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Bureau of Sugar Experiment Stations

A CONDENSED REPORT ON CANE DETERIORATION TRIALS: FAIRYMEAD, 1967 SEASON

February, 1968.

CANE DETERIORATION TRIALS: FAIRYMEAD, 1967 SEASON

The report set out below is a precis of a full report on these trials. The full report, which includes a complete record of all the results of the trials, was signed by Messrs. P.G. Atherton, Senior Mill Technologist, B.T. Egan, Senior Pathologist, and L.K. Kirby, Mill Technologist.

Introduction

Following discussion between the Australian Sugar Producers' Association and the Director of the Bureau of Sugar Experiment Stations it was decided to carry out a series of cane deterioration trials in the South Queensland district during the 1967 season. As the Management of Fairymead Mill offered to supply and harvest cane for these tests from their plantation, and to make available laboratory facilities for this work, it was decided to carry out the work at Fairymead.

The planning and supervision of the project was placed in the hands of the Bureau of Sugar Experiment Stations. This organization provided most of the major items of laboratory equipment, and had one officer working full time on the project with other officers working part time. The Central Sugar Cane Prices Board seconded two of its staff members to work under the direction of the Bureau supervisor. Fairymead mill, as well as arranging cane supply, arranged for the remainder of the necessary items of laboratory equipment to be provided, and also provided staff assistance for the work. Other parties interested in the project, with whom discussions were held regarding the work programme, were the Queensland Cane Growers' Council and the Fairymead Mill Suppliers' Committee.

Programme of Work

The tests were designed to compare the deterioration rates of stored mechanically harvested whole stalk cane and stored chopper harvested cane.

Basically, the weekly work programme consisted of :-

1. A zero to four days storage trial (analysed daily)
2. A zero and one day storage trial
3. A zero and three day storage trial

The commencement of this work programme was hampered initially due to very wet field conditions caused by early rains. Rain during the programme also caused some disruption and difficulties. The majority of trials, however, were harvested in spite of these problems, and the original programme was, infact, expanded in the latter stages of the season to increase the number of comparisons at storage times of two and four days.

These tests considered the deterioration of the cane from two aspects; firstly, the effect of storage on c.c.s. loss from both types of cane and, secondly, the effect of storage on the chemical composition of the juice obtained from the stored cane. This latter aspect is considered of importance as significant adverse changes in juice composition could seriously affect factory performance.

C.C.S. was determined by three methods on each sample, namely :-

1. C.C.S. by the normal method for cane payment, i.e. from first expressed juice analysis using spindle brix, and fibre per cent cane.

2. C.C.S. by the normal method for cane payment except that refractometer brix was used instead of spindle brix.

3. C.C.S. by direct wet disintegrator analysis of prepared cane.

In all tests weight loss was determined and the c.c.s. differences shown in the tables refer to corrected c.c.s., i.e. weight corrections have been applied to relate the c.c.s. values in the stored cane back to original weight.

The following aspects of first expressed juice composition were examined; purity, acidity, pH, reducing sugars, alcohol precipitated gums, and starch. The actual methods of analysis are detailed in a subsequent section.

Harvesting Procedure

The object of this investigation was to test the deterioration rate, under practical conditions, of cane which could be considered as being reasonably representative of that encountered in the South Queensland district. The trial sites available, which were limited, included crops in the "light", "medium", and "heavy" category, although the majority could be classed as medium. Evenness of field and crop were considered most important when selecting trial sites. Each plot was of sufficient area to provide three trucks of each type for the fresh cane sample and for each day's delay period.

The harvesting procedure adopted was to divide each trial site into two approximately equal portions and harvest one portion by chopper and the other by whole stalk machines. Randomization of trucks from each portion was then carried out during transport from the field to the mill siding.

For the purposes of this investigation "fresh cane" samples were those which had been burnt approximately one day previously and which were crushed with a minimum practicable time delay after harvesting. Average time delays are shown in the following table :-

TABLE 1. Time Delay - Hours

Sample	Zero	1 day	2 days	3 days	4 days
			Burn to Cut		
Whole Stalk	22	25	26	21	22
Chopper	24	30	32	27	29
			Cut to Crush		
Whole Stalk	6	28	50	73	98
Chopper	4	23	44	67	91
			Burn to Crush		
Whole Stalk	28	53	76	94	120
Chopper	28	53	76	94	120

Sampling and Analysis

All trucks in the test rakes of cane were weighed before the trucks for the zero test were tipped. Test trucks for the various days' time delay were then re-weighed just prior to tipping, so that weight loss over the storage period could be determined.

Cane for disintegrator analysis and moisture determination was removed from the prepared cane elevator in six snap portions, by means of a pneumatically-operated slide on the underside on the elevator. The resulting sample, of approximately 150 pounds of cane, was mixed and sub-sampled down to a ten pound aliquot. This was then hammer-milled for 15 seconds and analysed with a minimum of delay.

First expressed juice was sampled from number one mill in the normal manner, and the various analyses carried out with a minimum of delay.

The prepared cane and first expressed juice were analysed for the following :-

1. Prepared Cane Analysis

   (i) Moisture per cent cane
   (ii) Brix and pol per cent cane by the wet disintegrator method (ref. Deicke R. Proc. 10th Cong. I.S.S.C.T. p.173)

From the brix and moisture figures, fibre per cent cane was calculated by difference.

2. First Expressed Juice Analysis

   (i) Brix by spindle
   (ii) Brix by refractometer
   (iii) Pol by the dry lead method
   (iv) pH
   (v) Acidity by titration of a 10 ml sample to 8.5 pH with 0.1 N NaOH
   (vi) Reducing sugars by the method of Eynon and Lane. Results have been expressed as per cent of refractometer brix.
   (vii) Gums by the U.S. Department of Agriculture Method using phenol in place of anthrone. Results have been expressed as per cent of refractometer brix.
   (viii) Starch by the CL 6/65 method of the C.S.R. Company. (The starch results were found to be not relevant to the deterioration problem and have not been reported in this precis).

Results and Discussion

Cane Quality :

The average analyses for fresh cane samples are shown in table two.

From the averages in table two it can be seen that the cane harvested by the chopper machine would appear to be of a higher quality, in almost every aspect, than its whole-stalk counterpart. A statistical analysis of the results, however, has shown that, while the averages were different these differences were only statistically significant in the case of fibre per cent cane. The differences in the other averages could have been purely fortuitous and can only be taken as indicative.

