SAMPLING OF CRUSHER JUICE.

By G. S. MOBERLY.

As is generally known the method of sampling crusher juice for cane payment purposes, in this country, is to drill a hole in the juice plate under the crusher, and from a rod or wire protruding through this hole, a continuous stream of juice runs into a collecting bucket. Inclined baffles on the upper surface of the juice plate are used to mix the juice from all parts of the crusher roll before it passes the sample hole.

For some years past planters have been disconcerted by unaccountably large variations between the tests of consignments of cane cut from apparently uniform fields. Variations of more than two degrees of sucrose % cane and anything up to ten degrees of purity have frequently been noted. Last year this phenomenon was more frequent than usual. In an attempt to throw some light on the problem, I initiated an experiment with the two-fold object of checking the accuracy of the juice sampling, and at the same time to investigate the degree of variability of cane from the same field, or part of a field.

Nature of Experiment.—The experiment consisted of dividing the flow of juice from each consignment into four, five or six (usually six) consecutive portions, testing each portion separately, and comparing these tests with the regular samples taken in the ordinary way, and also comparing the separate tests with the average of each set of tests.

By means of a dipper with a long handle, juice was caught as it flowed off the juice plate, and was ladled into successive cans, at a rate of about 15 dips to the minute. Each can took from three to five minutes to fill, according to the crushing rate of the mill.

Altogether 139 consignments were tested at 9 different mills. It was not possible to get six subdivisions every time, and altogether 768 subsamples were taken.

Accuracy of Sampling Method.—As the primary interest of planters lies in the sucrose % cane and the purity of the crusher juice, these figures were compared for the purposes of the test. A uniform Java Ratio of 78.0 was used to convert sucrose % crusher juice to sucrose % cane.

In the following comparison the term "regular test" refers to the sample of juice taken in the ordinary way through the drip hole; "composite test" means the average of the partial tests for each consignment.

	Suc. % Cane	Purity Crusher Juice
Average of 139 regular tests	12.387	86.301
„ „ 139 composite „	12.399	86.332
Difference	0.012	0.031

The very slight difference can all be accounted for in 13 of the tests taken at two mills, where the regular test was in every case lower than the composite. At these two mills the sampling was apparently unsatisfactory. At other mills there was very little difference.

TABLE I.

Factory	No. of tests	Suc. % Cane		Purity of Juice	
		Regular	Composite	Regular	Composite
A	48	13.280	13.246	88.40	88.26
B	25	12.180	12.149	85.73	85.70
C	22	10.584	10.627	82.32	82.22
D	12	11.679	11.660	83.14	83.13
E	9	12.278	12.297	87.67	87.62
*F	8	12.564	12.800	87.71	88.90
G	5	12.096	12.096	86.54	86.58
H	5	13.128	13.166	88.70	88.72
*I	5	13.950	14.168	88.56	89.44

The two factories with unsatisfactory results are marked *.

In 11 instances in the case of sucrose and 9 instances in the case of purity the regular test was either higher or lower than any of the individual partial tests. In most cases the difference was very slight, and in only one of these cases was the sucrose difference between regular and composite tests greater than 0.3.

In two instances at Factory F there were serious discrepancies in purity.

Two main sources of error in the sampling method might be looked for:—

(1) Evaporation of the juice as it flows from the hole to the container.

(2) Inversion during the time of collection and subsequently.

The method of scooping the juice eliminates any likelihood of evaporation, and as the sub-samples were collected rapidly in clean tins, and analysed at once, there was little chance of inversion.

The close comparison between regular and composite tests shows that neither of these errors was present to any marked degree, except at Factories F and I. At these factories the trouble seems to have been due to inversion rather than evaporation, as there was little difference in the brix.

The experiment threw no light on the degree of representativeness of the regular sampling method, as the check method was less representative.

Variability within Consignments.—A very noticeable feature of the figures obtained was the great degree of variation between consecutive partial tests from the same consignment.

The average variations from the mean of the 139 different consignments are classified below:—

TABLE II.

Sucrose % Cane			Purity Crusher Juice		
Av. var. from mean	No. of instances	% of total	Av. var. from mean	No. of instances	% of total
Less than 0.1	14	10.1	Less than 0.5	29	20.9
0.11 to 0.2	39	28.1	0.51 to 1.0	61	43.9
0.21 to 0.3	25	18.0	1.01 to 1.5	38	27.3
0.31 to 0.4	22	15.8	1.51 to 2.0	8	5.8
0.41 to 0.5	18	12.9	Above 2.0	3	2.1
0.51 to 0.6	9	6.5			
Above 0.6	12	8.6			
	139	100.0		139	100.0

The degree of variability can also be shewn by the "spread," i.e., the difference in each case between the highest and the lowest test. These are classified below:—

TABLE III.

