SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

PROGRAMME FOR ANNUAL GENERAL MEETING 14 OCTOBER, 1982

TEA	9.00 - 9.30
Chairman's Report	9.30 - 9.45
The Cane : sugar ratio Murt Murdoch	9.45 - 10.00
Cane testing and quality variation Trevor Loudon	10.00 - 10.30
Cane deterioration Arnold Brokensha	10.30 - 11.00
Extraneous matter - its components and effects on milling Roy Blunt	11.00 - 11.30
Extraneous matter - field operations Mike Neethling	11.30 - 12.00
LUNCH	
Cane topping Quin Mann	2.00 - 2.20
Chemical ripeners Rob Donaldson	2.20 - 2.40
Nutrition and cane quality Tony Wood	2.40 - 3.00
Maturity patterns of cane varieties Geoff Inman-Bamber	3.00 - 3.20

Show trends in diff. areas?
relate these factors to climate

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

CANE/SUGAR RATIO

by

M G Murdoch

1. In the 1981/82 season the cane/sugar ratio was 9,50, the worst it has been since 1934.

2. Although the ratio varies considerably from season to season it is clear that the trend has been for it to increase since 1950.

3. The cane/sugar ratio is dependent on the sucrose content of cane and the proportion of the sucrose recovered in the factories as sugar. Recovery in the factories shows an increasing trend over the 30 year period.

4. Although sucrose % cane has decreased, the yield of sugar per hectare has increased. Obviously sucrose % cane is a factor in determining economic optimum yield as opposed to maximum yield.

5. If sucrose % cane decreases, then one or more of moisture, fibre, (soluble) non-sucrose must have increased as a percentage of cane. (Cane being defined as the total material delivered to the mill ie including any extraneous matter).

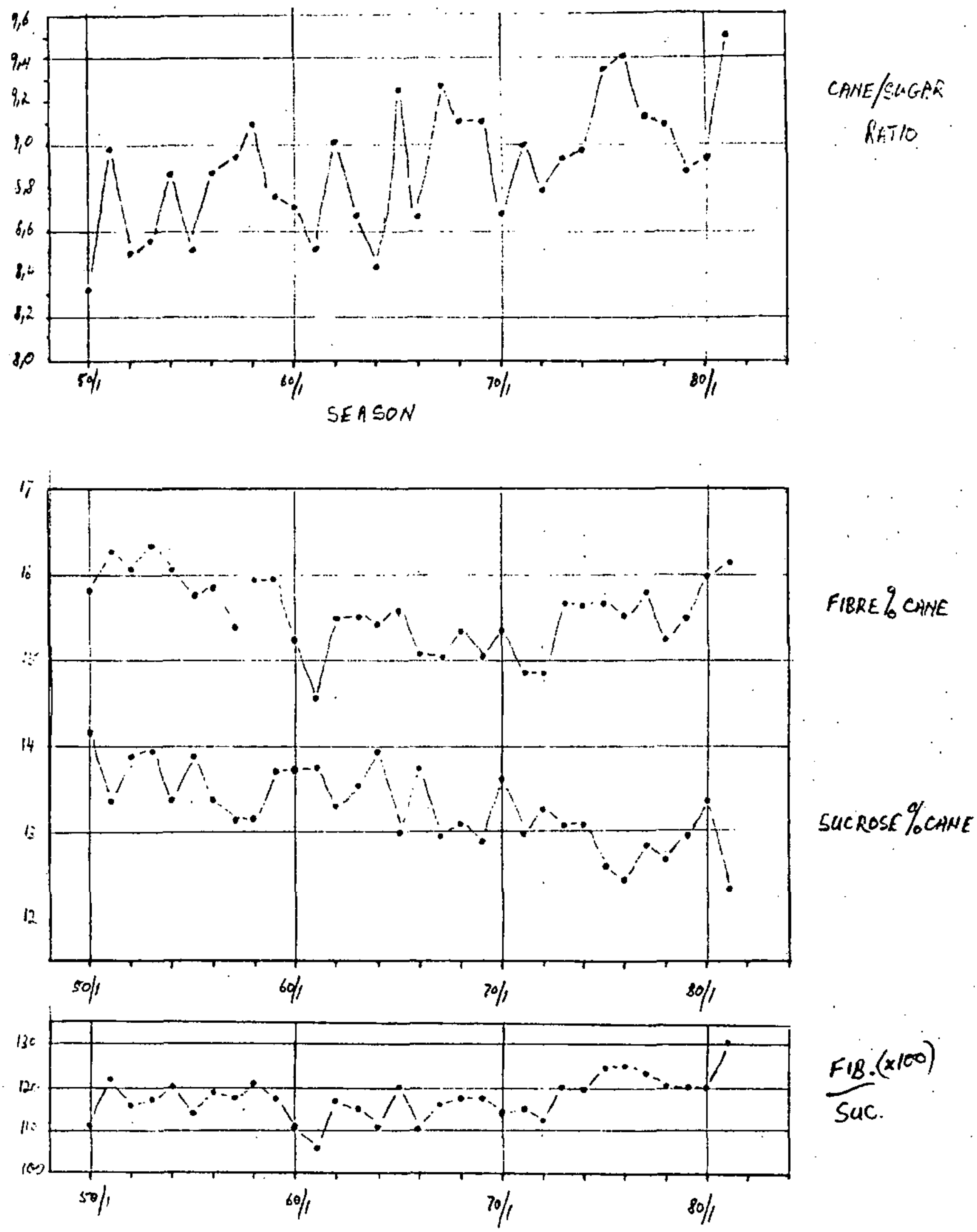
6. Although data for sucrose % cane can be compared (within reasonable limits) over a long period the data for the other components is not so comparable because of changes in definitions and analytical methods. A change in moisture percent appears to have been mostly responsible for the decline from 1950 through 1970 and thereafter an increase in fibre seems to have contributed.

