"A Study of the Effect of Rain on the Java Ratio"

By R. M. Bechard

Mr. Bechard: I would like to point out that these are the conclusions I arrived at. I would not like any committee to be involved in the recommendations. I suppose some people would think them rather drastic, but they are purely my own personal opinions.

Early during the 1927 season it was observed that the sucrose content of the cane as determined by the Java ratio method was reduced considerably during wet periods.

This drop in some instances was as much as 2 to 3% of the sucrose of the cane as judged by the previous and following samples.

It was obvious that a drop in sucrose would be the natural result of the cane being wet, as the quantity of sucrose being the same but the weight of material having increased, a reduction in the percentage was bound to follow.

Taking 100 tons of dry cane at a sucrose content of 13% we would have 13 tons of sucrose; had the cane increased in weight by 5% then this 13 tons of sucrose would be divided by 1.05 making the sucrose content drop to 12.38%, which would account for a drop of .62%. However, this could not account for that drop of 2 or 3% so other reasons had to be looked for.

The effect of rain on cane would be that the cane would carry along with it a certain amount of water; this would pass mostly in the crusher juice, diluting this juice and bringing it nearer to the composition of the cane, thereby increasing the Java ratio.

The procedure adopted at the majority of mills was to determine the Java ratio on a period of one week and apply that average figure to the crusher juice of the week.

Some determination of the Java ratio for shorter periods was then made and it was found that whereas the Java ratio prevailing during dry periods was in the neighbourhood of 76, a very much higher figure was obtained when it rained, on one occasion the figure was as high as 91, while the average for the week was 79.

It was obvious that this average figure applied indiscriminately to all the samples taken during the week would be too high for those taken during dry weather and too low for those taken during the wet periods thereby penalising the planters sending cane in wet weather to the benefit of those sending only in dry weather.

Another factor became apparent; if cane was weighed dry and became wet before crushing, the planter affected would not get the benefit of that increased weight and would consequently lose. This applies specially to the planters who are paid on weight delivered at sidings and on analysis made at the mills.

Had the cane been weighed wet, and crushed in the same state, then no loss of total sucrose would accrue to the planter provided that the determination was a true one and reflected accurately the sucrose content of the material cane plus water. Also provided that this lower figure was not such as to bring the cane into the rejection area of less than 9% sucrose.

It was obviously necessary then to determine the sucrose content of the cane to have:—

(1) The weight of cane as near as possible to the time of crushing.

(2) The Java Ratio applicable to the period when the cane was crushed and when identical conditions prevailed.

Later during the season when some comparative figures were available it became apparent that there was also a reduction in purity when cane was crushed wet. The result was that planters supplying cane of a high juice purity who were entitled to a bonus had this amount of bonus reduced sometime to nothing while the flat planters who were supplying cane of a lower juice purity had often their cane brought within the penalty range with the consequence that some of it was rejected.

The matter became so serious that some planters refused to deliver cane during wet weather.

Mr. Moberly, the Supervising Technologist of the South African Cane Growers' Association, deputised the writer to study the question at the Sugar Experiment Station, Mount Edgecombe. I must here express my appreciation for the help given to me there by the Director, Mr. H. H. Dodds and his staff, and also to Mr. G. S. Moberly who not only made the experiments possible but also advised me largely.

OBJECTS OF THE EXPERIMENTS.

The object was to find out:—

What percentage of water the cane was capable of holding under certain conditions, and also the effect of that water on the Java ratio, the sucrose content per cent. and the purity.

"A" was burnt cane approximating as much as possible to field conditions.

"B" was semi-trashed cane resembling the cane as received at the mill.

"C" was completely cleaned. A. B. and C. were fresh cane.

Experiment D. was made with the object of finding out if the time elapsing between cutting and weighing, and crushing had any further effects on the behaviour of the cane when wet.

D. 1 was weighed, crushed and tested 24 hours after cutting.

D. 2 was weighed, crushed and tested 48 hours after cutting.

D. 3 was weighed, crushed and tested 72 hours after cutting.

As inversion set in seriously at the time in the trashed portion and the results obtained so far had been negative it was not thought necessary to carry it any further.

As it was found during the course of these experiments that the total amount of water taken up by the cane whether mechanically held or otherwise, had not been fully expressed when the extraction had been from 35 to 50% in terms of juice extracted per cent. cane, experiment (E.) was made, the object being to find out at what point the total amount of water had been expressed or alternately at which stage of the milling the density of the juice was the least effected by the water on the cane.

