VARIETAL MILLING TESTS IN EAST AFRICA.

A COMPARISON OF Co.281, Co.290, P.O.J.2878 AND UBA.

By F. D. WHEELER.

With the advent of seedling canes to replace Uba, the suitability of certain new canes for particular circumstances becomes a leading question. The planter is particularly interested in his returns of both sugar and cane per acre, taking into account the ratooning value of each type of cane. The miller, with a factory balanced for the crushing of Uba cane, will have to consider whether any alteration in the capacities of the various departments will have to be made when crushing seedlings as against Uba.

This paper has been compiled from results of factory tests made throughout the 1940 season, and although in the results obtained and summarised there are some cane value figures, such as the comparative values of the seedlings under examination as against Uba in plant and ratoon canes, and also the tons of cane per ton of sugar figures, this paper deals essentially with the factory results obtained when crushing different varieties of cane.

The seedlings compard with Uba were P.O.J.2878, Co.281. and Co.290, and the tests, made fortnightly, have been carried out on plant and first ratoon canes of all the varieties mentioned, whilst only a few tests at similar periods of the season were possible on second ratoons. These latter tests were carried out on consecutive days, and are therefore comparative for that period. The figures obtained have been included in the comparative valuation summary tables in this paper.

From the purity of mixed juice obtained in the milling test, available sucrose (converted into 98.5° pol. sugar), has been calculated, taking as a basis for molasses purity 40°, an approximately average figure obtained throughout the season. This available sucrose figure was calculated by Prinsen Geerlig's formula, and has been taken as an approximately comparative figure for boiling house recovery. All canes having been dealt with in the same manner, comparative results have been obtained, although such results cannot include the variations in final molasses purities obtainable with the different varieties, nor the variations in purity increase due to clarification, and also a similar undetermined loss has been neglected, assuming this figure to be the same for all canes.

Owing to alterations in the clarification equipment of the factory testing these canes, the increases in purities due to clarification has not been obtainable, although a comparison in the ease or difficulty of clarification can be given by the experienced gained during the tests.

The milling plant used consisted of a three-roller crusher, circumferentially grooved with deep hooked chevrons, and four mills, the last two in the train having each its own independent engine. Mill settings were arranged for cane with a fibre content similar to Uba.

In all tests cold maceration water was applied at approximately 150 per cent. fibre behind the third mill, crusher and first mill juices going together to the mixed juice, second, third and fourth mill juices being applied behind the crusher, first and second mills respectively.

The tests of the plant canes covered the period from June to September; the first ratoons from July to November, and the second ratoons during November only.

From the appended tables of milling and sugar production it will be noticed that in all cases of plant and first ratoon tests, the tonnage per hour obtained with Uba was below that of the seedlings, although fibre per hour in the plants of this cane was just a few decimal points higher than Co.281, 0.45 tons higher than P.O.J.2878, and 15 per cent. higher than Co.290.

First ratoon tonnages of fibre per hour were all similar with the exception of Co.281, which cane, having dried out more than the others towards the end of the tests—thus increasing fibre per cent. cane—proved to contain a fibre easily crushed. This feature of Co.281 has been noticed in all the tests carried out, and compares to its advantage with the fibre of both P.O.J.2878 and Co.290.

The latter cane has proved the most troublesome in milling. This may partly be due to the poor steaming qualities of the bagasse, causing a shortage of high-pressure steam, in addition to the unsuitable mill settings for this low fibre content cane. Although the bagasse from P.O.J.2878 has burned well in the furnaces, there has always been a shortage of fuel when crushing this seedling. In both these cases, P.O.J.2878 and Co.290, back pressure steam was very low, and steam necessary for the boiling house had to be augmented with steam from the boilers during these trials. This applied to tests of both plant and ratoons canes of these varieties. There was no difficulty in crushing Uba, and during the tests sufficient fuel was always available, whilst back pressure steam was always sufficient for manufacturing purposes. When crushing Co.281 surplus fuel was available with both plants and ratoons, and sufficient back pressure for all the manufacturing departments in the factory, whilst the milling of this cane, as already mentioned, was carried out with ease.

From the results observed during these tests Co.281 was superior to all the other canes for crushing and steam-producing qualities, and in cane tonnage per hour has proved to be equal to P.O.J.2878 in both plants and first ratoons.

It will be seen from the tables that mill extractions obtained on the plant canes varied respectively with the fibre contents of each cane with the exception of Co.281, which, although of a higher fibre content than P.O.J.2878, nevertheless had a higher mill extraction.

