STOP – HULETTS "STALK ONLY PLEASE" PROGRAMME

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Abstract

The results obtained from 17 030 samples of cane taken by grab samplers at five Huletts mills during the 1975/76 season were analysed for extraneous matter. They indicate a mean of approximately 10% on gross cane. The benefits of a reduction to 7% are estimated and a proposed programme to achieve this target is outlined.

Introduction

Oliver Lyle in one of his entertaining and highly informative books wrote "Sugar cane is a gigantic grass and consists of roots, stalk and leaves". This is an adequate description of a great deal of cane delivered to Huletts mills, plus sand, mud, scrap iron and rocks at times. The milling companies would much prefer only to receive the stalk and a great deal of trouble is caused by processing the other components of our cane deliveries. Looking at the problem Huletts decided to draw up a programme which it is hoped will lead to a reduction in extraneous matter delivered to their mills in the not too distant future.

Basically, the programme was:

(i) to define the problem.
It was decided there were two distinct problems, cane with too much trash and tops on the one hand and cane with too much sand, rocks and mud on the other, with the occasional chunk of metal for good measure. It was decided to concentrate on cane with too much trash and tops for two reasons:
(*a*) trash and tops could probably be measured fairly easily.
(*b*) success in getting cleaner cane would probably solve the second problem to some extent.

(ii) to carry out a literature survey on the subject of poorly cleaned cane. This was done and a surprising amount of study has been carried out, and numerous papers prepared.

(iii) to introduce systems to measure the amount of trash and tops being received at Huletts mills. This was done at five mills as described later. The object was to measure the present problem and to collect base data for later comparison.

(iv) to evaluate the cost of the problem in order to get some idea of how much Huletts are losing by processing trashy cane.

(v) to propose a possible method of minimising the problem. It is not anticipated that it will be eliminated in the foreseeable future.

Literature survey

Several aspects were covered and some worth mentioning are as follows:

The analysis of the tops and trash bear little relation to the stalk they accompany. Studies conducted by Arceneaux and Davidson[2] indicated that the dry matter from green trash contains more than twice as much soluble solids as does the same quantity of dry matter from dry trash. Keller and Schaffer[4] found that an increase in trash of 1% increased the fibre % cane by 2,75%. Arceneaux and Davidson[2] found that sucrose losses in bagasse due to the presence of trash could increase by as much as 33%. This figure applied to South African mills would result in a change of 2% in mill extraction. They also found that trashy cane contributed molassegenic non-sugars to the juice with consequent increases in molasses losses, and that the efficiency of imbibition was decreased. The effect of trashy cane on the efficiency of diffusion plants has yet to be studied but we suspect that it is significant. Tests in Taiwan,[10] where an industrial quality control programme has been in use for many years, indicate that overall recovery is reduced by 0,34% for every increase in trash of 1%.

Many other factors were discussed in the papers surveyed, such as wear and tear on plant, reduced capacity, increased cane transport costs, and a comparison of cane harvesting and loading systems (push-pile loaders and grabs showing some appalling figures for extraneous matter content).

Sampling and measuring extraneous matter

The principal difficulty associated with the sampling of cane is the inherent heterogenity of the material. Cane delivered to the factory can best be described as a "tangled mass", the ability to withdraw representative samples from which poses problems. The hatch sampler produces a representative sample suitable for the determination of the simple constituents of cane such as pol, brix and fibre. However, due to the considerable preparative effect of knives the hatch sampler is not

TABLE 1
Analysis of Typical Clean Cane and Extraneous Matter

	Brix	Pol	Apparent Purity	Fibre %	ERC
Clean cane	14,81	12,78	86,3	12,48	11,20
Tops	8,78	3,25	37,0	11,92	0,20
Dry and Green trash	6,81	1,89	27,8	48,7	– 2,25

Note that while tops are not good for processing, trash is very much worse.