7. A number of factors or practices have changed over the period reviewed which could have affected one or more of the components of cane. Some of these are listed below:

   - change in varieties grown
   - decline in the average age at harvest
   - length of milling season
   - fertilizer practices
   - extraneous matter contents
   - proportions of burnt and trashed cane.

MGM/VSJ
1982.10.13

TOTAL DATA - SA SUGAR MILLS



Effect of ripening – will the effects be lost in the variation.

SASIAA

CANE TESTING AND CANE QUALITY VARIATIONS

by TREVOR LOUDON

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CANE TESTING AND CANE QUALITY VARIATIONS.

INTRODUCTION.

The cane producer in South Africa is paid for the quantity of sucrose that he delivers to the mill. The Sugar Industry Central Board is responsible for the performance of cane testing to determine the amount of sucrose delivered by each grower and for this purpose the Board employs its own cane testing staff, establishes its own laboratories and provides its own sampling and analytical equipment. The existence of an independent, industrial Cane Testing Service (C.T.S.) ensures that officially prescribed equipment and procedures are used uniformly throughout the Industry.

This opportunity is taken to provide a brief description of the South African method of cane testing ; to examine the extent to which sucrose fluctuations are occurring and to assess the levels of accuracy being attained with the South African method of cane testing.

In the course of a season near to one million individual consignments are tested ; this represents more than 95 percent of the total number of consignments delivered. Cane testing costs amount to 20 cents per ton of cane, of which 13 cents is borne by the grower.

The South African system of cane testing is generally recognised by sugar technologists as being probably the most sophisticated and the most accurate system of cane testing in existence. This opinion is however, not generally supported by growers and this is because seemingly irrational variations in the levels of sucrose % cane recorded for consignments of "the same cane from the same field" tends to undermine confidence in the validity of the test results.

SOUTH AFRICAN METHOD OF CANE EVALUATION.

The S.A. method of cane testing entails two separate phases:

i) the determination of the total amount of sucrose contained in the mixed juice and the final bagasse over a week : this constitutes the total amount of sucrose available for distribution among the individual cane consignments, and

ii) parallel and independent inspections of each individual consignment, entailing the capture of a cane sample from each consignment before it enters the mill. (DAC: DIRECT ANALYSIS OF CANE).

The total weekly sucrose tonnage determined as per (i) above, is distributed among the individual cane consignments pro-rata to their individual DAC pol % cane test results (determined as per (ii) above).

For the sake of completeness brief reference is made to the manner in which the sucrose price is determined via the division of proceeds and to the Relative System of cane payment.

2.1 DETERMINATION OF THE TOTAL AMOUNT OF SUCROSE ENTERING INTO THE FACTORY EACH WEEK.

The sucrose content of mixed juice (as determined via the Gas Liquid Chromatographic analytical technique) plus the sucrose content of final bagasse (assessed in terms of pol), together constitute the master measurement of the total amount of sucrose entering into the factory.

Samples of both the mixed juice and the final bagasse are inspected for pol contents in the C.T.S. laboratories, every hour throughout the week. Composite samples of mixed juice are collected over the week at each factory. These weekly collective samples are stored and transported under freeze preservation to a central C.T.S. GLC laboratory where they are examined for both sucrose and pol. The sucrose/pol ratios so determined are applied to the pol tonnages in mixed juice as determined at the factories, to convert them to sucrose.

The C.T.S. attends to the determination of the mass of mixed juice, which involves a correction for insoluble solids content, and to the determination of the mass of bagasse.

With the advent of diffusion the use of the basic factory equation to determine bagasse mass, was rendered inoperative due to excessive unmeasured evaporation. Attempts to measure the mass of bagasse directly, using belt weighers, radiation weighers, dump weighers etc., all proved unsuccessful. The problem was satisfactorily overcome by using the tons fibre in cane, as determined via DAC, (and corrected for insoluble solids in mixed juice) in conjunction with the fibre % bagasse analysis, to calculate the mass of bagasse.

The determination of the total amount of sucrose entering into the factory constitutes a service that is of fundamental importance to both millers and growers : it is the cornerstone of miller/grower and miller/miller divisions of monies and it is also a fundamental constituent of the factory control data.

2.2 DISTRIBUTION OF TOTAL SUCROSE IN CANE.

At the end of each week the total, master tonnage of sucrose in cane is distributed among the individual cane deliveries to that mill, pro-rata to the pol % cane results obtained for the individual consignments of cane as determined by the DAC inspections i.e. the Direct Analysis of Cane, results.

2.1.1 Cane Sampling.

Samples of cane from individual cane consignments are captured at the top of the slat conveyor which elevates the cane to the first mill feed-chute.

At this point the cane has already passed through the cane knives and mill shredder and is in a finely divided condition. An aperture, across the full width of the carrier, is covered with a sliding gate which is opened and closed at frequent intervals to provide a regular fall-out of the finely prepared cane. This primary sample is sub-divided via a series of flip-flap sub-samplers.

Sampling of prepared cane in this manner is highly efficient and has considerable advantage in its randomness and ease of automation. But it requires that each individual parcel of cane be demarcated and identified along cane carrier systems that are often extensive and complex. Cane yard storage and increasing crushing rates are further aggravations. The advent of the electronic cane tracking device has played a vital role in the success of current cane sampling operations.