For this purpose a large sample of cane was divided into two halves, one section being burned and one being trashed in the usual manner, each portion being sub-sampled into three portions; one for check, one for mechanically carried water, and one for total possible absorption.

E. 1. Control.

E. 2. Cane carrying water mechanically.

E. 3. Cane carrying water both mechanically and absorbed by the tissues.

As it was obviously impossible to wait for rain to carry out the experiments, some methods of artificially wetting the cane to obtain the effect of rain had to be devised.

In A. B. and C., part of No. 2 was watered with a watering can for a couple of minutes and part was placed lying in water for three minutes.

No. 3 part was watered several times during the course of half-an-hour and part was immersed in water for the same length of time.

No. 4 was sprayed over night while part was dipped in water for 16 hours. As the results obtained by spraying and dipping were exactly the same, the results obtained in each case were treated as one.

In the case of experiment B. No. 2, the results obtained by soaking for 3 minutes and 30 minutes were identical. And B. 2 and B. 3 were treated as one. This, therefore, represents the average of 8 tests, made on samples of 25-lbs. of cane each; all the other in A. B. and C. represent the average of 4 samples each made on the same quantity of cane.

Experiment D. was not duplicated but consists of one large sample, sub-sampled in two parts. One part was stood upright, surrounded with loose trash and burnt, the other part was trashed in the same manner as the average cane received at the mill.

Each portion was separated in three parts to be tested after various periods; finally, these were sub-sampled into two parts, one to serve as check and one to be immersed in water before testing. The time of immersion, in all cases was 15 minutes, and the samples were kept in the shade, the weather being dry. All the samples were made into bundles of 9,000 grs. Each day the cane was weighed before soaking to obtain the loss of weight by evaporation and again afterwards to obtain the percentage of water taken up, and tested in the same manner as A. B. and C., the fibre being also determined. Table "Y" gives the results obtained.

It is to be noted here on a matter having no bearing on the objects of the experiment, that burnt cane kept better than trashed cane, and also that it was easier to obtain the juice from burnt cane that had been standing for some time than that from trashed cane stood for the same time.

From these exeriments it would appear:—

Cane is capable of taking up quantities of water up to about 10% of its own weight; of this amount about half is carried mechanically and the other half absorbed in the tissues of the cane and accompanying trash; the water carried mechanically was in the form of a film, under laboratory conditions could not be in any other form as the sticks of cane had to be handled singly so that a certain amount of water was drained off. In milling practice this quantity of water could be larger, as the layer of cane going up to the mill would allow for more water being carried. It will be noticed that these figures do not apply to perfectly cleaned cane which could carry only one quarter of the mechanically held water and about half of the total water.

The cane took up the water very greedily until the film was formed, thereafter the rate of absorption was greatly reduced.

The reduction of sucrose per cent. cane was proportional to the quantity of water taken up by the cane.

The increase of the Java ratio followed a very definite course for each type of cane. This was shown graphically to be a curve in the case of burnt cane and a straight line in the case of trashed

cane. The time elapsing between the cutting and crushing had no material effect on the results obtained; this applies to the water carried mechanically.

The mechanically held water did not reduce the purity of the crusher juice.

There was a decrease noted in purity in the case of the water absorbed in the tissues of the cane. This applies to the first juice expressed.

There was no reduction in the total quantity of sucrose present showing that there was no destruction of sucrose, and no resultant decrease in the value of the cane.

Experiment " E " will be discussed later.

Reduction of Sucrose.

It will be noted in experiment "A. 4" the Java ratio calculated in terms of dry cane was increased to 90.07 whereas that of the control experiment was 75.86.

A Java ratio of over 90 was obtained in actual milling practice, over a period of 24 hours, so that figure is not excessive.

Had a Java ratio of say 78 been the weekly average one and taking a cane containing 13% sucrose, the crusher juice in the case of A. 1 would be 16.73 giving 13.05 for that cane at 78 Java ratio, whereas the crusher juice of the cane under A. 4 conditions would be 13.11 which would give a sucrose content of 10.22 for the same cane, showing an error in calculations due to faulty method equal to 2.78% cane to the planter delivering cane on that day, whereas, the one delivering under dry conditions would benefit to the extent of .05% cane.

Reduction of Purity.