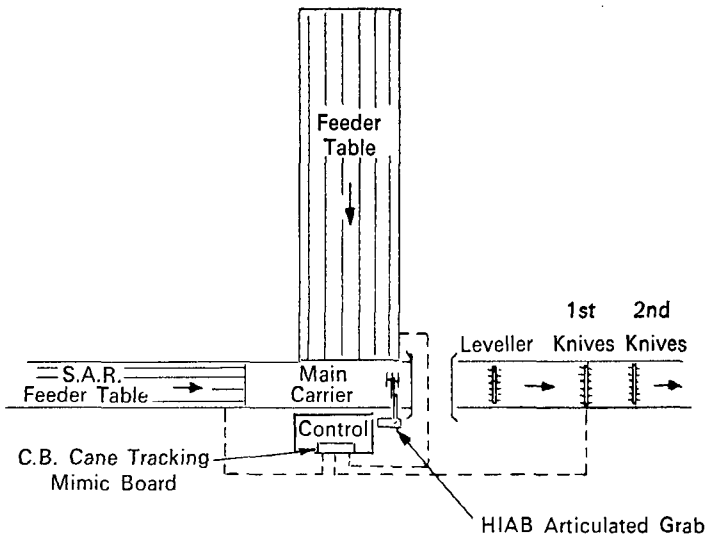
TABLE 2
Percentage of Dry Matter, Fibre and Soluble Solids in Dry and Green Trash

Condition of Trash	Dry Matter % Fibre	Fibre % Trash	Soluble Solids % Dry Matter			
			Ash	Nitrogen	Other Soluble Solids by Difference	Total
Dry	85,27	80,93	0,94	0,06	4,09	5,09
Green	32,90	28,80	3,24	0,17	9,05	12,46

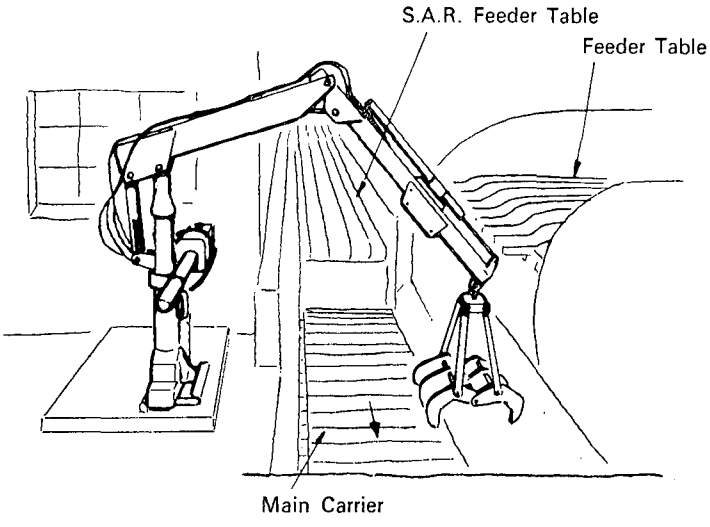
at all suitable for the determination of extraneous matter in the form of tops and trash.

Core sampling of wholestick cane renders the attainment of representative samples difficult since part of the extraneous matter may be stripped off the stalk and not included in the sample. Sampling by manual means entirely, although feasible, is not only expensive in labour and space but also subject to human error and bias. A working solution however is the use of the articulated mechanical grab for the sampling of wholestick cane. After prior development work at Darnall a Hiab grab sampler was installed at each of Huletts north coast mills during the 1975/76 season and these have operated successfully throughout this past season.

These grabs were positioned on fixed foundations alongside the main cane carrier (Fig. 1) and before the knives so that samples of wholestick cane could be withdrawn. The motion of the grab is such that it samples a representative "bite" through the cane blanket and over the whole width of the carrier. The bite varying from 25-50 kg is not subsampled and the % trash and % tops are determined directly using a standardised technique in operation at all the mills and performed by two analysts (see Appendix A). The system at this stage does not permit the determination of mud and sand along with the cane.



Plan showing position of grab



Sketch of Hiab articulated grab

FIGURE 1

During the 1975/76 season 17 030 samples were taken at Huletts five mills, the results being classified into burnt and unburnt cane, and the tops and trash were measured for each sample. The overall results are shown in Table 3 and this indicates a trash and tops content of all samples as a percentage of gross cane. The mean is 9,59% with a standard deviation of 5,27%.

All cane was manually cut. Some may have been machine loaded but the quantity was not very great. Extensive testing in Cuba[8] shows 3% extraneous matter for manually cut and loaded unburnt cane, and 4% for manually cut and mechanically loaded cane as the average of 5 seasons sampling. Australia classify 0-3% acceptable, 4%-5% dirty and 6% very dirty. Mechanical harvesting of green cane in Louisiana produces extraneous matter of approximately 8%. It would appear that, with the possible exception of Hawaii, South Africa accepts for delivery to its mills cane which would be classified as unacceptable in most other parts of the sugar cane world.

In addition to regular sampling Huletts ran a series of 56 tests at Felixton mill in which cane mass, variety, fibre %, trash %, top % and time to crush were recorded, and the results were analysed on a computer. The following formula was produced indicating the effect of extraneous matter on crushing rates for Felixton I Tandem.