It is recognised that if cane could be sampled "at the weighbridge" with a corer or a grab then tangible cost savings and efficiency gains could be achieved in cane yard operations. On the other hand it is also generally recognised that our existing method of sampling prepared cane with a hatch, is the best of the known means of sampling cane. An industrial experiment is at present in progress in which the accuracy of core sampling is being evaluated in comparison with hatch sampling. Grab sampling of whole stalk cane is another expedient which may warrant further consideration.

2.2.2 Cane Analysis.

This is the relatively easy part of the cane testing operation, and with the aid of advanced equipment including automatic saccharimeters, automatic refractometers, electronic laboratory balances etc., a very high standard of analytical accuracy is attained.

A measured quantity of water (2 000g) is blended with 1000g of the cane sample in a high speed homogeniser. Sucrose and brix inspections are made upon the extract. The moisture content of the cane is needed to complete the calculation of sucrose % cane and brix % cane and for this purpose a second portion of the cane sample (300g) is dried at 105°C for 60 minutes. Fibre % cane and purity of cane extract are also derived.

2.2.3 Data Processing: Autolab.

Daily returns to growers containing information re their cane weights and test results are processed locally, but all of the raw data is brought to the S.A.S.A. Computer Centre in Durban for integration with data from other factories in various Industrial D.P. systems including : detailed planters returns, Relative Cane Payment, Millers cane payment schedules, S.A. Cane Growers cane quality control scheme, harvest to crush delay monitoring, S.A.S.A. cane transport subsidy scheme etc.

Mini-computers are now being installed in the C.T.S. laboratories. They are linked directly to the factory massmeters and to the laboratory instruments thus affording automated data acquisition. They are also to be linked to the central S.A.S.A. computer to provide an on-line data communication network across the Industry. The "Autolab" system is reducing costs and human error via reductions in staff numbers and is improving efficiency via extensive use of error checks.

2.3 RELATIVE SUCROSE.

It is a well known fact that the sucrose content of cane follows a seasonal maturation trend and that growers are therefore required to deliver rateably thoughout the season. However, this is not always possible (e.g. small growers, or growers with cane that has suffered damage from fire, frost, pest infestation, or where mechanised group harvesting is practiced) and under a system of cane payment based upon actual sucrose, non-rateable deliveries can result in serious inequities.

Relative cane payment is designed to overcome this problem and although it may not be perfect, it certainly minmises the disparities associated with non-rateable deliveries. A RELATIVE sucrose % cane is calculated weekly for every individual cane supply as follows:

A grower's actual sucrose % cane average is compared with the average actual sucrose % cane recorded for the total mill quota delivery in that week, and the difference is applied (i.e. added to or subtracted from) the average actual sucrose % cane recorded for the total mill quota cane delivery, over the whole season.

RELATIVE SUC. % CANE	=	GROWER'S WEEKLY ACTUAL SUC. % CANE AVERAGE.	-	MILL QUOTA SUPPLY WEEKLY ACT. AVERAGE SUC. % CANE.	+	MILL QUOTA SUPPLY. SEASON ACT. AVERAGE SUC. % CANE.

Cane payments are based upon the Relative Sucrose contents of cane supplies.

The relative system operates under the assumption that the relationship between the individual supplier's sucrose % cane and the total mill quota supply average sucrose % cane remains constant throughout the season.

The seasonal sucrose % average for the total mill group quota supply can only be determined upon completion of the season. It is therefore necessary to operate during the season with an estimated seasonal average, and at the end of the season the data is adjusted accordingly.

2.4 DIVISION OF PROCEEDS AND DETERMINATION OF SUCROSE PRICE.

The cane grower is entitled to a share in the monies accrued from the sales of the Industrial productions of sugar and molasses. His participation therein is based upon the quantity of relative sucrose credited to his cane deliveries.

The division of proceeds is determined annually by an Industrial Costs And Division of Proceeds Committee. The division of proceeds is two tiered:

a) as the initial requirement, the production costs in both sections are to be recovered, and then from the remaining monies

b) both sections are to be provided with a reasonable return on capital (in full or part, depending upon monies available).

A surplus of proceeds i.e. monies in excess of the fulfillment of requirements (a) and (b) above, are placed in the Price Stabilisation Fund.

EXAMPLE OF DIVISION OF PROCEEDS.

		RAND (MILLIONS)
1.	PROCEEDS.	
	Sale of Sugar : Local Market	456
	Sale of Sugar : Export	292
	Sale of Final Molasses	27
	TOTAL PROCEEDS	775
2.	INDUSTRIAL EXPENDITURE.	
	Levies	27
	Sugar Transport	11
	Selling Commission	2
	Refining Costs	49
	TOTAL INDUSTRIAL EXPENDITURE	89
3.	PROCEEDS AVAILABLE FOR DISTRIBUTION.	686

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4. SECTIONAL REQUIREMENTS.

	GROWER	MILLER	TOTAL
	(Rand in Millions)		
Two Tiered:			
1. PRODUCTION COSTS :	349	209	558
2. RETURN ON CAPITAL:	46 (7%)	36 (14%)	82
TOTAL REQUIREMENTS:	395	245	640
	62%	38%	

NOTES:

i) Grower return on capital invested is 7% : appreciating assets.

ii) Mill return on capital invested is 14% : depreciating assets.

iii) In the example above there is a surplus of R46 million which would go to the Price Stabilisation Fund. In the event of a shortfall the deficit might be filled from the Stabilisation Fund or via an industrial loan or be borne both sections (in the 2nd tier ratio of 46 : 36).

SUCROSE PRICE:

In the above example the total grower share of the net Industrial Proceeds amounted to R395 million, and if the total sucrose delivery was 2 400 000 tons, then the millers would have been required to pay the growers at the rate of R164-58 per ton of sucrose.

CANE TESTING ASSESSMENT : HOW GOOD IS IT?.