This can be due to either loss of sucrose, or extraction of more non-sugars by the crusher roller, the water carried by the cane acting as maceration water.

If there is a loss of sugar the miller would lose, if not, and the second alternative was the case, then the miller would not suffer.

In all the experiments there was no reduction of the quantity of sucrose present, when calculated in terms of dry cane. In milling practice had there been such a loss we would expect that the purity of the mixed juice would be lowered correspondingly. If, however, this purity was not reduced the co-efficient would not be affected.

It must be remembered that the object of the bonus and penalty system was to make the planter share in the increased or reduced recovery due to the high or low purity of the juice. Therefore, if this bonus is reduced, or the penalty increased fictitiously, the planter would not get the benefit he would be entitled to.

I am showing below that the purity of the mixed juice was not reduced when that of the crusher juice was reduced by rain; the figures quoted are actual figures taken from milling practice at two different periods when this drop was very pronounced, they are averages of 24 hours sampling:—

Date	Purity of crusher juice.	Purity of mixed juice.	Difference.	Rainfall.
14th Sept.	89.8	84.9	4.9	nil
15th „	89.6	85.0	4.6	.04
16th „	87.9	85.0	2.9	.90
17th „	87.4	84.9	2.5	.07
25th Oct.	90.1	86.6	3.5	nil
26th „	89.7	86.8	2.9	.29
27th „	89.8	86.6	3.2	.12
28th „	89.9	86.3	3.6	.04
29th „	88.0	86.1	1.9	3.40

Increase of Java Ratio.

This problem is complicated by three factors.

I must point out at the outset that this has no bearing on the total of sucrose the miller will eventually pay for, but the distribution to the planter is affected.

When rain sets in, some cane is already in the mill yard weighed. Some arrives later and is weighed wet, therefore, if the Java ratio is determined for these indiscriminately the figure for the cane weighed wet will be too high and that for the cane weighed dry will be too low. The Java ratio determined at the end of one week when the weather conditions were not identical throughout the week has no relation whatsoever to the correct figure applying to various periods; also the amount of slip on the roller due to wet cane will also have some effect on the figure.

Experiment A. 2 gives a Java ratio of 75.18 if the cane is calculated dry and 77.66 when calculated wet. No. 3 gives 76.19 and 81.34. No. 4 81.51 and 90.07. The same differences will be found in experiment B. and C.

Suggestions to Correct or Remedy the Errors of Calculations.

It becomes necessary to:—

(1) Minimise the difference betwen the weight of cane weighed and crushed. This can be done by bringing the weighbridge as near as possible to the cane carrier.

(2) Establish the correct Java ratio applicable as near as possible to the period when the cane was actually crushed. This figure should be established either every 24 hours or better still the week should be divided into rainy periods and dry periods.

(3) Re-establish the purity of the crusher juice.

The following procedure could be adopted:— The normal difference between purity of crusher and mixed juices for the two days immediately preceding rain to be established, let this figure = A.

Find the difference between these purities when there is a drop in that of the crusher juice due to rain, let that figure = B.

Then (A—B) to be added to each individual purities during that period, e.g. The average difference for the 14th and 15th of September in the mill figures quoted higher was 4.75.

That difference on the 16th fell to 2.9, therefore 4.75—2.9 = 1.85 to be added to the purities of all planters who had cane crushed during that period.

(4) When cane is brought within the rejected area of being below 9% then before that cane is rejected the sucrose per cent. of the dry cane should be determined. This can be done in the following manner:—

The dilution per cent. dry cane to be calculated in the following manner. The average brix per cent. of the two days immediately preceding rain to be determined, and the same figure for each day of the rainy period also to be determined.

Then

$$\frac{\text{brix dry cane} - \text{brix wet cane}}{\text{brix wet cane.}} \times 100 = \text{dilution per cent. cane.}$$

$$\text{Brix of cane} = \frac{\text{Total tons brix mixed juice} + \text{tons brix in residual juice}}{\text{Tons Cane.}}$$

Tons dry cane = tons wet cane — tons rain water.

Tons rain water is calculated as shown above by dilution water and by applying the dilution per cent. wet cane to the tons of wet cane.

$$\text{Sucrose per cent. dry cane} = \frac{\text{Tons adjusted sucrose}}{\text{Tons dry cane.}}$$

All cane bought at mill weight to have sucrose content shown in terms of wet cane but no rejection to take place unless the sucrose per cent. dry cane is lower than the rejection point.