TABLE 2. Average Analyses of Fresh Cane

	Whole Stick	Chopper	Diff.
% Fibre in Cane	14.68	14.19	0.49
C.C.S. IXJ Spindle	14.17	14.29	-0.12
C.C.S. IXJ Refractometer	14.52	14.65	-0.13
C.C.S. Disintegrator	14.28	14.42	-0.14
IXJ Spindle Purity	87.64	87.88	-0.24
IXJ Refractometer Purity	90.70	90.87	-0.17
IXJ pH	5.43	5.41	0.02
IXJ Acidity	1.94	1.88	0.06
IXJ Reducing Sugars % Solids	1.54	1.47	0.07
IXJ Gums % Solids	0.31	0.32	-0.01

Furthermore, in the case of the average c.c.s. figures, the higher c.c.s. for the chopper harvested cane can be almost entirely explained by the lower fibre content of this cane. This lower fibre content for the chopper harvested cane would appear to be due to a lower extraneous matter content. This contention cannot be proven, and is merely an observation, but the chopper cane appeared, by visual examination, to be of a lower extraneous matter content. The chopper harvesters used in these trials were fitted with blower attachments, which did remove a substantial proportion of any extraneous matter harvested.

From table two it can also be seen that, for both whole stalk and chopper cane, the disintegrator method of cane analysis gave a higher c.c.s. than the standard first expressed juice method. However, these differences were not statistically significant and could quite possibly be due to chance, as an examination of test results shows both positive and negative differences between the two methods.

Overall Average Differences in Quality after One, Two, Three and Four Days' Storage

The changes in first expressed juice and cane composition due to storage are shown in tables three to ten inclusive. The mean differences shown in these tables have been subjected to statistical analysis using the students' "t" test. The results of these "t" tests are set out in the tables with one, two or three asterisks to indicate when a difference is significant at the five per cent level, the one per cent level and the point one per cent level respectively.

TABLE 3. One Day Storage: September-October

Differences Zero to One Day	Whole Stalk Harvested				Chopper Harvested				Increased Deterioration Chopper over Whole Stalk		
	Mean	% Change	S. E.	"t"	Mean	% Change	S. E.	"t"	Mean	S. E.	"t"
Weight	-	- 1.3	-	-	-	- 1.2	-	-	-	-	-
C.C.S. Spin.	-0.11	- 0.8	0.146	0.72	-0.06	- 0.4	0.146	0.44	-0.05	0.181	0.23
C.C.S. Ref.	-0.13	- 0.9	0.133	0.95	-0.11	- 0.7	0.135	0.84	-0.02	0.139	0.10
C.C.S. Disr.	-0.30	- 2.1	0.143	2.08	-0.22	- 1.5	0.182	1.20	-0.08	0.232	0.34
IXJ Purity	+0.53	+ 0.6	0.563	0.94	-0.08	- 0.1	0.408	0.19	0.61	0.852	0.71
IXJ pH	+0.07	+ 1.3	0.022	3.05*	-0.08	- 1.5	0.063	1.19	0.15	0.066	2.16(6%)
IXJ Acidity	+0.03	+ 1.8	0.149	0.18	-0.06	- 3.6	0.077	0.78	0.09	0.181	0.52
IXJ R/S	+0.11	+ 7.6	0.181	0.58	+0.24	+18.2	0.102	2.34*	0.13	0.168	0.80
IXJ Gums	+0.06	+20.0	0.018	3.26**	+0.18	+58.1	0.066	2.71*	0.12	0.065	1.83

TABLE 4. One Day Storage: November-December

Differences Zero to One Day	Whole Stalk Harvested				Chopper Harvested				Increased Deterioration Chopper over Whole Stalk		
	Mean	% Change	S. E.	"t"	Mean	% Change	S. E.	"t"	Mean	S. E.	"t"
Weight	-	- 0.8	-	-	-	- 0.9	-	-	-	-	-
C.C.S. Spin.	+0.09	+ 0.6	0.247	0.35	-0.03	- 0.2	0.220	0.13	0.12	0.319	0.36
C.C.S. Ref.	+0.13	+ 0.9	0.231	0.56	-0.13	- 0.9	0.208	0.63	0.26	0.305	0.86
C.C.S. Disr.	+0.17	+ 1.2	0.286	0.60	+0.09	+ 0.7	0.181	0.51	0.08	0.377	0.21
IXJ Purity	-0.56	- 0.6	0.534	1.04	-0.56	- 0.6	0.486	1.16	Zero	0.695	Zero
IXJ pH	-0.09	- 1.7	0.050	1.70	-0.16	- 3.0	0.068	2.28*	0.07	0.046	1.52
IXJ Acidity	+0.13	+ 5.6	0.213	0.59	+0.21	+ 9.5	0.212	0.98	0.08	0.222	0.37
IXJ R/S	+0.07	+ 4.1	0.165	0.41	+0.36	+21.2	0.143	2.50*	0.29	0.105	2.78*
IXJ Gums	+0.04	+12.5	0.025	1.64	+0.32	+97.0	0.079	4.01**	0.28	0.092	3.00*

TABLE 5. One Day Storage: Whole Season

Differences Zero to One Day	Whole Stalk Harvested				Chopper Harvested				Increased Deterioration Chopper over Whole Stalk		
	Mean	% Change	S. E.	"t"	Mean	% Change	S. E.	"t"	Mean	S. E.	"t"
Weight	-	- 1.1	-	-	-	- 1.1	-	-	-	-	-
C.C.S. Spin.	-0.02	- 0.1	0.134	0.16	-0.05	- 0.4	0.123	0.40	0.02	0.218	0.12
C.C.S. Ref.	-0.02	- 0.1	0.125	0.12	-0.12	- 0.8	0.115	1.05	0.10	0.153	0.69
C.C.S. Disr.	-0.09	- 0.6	0.153	0.62	-0.08	- 0.6	0.131	0.63	-0.01	0.205	0.05
IXJ Purity	+0.06	+ 0.1	0.402	0.14	-0.29	- 0.3	0.309	0.94	0.35	0.560	0.62
IXJ pH	Zero	Zero	0.030	0.07	-0.11	- 2.0	0.046	2.41*	0.11	0.041	2.65*
IXJ Acidity	+0.07	+ 3.6	0.123	0.57	+0.06	+ 3.2	0.125	0.46	-0.01	0.139	0.09
IXJ R/S	+0.09	+ 5.8	0.122	0.73	+0.29	+19.7	0.083	3.51**	0.20	0.105	1.92
IXJ Gums	+0.05	+16.1	0.015	3.47**	+0.24	+75.0	0.052	4.64***	0.19	0.055	3.40**