Tons cane/hour = 127,8 − 3,2 trash % cane + 1,7 tops % cane

The results indicate that tops actually increase the crushing rate and this was puzzling until it was remembered that as tops often have a lower fibre content than cane the mill crushes them easily, but tops are not wanted. Whilst they crush easily the juice will give problems in processing.

Regression analysis showed the effect of both fibre and trash on crushing rate as:

1% increase in fibre reduces crushing rate by 4,6% ± 1,2% (say 5) and

1% increase in trash reduces crushing rate by 2,7% ± 0,7% (say 3%).

It is known from Keller and Schaffer[4] that 1% trash increases the fibre % cane by 2,75%.

Evaluating the cost of processing extraneous matter

An attempt has been made to give a money value to these data. With reduced trash it is possible to:

Crush more cane without major capital additions.
Improve overall recoveries.
Reduce transport costs.
Reduce down-time and maintenance costs.
Shorten the season for the same sugar production.

Some of these can easily be expressed in money, others it is known will save money but not how much.

1. Crushing more cane without major capital additions

Season 1975/76	*Industrially*	*Huletts*
Tons cane crushed	16 m	5,8 m
Fibre % cane	16,94	16,19
Tons fibre	2 710 400	939 020
Extraneous matter % say . .	10	9,6
Tons extraneous matter . .	1 600 000	556 800
By reducing extraneous matter[4] by 3%, fibre will reduce by 2,75 × 3% to	15,54	14,85
Equivalent tons cane . . .	17,4 m	6,3 m
Increased tonnage	1,4 m	500 000
% Increase	9%	9%

Check:

Tests at Felixton showed that a 1% reduction in trash would increase crushing rate by 3% so a 3% reduction would increase rate by 9%. It would appear that Keller and Schaffer's[4] figures agree fairly closely with Huletts tests so far.

Huletts expansions over the last few years have averaged out at R22 per ton of extra annual cane capacity, thus a programme to increase capacity by 100 000 tons of cane per annum costs R2,2 m. Huletts have long since passed the stage where they can get any more cane through their factories without major capital expenditure, so-called marginal expansions are no longer "marginal" capital expenditures. This applies to the great majority of South African factories. By reducing the extraneous matter content to 7% the South African industry could avoid installing capacity of some 1,4 m tons at a capital cost of some R30 m.

2. Improving overall recoveries

Huletts have not yet evaluated this. Investigations elsewhere seem to indicate 0,30 to 0,34% increase in overall recoveries per 1% reduction in trash content. If this is so then reducing extraneous matter from 10% to 7% would improve recoveries by 1% and this is an increased revenue to the whole industry of R6 390 000 at today's prices.

3. Reducing transport costs

The combined miller and grower cost claim in the 1975/76 season for cane transport was R28,8 m, i.e. R1,71 per ton cane delivered. Every ton of trash cost R1,71 to deliver too and approximately 1,6 m tons of trash and tops were delivered. If there was a reduction of the 10% extraneous matter to 7%, R820 000 per annum would be saved in the industry.

4. Reducing down-time and maintenance

Trashy cane is known to choke knives and shredders, and bring in sand and soil, but the cost of this is not known accurately. A reduction of extraneous matter in future would enable a cost comparison to be made. It is certain however that they are costly in money, and affect morale of factory staff who look at the condition of cane supplies with despair.

5. Reduction of crushing season

By an increase in crushing rate the season can be reduced by some 9% for the same production if extraneous matter were reduced to 7%. For some years now Huletts Operations Research Department has collected data on sucrose contents during the seasons and the effects of shorter seasons on sucrose content.[11] In the case of tests at Felixton it was estimated that a shorter season (reduced from 40 weeks to 37) would increase the sucrose content of cane by 0,095%. If a figure of 0,1% is taken and applied to industrial figures of last season, merely as a guide, there is an increase of sucrose content of 16 813 tons or 14 352 tons of sugar produced. This would increase the revenue of the industry by R4,3 m.

Summary of Benefits

If extraneous matter is reduced from 10% to 7% and the level of cane production kept the same the estimated industrial benefits are:

(1)	Improved overall recovery . .	R6 390 000
(2)	Reduced transport costs . . .	820 000
(3)	Reduction of crushing season .	4 300 000
	Benefits per annum . . .	R11 510 000

In addition there would be provided additional capacity for some 1,4 m tons of fairly clean cane (7%) with a resultant capital saving of approximately R30 m. It is Huletts belief that these figures are conservative as they do not allow for improved running time and reduced maintenance which can be expected with cleaner cane.