For cane at siding weight; the sucrose content to be shown as percentage of the dry article, when that cane is delivered dry.

I prefer this method to that of calculating the dilution caused by rain water, by the method of sampling the first or second mill juice simultaneously, as that of first crusher for the reasons of the difficulty of sampling these juices.

Also all experiments made by me proved conclusively that the water taken up by the cane followed the bagasse right through the various pressures applied, and although the largest portion of this water passes away with the first juice expressed (especially in the case where the application of water was of short duration), the fact remains that even after 4 pressures totalling an extraction of over 50% in terms of juice per cent. cane, portions of this water were still expressed and diluted the juice.

I might say here that in my opinion it would be only fair if when the scale of bonuses and penalties on fibre content come into operation, that the fibre per cent. cane be expressed in terms of dry cane.

It would also be in the interests of the planters if in the districts where cane is trashed, they would pay particular notice to the trashing of the cane.

EFFECTS OF RAIN WATER ON CUT CANE—TABLE "X."

		"A"—BURNT CANE				"B"—ORDINARY TRASHED CANE				"C"—CLEAN CANE			
		1	2	3	4	1	2	3	4	1	2	3	4
Juice ...	Brix	13.75	12.89	12.26	11.12	15.32	14.62	—	13.47	15.50	15.50	15.30	15.10
	Sucrose ...	10.11	9.72	9.35	7.92	12.83	11.79	—	10.96	13.28	13.25	12.99	12.93
	Purity... ...	73.52	75.40	76.26	71.22	83.74	80.64	—	81.36	85.67	85.48	84.90	85.62
Crushed Cane	Sucrose % ...	7.670	7.308	7.124	6.456	9.314	8.806	—	8.482	10.595	10.517	10.297	10.227
	Juice % ...	34.34	34.13	33.67	37.44	34.59	35.90	—	38.24	50.11	49.86	49.10	48.33
	Bagasse % ...	65.65	65.87	66.33	62.56	65.41	64.08	—	61.76	49.89	50.14	50.90	51.67
	Java Ratio ...	75.86	75.18	76.19	81.51	72.59	74.69	—	77.39	79.78	79.37	79.26	79.09
	Water held %	nil	3.42	6.76	10.48	nil	5.18	5.22	9.88	nil	1.67	3.47	4.37
Dry Cane	Sucrose % ...	7.670	7.549	7.606	7.134	9.314	9.259	—	9.293	10.595	10.692	10.654	10.675
	Bagasse % ...	65.65	68.03	70.81	69.12	65.41	67.40	—	67.66	49.89	50.97	52.67	53.94
	Juice % ...	34.34	35.26	35.94	41.35	34.59	37.77	—	41.88	50.11	50.69	50.80	50.43
	Java Ratio ...	75.86.	77.66	81.34	90.07	72.59	78.53	—	84.78	79.78	80.69	82.02	82.55

1.—Dry Cane. 2.—Soaked 3 minutes. 3.—Soaked 30 minutes. 4.—Soaked 16 hours.

EFFECTS OF RAIN WATER ON CUT CANE—TABLE "Y."

		24 HOURS OLD—"D 1"				48 HOURS OLD—"D 2"				72 HOURS OLD—"D 3"			
		Burnt		Trashed		Burnt		Trashed		Burnt		Trashed	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Loss of weight % cane		.55	.55	.88	.88	1.61	2.22	2.55	2.22	3.33	3.55	3.22	2.88
Juice ...	Brix ...	13.50	13.70	14.16	13.80	15.05	13.45	13.95	13.45	14.85	13.70	14.95	13.55
	Sucrose ...	10.07	10.83	11.02	10.70	12.03	10.54	9.41	9.73	11.56	10.87	10.23	9.27
	Purity... ...	74.59	79.05	75.47	77.53	79.93	78.36	67.45	72.34	77.84	79.34	68.42	68.41
Crushed Cane	Bagasse % ...	63.51	65.12	65.52	64.56	68.72	66.75	66.99	67.19	66.72	65.32	70.32	67.84
	Juice % ...	36.49	34.88	34.48	35.44	31.28	33.25	33.01	32.81	33.28	34.68	29.68	32.16
	Sucrose % ...	8.237	8.563	9.041	8.569	9.604	8.677	7.661	7.223	9.398	9.125	8.028	6.644
	Fibre	12.97	13.48	13.37	13.85	14.00	13.42	14.69	14.58	13.15	13.17	14.86	15.33
	Java ratio ...	81.79	79.06	82.04	80.08	79.83	82.32	81.41	74.23	81.29	83.94	78.47	71.67
Dry Cane	Bagasse % ...	63.51	68.54	65. 2	67.10	68.72	69.48	66.99	69.94	66.72	68.49	70.32	71.10
	Juice % ...	36.49	36.70	34.48	36.82	31.28	34.60	33.01	34.14	33.28	36.34	29.68	33.69
	Sucrose % ...	8.237	9.013	9.041	8.905	9.604	9.032	7.661	7.519	9.398	9.567	8.028	6.963
	Fibre % ...	12.97	14.19	13.37	14.39	14.00	13.97	14.68	15.18	13.15	13.81	14.86	16.07
	Java Ratio ...	81.79	83.22	82.04	83.22	79.83	85.69	81.41	77.27	81.29	88.01	78.47	75.11
	Water held %	nil	5.25	nil	3.92	nil	4.09	nil	4.09	nil	4.83	nil	4.80