3.1 ACCURACY OF AN INDIVIDUAL CONSIGNMENT TEST.

That accuracy of a test method should be gauged in terms of two components : bias and precision. Controlled tests (comparing static with dynamic hatch fall-outs) have shown that the hatch method of cane sampling (and analysis) is without bias.

It has also been established via special tests (herringbone duplication), that when a cane consignment of 20 tons is sampled at the rate of one hatch fall-out (approximately 40 to 60 kg) per 3 tons of cane, then the test result is estimated at having the following levels of precision:

STANDARD DEVIATION OF A CONSIGNMENT TEST:

±0,30 units of sucrose % cane.
±0,60 units of fibre % cane.

3.2 ACCURACY OF THE AVERAGE OF MULTIPLE TESTS.

The level of imprecision associated with a single consignment test is both moderate and random and therefore with successive consignment tests the imprecision associated with the average test result rapidly diminishes (averages out) and becomes minimal.

EXAMPLE:

Consider a grower who delivers 9 x 20 ton consignments per week over a 40 week season:

NUMBER OF CONSIGNMENT TESTS	S.E. OF MULTIPLE TEST AVERAGE SUCROSE % CANE	FIBRE % CANE
1	±0,30	±0,60
9 (week)	±0,10	±0,20
36 (month)	±0,05	±0,10
360 (season)	±0,015	±0,03

Expressed in common parlance:

This grower can be ninety-nine percent sure that the sucrose content of his cane is being determined to within the following limits of accuracy (the true sucrose % cane is taken to be 13,0 in all categories):

	TRUE SUCROSE	SUCROSE % CANE TEST RESULT/AVERAGE WILL FALL WITHIN THE FOLLOWING RANGE	PERCENTAGE POTENTIAL ERROR
Single Test :	13,0	12,2 to 13,8	±6%
Weekly Average :	13,0	12,7 to 13,3	±2%
Month Average :	13,0	12,85 to 13,15	±1%
Season Average :	13,0	12,96 to 13,04	±0,3%

Assuming this grower delivered 720 tons of cane in the month and that the cane price was R20 per ton, he should then have been paid R14 400. The imprecision of his test average is ±1% i.e. his payment would have been within ±R144 of the R14 400.

Over the season his payment on 7 200 tons cane should have been R144 000. The imprecision of his season's test average is ± 0,3% i.e. his payment would have been within ±R432 of the R144 000.

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3.3 ACTUAL LEVELS OF SUCROSE % CANE FLUCTUATIONS.

The standard deviation of the differences between a single sucrose % cane test result and a grower's weekly sucrose % cane average is of the order of ± 0,85 units of sucrose % cane.

Fluctuations of this magnitude are commonplace and occur consistently at all mills.

The total variation stems from two sources:

a) the real variation which exists in the quality of cane from one consignment to another, and

b) the margin of imprecision associated with the test method.

Having established the total variation and the variation due to the test imprecision it is possible to estimate the real i.e.per se variation in cane quality and this is found to be :

S.D. OF THE REAL VARIATION IN CANE QUALITY FROM ONE CONSIGNMENT TO ANOTHER (SAME GROWER IN SAME WEEK) : ± 0,8 UNITS OF SUCROSE % CANE.

This magnitude of variation is an inescapable fact. There are various agronomic factors which cause large variations in cane quality from one patch to another in the same field, and inter alia these include:

soil classification
variable drainage patterns
variable fertiliser application
height of cut above ground
degree of topping/trashing
drought/pest infestation/frost afflictions (patches)
intensity of burn
sweepings (stale/trampled cane).

3.4 COMPARISON OF DAC AND MILL BALANCE TOTAL POL TONNAGES.

Over a weekly period the summation of the tonnages of pol in the individual cane consignments (as determined by DAC) should compare closely with the total amount of pol measured via the mill balance (i.e. in the mixed juice plus final bagasse) in the same weekly period.

They constitute separate, parallel measurements of the total pol in cane and a comparison of one against the other affords an excellent basis of monitoring the correctness of the cane testing and factory control data.

The ratio between the DAC and mill balance measurements of total pol entering into all mills during the 1981/82 season was 0,996 and the S.D. of the individual mill ratios around this mean, was ±0,004.

The individual weekly pol ratios (i.e. Pol Factors) vary a little more widely and on average the S.D. of the weekly mill ratios is ±0,009.

3.5 DIVERSION COMPARISONS.

Controlled tests have been conducted wherein cane cut by a grower on the same day from the same field was randomly loaded into two hilos and despatched to two different mills. This exercise was conducted daily over a period of several weeks and was repeated for five different growers.

RESULTS:

GROWER	NUMBER OF PERIOD TESTS	MEAN SUCROSE % CANE MILL I	MILL II	S.D. OF DIFFERENCES.
A	51	13,43	13,38	±0,78
B	26	15,41	15,51	±0,43
C	42	14,05	14,15	±0,87
D	16	14,40	14,4	±0,52
E	21	13,82	13,79	±0,76
MEANS	156	14,13	14,14	±0,74

The above tests embodied special effort to ensure that each pair of hilos contained the "same cane". On a routine basis, many growers deliver their cane to more than one mill in the same week. Whether these supplies are randomly divided is unknown to us. Nevertheless we use the computer to produce comparisons of the to-date analyses for these particular cane supplies. Examples of the data comparisons are shown in the attached Table A.

3.6 "DUPLICATE" INSPECTIONS OF GROWERS' CANE SUPPLIES.

