

SUMMARY OF EXPERIMENTS CONDUCTED WITH A CANE SAMPLING MACHINE

By G. S. MOBERLY.

This report deals with certain experiments which were carried out to test a proposed method of sampling cane for the purpose of finding sucrose per cent. cane for cane payment purposes. The report is a brief summary of a series of tests carried out during 1946, 1947 and 1948. Full reports of these tests are in the hands of the Technical Secretary, and any persons interested are referred to them.

The machine which was under test was devised in 1936 by O. A. Feltham and, with the collaboration of Patrick Murray, was constructed by Messrs. Duncan Stewart of Glasgow.

The general principle of the machine is that a circular saw driven by an electric motor is mounted on an oscillating frame, the oscillating motion being imparted by a cam-wheel geared to the carrier chain. At regular intervals the rotating saw-blade is inserted transversely into the carrier through a narrow slot in the side of the latter, and then withdrawn. The blade shreds the cane that it comes into contact with, and ejects the shreds into a hopper, from which they are collected in a suitable container and used as a sample representing all the cane that was passing during the operation of the machine.

The first series of tests on this machine was carried out at Chakas Kraal in 1939 by the staff of the Experiment Station.¹ The experiment was not carried to finality, but the report on the work done indicated that there were reasonable prospects that the machine might prove satisfactory.

In 1946 the Sugar Industry Central Board undertook the conduct of a further test of this machine. This experiment was carried out at Gledhow, under the control of the author.

The work done was very extensive, and covered the following:—

A. Preliminary tests to determine a suitable method of calculating sucrose from the sample obtained.

Experiments were carried out using an autoclave (Fillery cooker) and also the usual digesters with reflux condensers. The autoclave method was found to have no advantages, and was discarded.

Tests made with varying quantities of sodium carbonate indicated that the quantities specified for bagasse tests in the Recommended Methods of the South African Sugar Technologists' Association were insufficient, and the amount was increased to 40 ml. of 20 per cent. Na_2CO_3 .

Tests for time of boiling indicated that one hour was most satisfactory.

B. Mechanical test of the machine under working conditions.

Considerable difficulty was experienced from the lateral thrust of the moving cane on the blade, which was inserted at right-angles to the carrier. Several modifications were made to meet this difficulty.

An attempt was made to introduce a two-speed device in order to speed up the rate of sampling for small samples. This proved unsatisfactory, as the high speed was too great a strain on the mechanism.

Further difficulty was experienced from the entry of large particles falling through the slot in the carrier during the time that the blade was withdrawn. This was eventually overcome by reducing the width of the slot. This was effected by covering the slot with a wooden plate and allowing the blade to cut its own way through.

Experiments were tried with a number of different types of blade, and eventually two were selected as being likely to be successful. One had a convex-concave tooth rotating with the convex edge leading. The other consisted of two superimposed blades, each with small triangular teeth.

C. Tests of simultaneous samples to test the consistency of sampling.

These tests showed that there was an appreciable variation between different samples taken simultaneously, usually between 0.2 and 0.3 per cent. of sucrose.

D. Tests of samples from the sampling machine compared with bulk samples taken from the carrier.

Samples of 200 lbs. were taken from the carrier and sub-sampled to 70 lbs. These sub-samples were then finely shredded and pressed. The extracted juice and the residue were separately analysed, and the percentage of sucrose in cane thereby obtained was compared with the analyses of samples from the sampling machine.

These tests showed very wide divergence between the two samples, the average differences being 0.1 and 0.5 for the two blades referred to above. This discrepancy will be referred to again at a later stage of this report.

E. Period runs.

The machine was used for sampling all consignments of cane during 24 hour runs, and the results obtained were compared with the sucrose determined as entering the factory in the mixed juice and bagasse. No concordance whatsoever was found

between the two sets of figures, variations being in both directions, and on occasions the difference was as high as 1.0 per cent. of sucrose in cane.

Considerable mechanical difficulty was experienced with the machine during these long runs.

As a result of this series of experiments the opinion was expressed that the machine, as then constructed, was not suitable for its purpose, but it might be re-designed. It was proposed that it should be erected in such a manner as to insert the blade parallel with the travel of the cane instead of transverse to it.