EXPERIMENT "E"—TABLE "Z."

	BURNT CANE						TRASHED CANE					
	Juice Ext. % Cane			Brix			Juice Ext. % Cane			Brix		
	E.1	E.2	E.3	E.1	E.2	E.3	E.1	E.2	E.3	E.1	E.2	E.3
First pressing	31.10	34.00	36.65	17.14	15.78	15.14	32.33	35.16	35.81	16.73	15.73	14.5
Second pressing	11.41	10.87	9.48	17.29	16.24	15.30	11.13	8.98	10.49	16.63	15.78	15.00
Third pressing	6.41	5.76	7.02	17.26	16.75	15.60	5.26	6.12	5.91	16.70	15.97	15.3
Fourth pressing	2.40	2.63	3.21	17.72	16.68	15.45	2.55	3.33	3.68	17.38	16.58	15.60
TOTAL ...	51.32	53.26	56.36				51.29	53.60	55.89			
Water taken up % Cane ...	nil	3.75	6.67				nil	4.58	10.83			

All percentages given in terms of dry cane.

Cane was weighed before and after burning. No loss of weight was apparent.

E.1—Control.
E.2—Mechanically carried water.
E.3—Water both absorbed and carried mechanically.

EXPERIMENT "E."

	BURNT CANE				TRASHED CANE		
	Weight of Juice				Weight of Juice		
	E.1	E.2	E.3		E.1	E.2	E.3
First pressing	8,461	9,251	9,971	First pressing	8,795	9,566	9,743
Second pressing	3,103	2,956	2,579	Second pressing	3,029	2,443	2,853
Third pressing	1,744	1,567	1,910	Third pressing	1,436	1,665	1,607
Fourth pressing	654	716	872	Fourth pressing	695	907	1,001
	13,962	14,590	15,332		13,955	14,581	15,204
Water	Nil	1,020	1,814	Water	Nil	1,247	2,947

Cane, all samples 27.205 grs

BRIX CORRESPONDING

First pressing	17.14	15.78	15.14	First pressing	16.73	15.73	14.50
Second pressing	17.29	16.24	15.30	Second pressing	16.63	15.78	15.05
Third pressing	17.26	16.75	15.60	Third pressing	16.70	15.97	15.10
Fourth pressing	17.72	16.68	15.45	Fourth pressing	17.38	16.58	15.69

Chairman: I think it is evident the marked fluctuations we have found in the past season were not anticipated when the methods of analysis for payment of sucrose were laid down. It is a matter that ought to be thoroughly gone into.

Clarification and Filtration.

Chairman: This Committee had a very complete and voluminous report last year, but this year, owing to a variety of reasons, they have not been in a position to make a report. The committee is still in active existence, and a letter was circulated to all mills from this committee asking that their members should attend this meeting and report any observations that had occurred during the last season on filtration and clarification likely to be of general interest; the subject is open for discussion now.