Huletts "Stalk Only Please" Programme — Stop

It would be unrealistic to expect that just by asking the growers for "stalk only" this will happen overnight, no matter how co-operative they may be. Years of acceptance of cane consignments in practically any condition will take years of rectification. Labour attitudes, harvesting systems, supervision — all have to change and this will take time, patience, co-operation and money.

But a start has to be made somewhere and a study of the sampling results suggested that the problem be approached from the "unacceptably bad" angle. The typical bell distribution of the condition of cane deliveries revealed that there were considerable deliveries of very dirty cane outside the

TABLE 3

Huletts Sugar Ltd — Extraneous Matter Control Scheme

	All Cane Combined					
	EM	FX	AK	DL	ME	Group
Number of Growers	97	100	179	104	52	532
Total Number of Samples	2 312	4 113	3 243	5 005	2 357	17 030
Samples/Grower:						
Mean	24	41	18	48	45	32
Standard Deviation	36	90	16	64	61	56
Trash (%):						
Mean	8,98	6,22	6,61	6,89	5,84	6,82
Standard Deviation of All Samples	4,67	4,25	4,12	2,86	3,99	4,00
Standard Deviation of Growers' Means	2,29	1,76	1,85	0,91	2,09	1,96
Standard Deviation of Average Grower	4,18	3,93	3,81	2,74	3,45	3,56
Tops (%):						
Mean	2,09	3,36	3,26	1,24	5,01	2,77
Standard Deviation of All Samples	1,60	2,38	3,07	1,20	4,04	2,79
Standard Deviation of Growers' Means	0,70	0,53	1,80	0,41	2,57	1,82
Standard Deviation of Average Grower	1,48	2,35	2,60	1,14	3,17	2,17
Trash + Tops:						
Mean	11,08	9,58	9,87	8,14	10,85	9,59
Standard Deviation of All Samples	5,25	5,66	5,76	3,39	6,29	5,27
Standard Deviation of Growers' Means	2,36	2,07	2,97	1,12	3,73	2,63
Standard Deviation of Average Grower	4,81	5,34	5,12	3,24	5,15	4,66

standard deviation, e.g. if the mean of all samples at a mill was 9,59% with a standard deviation of 5,27% giving a total of 14,86%, there are still many consignments with a greater amount of extraneous matter.

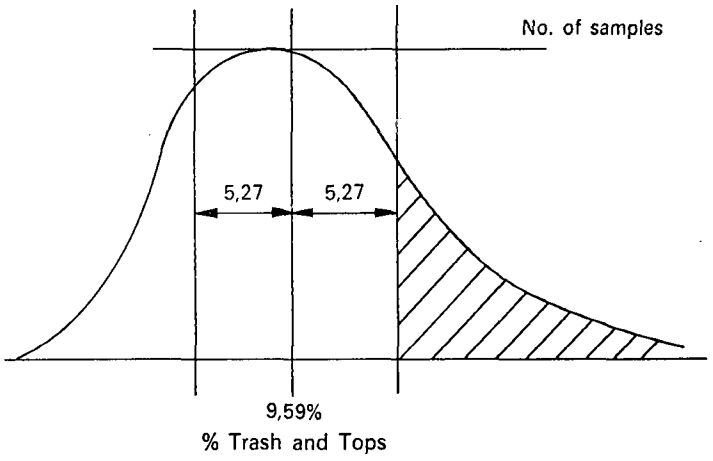


FIGURE 2

It is felt that those consignments above 15% are unacceptably bad and the aim should be to eliminate them. If successful then the bell curve will start to move to the left, and progressively year by year should improve until an acceptable level is reached (see Fig. 3).

Another interesting feature of Huletts analysis of sampling results is that in some areas the bell curves for each individual grower are similar in shape to the mill average, which indicates that in general the growers send in cane of similar quality.