A Technical Advisory Committee appointed by the Sugar Industry Central Board to supervise the experiment, in commenting on the report of the work conducted in 1946, expressed the opinion that the comparison made with hand samples taken from the carrier, and subsequently analysed by shredding and pressing, was not a sound one, and that a better comparison would be with a large sample from the carrier crushed in a power-mill and analysed for sucrose in juice and bagasse. The Central Board agreed to have this done, but the actual work was not carried out until 1948.

In the meanwhile, a further series of experiments was carried out in 1947, in an attempt to devise a more satisfactory type of blade.

The difficulty that had been experienced with all the blades used hitherto was that the pointed ends of the blades tended to hook large particles and to drag them through into the sample. Some improvement had already been effected by using a blade with backward trailing teeth. A new blade was now made with rounded teeth that had no points.

During this stage of the experiments no analyses were carried out, but the samples obtained were sieved through a series of screens to examine the degree of disintegration obtained and to determine quantitatively the amount of large pieces present in the sample.

These tests indicated that the new round-toothed blade was a considerable improvement on the others, and it was decided to use it in any further experiments.

During the 1948 season the experiment was renewed at Gledhow. On this occasion the machine was mounted below the chute leading from the carrier to the crusher, in such a way that the blade entered a slot cut in the centre line of the chute. The cam and oscillating device were dispensed with and the blade inserted by means of a hand lever at the beginning of each sample, remaining in contact with the cane throughout the whole run of the sample.

This alteration effected a great simplification and overcame most of the mechanical difficulties previously experienced. Very little mechanical trouble was experienced on this occasion.

As a basis of comparison, samples of 200 lbs. of cane were taken from the carrier and transported to Darnall, where they were crushed in a power-mill, kindly lent by Sir J. L. Hulett & Sons Ltd. Each sample was crushed in two parallel lots of 100 lbs., and sucrose per cent. cane determined in the usual way. Comparisons were then made with samples taken by the sampling machine from the same consignments of cane, also tested in duplicate.

These comparisons showed, in almost every case, a very much higher sucrose percentage for the samples put through the power-mill, the difference being sometimes as high as 2.0 per cent. of cane. Fibre tests also showed very much lower fibres. Parallel tests of duplicate samples through the power-mill were usually very close. Parallel samples from the sampling machine were not so good, and sometimes showed considerable divergence.

These differences suggested that adhering trash was being lost when sampling cane and transporting it to Darnall. However, most of the samples were from burnt cane, and in any case the differences were greater than could be accounted for by loss of trash alone. The lapse of time between sampling and crushing was usually about one hour, so there was little likelihood of concentration by evaporation.

Moreover, the sampling machine results in general agreed fairly well with the analyses of the whole of the cane crushed at Gledhow, whereas the percentages of sucrose obtained from the power-mill tests were nearly all over 16 per cent. and much higher than was being obtained at Gledhow at that time of year.

These results were very difficult to interpret. In any case, they indicated that the power-mill tests did not provide a satisfactory basis of comparison. The only judgment that could be made of the sampling machine was in the light of the internal consistency of the samples. The tests carried out both in 1946 and 1948 indicated that the sampling machine in conjunction with the method of analysis employed did not give a result that could be relied upon. Parallel samples from the same consignments tested under identical conditions gave significantly different results.

Although the experiment, in the absence of a satisfactory basis of comparison, cannot be considered as conclusive, there appeared to be sufficient evidence to indicate that the proposed new method of sampling was not reliable, and the author recommended to the Sugar Industry Central Board that the experiment with the machine in its present form be not proceeded with any further.

The author's thanks are due to the Sugar Industry Central Board who had the experiments carried out, to the Gledhow-Chakas Kraal Sugar Company who provided all facilities and gave invaluable assistance,

and to numerous others whose help and advice were greatly appreciated.

REFERENCE.

¹ Christianson, W. O., (1940): 14. Proceedings S.A.S.T.A., p. 135.