TABLE 6. Three Days Storage: September-October

Differences Zero to Three Days	Whole Stalk Harvested				Chopper Harvested				Increased Deterioration Chopper over Whole Stalk		
	Mean	% Change	S.E.	"t"	Mean	% Change	S.E.	"t"	Mean	S.E.	"t"
Weight	-	- 2.7	-	-	-	- 3.7	-	-	-	-	-
C.C.S. Spin.	-0.33	- 2.3	0.198	1.68	-1.08	- 7.4	0.229	4.70***	0.75	0.348	2.14(6%)
C.C.S. Ref.	-0.33	- 2.2	0.217	1.51	-1.08	- 7.2	0.206	5.26***	0.75	0.330	2.29*
C.C.S. Disr.	-0.51	- 3.5	0.199	2.58*	-1.55	-10.4	0.244	6.34***	1.04	0.259	3.99**
IXJ Purity	+0.03	Zero	0.497	0.06	-2.31	- 2.6	0.604	3.82**	2.34	0.951	2.46*
IXJ pH	-0.05	- 0.9	0.046	1.00	-0.30	- 5.5	0.069	4.32**	0.25	0.075	3.41**
IXJ Acidity	+0.12	+ 7.1	0.118	1.02	+0.38	+22.8	0.118	3.20**	0.26	0.177	1.45
IXJ R/S	+0.11	+ 7.6	0.113	1.02	+1.10	+83.3	0.167	6.58***	0.99	0.189	5.21***
IXJ Gums	+0.40	+133.3	0.074	5.36***	+1.24	+387.5	0.216	5.73***	0.84	0.206	4.08**

TABLE 7. Three Days Storage: November-December

Differences Zero to Three Days	Whole Stalk Harvested				Chopper Harvested				Increased Deterioration Chopper over Whole Stalk		
	Mean	% Change	S.E.	"t"	Mean	% Change	S.E.	"t"	Mean	S.E.	"t"
Weight	-	- 3.2	-	-	-	- 4.3	-	-	-	-	-
C.C.S. Spin.	-0.30	- 2.2	0.454	0.66	-1.39	-10.1	0.251	5.55***	1.09	0.451	2.43*
C.C.S. Ref.	-0.40	- 2.8	0.478	0.84	-1.46	-10.3	0.256	5.71***	1.06	0.487	2.17(6%)
C.C.S. Disr.	-0.40	- 2.9	0.527	0.85	-1.75	-12.8	0.246	7.06***	1.35	0.370	3.49**
IXJ Purity	-0.39	- 0.4	0.811	0.49	-3.74	- 4.3	0.707	5.29***	3.35	0.830	4.03**
IXJ pH	-0.04	- 0.7	0.057	0.68	-0.44	- 8.3	0.082	5.38***	0.40	0.087	4.58**
IXJ Acidity	-0.29	-12.6	0.234	1.24	+1.06	+48.0	0.227	4.68**	1.35	0.298	4.54**
IXJ R/S	+0.56	+32.9	0.336	1.66	+1.64	+96.5	0.451	3.64**	1.08	0.351	3.10*
IXJ Gums	+0.23	+71.9	0.067	3.35**	+1.21	+366.7	0.164	7.37***	0.98	0.134	7.33***

TABLE 8. Three Days Storage: Whole Season

Differences Zero to Three Days	Whole Stalk Harvested				Chopper Harvested				Increased Deterioration Chopper over Whole Stalk		
	Mean	% Change	S. E.	"t"	Mean	% Change	S. E.	"t"	Mean	S. E.	"t"
Weight	-	- 2.9	-	-	-	- 4.0	-	-	-	-	-
C. C. S. Spin.	-0.32	- 2.3	0.218	1.46	-1.21	- 8.5	0.169	7.17***	0.89	0.273	3.27**
C. C. S. Ref.	-0.36	- 2.5	0.233	1.55	-1.25	- 8.5	0.161	7.74***	0.89	0.271	3.27**
C. C. S. Disr.	-0.46	- 3.2	0.234	2.09*	-1.63	-11.3	0.174	9.32***	1.17	0.211	5.37***
IXJ Purity	-0.15	- 0.2	0.439	0.35	-2.92	- 3.3	0.475	6.15***	2.77	0.644	4.30***
IXJ pH	-0.04	- 0.7	0.035	1.23	-0.36	- 6.7	0.054	6.70***	0.32	0.058	5.50***
IXJ Acidity	-0.06	- 3.1	0.126	0.44	+0.67	+35.6	0.138	4.86***	0.73	0.199	3.66**
IXJ R/S	+0.30	+19.5	0.160	1.90	+1.33	+90.5	0.217	6.14***	1.03	0.180	5.71***
IXJ Gums	+0.32	+103.2	0.054	6.03***	+1.23	+384.4	0.139	8.81***	0.91	0.127	7.10***

TABLE 9. Two Days Storage: Whole Season

Differences Zero to Two Days	Whole Stalk Harvested				Chopper Harvested				Increased Deterioration Chopper over Whole Stalk		
	Mean	% Change	S. E.	"t"	Mean	% Change	S. E.	"t"	Mean	S. E.	"t"
Weight	-	- 2.3	-	-	-	- 2.6	-	-	-	-	-
C. C. S. Spin.	-0.18	- 1.3	0.298	0.62	-0.59	- 4.1	0.141	4.18**	0.41	0.311	1.31
C. C. S. Ref.	-0.19	- 1.3	0.290	0.65	-0.54	- 3.7	0.142	3.83**	0.35	0.334	1.07
C. C. S. Disr.	-0.15	- 1.1	0.305	0.50	-0.80	- 5.6	0.240	3.32**	0.65	0.282	2.28*
IXJ Purity	-0.97	- 1.1	0.558	1.74	-1.55	- 1.8	0.342	4.54***	0.58	0.673	0.86
IXJ pH	-0.08	- 1.5	0.059	1.40	-0.31	- 5.7	0.057	5.46***	0.23	0.050	4.58***
IXJ Acidity	+0.35	+18.0	0.198	1.76	+0.34	+18.1	0.150	2.29*	-0.01	0.183	0.03
IXJ R/S	+0.29	+18.8	0.163	(10%) 1.77	+0.89	+60.5	0.187	4.75***	0.60	0.183	3.28**
IXJ Gums	+0.18	+58.1	0.056	(10%) 3.29**	+0.76	+237.5	0.168	4.50***	0.58	0.148	3.86**