Further indication of the correctness with which sucrose levels are being credited to individual growers is provided by splitting each grower's own tests into two separate streams, by placing his 1st, 3rd, 5th, etc., lists into one stream, and his 2nd, 4th, 6th, etc., in the other stream. The sucrose % cane means of each stream provide separate/parallel measures of the quality of his cane. A wide variation exists in the sucrose content of cane from one grower to another but the two to-date means for each individual grower are in close agreement with one another.

A set of comparisons are given in the Table B attached hereto.

TABLE A:

DIVERSION COMPARISONS.

	CRUSHED AT	TONS CANE	POL % CANE	FIBRE % CANE
UMFOLOZI - FELIXTON	UF	1 000	12,4	18,5
	FX	2 800	12,3	18,5
UMFOLOZI - EMPANGENI	UF	2 800	12,9	14,1
	EM	800	13,0	14,3
EMPANGENI - FELIXTON	EM	26 000	11,5	18,3
	FX	30 000	11,5	18,1
EMPANGENI - AMATIKULU	EM	3 200	13,2	14,3
	AK	1 500	13,5	14,3
FELIXTON - AMATIKULU	FX	52 000	12,4	16,0
	AK	17 000	12,4	15,9
FELIXTON - GLEDHOW	FX	5 100	11,7	16,0
	GH	2 100	11,9	16,0
AMATIKULU - DARNALL	AK	12 600	11,9	16,7
	DL	5 200	11,9	17,1
DARNALL - GLEDHOW	DL	54 000	12,8	16,4
	GH	74 000	12,6	16,5
GLEDHOW - TONGAAT	GH	49 000	11,8	17,3
	TS	120 000	11,6	17,6
ILLOVO - SEZELA	IL	22 600	13,7	15,3
	SZ	13 800	13,7	15,6
ILLOVO - NOODSBERG	IL	8 000	13,9	13,5
	NB	17 000	13,8	13,3

TABLE B:

COMPARISONS OF EACH INDIVIDUAL GROWER'S TWO TODATE SUCROSE % CANE AVERAGES

16,8	and	16,6	14,5	and	14,3	13,5	and	13,5	12,6	and	12,8
15,8	"	15,9	14,3	"	14,2	13,4	"	13,6	12,6	"	12,8
15,7	"	15,9	14,3	"	14,2	13,5	"	13,5	12,6	"	12,8
15,5	"	15,7	14,2	"	14,3	13,5	"	13,4	12,7	"	12,6
15,4	"	15,5	14,2	"	14,3	13,6	"	13,4	12,6	"	12,6
15,4	"	15,4	14,2	"	14,3	13,5	"	13,4	12,7	"	12,5
15,5	"	15,3	14,1	"	14,3	13,5	"	13,4	12,6	"	12,5
15,4	"	15,4	14,2	"	14,1	13,4	"	13,6	12,5	"	12,6
15,3	"	15,4	14,2	"	14,1	13,5	"	13,4	12,5	"	12,4
15,4	"	15,2	14,1	"	14,2	13,4	"	13,4	12,4	"	12,3
15,3	"	15,1	14,2	"	14,0	13,5	"	13,4	12,3	"	12,3
15,2	"	15,2	14,1	"	14,0	13,4	"	13,4	12,2	"	12,4
15,2	"	15,2	14,1	"	13,9	13,4	"	13,4	12,2	"	12,3
[illegible]	"	15,1	13,9	"	14,0	13,3	"	13,5	12,3	"	12,2
15,0	"	15,2	14,0	"	14,0	13,4	"	13,3	12,2	"	12,2
15,1	"	15,1	13,9	"	14,0	13,4	"	13,2	12,0	"	12,1
15,1	"	15,1	14,0	"	13,9	13,2	"	13,5	12,0	"	12,0
15,1	"	15,0	13,9	"	14,0	13,3	"	13,4	11,9	"	12,1
15,0	"	15,1	14,0	"	13,9	13,3	"	13,2	11,8	"	12,1
15,0	"	15,0	13,8	"	14,0	13,4	"	13,2	11,9	"	11,9
15,0	"	15,1	13,9	"	13,9	13,3	"	13,3	12,0	"	11,8
14,9	"	15,0	13,9	"	13,9	13,4	"	13,1	11,9	"	11,8
14,8	"	15,0	13,9	"	13,9	13,4	"	13,2	11,7	"	11,9
14,9	"	14,8	13,9	"	13,8	13,3	"	13,2	11,7	"	11,8
14,8	"	15,0	13,8	"	13,9	13,2	"	13,2	11,8	"	11,6
14,9	"	14,8	13,8	"	13,9	13,2	"	13,2	11,7	"	11,6
14,9	"	14,8	13,9	"	13,8	13,2	"	13,2	11,8	"	11,6
14,8	"	14,9	13,7	"	13,9	13,1	"	13,2	11,7	"	11,6
[illegible]	"	14,8	13,7	"	13,9	13,0	"	13,2	11,5	"	11,8
[illegible]	"	14,8	13,8	"	13,8	13,1	"	13,1	11,6	"	11,6
14,7	"	14,7	13,8	"	13,7	12,9	"	13,2	11,4	"	11,6
14,7	"	14,6	13,6	"	13,8	13,1	"	13,1	11,6	"	11,4
14,6	"	14,7	13,8	"	13,7	13,2	"	13,0	11,2	"	11,3
14,8	"	14,5	13,7	"	13,8	13,1	"	13,0	11,2	"	11,1
14,6	"	14,7	13,7	"	13,7	13,1	"	13,1	11,1	"	11,1
14,6	"	14,7	13,6	"	13,7	13,0	"	13,1	10,8	"	11,1
14,5	"	14,7	13,6	"	13,7	13,1	"	13,0	10,9	"	11,0
14,6	"	14,5	13,7	"	13,6	12,9	"	13,0	10,6	"	10,8
14,5	"	14,6	13,7	"	13,6	13,0	"	12,9	10,8	"	10,6
14,4	"	14,6	13,6	"	13,6	12,8	"	13,0	10,6	"	10,8
14,5	"	14,5	13,5	"	13,7	12,8	"	12,9	10,6	"	10,7
14,5	"	14,5	13,7	"	13,5	12,8	"	12,9	9,9	"	10,0
14,4	"	14,5	13,6	"	13,6	12,7	"	12,9	9,4	"	9,8
14,5	"	14,4	13,5	"	13,7	12,7	"	12,7			

S.A.S.I.A.A.