In the first ratoon trials Co.281 had the lowest mill extraction, 0.70 per cent. lower than P.O.J.2878 and 0.44 per cent. lower than Co.290, although it must be noted that the fibre content was over 2 per cent. higher than either of these canes.

In all cases P.O.J.2878 had the highest sucrose per cent. cane figure, followed by Co.281, Co.290 and Uba in this order. With the exception of the plant canes, Co.290 had the lowest purity of mixed juice throughout, Uba being next. Co.290 first ratoon purity improved slightly on its plant cane purity, but fell below that of Uba in the second ratoons, whilst Co.281 maintained a higher purity than P.O.J.2878 in both first and second ratoons. The purity of the Co.281 plant cane juice being only 0.1 degree below the P.O.J.2878, the average of the three years' canes gives the lead to Co.281 in purity.

Higher purities theoretically give a higher available sucrose figure, which, in turn, helps the boiling house recovery, less impurities having to be worked. Admittedly the nature of the impurities also have an effect upon the boiling house recovery, but the computation of the relative values in this respect is difficult to assess in figures.

The sugar manufactured in the factory is rated on a colour basis for customs purposes, the lighter the colour the higher the duties. Under these circumstances the use of sulphur dioxide in clarification is not possible, and juices can be dealt with by the use of lime, phosphoric acid and phosphate of soda only, and variations in the quantity and the methods of applying heat. Actually all clarification carried out during the tests has been by the double-heating, double-liming process, it having been found that consistently better results have been obtained by this method in the factory making these tests.

Generally speaking, it has been found that the softer cane juices required a higher temperature for clarification than do the harder canes, thus requiring the use of more steam. As has already been mentioned, the softer canes under discussion, P.O.J.2878 and Co.290, produced insufficient steam for factory purposes, and the heat balance of a factory with no auxiliary fuel thus finds it more difficult to maintain the heat balance with extra steam necessary at the juice heaters.

It has also been noticed, during these tests at any rate, that the softer canes had a lower crusher juice brix than did Co.281, although Uba juice was also lower than this seedling. This higher brix of Co.281 juice throws less work upon the evaporators, which again helps the heat balance of the factory, the softer canes requiring more steam in this department also.

Under ordinary circumstances, i.e., clean cane cut during dry weather, the order of difficulty in clarifying the juices from the various canes was as follows, commencing with the most difficult: Co.290, P.O.J.2878, Uba, Co.281. During wet weather and with trashy cane the first three canes consistently gave trouble in clarification, and necessitated the use of quantities of phosphoric acid. Co.281, even in wet weather, seldom had adhering trash, and there was never any difficulty in clarifying this juice.

P.O.J.2878 generally had a lower P_2O_5 content in the juice, and although on occasions this proved sufficient for clarification purposes, additional phosphoric acid usually had to be added in order to obtain a well-clarified juice.

Clean Co.290 produced a darker coloured juice than any of the other canes and needed the use of phosphoric acid and high temperatures to produce a clear juice. The P_2O_5 content of this juice was usually up to the recognised minimum standard necessary for good clarification, but with the addition of extra phosphoric acid for lightening the colour of the juice, more lime was necessary to clarify, thus increasing the chemical bill.

As already stated, Co.281 gave no trouble at all in the clarification department, and the chemical consumption was no more than that necessary for Uba.

In sugar production per hour P.O.J.2878 leads all the other canes, followed respectively by Co.281, Co.290 and Uba. It will be noticed, however, that the comparative speeds of sugar production per hour were not in the same ratio as the tons of cane per hour milled. For example, the crushing rate of Uba plants at 50.30 tons per hour was increased by nearly 9 per cent. to 54.72 tons per hour when crushing P.O.J.2878, whilst the sugar production per hour increase was from 4.30 tons with Uba to 6.30 tons with P.O.J.2878, an increase of 46.5 per cent.

It will also be noticed that the respective values of each seedling cane in sugar produced per hour as compared to Uba 100 per cent., was slightly higher in each case than the comparative values of sugar produced per 3,000 tons of cane of each respective cane variety. Sugar produced per 1,000 tons of cane increased with each ratoon in all cases except Co.290. In the latter variety first ratoons improved very slightly on the plant canes, but dropped below any other canes in second ratoons. From these figures it would appear that this variety does not ratoon well under our conditions, and, coupled with the factory results already noted, Co.290 does not compare at all favourably with either P.O.J.2878 or Co.281.