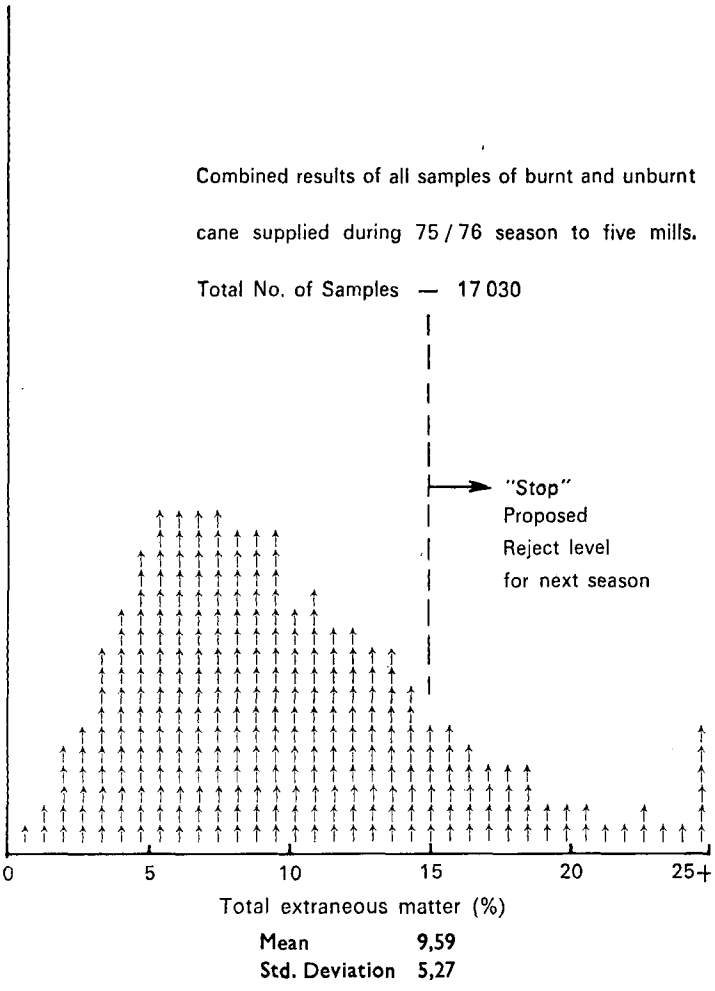


FIGURE 3 "Stalk only please" programme.

In these cases all growers are monitored consistently and continuously. In other areas there is a distinct difference between the bell curves for individual growers which indicates that some growers are consistently bad and other growers are consistently good. When this happens it is easier to be aware of the possible source of dirty consignments.

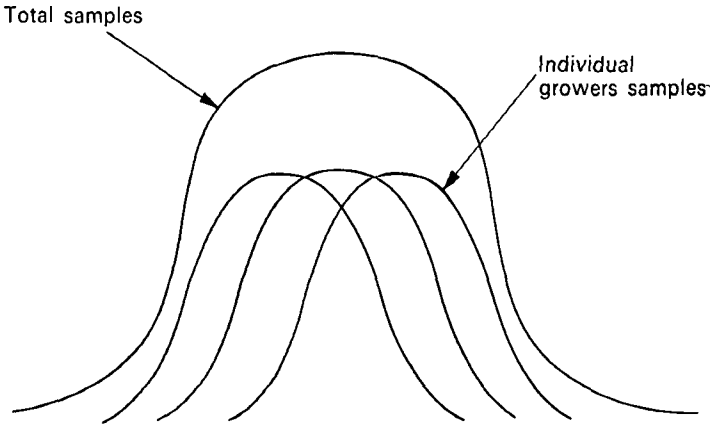


FIGURE 4 Distribution curves of individual growers similar to that of total samples indicates most growers tend to send in a wide variety of good and bad consignments.

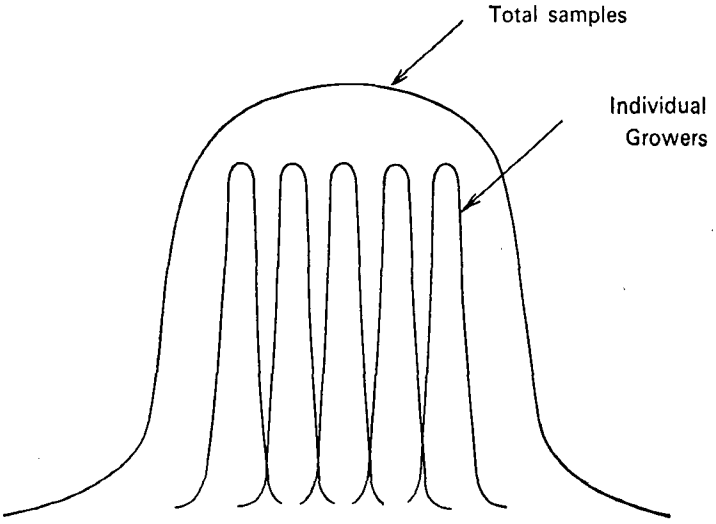


FIGURE 5 Distribution curves of individual growers are elongated indicating that their consignments are much more consistent — usually good or usually bad.