Sucrose % Cane.			Purity of Crusher Juice		
Spread	No. of instances	% of total	Spread	No. of instances	% of total
Less than 0.10	66	47.5	Less than 0.25	54	38.9
0.11 to 0.20	33	23.7	0.26 to 0.50	47	33.8
0.21 to 0.30	25	18.0	0.51 to 0.75	12	8.6
0.31 to 0.40	6	4.3	0.76 to 1.00	18	12.9
Above 0.40	9	6.5	Above 1.00	8	5.8
	139	100.0		139	100.0

Since 0.1 sucrose % cane corresponds with about 0.7 purity of crusher juice, it will be seen that the variability is less marked in the case of purity than of sucrose. This would appear to indicate that the variability is due more to different degrees of drying out in different parts of the consignment than to differences in maturity. This may be due to differences in the intensity of the fire when the cane is burnt.

This great degree of variability shows how important it is that the juice sample should correspond with as large a proportion of the cane as possible.

It might be expected that, due to drying out, the first sub-samples representing the tops of the trucks would show a higher average brix than the later sub-samples representing the bottom of the trucks.

Unfortunately I neglected to take note of weather conditions while the tests were being carried out, and some of them were done during wet weather when the brix of the juice might be expected to be lower for the top of the truck. It is probably due to this cause that there is practically no difference between the crusher juice analyses from the tops and bottoms.

	Brix	Sucrose	Purity
Average of first two tests	18.81	16.223	86.25
„ „ last two tests	18.76	16.173	86.23

When considered for separate mills there is a difference in some cases.

TABLE IV.

Factory	No. of Tests	Brix Tops	Brix Bottoms	Diff.	Purity Tops	Purity Bottoms	Diff.
A	48	19.27	19.27	—	88.49	88.19	+ 0.30
B	25	18.19	18.13	+ 0.06	85.87	85.58	+ 0.29
C	22	18.87	18.74	+ 0.07	82.80	81.63	+ 1.17
D	12	17.63	18.28	— 0.65	83.00	83.45	— 0.45
E	9	17.92	18.05	— 0.13	87.26	87.71	— 0.45
F	8	18.68	18.37	+ 0.28	89.54	88.11	+ 1.43

At A and B the difference is negligible in either case. At C and F there is a heavy drop in purity at the bottom of the trucks with negligible brix difference at C and a noticeable brix drop at the bottom of F. At D and E there is a rise in purity at the bottom of the trucks, and a rise in brix at the bottom of D.

These differences are not easy to explain. The brix differences are due, presumably, either to drying out or wetting, but why should there be a marked difference in purity? In the case of C and F it is possible to suggest differential loading on the part of planters, who expect to get the tops of their trucks better sampled than the bottom. An examination of cane from individual planters at C shows that the difference between top and bottom is fairly constant, and it is hardly likely that all planters have indulged in this practice to an equal extent.

Whatever may be the cause of these variations, they are undoubtedly significant, as the experimental error is in the neighbourhood of 0.1 for brix and 0.6 for purity, in the case of single samples.

Variation between Consignments.—Variations between consignments from apparently even fields have frequently been observed of about the same order of magnitude as that observed between the sub-samples. These latter variations do not altogether explain the former, as a complete truck represents, on an average, five and a half sub-samples, and is therefore a larger representation of field conditions. The increased accuracy of these larger samples should be $\sqrt{5.5}$ or 2.34, whereas the variation in the case of complete trucks is in some cases at least as great as that observed for sub-samples.

Summary:

(1) The analysis of sub-samples does not reveal that there is any apparent evaporation or chemical deterioration of the juice samples taken in the ordinary way for cane testing purposes.

(2) There is wide degree of variability, both in sucrose and purity, between different layers of a single consignment.

(3) This variability appears to be due more to varying degrees of drying out than to differences in maturity. It may be due to differences in the intensity of the fire when a field is burnt.

(4) The great degree of variability emphasises the importance of taking the juice sample from the maximum proportion of the consignment.

(5) Both plus and minus differences in brix are observed in the juice from the tops and bottoms of the trucks, due presumably, to drying out and wetting.

(6) Plus and minus differences in purity are also observed in the juice from the tops and bottoms of trucks. These differences are harder to account for, but I do not believe that they are due to differential loading.

(7) The observed variability between sub-samples does not entirely account for the observed variability between consignments from apparently even fields.

