, and so on, which were regional in nature, the weighting of the data should be on basis of area. Ideally, c.c.s. should have been weighted on the basis of acres for these factors. On the other hand, other factors such as crop class, would ideally be weighted by tons of cane. Acreage data were not available for this particular study and it was considered that weighting on the basis of tons of cane was the next best approximation for all factors. If cane per acre were constant over the whole area, the two weighting factors would produce the same result.

Although c.c.s. was the foremost consideration in the conduct of these analyses of data, the effects of the various factors on yields of cane should not be neglected in any future studies of this type. Too often, farmers are obsessed with c.c.s. and will accept a low yielding crop with a c.c.s. above mill average rather than aim for a crop which optimizes returns.

For some of the factors examined, placing too much emphasis on the c.c.s. data could result in erroneous recommendations, e.g. although variety A could be superior in c.c.s. to variety B late in the season, it should not be recommended for late season harvest if ratoons from a late cut crop are inferior. Similarly, because high c.c.s. cane is grown on gravelly soils, it does not make them the most desirable soils in the area, since they are recognized as being low producers.

Overall, the study has shown considerable consistency in the c.c.s. obtained throughout the Babinda mill area irrespective of the various factors taken into consideration. It would seem, therefore, that there is an influence of local climate on the level to which cane can accumulate sugar, which overrides most other factors. Although minor improvements in c.c.s. may be derived from variations in management techniques, except for reducing delays in the milling of cane, the study has given very little indication of the type of management improvements which should be attempted. As pointed out previously, yields of cane must also be taken into consideration, and it is possible that the Babinda farmers will have to be reconciled to being producers of comparatively low c.c.s. cane and concentrate on techniques which will improve the yielding ability of their crops without lowering the c.c.s. further. In this respect, the large areas of land in the Babinda area which remain in a wet state for many months of the year should be the subject of further study on the effects of drainage on the production of sugar per acre.

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