TABLE 10. Four Days Storage: Whole Season

Differences Zero to Four Days	Whole Stalk Harvested				Chopper Harvested				Increased Deterioration Chopper over Whole Stalk		
	Mean	% Change	S.E.	"t"	Mean	% Change	S.E.	"t"	Mean	S.E.	"t"
Weight	-	- 4.0	-	-	-	- 5.2	-	-	-	-	-
C.C.S. Spin.	-0.42	- 3.0	0.227	1.86 (10%)	-1.67	-11.7	0.193	8.65***	1.25	0.150	8.31***
C.C.S. Ref.	-0.50	- 3.4	0.235	2.11 (6%)	-1.77	-12.2	0.204	8.69***	1.27	0.237	5.39***
C.C.S. Disr.	-0.82	- 5.7	0.245	3.34***	-2.67	-18.5	0.350	7.64***	1.85	0.280	6.62***
IXJ Purity	+0.12	+ 0.1	0.436	0.27	-3.61	- 4.1	0.563	6.41***	3.73	0.633	5.88***
IXJ pH	-0.09	- 1.7	0.045	2.04 (7%)	-0.56	-10.4	0.061	9.17***	0.47	0.081	5.76***
IXJ Acidity	+0.05	+ 2.6	0.175	0.28	+1.05	+55.9	0.159	6.59***	1.00	0.243	4.11**
IXJ R/S	+0.42	+27.3	0.202	2.07 (6%)	+1.85	+125.9	0.299	6.18***	1.43	0.221	6.47***
IXJ Gums	+0.44	+141.9	0.076	5.80***	+1.71	+534.4	0.226	7.58***	1.27	0.211	6.03***

LEGEND

1. S.E. equals standard error of the mean
2. * indicates a difference significant at the 5% level
3. ** indicates a difference significant at the 1% level
4. *** indicates a difference significant at the 0.1% level
5. IXJ R/S refers to Reducing Sugars % Solids
6. IXJ Gums refers to Gums % Solids

These tables will now be discussed according to the variables concerned.

1. Weight Loss

As mentioned previously, a considerable quantity of rain fell during the period of these investigations. In all approximately 30 per cent of trials were affected to some degree by rainfall and, in certain instances, weight increases were encountered as a result of water absorption by stored samples.

A summary of weight changes, which have been converted to exact 24 hour storage intervals, is shown in table 11.

TABLE 11. Per Cent Weight Loss

	Whole Stalk Cane	Chopper Cane
24 hours storage	1.21	1.35
48 hours storage	2.52	3.02
72 hours storage	3.04	4.12
96 hours storage	3.83	5.15

It can be seen that the weight losses are higher for chopper cane than for whole stalk harvested cane. This would be expected due to the larger surface area of exposed ends in chopper samples.

2. C.C.S. Loss

Considering c.c.s. loss, it can be seen that small c.c.s. losses have been recorded, for both types of cane, after one day's storage. These losses were not, however, statistically significant and can only be considered as indicative.

Once the cane has been stored for two days, however, statistically significant losses have occurred in the chopper cane, amounting to some 4.1 per cent of the original c.c.s., as determined by the standard method, and 5.6 per cent, as determined by disintegrator analysis. Furthermore, the difference in c.c.s. loss between the whole stalk and chopper cane can be seen to be statistically significant, when considering disintegrator analysis.

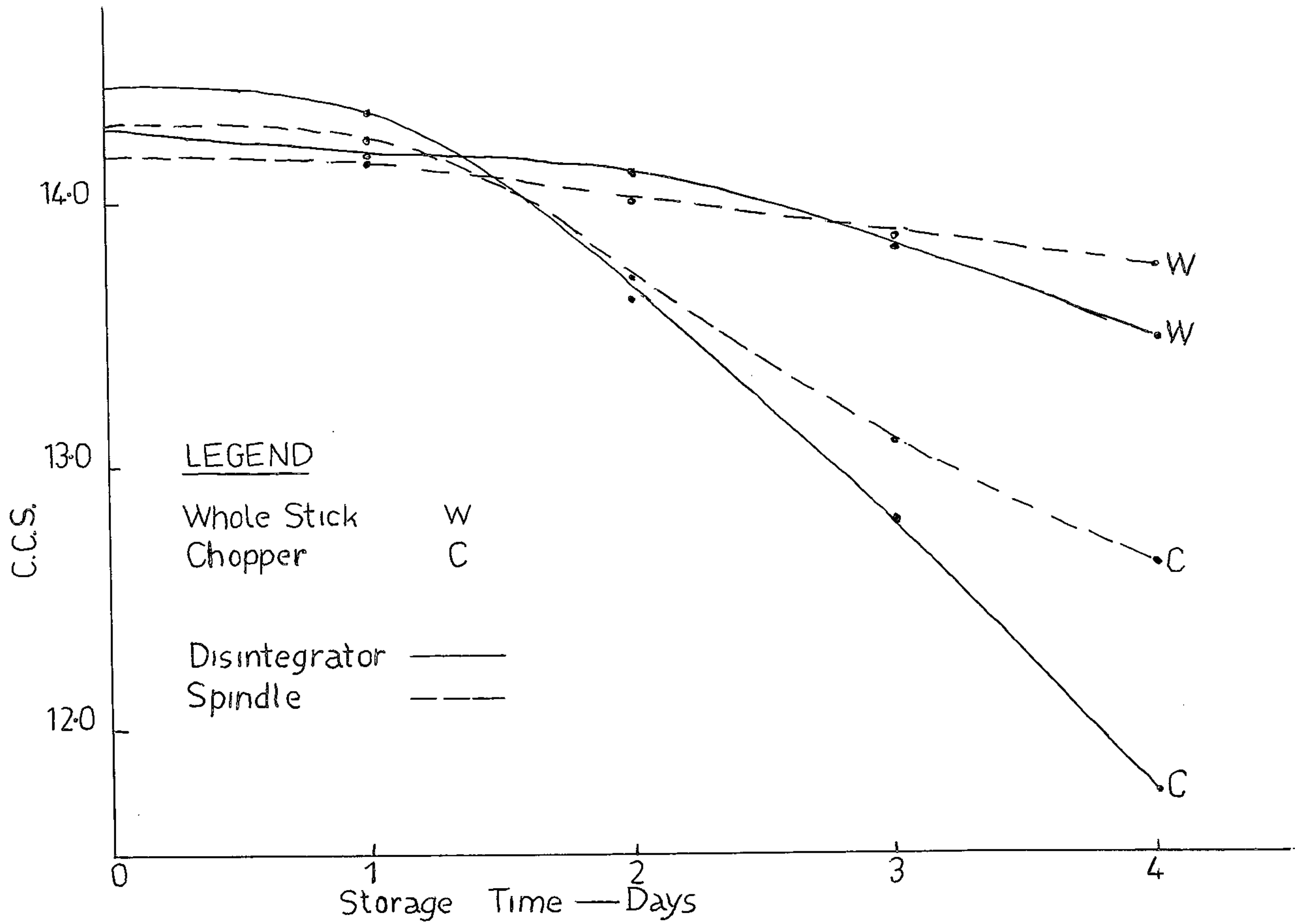
When the cane has been stored for more than two days, statistically significant losses are apparent in both types of cane. The losses in chopper cane are, however, some three and a half times as high as the losses for whole stalk cane. The increased loss for chopper cane is shown to be statistically significant at better than the one per cent level in every case. After three days' storage, the period for a normal weekly shut-down, the chopper cane has lost some 8.5 per cent of original c.c.s., as determined by the standard method, and some 11.3 per cent by disintegrator analysis. These figures would represent a serious economic loss to both grower and miller.