Mr. MOBERLY prefaced his reading of the paper by stating that this was no more than a brief resume of experiments which extended over three seasons, as it was impossible in the time available to go fully into them. The original report was nearly fifty pages long, and there were two more reports covering work in subsequent years. The Hon. Technical Secretary would have a copy of the full reports available to anyone who desired more detail.

The PRESIDENT pointed out that while the work done was a continuation of the experiments carried out by Mr. Christianson in 1939 and reported in our 1940 Proceedings, some of the results were different from those found then. In the first place, it was found in 1939 that one hour's boiling of the shreds from the sampler was not enough, and that a two-hour period showed a distinct rise in polarization. There might be a difference in fineness of the shreds, but he thought at least one of the blades was the same as that used in 1939. Secondly, it was now stated that a laboratory power-mill sample of 200lbs. of cane was an unsatisfactory basis for comparison, because this gave a test much higher than did either the cane sampler machine or the actual sucrose obtained at Gledhow factory at the time. He did not agree that a large hand sample was necessarily unsatisfactory, for this sampling method had been tried out not only in 1939, but also some time before, when experiments had been carried out at Gledhow in connection with varietal differences, and it seemed to him to be the only basis that one could use. One had to have some standard, for if one compared the sampling machine with the Java Ratio method, one did not know which was correct.

The work was carried out in an attempt to find a more satisfactory way of sucrose distribution between growers, as there was some dissatisfaction with the present Java Ratio method. This latter method, although it had many faults, had more distinct advantages also. It was very simple, and except when planters sent in an undue amount of trash with their cane, on the average it did not work badly. A lot of work had been reported on by Birkett, who found that, in a normal year, in 90 per cent. of the tests the difference between the Java Ratio method and the actual sucrose in consignments would not be more than 0.3 per cent. sucrose in cane. In an abnormally droughty year this proportion might fall, but not as low as 80 per cent. If these results applied in South Africa this could be considered quite

satisfactory. Small variations such as these would cancel out, especially if the Java Ratio were calculated on a daily, rather than a weekly, basis.

There was, however, one great disadvantage in the Java Ratio method; and that was the effect of trash on the Java Ratio. This ratio was affected by two factors. One of these was the ratio of the sucrose percentage of the absolute juice to that of the crusher juice, and the other was the fibre percentage of the cane. The first factor was rather uncertain, being affected by the cane being diseased or dirty and by various other conditions; but the effect of fibre on the Java Ratio was straightforward and could be expressed by a normal regression formula. He would suggest that to improve sucrose distribution, occasional fibre determinations to modify the Java Ratio could be carried out.

Mr. CHRISTIANSON expressed concern at Mr. Moberly's statement that a large hand sample analysed by means of a laboratory mill provided no basis for testing the sampling machine. He knew that one could get very queer results from test mills unless adequate steps were taken to ensure that the resulting bagasse was properly subsampled. He asked the author how the subsampling was done, and if all the bagasse was disintegrated and thoroughly mixed before being sampled.

Mr. MOBERLY explained that after the sample had been crushed by the power-mill twice, a large portion of the bagasse was taken and chopped up with a cane-knife on a block, and this chopped-up portion was again subsampled and tested. No form of disintegrator was available.

He referred to the points raised by the President about the time of boiling, and the difference between the results at Chakas Kraal and his own figures. The determination of the time of boiling was carried out in the first place, not on samples from this machine, but on shreds from the Queensland shredder, which gave a somewhat similar product. These shreds were subdivided into several subsamples, all but one of which were boiled for varying intervals of time. This remaining sample was squeezed in a hydraulic press, the juice tested, and the residue was tested by digestion by the same method as was used for the other subsamples. This test on this residue was subject to the same doubts as was the digestion of the others, but as the greater proportion of sucrose was in the juice and only a small portion in the residue, he was able to get a test not nearly so subject to any error in time of boiling. He found that the results from such squeezing and digestion of the residue gave an average equal to the plain digestion for one hour and a half.