In the case of P.O.J.2878 the additional necessary fuel, and also the greater difficulty in clarification, necessitating the use of more chemicals as compared to Co.281, more than offsets the increase in sugar content and sugar produced per hour.

For this factory's purposes during these tests it would appear that the Co.281 was the most suitable for all our conditions.

From the factory capacity point of view, the figures summarised would appear to offer two alternatives when crushing seedling canes as against Uba. Either the milling speed would have to be reduced to suit the capacity of the manufacturing departments, or else the latter would need to be increased in size, always providing the factory capacity was well balanced when crushing Uba. The amount of this increase is not so evident, as obviously the increase in purity is coupled with a decrease in impurity by a similar amount.

Plant Cane.

	Uba.	P.O.J. 2878.	Co. 281.	Co. 290.
Tons cane per hour	50.30	54.72	54.66	53.52
Tons fibre per hour	7.86	7.41	7.79	6.64
Fibre per cent. cane	15.63	13.53	14.25	12.40
Sucrose per cent. cane	10.80	13.93	13.11	12.51
Purity of mixed juices... ...	81.56	85.15	85.02	83.15
Mill extraction	91.88	92.11	92.25	92.54
Tons sugar per hour 98.5° pol.	4.30	6.30	5.92	5.43
Tons cane per ton sugar ...	11.72	8.68	9.23	9.85
Tons sugar per 1,000 tons cane	85.3	115.1	108.2	101.5
Tons sugar per Uba 100 per cent.	100.0	134.6	126.9	118.9

First Ratoons.

	Uba.	P.O.J. 2878.	Co. 281.	Co. 290.
Tons cane per hour	48.11	51.12	51.50	50.91
Tons fibre per hour	7.50	7.32	8.52	7.39
Fibre per cent. cane	15.60	14.32	16.54	14.53
Sucrose per cent. cane	12.55	14.91	14.24	12.68
Purity mixed juice	84.59	86.11	86.82	84.41
Mill extraction	91.10	91.22	90.52	90.96
Tons sugar per hour 98.5° pol.	4.91	6.29	6.05	5.23
Tons cane per ton sugar ...	9.82	8.13	8.52	9.73
Tons sugar per 1,000 tons cane	102.0	123.1	117.4	102.7
Tons sugar per Uba 100 per cent.	100.0	120.5	115.2	100.8

Second Ratoons.

	Uba.	P.O.J. 2878.	Co. 281.	Co. 290.
Tons cane per hour	52.63	52.84	51.72	55.22
Tons fibre per hour	8.23	6.64	8.13	7.98
Fibre per cent. cane	15.63	12.57	15.71	14.46
Sucrose per cent. cane... ...	13.83	15.14	14.35	12.75
Purity of mixed juice	84.1	85.8	86.1	80.5
Mill extraction	90.66	93.84	91.82	90.16
Tons sugar per hour 98.5° pol.	5.86	6.78	6.17	5.40
Tons cane per ton sugar ...	8.98	7.80	8.39	10.22
Tons sugar per 1,000 tons cane	111.3	128.2	119.1	97.8
Tons sugar per Uba 100 per cent.	100.0	115.2	106.8	87.8

Total Sugar made per 1,000 tons each Ratoon Cane.

	Uba.	P.O.J. 2878.	Co. 281.	Co. 290.
Plant cane	85.3	115.1	108.2	101.5
First ratoons...	102.0	123.1	117.4	102.7
Second ratoons	111.3	128.2	119.1	97.8
Total	298.6	366.4	344.7	302.0
Uba 100 per cent....	100.0	122.6	115.5	101.2

Total Sugar made per Hour.

	Uba.	P.O.J. 2878.	Co. 281.	Co. 290.
Plant cane	4.30	6.30	5.92	5.43
First ratoons	4.91	6.29	6.05	5.23
Second ratoons	5.86	6.78	6.17	5.40
Total	15.07	19.37	18.14	16.06
Uba 100 per cent....	100.0	127.9	120.5	106.7

SUMMARY.

Milling tests on the varieties Co.281, Co.290, P.O.J.2878 and Uba were done. These tests were made fortnightly for plant cane and first ratoons and on consecutive days for second ratoons.

Co.281.

Under the conditions of this experiment Co.281 proved to be the most suitable cane. Not only was it superior to all other varieties for crushing and steam-raising qualities, but it also had a high brix and purity of mixed juice and gave no trouble

in clarification. It was second only to P.O.J.2878 in tons sugar made per hour. In spite of its high fibre it gave a good extraction.