CANE DETERIORATION

by

Arnold Brokensha

1. DETERIORATION LOSSES IN WHOLE STALK CANE.

Numerous trials conducted in the South African sugar industry to determine the deterioration losses following the harvesting of whole stalk sugar cane have been reported by Wood et al [1,2,3]. The trials covered unburnt cane, burnt cane cut immediately and burnt cane which was allowed to remain standing for a number of days before cutting. Trials were conducted at different times of the year and average deterioration rates for the three cane conditions viz. unburnt, burnt cut immediately and burnt left standing are given below:

TABLE I.

UNBURNT CANE.

DAYS AFTER CUTTING	UNITS RECOVERABLE SUGAR	PURITY
0	100	90,9
2	95	88,6
4	89	85,9
7	83	82,9
11	77	79,9
21	62	71,6

TABLE 2.

BURNT CANE CUT IMMEDIATELY.

DAYS AFTER BURNING	UNITS RECOVERABLE SUGAR	PURITY
0	100	90,1
2	96	88,9
4	96	88,3
7	89	85,1
11	72	76,6
21	47	65,6

TABLE 3.

BURNT CANE LEFT STANDING.

DAYS AFTER BURNING	UNITS RECOVERABLE SUGAR	PURITY
0	100	90,2
2	94	89,8
4	93	89,8
6	89	87,9
8	86	87,4
13	79	84,4

...../2

NOTE:
The data presented in the Tables 1 and 2 reported by Wood R.A.: SASTA Congress 1972.

Data contained in Table 3 reported by Wood R.A.: SASTA Congress 1973.

Losses were lower than those indicated above during the cool dry winter period and more rapid in the hot humid summer months.

Table 4 shows the average decline per day in ERS (expressed as a percentage of the initial level) for various intervals from day O.

TABLE 4.

DECLINE IN UNITS RECOVERABLE SUGAR.

DAYS AFTER CUT/BURN	UNBURNT	BURNT CUT IMMEDIATELY	BURNT LEFT STANDING
0	-	-	-
2	2,5	2,0	3,0
4	2,8	1,0	1,8
7	2,4	1,6	(1,8)
11	2,1	2,5	(1,4)
21	1,8	2,5	-

( ) = interpolated data

It is seen that over the first seven days the unburnt cane has a higher deterioration rate than the burnt cane.

It has been suggested that a reason for the difference is that the pre-harvest burn effectively sterilizes part of the stalk, covering it with a protective coating of charred material or concentrated juice which delays infection by micro-organisms causing deterioration. However, the unburnt cane stalk remains unsterilized and unprotected and is more prone to infection and thus deterioration. The reason for the poorer keeping quality of the burnt cane left standing compared to burnt cane cut immediately could be that with the former there is an uptake of water from the soil by the undamaged root system of the cane plant whilst the leaf transpiration is halted or much reduced and the resultant dilution of the juice and circulation of soil water in the burnt standing cane may tend to encourage and spread the action of micro-organisms.

From Table 4 it is seen that over the first week the average loss in recoverable sugar per day for unburnt cane is 2,4 percent while for burnt cane the figure is 1,7 percent. For simplicity an average figure of 2 percent per day is used within the industry. This is a significant rate of loss and the implication is that if the industrial average delay between harvesting and milling of sugarcane could be reduced by 1 day there would be additional production of approximately 40 000 tons sugar (at current levels of production).

A survey undertaken some years ago indicated that the average harvest to crush delay for the industry is 3 days with at least a third of production having delays in excess of this figure. There is clearly room for improvement and practises necessary for attaining low delay levels are set out below.

2. PRACTISES NECESSARY FOR ATTAINING LOW DELAY LEVELS.

2.1 Minimum size burns.

The table below illustrates the effect of various burning cycles on burn to cut delays. Assumptions in the calculations are that burning takes place in the morning (6 a.m.) and that cutting is conducted on six days of the week i.e. Monday to Saturday. In the no overlap burning situation it is assumed that the grower will commence cutting the new burn on the same day as it was burnt. In the overlap burning situation it is assumed that when the grower burns, he still has one day's supply of the previous burn in hand; accordingly he will only commence cutting the latest burn the day after burning.

TABLE 5.

Burning Cycle		Average delay from Burn to Cut (hours)	
		No Overlap Burning	1 day Overlap Burning
i)	Daily	3	31
ii)	Three times per week:		
	a) Mon; Wed; Frid.	15	43
	b) Tues; Thurs; Sat.	19	47
iii)	Twice per week:		
	a) Monday and Thursday	27	55
	b) Tuesday and Friday	31	59
	c) Wednesday and Saturday	35	63
iv)	Once per week:		
	a) Mondays	63	91
	b) Tuesdays	67	95
	c) Wednesdays	71	99
	d) Thursdays	75	103
	e) Fridays	79	107
	f) Saturdays	83	111

The above do not cover all possible combinations but are sufficient to illustrate how rapidly the delays increase with reduced burning frequency and with overlapping burns.