The details of implementing STOP have yet to be completed. In general Huletts have to:

(*a*) Continue sampling.

(*b*) Train cane yard inspectors to recognise unacceptable consignments before they are placed on the mill carriers.

(*c*) Work out an agreed warning and subsequent rejection procedure with Mill Group Boards.

Acknowledgements

This study would not have been possible without the active co-operation and willing work of Huletts mill staffs and the members of Huletts Technical Departments. The author is merely the collector and disseminator of the information given.

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APPENDIX A

Sampling System at Huletts Mills

(1) In order to obtain a true measure of the percentage of extraneous matter delivered to the mill, each grower's cane is sampled in proportion to his daily/weekly allocation. The limiting factor in this regard is the total number of samples which can be physically analysed per week. This number (approximately 195) is divided up amongst the growers in proportion to their weekly allocation so that each is sampled a specific number of times per week.

(2) A theoretical case demonstrates this in Table A.

TABLE A
Proportioning of Sampling

Grower	Weekly Allocation	Percentage of total tonnage	No. of Samples to be taken per week
A	1 000	11,1	11,1 of 195 = 22
B	2 000	22,2	43
C	1 500	16,7	32
D	4 000	44,4	87
E	500	5,6	11
	9 000	100 %	195

(3) At present the objective of the sampling scheme is to measure the amount of extraneous matter entering the mills and not to control it. Standards must first be drawn up and this scheme hopefully will provide sufficient data for this purpose. Table III shows the results of the extraneous matter sampling obtained during the year as calculated on a weighted average to-date basis by a computer. It is apparent from this that different mills have different extraneous matter levels, probably for several reasons. We have other data on burnt and unburnt cane, and if necessary we can programme the computer to print out individual grower performances.

(4) Statistical interpretation of the preliminary results indicated with confidence of well over 99,9% that the variations within each consignment were not so large as to obscure variations between consignments.

On the results obtained from the whole season Mr R. Hoekstra of Operations Research commented:

"... the differences in average trash % cane and also in average tops % cane between individual growers are extremely significant. This implies that, when it comes to the trashing of unburnt cane, some growers are consistently on the good side and others consistently on the bad. The fact that one can obtain results like this suggest that the statistical sampling procedure is reliable, otherwise the respective standard deviations for samples of the average grower and for all samples for all growers would not have differed significantly."

(5) *Equipment Costs*

A brief outline of the cost of equipment required as at January 1975 is given below:

Grab (complete)	4 400	
Installation cost	600	
Shelter, Furniture and Electrical	1 800	
		6 800
Two Beam Balances		1 400
		R8 200
Total Capital Cost at five mills		R41 000

(Extract from the Huletts Laboratory Operations Manual)

Extraneous Matter Determination of Wholestick Cane

Definition

(1) Trash is defined as all loose, green and dry, leaves and sheaths and all attached green and dry leaves and sheaths but below the natural breaking point of the stalk.

(2) Tops are defined as that portion of the stalk above the natural breaking point plus all leaves and sheaths, green or dead, attached to that part of the stalk.

Procedure

(1) The whole sample from one grab is weighed to the nearest 10 grams and the mass recorded (W_1).

(2) Trash is removed by hand, weighed to the nearest 10 grams and the mass recorded (W_2).

(3) Stalks are topped at the natural breaking point (i.e. when that part of the stalk is present). This may be done either manually or by means of a cane knife. The former method is preferable as it eliminates human error.

(4) Tops are weighed to the nearest 10 grams and the mass noted (W_3).

(5) Percent tops and trash are given by:

$$\% \text{ Trash} = \frac{100 \times W_2}{W_1}$$

$$\% \text{ Tops} = \frac{100 \times W_3}{W_1}$$

(6) The following points must be noted:

(*a*) Spring balances cannot be assized and thus a beam balance must be used.

(*b*) If only one balance is used for weighing the cane, tops and trash it should weigh up to 100 kg, to the nearest 1 or 10 gram.

(*c*) The complete load of cane obtained by the grab must be weighed, i.e. no sub-sampling of the grab sample.

(*d*) Six analysts are required, i.e. 2 per shift. One unit of labour per shift has been found inadequate for the volume of work.

(*e*) No percentage calculations are to be performed by the analysts, the computer division will perform all calculations, print-outs, etc.