The accompanying graph shows the fall in c.c.s. versus storage time, for both types of cane, when analysed by both the standard method and the disintegrator method. The graph shows clearly the far more rapid fall in chopper cane c.c.s. than whole stalk cane c.c.s. It also illustrates the fact that, whilst the c.c.s. determined by disintegrator starts at a higher level than the c.c.s. determined by the standard method, it falls at a greater rate when the cane is stored. The result of this combination of factors is that the c.c.s. determined by disintegrator becomes lower than the c.c.s. determined by the standard method after a period of some three days for whole stalk cane, and one and a half days for chopper cane. It should, however, be pointed out that, in this instance, the original differences between c.c.s. by disintegrator and by the standard method were not proven to be statistically significant and the trends in this aspect of the work can be considered as indicative only.

Considering tables six, seven and eight, it can be seen that the deterioration rate for chopper cane increased considerably towards the end of the season, as would be expected due to the hotter conditions at the end of the year.

3. Juice Purity Changes

From the tables it can be seen that there were no statistically significant changes in the purity of juice from whole stalk cane. However, there were significant changes in the purity of juice from chopper cane which had been stored for two or more days. Purity drops of some three units



14·0
13·0
12·0
C.C.S.
LEGEND
Whole Stick W
Chopper C
Disintegrator
Spindle
W
W
C
C
0
1
2
3
4
Storage Time — Days

occurred in chopper cane after three days storage and this lower purity would cause increases in factory losses when processing juice from this cane.

4. Changes in Juice pH and Acidity

These results show an almost identical pattern with the results for juice purity. There are no statistically significant changes with whole stalk cane, but very significant changes with chopper harvested cane. This increase in acidity (decrease in pH) indicates, as did the change in purity, the deteriorated nature of the juice from stored chopper cane.

5. Changes in Reducing Sugar Content of Juice

This aspect, once again, follows the pattern shown before except that statistically significant deterioration is evident in the juice from chopper cane after one day's storage. This indicates that appreciable deterioration of juice has occurred even at this stage.

6. Changes in Gum Content of Juice

The percentage changes in gum content and the statistical significance of these changes are set out in table 12.

TABLE 12. Per Cent Increase in Gum Content

Storage Time	Whole Stalk Cane	Chopper Cane
One day	16.1 **	75.0 ***
Two days	58.1 **	237.5 ***
Three days	103.2 ***	384.4 ***
Four days	141.9 ***	534.4 ***

It can be seen that the increases for chopper cane are of a much higher order than those for whole stalk cane, but the figures are most disturbing in that they show that significant changes have occurred in the juice from both types of cane, after only one day's storage.

Conclusions

From an overall study of the results it can be seen, from the point of view of c. c. s., that losses after 24 hours storage were relatively small and could not be proven to be statistically significant. However, even after this period, undesirable changes have occurred in the composition of the juice from both types of cane. This would indicate that minimum practicable storage times are desirable for both types of cane. With storage periods longer than one day, both types of cane show further deterioration, but the chopper cane deteriorates at a much faster rate than does the whole stalk cane. The changes which have occurred in chopper cane after week-end storage represent considerable monetary loss to both grower and miller.

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THE PRODUCTION POTENTIAL OF EXISTING ASSIGNED AREAS

The purpose of this paper is to attempt an assessment of the production potential of Queensland's existing assigned areas under different conditions. The circumstances which might be expected to influence production levels would include :-

(1) maximum usage of net assignments,

(2) alteration of the existing Central Sugar Cane Prices Board order to provide for annual harvest of 80 per cent of gross assignment,

(3) anticipated upward trend due to varietal, biological and nutritional improvements, and

(4) varying climatic conditions.

Maximum Usage of Net Assignments

It is essential, if an estimate is to be made of production potential on existing net assignments, to examine present farming procedures and to keep in mind the proviso that all sugar grown on the net area will be acquired.

With this in mind the production figures for the 1962 season have been analysed. The sugar areas have been divided into Northern (ten mills), Lower Burdekin (four mills), Central (eight mills) and Southern (nine mills). A table is set out below showing, for each division, the net assigned acreage, the acreage harvested for milling in 1962, and the acreage harvested for plants.

TABLE I

Division	Net Assigned Acreage	1962 Harvested Acreage	Acreage Used for Plants	Acreage of net Assignment not Used
Northern	149,718	141,000	3,765 (2.5%)	1,959
Lower Burdekin	52,290	39,911	987 (1.9%)	10,244
Central	144,628	119,405	2,539 (1.7%)	19,792
Southern	99,629	87,161	1,652 (1.7%)	3,924

Note : In each division an allowance has been made, amounting to 2 per cent of the net assigned area, for other reasons than plant usage before calculating "assignment not used". The area stoodover in the south has not been included since it is assigned area being used.

Footnote : The calculations used in this paper do not include New South Wales, and all sugar figures quoted are in terms of 94 n.t.

Taking the northern division as an example the acreage used for plants represented 2.5 per cent of the net assigned area; a further 2 per cent was allowed for difficulties in always having the full area in cane; and the 1959 acres still not accounted for represented 1.3 per cent of the net assigned acreage. It should be practicable to get most, if not all, of this 1.3 per cent into the annual harvest and thus approach more closely to the maximim harvestable area allowed by the net assignment. The weighted average sugar per acre production in this division in 1962 was 4.41 tons; so the not-used 1959 acres would have produced an extra 8,640 tons of sugar.