The ideal is clearly daily burning but where this is not possible no more than a two day burn should be made. Overlap burning i.e. burning a new area before cutting of the previous burn has been completed is to be avoided.

2.2 Cut and despatch on same day.

The table below illustrates the reductions in cut to despatch delays brought about by increasing the proportion of cane despatched to the mill on the same day as it was cut. In the table it is assumed that if the cane is not despatched on the same day as it was cut, it will be despatched the following day (except on Sundays).

TABLE 6.

% DAY O CANE	CUT TO DESPATCH DELAY (HOURS)
0	30
25	22
50	17
75	10
100	5

The target should be to cut and despatch all the cane on the same day. Payment to the individual cutter on the basis of row length cut rather than individual bundle mass will greatly facilitate this objective.

2.3 Minimum cane stockpiling.

All unnecessary stockpiling of cane must be eliminated. In this regard good communication between miller, transporter and grower regarding cane allocation cut backs is an essential ingredient.

2.4 Group harvesting.

The present system of individual grower rateable deliveries does have an inhibiting influence on efforts to reduce delays and a move to group harvesting will permit significant reductions in delays for the following reasons:

i) It will facilitate shorter burn to cut delays.

As indicated in section 2.1, daily burning will give the minimum burn to cut delay. However, daily burning is onerous for farm management and labour and there is the cost of cutting additional fire breaks with which to contend - this latter aspect assumes increasing importance the smaller the grower's daily allocation.

Group burning on a daily basis, in combination with group harvesting would meet the objections against daily burning. For example if three growers, who as individuals each delivered rateably for six days a week, were to combine forces the net result would be that each grower's weekly allocation would now be burnt and harvested in two days. For the individual grower this means only two daily burns instead of the six that would be required for daily burning if he operated on his own. (It is assumed that only the 'home' grower and his own farm labour are required to be present at the burn).

ii) <u>Improve control over cane flow from field to mill.</u>

Group harvesting will mean a reduction in the number of farms being harvested at any one time, and this will allow for more efficient control of the cane flow from field to mill. It will simplify communication between miller and grower, lead to a reduction in the amount of cane stockpiled, and facilitate the application to a greater extent than at present of the first in, first out principle at zones and in the mill yard.

iii) <u>Reduce zone delays encountered by certain small growers.</u>

At some mills there are small growers who receive individual tests but whose daily delivery allocations are insufficient to fill a hilo vehicle and accordingly their cane has to be stockpiled until there is sufficient to fill the vehicle. Group harvesting which permits a much larger flow of cane from the individual farm whilst it is being harvested will eliminate the need to stockpile cane for more than a day in order to fill a bulk haulage vehicle.

2.4 <u>Regular milling.</u>

Regular milling is an essential requirement for a smooth and efficient cane flow from field to mill and for the maintenance of minimum cane stocks in the pipeline.

Shown below in Table 7 are the minimum average zone - mill yard delays allowed by various milling programmes under steady state conditions and with similar cane flow patterns ex field.

...../6

TABLE 7.

MILLING PROGRAMME.	ZONE - MILL YARD DELAY.
Monday stop - 14 hours (02h00 - 16h00)	22 hours
Monday stop - 24 hours (Sun 16h00 - Mon 16h00)	17 hours
Sunday stop - 14 hours (02h00 - 16h00)	18 hours
Monday stop - 14 hours (Sun 20h00 - Mon 10h00)	16 hours
Sunday stop - 24 hours (Sat 16h00 - Sun 16h00)	14 hours
Sunday stop - 24 hours (Sat 18h00 - Sun 18h00)	14 hours
Sunday stop - 24 hours (Sun 10h00 - Mon 10h00)	11 hours

Zone - mill yard delay = Delay from the time the cane arrives ex field at the zone or mill yard until it is crushed.

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SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

EXTRANEOUS MATTER : IT'S COMPONENTS AND EFFECTS ON THE FACTORY

by Roy Blunt

INTRODUCTION

Cane quality on the whole has been and will be criticized by any miller. Some will criticize it when the quality is poor; others will criticize it for the sake of criticism and generally put the blame on someone else. The steady decline in sugar production from both a quantity and quality point of view is causing considerable concern to the industry.

I have always been influenced by a quotation I read soon after joining the sugar industry: "Sucrose is manufactured in the cane plant. It is not made in the factory; there, it is merely extracted and crystallized into sugar". This is a very true and factual statement.

You make the sucrose. We attempt to make the sugar, the molasses, the filter cake, the bagasse, the water, the ash, the power and what fun we have: like a baker playing with dough. We cannot transform the sucrose into solid sugar unless we extract the liquid from the raw product, but a volume of extraneous matter is generally delivered to the miller together with the cane.

I must state categorically that the genuine industrial concern for the decline in cane quality as supplied to the millers, does not start and end with extraneous matter only. There are many other concerns but, today we are to talk about extraneous matter and it's effects on milling.

I have divided extraneous matter into cane associated and non-cane associated matter:

Cane associated extraneous matter	Non-cane associated extraneous matter
trash	rocks, stones, sand, chains
tops	tramp iron, SAR iron, chemicals
roots and the soil	foreign bodies
sand	

Extraneous matter can be classified into:

- that which has financial benefits to the miller
- that which has no financial benefits and in fact costs the miller a considerable sum of money.

Financial benefits could be derived from:

1. Trash: - offset fuel bill.

   My opinion is that millers should install sufficient equipment so as to handle extra fibre without a drop in performance.

   Of course surplus bagasse has proved to be a real problem but I always shudder when I see cane being burnt and all that energy going to waste. On the other hand there could also be some advantages to both millers and growers if the time from burning to crushing was reduced. My opinion would therefore be to limit the burning of cane and for the millers to accept excess fibre and install equipment to handle the higher fibre from trash.