P.O.J.2878.

While this variety gave the highest tons sugar made per hour, the best sucrose per cent. cane and a very good mill extraction, as well as a high purity of mixed juice, the clarification was rather poor. Although the bagasse burned well, there was always a shortage of fuel when crushing this variety.

Co.290.

Co.290 did not compare favourably with the other two new varieties. It gave most trouble in milling. This may partly be due to the poor steaming qualities of its bagasse and to unsuitable mill settings for this low fibre cane. The purity of the mixed juice was low and it gave most trouble in clarification. It did not ratoon well either.

Uba.

This variety was used as a basis of comparison. In plant cane and first ratoons a lower tonnage of cane per hour was obtained than was the case with the seedlings. Less sugar was made per hour from Uba than from any other variety, except that in second ratoons Co.290 gave a lower yield. The purity of mixed juice was rather low, but no difficulty in clarification was experienced.

The VICE-PRESIDENT, in opening the paper for discussion, said that these experiments had been done in a neighbouring country. Conditions were not quite the same as ours, but there were many points of similarity.

Mr. DYMOND said that Mr. Wheeler had used certain theoretical formulæ. In South Africa there had been considerable doubt in the last few years as to the effect of a few degrees of purity. Mr. Dymond referred to an article by A. R. Ness in a recent "International Sugar Journal." It was found in Colorado that two beet factories of comparable size, similar equipment and operated under similar conditions gave different results. The average results for a five-year period were as follows :—

Factory No.	Sugar per cent. beet.	Apparent purity.	Apparent purity thin juice.	Sugar in molasses per cent. beet.
1	15.30	83.9	88.8	1.99
2	15.80	85.4	88.8	2.08

Ness investigated this further and found the non-sugars and the inorganic composition of them almost the same. The reason why factory No. 2 had a greater loss in molasses was due to a large amount of nitrogenous compounds which could not be eliminated in the juice.

The results obtained by Mr. Wheeler in Portuguese East Africa, which is far away from South Africa and under different conditions, might be very different to results in this country.

Mr. Wheeler referred to clean cane. In this country clean cane was a rarity and trash influenced extraction and also eemed to have an effect on boiling house recovery.

The effect of fibre on extraction had been discussed by mathematicians. The factor of mixed supply was very important. In South Africa fibre varied continuously, not only in quantity but also in quality, and under those conditions it was impossible to set the mills to obtain the maximum theoretical extraction.

Mr. WHEELER said that he used the Prinsen Geerligs formula in obtaining the available sucrose. He agreed that we knew very little about the non-sucrose composition of juice and that this might have an effect on recovery ; but under the conditions of the experiment available sucrose had to be calculated to serve as a basis for comparison.

When cane was burned, as was general practice in Zambesi, the cane supply was clean. In wet weather it was, of course, impossible to burn the trash, and under those conditions great difficulties were experienced in clarification. The trash also affected the extraction, and this again brought up the fibre question.

Mr. DODDS asked whether Mr. Wheeler could give the field performance of Co.290. He had received annual reports from Incomati Estates which showed that Co.290 gave excellent results in the fields and there were no complaints about its manufacturing qualities. Their milling efficiency had improved since crushing this variety, although no structural improvement in plant was made.

Mr. WHEELER said that he had no actual figures as regards the field performance of Co.290. He pointed out, however, that at Incomati the bulk of the cane supply was Co.290 and their mills were consequently set for this low-fibred cane, with the result that better results were obtained.

Mr. RAULT said that he had carried out some experiments on the effect of trash on extraction. He found that trash did carry away some sugar, but not as much as ordinary fibre. The result was therefore that the quantity of bagasse increased, but the sucrose per cent. bagasse decreased as a result of trashy cane. It was not correct to say that trash had no sugar either. He had found traces of sugar even in quite dry trash.

Mr. VIGER said it was interesting that in these tests all juices clarified easily by the simple defecation method. Mr. Wheeler used the fractional liming and double-heating process recommended by J. G. Davies. Davies demonstrated that the elimination of non-sugars, colloids, colloid nitrogen, pentosan and other substances extracted by ether were at a maximum. A reduction in mud volume was also noticed. Mr. Viger said he had tried this method with South African juices many a time. The results were, however, most disappointing. This was probably due to some peculiar soil and climatic conditions in this country.