The Lower Burdekin division is a somewhat different problem. There it has been almost traditional to grow large plant crops of cane, but to pay - in the main - scant attention to ratoon crops; ratoons have been looked upon as catch crops and not given the care they deserve. The result of ploughing out so much land after harvesting plant cane has been that the percentage of net assignment used annually is much less than in the Northern division. The figures in the table above show that after allowing for cane plants and an extra 2 per cent for contingencies there were still 10,244 acres of the net assignment not harvested. An examination of Lower Burdekin figures discloses that plant cane averaged 7.41 tons of sugar per acre and ratoon cane 5.06 tons per acre. With a net assigned area of 52,290 acres, and the aforementioned allowances for plants and contingencies, there should have been 50,211 acres available for harvesting. With a normal rotation of one plant to two ratoons the following would have applied :

16,737 acres plant @ 7.41	= 124,022 tons sugar
33,474 acres ratoons @ 5.06	= 169,378 tons sugar
Total	293,400 tons sugar

Since the sugar production on the Lower Burdekin in 1962 with the present system was 241,513 tons a change to the more uniformly practised one plant - two ratoon system would appear to increase sugar production by 42,000 tons.

In the Central division a similar position applies but it is not so marked as in the Lower Burdekin. Here the ratio of ratoon to plant cane acreage is 1.37 instead of the theoretical 2. However, more care is given to ratoon crops than in the Lower Burdekin. After allowing for plant requirements and 2 per cent for contingencies there were still 19,792 acres of the net assignment not harvested in 1962. If we take the net assigned area of 144,628 acres and deduct the allowance for plants and contingencies there should have been 139,193 acres available for harvest. The following calculations would apply :-

46,398 acres plant @ 5.49	= 254,725 tons sugar
92,796 acres ratoon @ 4.00	= 371,184 tons sugar
Total	625,909 tons sugar

The 1962 sugar production in the Central division was 552,878 tons, so a change to the one plant - two ratoon system should result in a gain of 73,000 tons of sugar.

In the Southern division the rotation is more conventional - similar to the Northern division. The table shows that only 3,924 acres were not utilised and, with an average sugar production of 3.94 tons per acre, a further 15,460 tons of sugar could be produced.

Summarising the possible sugar production increase in the four divisions in a year such as 1962 the following is arrived at :-

Northern	8,640 tons 94 n.t. sugar
Lower Burdekin	42,000 tons 94 n.t. sugar
Central	73,000 tons 94 n.t. sugar
Southern	15,460 tons 94 n.t. sugar
Total	139,100 tons 94 n.t. sugar

Since, in 1962, the aggregate sugar production for the State was 1,770,422 tons the proposed optimum usage of the existing net assignment would, in a similar year, add 139,100 tons of sugar to the 1962 figure. This would result in an outturn of 1,909,522 tons.

Alteration from a 75 to an 80 per cent net assigned area

For nearly forty years the proportion of any grower's gross assignment which is permitted to be harvested in any given year has been controlled by an order of the Central Sugar Cane Prices Board. This power was given to the Board by Section 6A (2) of the old Act but is more specifically set out in Section 41 of the 1962 Act.

Section 41 states :-

"(1) In respect of each and every assignment the Central Board shall determine a net area.

(2) The maximum area of land within the defined boundaries of the lands contained in an assignment from which sugar cane may be harvested for delivery to a mill in any season or seasons shall be the net area of the assignment.

(3) The Central Board may at any time and from time to time vary the net area of the assignment with respect to any annual harvest."

As is generally known, the net area presently determined is 75 per cent of the gross.

Throughout the sugar world the frequency of land usage for sugar cane varies between fairly wide limits. In Hawaii, for example, it is normal to grow a plant and three ratoon crops (all of two year duration) and to plough out the final stubble and to replant within a fortnight. There are no fallows or alternative crops. This means that the land is out of cane for only two weeks every eight years. At the other end of the scale the traditional Javan system was to grow only a one-year plant crop and then divert the land for at least two years under food crops. In Queensland the system is between these extremes, and the 75 per cent limitation provides for a rotation which allows a farm to grow a plant and two ratoon crops and then have a six or twelve months fallow (usually under legumes) before being replanted with cane. It frequently happens that, due to flood or pest damage a crop may be ploughed out before its rotation is completed and, to maintain the harvest at 75 per cent of the gross assignment, an extra ratoon is grown on another block. There is ample experience available regarding the capacity of modern cane varieties to produce crops beyond the normal second ratoon.

One means by which more intensive agriculture could be practised on existing assignments would be to increase the net area of the assignment. If that increase were made to a figure of 80 per cent of the gross the natural rotation would be a plant and three ratoon crops with 20 per cent of the gross area fallowed each year.

Despite the arguments of those who decry a monocultural system in the agricultural world, there is a conspicuous lack of evidence to indicate that monoculture has harmed sugar cane soils. Among the oldest cane growing countries of the world are the islands of the British West Indies where it is common to grow fourth, fifth and sixth ratoons and where there is no evidence of soil damage due to lack of rotation. Another country is Mauritius where sixth, seventh and eighth ratoons are common and where there is a similar lack of evidence against growing one crop for a long period on the same soil.

There is a tendency, in some areas in our industry at least, to consider the plant crop as the real profit earner and the subsequent ratoon or ratoons as not deserving of the same measure of attention. If the season is good and the ratoons yield well, so much the better; but if it is not a good year, then there is not much lost. That is a defeatist philosophy. Experience in the Northern and Southern divisions, as discussed earlier in this statement - shows that first and second ratoons can be grown on all properties, to the extent that the net assigned area will allow. But we are more interested, in this portion of the statement, in examining the practicability of growing third ratoons and calculating how such a change in system would improve our industry production.

Statistics from certain overseas countries where long ratooning is practised indicate how the varieties of those countries behave in their particular environments. Such figures are available from Mauritius, Barbados and Jamaica and are set out below :-

Mauritius

Crop	Yield as % of plant cane	% drop from preceding crop
Plant	100	
First ratoon	95.5	4.5
Second ratoon	91.1	4.4
Third ratoon	87.5	3.6
Fourth ratoon	84.8	2.7
Fifth ratoon	83.0	1.8
Sixth ratoon	82.1	0.9

These figures are the averages for the entire crop and illustrate the remarkable capacity of the crop to yield at almost the same level after repeated ratooning. The lessening fall-off in yield suggests that the production curve flattens out at about the eighth ratoons.

In Barbados the figures are not so good as in Mauritius, nor are they in Jamaica - as is shown.