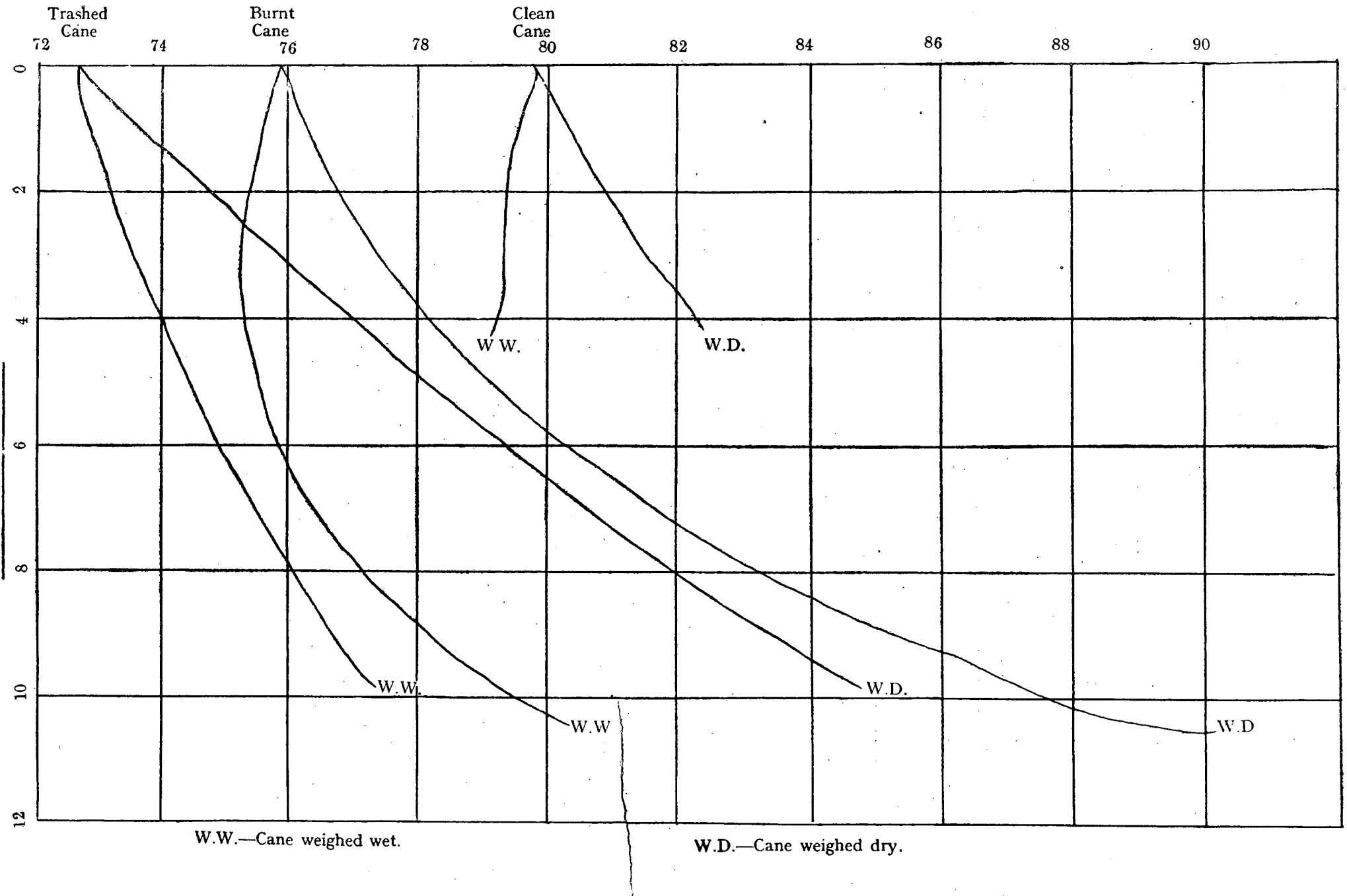
No discussion.

Waste Products of Sugar Mills.

Chairman: The committee dealing with this subject has had very great difficulty in getting representative meetings on this matter during the year and there is no collective report, but we have some very interesting individual contributions from members and one of these is a paper which appears next on the agenda.

The convenor of this committee (Mr. D. McRae) has compiled also a most useful bibliography of references to waste products of the sugar industry published in the technical literature, which will be issued with the proceedings of this conference.

JAVA RATIO.


Trashed Cane
Burnt Cane
Clean Cane
72
74
76
78
80
82
84
86
88
90
0
2
4
6
8
10
12
W W.
W.D.
W.W.
W.W
W.D.
W.D
W.W.—Cane weighed wet.
W.D.—Cane weighed dry.