The attached diagram represents a few of the most erratic and a few of the most regular of the samples tested.

CHAIRMAN: I think Mr. Moberly has given us a very interesting paper. I am not a chemist myself, but I have always understood that the sampling of cane has always been considered to be a matter of great difficulty. If I am not mistaken

Mr. Moberly recently designed a machine for the mechanical sampling of cane, and I would be interested to know whether this has proved successful.

Mr. MOBERLY: The Chairman has reminded me of an experiment I carried out the year before last. It was an attempt to produce a method of testing the cane directly in the trucks, which would have eliminated the necessity of these samples, but unfortunately I cannot report that there was any success in that direction. The principle of the machine was that we had a boring machine—an auger—enclosed in a tube, and the shaft driving it was a helical screw conveyor. The idea was that this was to be driven right through the load of cane(the auger boring a passage through the mass of cane and helical conveyor was to carry the chips down the tube. The auger worked quite nicely. We cut the cane all right, and then everything that was cut off jammed solidly in the screw conveyor. Despite a trial of a number of differences in form, we never succeeded in getting that screw conveyor to carry the moist chips. When run into a bit of wood, it would take the dry shavings right through. As soon as you tried it on cane, the moist chips would not carry along the screw conveyor. The result was entirely negative. I was reminded of this and asked whether I would say something about it, so I have mentioned it. I do not know whether anyone else has had experience of sampling cane as it stands in the truck.

CHAIRMAN: Has anyone anything to say in regard to discussing this paper? I reminded Mr. Moberly of this interesting experiment of his. I saw the machine which he intended to use, and I was rather sorry to hear that it had apparently failed in its object. I think I would advise Mr. Moberly to persevere a little, it may be until some small modification which is required is made. A tool of that description, for getting a sample direct from the truck, capable of bearing through the body of the load of cane in the truck and extracting a sample is certainly something to be desired, because it would save a lot of the present messy work under the crushers, and the amount of labour entailed in collecting these samples. The apparent difficulty in getting these samples to show anything in the way of regularity only shows that nearly all the problems that we come up against in the matter of chemical control of the sugar factory are not simple ones. They look simple at the start. As we look further into them, we see their complications. I think that is characteristic of almost every department in our Industry.

Is there anyone who wishes to speak on the subject?

Mr. FOWLIE: I would like to broach an idea that occurred to me in connection with this sampling with an auger. If the method is reasonably likely to be successful, it surely is not beyond the skill of some of our engineering friends to perfect the details of pushing in and pulling out the auger and chips enclosed. It has occurred to me that it might be possible to fit this on top of a framework over the railroad where the trucks come in, and have the use of power to push the auger down into the load and draw it up again, bringing the chips with it.

CHAIRMAN: These things, of course, are quite possible. Nothing is impossible to the engineer if you give him enough money to get on with it. But I suppose the apparatus Mr. Moberly was using was too light, probably. I see no reason why it should not work satisfactory. Of course one is very confident before he actually gets into the real difficulties of tackling a subject like this, but I am sure the thing could be done, and it is for a person in Mr. Moberly's position to see whether it would be really worth while. Personally, I think it would be a pity to give up the idea simply because of an initial failure. From what I saw of the apparatus, I thought at the time it was too light for the work it was intended to do.

Mr. MOBERLY: I did not give the thing up without a good many goes at it, and attempts to modify the original plan. I carried on until the available money which had been voted by the Cane Growers' Association had been about exhausted. I am still interested in the thing. I would be very glad to show it to any engineer, or anyone else who might be interested, and I would certainly very much welcome any practical proposition which could be suggested for getting the thing to work, because if it could be made to work, it has several very marked advantages. One is that you could sample all your cane in your yard right away. Also, you would be dealing with a very much less messy material in the sample—something which does not splash. There are many other points of advantage which this opens up, so that if any of you have ideas, I am not at all too proud to hear them and do what I can with them.

CHAIRMAN: I would ask you to give Mr. Moberly a vote of thanks for his contribution on this subject.

Carried.

CHAIRMAN: I will now call upon Mr. Dymond to give us his paper on the Comparative Chemical and Agricultural Data, collected from experimental plots of new variety canes.

Mr. DYMOND: At the outset I would like to ease your minds about the paper, in that I am not going to read all the figures contained therein. Also, I would like to point out that work of this nature is only possible with the co-operation of a lot of people, and I have to thank the Director of the Experiment Station, also Mr. Colepeper, and others, and the Staff of Darnall and Felixton Factories for enabling this work to be carried out at all.

A FEW EXAMPLES OF SPECIAL CRUSHER JUICE TESTS.