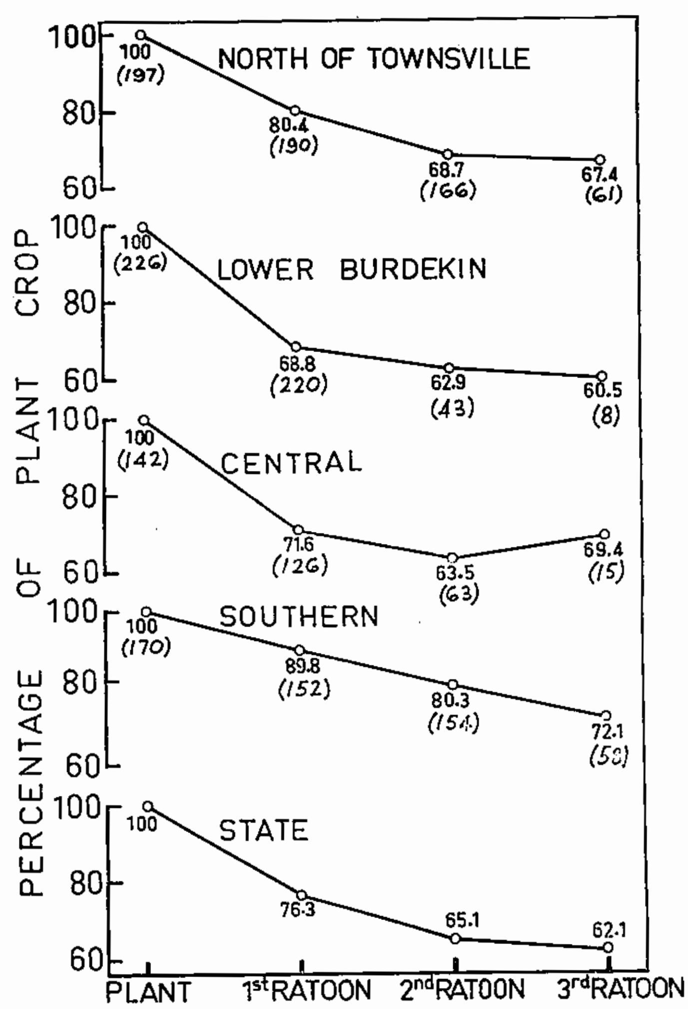
Barbados

Crop	Yield as % of plant cane	% drop from preceding crop
Plant	100	
First ratoon	86.2	13.8
Second ratoon	79.0	7.2
Third ratoon	75.2	3.8
Fourth and fifth ratoon	72.8	2.4

Jamaica

Crop	Yield as % of plant cane	% drop from preceding crop
Plant	100	
First ratoon	83.5	16.5
Second ratoon	79.5	4.0
Third ratoon	79.2	0.3
Older ratoon	75.9	3.3

To illustrate what happens under Queensland conditions it has been necessary to collect special figures since our normally available statistics do not separate first and second ratoon yields, and it was also essential to obtain as many figures as practicable relating to third ratoon yields.



Illustrating the general yielding capacity of Queensland varieties, in plant and succeeding ratoon crops, in the four main divisions of the industry.

So that these figures would be comparable, and not influenced by over-riding seasonal effects, a survey was made in all sugar districts early in 1963. Growers who kept records were asked to supply figures for all varieties which included plant, first and second ratoons, and third ratoons if available, appertaining to the 1962 harvesting season. In that way it has been possible to calculate weighted averages for the four major divisions, the figures all relating to the same season. This summary of yields is shown graphically in the above figure. The graph lines are shown for each district division and for the State as a whole. The plant cane crop is taken as being 100 per cent and each successive ratoon crop as a percentage of the plant crop. At each point on the line the upper figure indicates the percentage, and the lower figure the number of farms from which the figures were collected. This information gives a lead to the expectancy of production of third ratoon cane and allows some assessment of the manner in which gross sugar yield would be affected if a change were made in the Central Sugar Cane Prices Board order to allow 80 per cent of the net area to be harvested annually.

We will use the Northern Division as an example once more, taking 80 per cent of the gross as being the net assignment and use the 1962 season sugar per acre figures for plant and for ratoon cane; these were 5.34 and 3.96 tons respectively. A figure for third ratoon sugar per acre is arrived at by applying the figure in the graph - 67.4 per cent of the plant cane, which is 3.60 tons sugar per acre. We would then have :-

Net assigned area 159,174 acres.	
Less 2.5% for plants and 2% for contingencies	= 151,981 acres
Equivalent to 37,995 ac. plant cane @ 5.34	= 202,893 tons sugar
75,990 ac. 1st and 2nd ratoon @ 3.96	= 300,920 tons sugar
37,995 ac. 3rd ratoon @ 3.60	= 136,782 tons sugar
Total	640,595 tons sugar

If similar reasoning is applied to the Lower Burdekin division the figures become :-

Net assigned area 54,840 acres	
Less 1.9% for plants and 2% for contingencies	= 52,701 acres
Equivalent to 13,175 ac. plant cane @ 7.41	= 97,627 tons sugar
26,350 ac. 1st and 2nd ratoon @ 5.06	=133,331 tons sugar
13,175 ac. 3rd ratoon @ 4.48	= 59,024 tons sugar
Total	289,982 tons sugar

In the Central and Southern divisions respectively the figures would be :-

Central

Net assigned area 153,892 acres	
Less 1.7% for plants and 2% for contingencies	= 148,198 acres
Equivalent to 37,049 ac. plant cane @ 5.49	= 203,399 tons sugar
74,098 ac. 1st and 2nd ratoon @ 4.00	= 296,392 tons sugar
37,049 ac. 3rd ratoon @ 3.81	= 141,157 tons sugar
Total	640,948 tons sugar

Southern

Net assigned area 104,992 acres	
Less 1.7% for plants and 2% for contingencies	= 101,104 acres
Equivalent to 25,276 ac. plant cane @ 4.52	= 114,248 tons sugar
50,552 ac. 1st and 2nd ratoon @ 3.68	= 186,031 tons sugar
25,276 ac. 3rd ratoon @ 3.25	= 82,147 tons sugar
Total	382,426 tons sugar

State total for sugar produced under 100/80 assignment system = 1,953,951 tons.

Since, in the previous section dealing with maximum usage of the existing net assigned area, it was shown that production might reasonably be expected to rise from the 1962 level of 1,770,422 tons to 1,909,522 tons, the increase due to changing to an 80 per cent net assigned area (and still making maximum usage of the land) is surprisingly small, but it is a further 44,429 tons.

Anticipated Upward Trend due to Research Results

The 1962 sugar production of approximately 1,770,422 tons of 94 n.t. was the largest ever produced. It exceeded the previous best by a large margin - about 30.8 per cent - the previous best production being in 1958.

But 1958, as well as the two succeeding years, was one of production in excess of acquisition. The table which follows shows the actual harvested area and production figures for those three years as well as the estimated available area, crop and sugar for the same seasons.