His attention was then drawn to an error in the quantity of water used in the digestion method. The methods of our Association, when dealing with the

analysis of bagasse, allow for moisture in the bagasse on a 50 per cent. basis. That was not correct, as allowance should be made, not for moisture, but for the solution present—dissolved solids as well as moisture. In the case of factory bagasse the discrepancy was trifling, but with shredded cane it was important. It was necessary to recalculate the tests on this basis, and then it was found that the test by pressing and digesting of the residue gave a figure equal to that obtained by boiling the shreds for one hour.

The PRESIDENT pointed out that, as Mr. Moberly had said, there was an increase in polarization from one to two hours, and whichever basis was used that increase could not be made to disappear.

Dr. DODDS stated that an accurate and reliable method of testing and sampling cane was certainly a consummation very devoutly to be wished, and it was unfortunate that this method, on which so much time has been spent, did not seem to take us very much further. Certainly the Java Ratio method led to many inaccuracies. He knew from his own experience that cane could test much higher in sucrose at one factory than it did at another—not occasionally, but systematically. But it was very difficult to suggest any alternative. In Louisiana, he believed, they still paid for cane on the sucrose analysis of the juice only and discard the fibre altogether. That, he thought, was even worse than the Java Ratio—putting a premium on cane that is of poor quality and high fibre. He thought we might do something on lines similar to Queensland, with more fibre tests. That might be investigated a little further, to find a more convenient and reliable method of sampling and testing cane for fibre. Otherwise the position at present was not very hopeful. However, he hoped that this Association would continue these very valuable attempts and eventually arrive at some method of reliably sampling and testing cane.

Mr. MOBERLY said that Dr. Dodds had mentioned something which came home to him very much—the matter of the different results obtained by sending cane to different mills; that was the inevitable result of using this Java Ratio method. If it was merely due to the different conditions, it would not matter, but when it is due to the fact that one mill takes the bulk of high-fibred, and the other mill takes low-fibred cane, this transfer from one mill to the other becomes significant. There was obviously some disturbance going to take place with reference to one grower's cane and another's.

He was able to devise a method of fibre analysis which, while not rapid enough to give a sample for every consignment of cane, did enable quite a considerable number of samples to be done during an ordinary routine shift. The method was used in conjunction with the shredder. The whole of the

residue from the digestion was put into a large linen bag, pressed in a hydraulic press, and then put into a sink, and every few minutes somebody would come along and give it a squeeze. After two hours' soaking in running water with periodical squeezes, it was taken out and pressed well. He took a sample of the final run-off from the last pressing representing the residual juice, and tested it and made an adjustment, but found eventually that that adjustment was so small that he got quite a good enough comparative test by taking the pressed residue in the bag and heating it in an oven for four hours. The dry residue was fibre to within one place of decimals. He could not dry that sample in the bag itself—it would never dry out. He used to pour the contents of a bag into a tray, turn the bag inside out and lay the bag on top of the contents of the tray, and he found that if he weighed it after four hours, deducted the weight of the bag and made the necessary calculations, he got a figure which was consistent in a number of different samples.

Mr. WALSH thought that a tribute should be paid to Mr. Moberly and his assistants for the tremendous amount of hard work done. If the mechanical side of the experiment had been as thorough as the chemical work, he thought we should have seen different results. The short report summarised a tremendous amount of work.

Looking at it broadly, this was the same kind of sampling as was done in many other industries, and, as such, it deserved further investigation.

Mr. RAULT said that after visiting other countries, he thought that we here could be complimented on our chemical control methods. He doubted that we would accept some of the methods used overseas.

Here, although we tried our best, we did often fall short of the ideal, especially when endeavouring to test dirty canes. The Java Ratio fluctuated considerably, but he did not agree with Dr. Dodds that it could vary from factory to factory sufficiently to cause a difference of one per cent. in sucrose content of cane. He thought this more likely to be due to errors of sampling. However, there was the difficulty that we were not able to reflect in our cane-testing the amount of trash and foreign matter in individual samples.

Mr. MOBERLY stated that while the paper did not condemn the idea of a mechanical method of sampling whole cane, it did indicate that the machine under discussion, in its present form and in conjunction with the method of analysis that was employed, did not give reliable results. He had no doubt that the machine could be fundamentally redesigned and successfully used in conjunction with an analytical method more suitable to shredded material rich in sucrose.