TABLE II

Year	Statistics Recorded			Crop Estimates		
	Acreage harv.	Tons crushed	Sugar Made	Acreage avail.	Tons cane available	Tons sugar available
1958	356,210	9,740,795	1,353,543	392,000	10,675,000	1,473,000
1959	299,732	8,427,731	1,217,020	406,000	10,391,000	1,411,500
1960	327,246	8,685,426	1,319,633	388,000	9,875,000	1,382,000

Note : The acreage estimated as being available for harvest in 1959 contained much standover cane from 1958 and was, on that account, inflated.

If these estimated figures are considered in relation to the sugar production of 1962 it will be seen that the record 1962 figure, although a big step forward, was not such a sudden increase as the recorded figures would indicate. If one examines the sugar figures only, the last five years' production was as follows :-

TABLE III

Year	Sugar grown	Percentage of 1953-57 Average
1958	1,473,000 (estd.)	114
1959	1,411,500 (estd.)	110
1960	1,382,000 (estd.)	108
1961	1,315,393 (actual)	102
1962	1,770,422 (actual)	138

These performances indicate a distinct upgrade in production when the 1958-62 period is compared with the 1953-57 period, and a study of the ten years' figures gives a clearer portrayal of the position than does a comparison of 1962 output with the previous best year. Within that ten-year period the net assigned area rose only from 434,203 to 446,265 acres.

In this same decade the tons sugar per acre averaged 3.40 in the first five years and 4.00 in the last five. Because of this marked rise from one five-year period to the next it is reasonable to accept that the second five-year period (1958-1962) established a new basis for predicting future production. Within this latter five years the sugar per acre figure ranged from 3.53 to 4.57 tons with an average of 4.00.

It is not unreasonable to expect therefore that production forecasts in years in the near future might be based on :-

Minimum (sub-normal season)	3.6 tons sugar per acre
Reasonable (average season)	4.0 tons sugar per acre
Maximum (good season)	4.6 tons sugar per acre

Varying Climatic Conditions

All of the calculations in the first two sections of this paper are based on yields achieved in the 1962 season which, in our present opinion, must be classed as a very good one.

But it is known that the seasonal factor, and its effect on overall production, can be very important. A cyclone or a bad flood year, a drought in Mackay, a drought and a frost in the south can all affect the final sugar tonnage quite severely. However, the industry is not nearly so vulnerable to these seasonal factors as it was a decade ago. The hardy, hybrid canes grown in all areas, but particularly in the central and southern divisions, have smoothed out the previously experienced wild variations in yields. The steady replacement of noble-type canes by more lodging resistant types in flood-prone locations is reducing losses in wet years. And there is a growing awareness of the danger inherent in growing brittle canes in the cyclone belt.

If one accepts the opinion of the meteorologist that, over a considerable period of years, the "average" year is not changing much then we may expect good and subnormal seasons which will result in yields above and below the trend lines. But, by the same reasoning, if the "average" season continues to obtain in the sugar areas, the upward movement shown in the trend lines should persist.

However, the overall effect - with unchanging area under crop - would be that annual yield fluctuations will continue to occur and, for purposes of forecasting sugar output a number of years ahead, it will be necessary to estimate what may be the position in a good, an average and a subnormal season. For such purposes the figures of sugar per acre mentioned previously, viz. 4.6, 4.0 and 3.6 should be reasonably acceptable.

Summary and Conclusions

(1) An examination has been made of the existing assigned areas in the industry and of the use being made of them in the four major divisions.

(2) It is apparent that the net assigned acreage is not being fully used after allowing the actual percentage which is cut for plants each year and a further 2 per cent for unforeseen contingencies.

(3) This unused net assignment (unused in the sense of not being harvested each year) amounted in 1962 to Northern 1,959 ac., Burdekin 10,244 ac., Central 19,792 ac., and Southern 3,924 ac.

(4) Using 1962 yield statistics, and calculating on the basis that each division would be harvesting plant and ratoon acreage in the ratio of 1:2, these unused areas would produce extra sugar (over and above 1962 figures) of the order of

Northern	8,640 tons
Lower Burdekin	42,000 tons
Central	73,000 tons
Southern	15,460 tons
Total	139,100 tons

Should such a practice have obtained in 1962 the overall sugar production would have reached 1,909,522 tons.

(5) A further examination was made of the effect of altering the 100/75 assignment system to a 100/80 system. The 100/80 system, applied to 1962 yields for plant and first and second ratoon cane, and using collected statistical data for third ratoons, resulted in a sugar yield of 1,953,951 tons. This also presupposed optimum usage of the net assignment as in the earlier calculations shown under (4).

(6) Production trend lines point to a gradual improvement in cane per acre and sugar content of cane and suggest that, providing research advances continue, the sugar per acre yield will continue to grow.

(7) There is some evidence to suggest that, in the next five or ten years, and in the absence of a major catastrophe, a reasonable expectation of sugar yield per acre in a good, average and subnormal season, may be 4.6, 4.0 and 3.6 tons respectively. This conclusion, applied to earlier calculations, would result in a table such as follows :-

	Under existing conditions of land usage	Making maximum use of net assignment	Making maximum use of a 100/80 assignment system
	Tons	Tons	Tons
Good year	1,770,422	1,909,522	1,953,951
Average year	1,539,498	1,660,454	1,699,105
Subnormal year	1,385,548	1,494,409	1,529,194

(8) The relatively small additional increase in sugar production resulting from a change to a 100/80 assignment and harvest system is due to the fact that, although there is a 5 per cent increase in harvestable acreage, there is a reduction in plant cane area and an increase in third ratoon area.

(9) It is believed that, with more attention to cultivation, nutrition and watering, ratoons in the Lower Burdekin division could be of greater magnitude, and that the drop from plant to ratoon crops could be reduced. This would provide a further avenue for increased sugar output in that district.

These three figures will be used as the basis for certain other calculations which follow in this paper.

There is evidence to support the statement that the yield of sugar per acre is on the upgrade. It is possible using to-date production figures, to define mathematically calculated trend lines which indicate the movement of production per unit area without the peaks and valleys associated with varying seasons. Such trend lines for "tons of cane per acre" and for "C.C.S." have been prepared for the period 1948 to 1962 for each major district division, and for the State as a whole. An examination of these shows different trends in different divisions, but there is a well-defined upward movement in both cane per acre and sugar content of cane throughout the industry. Should similar technical improvements continue in, say, the 1963-67 period - as in the 1958-62 period, then the continuation of the upward trend in sugar per acre production should be expected.