2. Tops: - it has always been debated as to whether or not cane should be topped. From my experience there appear to be two distinct seasonal effects of tops. Early in the crushing season, the invert sugars associated with the tops appear to assist in the crystallization and therefore recovery of sugar. This is when the miller is happiest but towards the end of the

crop from December to February, the invert sugars hamper the crystallization process and long faces are evident in the factories.

Nevertheless, tops bring in molasses and therefore finance so perhaps they are not so bad after all. One thing is certain and that is that all tops produce a colour input and the miller has very little at his disposal to combat this without great expense.

There are no financial benefits from the rest of the extraneous matter so it all costs the miller money.

Non-cane associated - extraneous matter can be considered as that causing immediate damage and that resulting in long term damage.

Most milling factories have a single preparation plant which comprises a two-stage cane knifing plant and a shredder. It would be uneconomical to duplicate this preparation stage as it would require standby feed tables, unloaders, off-loaders as well as the carrier systems through the preparation plant.

The preparation plants in South Africa have been upgraded during the past decades so as to pulverise the cane to a prep index which assists in the extraction of liquid sucrose in the milling train.

The speed, weight and strength of materials from which cane knives and shredder hammers are made, has increased to levels where shock loading eg. via tramp iron, rocks and chains, shatters the blades which in turn could do further damage down the line if they are not removed by in-line magnets. When any of this preparation equipment is damaged, it generally forces the miller to stop production. This stop is to replace cutters etc., which automatically rebalance the rotors and thereby prevent any further damage to equipment.

Breakdowns in the factory cause a chain reaction as it affects the growers' performance regarding the harvesting and delivery of cane. It is this type of downtime that will increase the length of the crushing season for once downtime has been incurred, it is unlikely that it will be made up.

Unfortunately there are few practical applications available to warn the operators of the presence of foreign material before damage is done. The miller tends to rely on the operators to spot the foreign items and as you can appreciate, 1 out of 10 incidents is probably a fair result. These are the obvious and immediate areas of damage caused by extraneous matter. Plant repairs cost the miller money and downtime is expensive to both millers and growers from a productivity point of view. Preparation plant stoppages vary from miller to miller but on average some 60 hours of crushing time is lost in a season. This is nearly half a week's production or 1,5% of the annual crop.

NB. Concerning long term damage caused by extraneous matter, sand and soil have the most serious effects. Sand has a tremendous wear factor on the cutting edges of knives and hammers to a point where the throughput of cane is limited because the equipment becomes choked by cane which is no longer sliced and shredded. It is now common for factories to plan a mid-week stop to change cutting blades and hammers. This ensures that the throughput of cane during the latter part of the week is not hampered. Sand has a detrimental effect on the milling train where the extreme abrasiveness of the sand and liquid takes its toll on all metal in its contact, even stainless steel. If the milling rollers were not constantly roughened by applying arc welding to the surface, the throughput and efficiency of extraction would be seriously affected.

There are two distinct differences in the effects of sand in milling and diffusion factories. Milling factories remove the majority of the suspended solids with the mixed juice. This cane be handled fairly satisfactorily in clarifiers (or subsiders) but sucrose losses over the filter station generally increase because of the increased volume of mud the station has to handle. The wear and tear of most mechanical parts must, however, not be overlooked.

The filtering effect of the bagasse blanket of the diffuser results in most of the suspended solids being left in the bagasse. The bagasse is burnt in the boilers and damage to the boiler tubes and fan blades is increasing at an alarming rate as are the cost of repairs. As more and more factories change over to diffusers, so the erosion of boiler parts worsens. In years gone by, it was seldom that downtime was caused by boiler plant.

The fact remains that in factories the input of suspended solids will take its toll on equipment. In this context, it is up to the millers to decide which part of the factory they are prepared to sacrifice when trying to justify a process economically.

Sand in bagasse is, in my opinion the most serious. Excessive loads of sand affect the extraction process by producing bagasse with a higher moisture content and hinders boiler efficiency. Sand has often nearly extinguished boiler fires which causes a disruption in the steam supply to the factory and the ripple effects must be felt by the grower. The annual cost to the miller of the direct results of extraneous matter was estimated at N.S.C. in 1975. These have been updated and are shown below:

Cane preparation		R124 000
Milling		R115 000
Boilers		R 80 000
Extra labour		R 20 000
Transport:	filter cake S/solids removal extraneous matter 12%	R150 000
B. house losses		R 80 000
	TOTAL	R569 000

This is equivalent to 47 cents per ton cane or R4.25 per ton sugar. To the miller these are very high costs.

Gentlemen, today I have probably not told you anything new. We are all aware of the mounting problems in the sugar industry but should nevertheless always attempt to bring home the whole truth. Perhaps today's discussion will lead to alternative ways and means of improving our industry and if the industrial average of extraneous matter is still 12%, then it means that each year, two factories crush nothing but extraneous matter

PKM/PMO

22.10.82

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

EXTRANEOUS MATTER - FIELD OPERATIONS

by

Mike Neethling

Extraneous matter - Trash
Tops
Soil
Rocks etc

1. Trash

Removing trash from cane has one simple solution - burn before harvest.

The answer is not as simple as this and should be the result of deliberation between the pros and cons of trashing.

Advantages of trashing

1. Increased yields - 9 t/ha/annum
2. Increase effective rainfall
3. Reduction in soil loss
4. Weed control.

Disadvantages of trashing

1. Reduced productivity of cutters
2. Reduced payloads
3. Increased transport costs
4. Milling problems
5. Fire hazard
6. Poor ratooning in cooler areas.

2. Tops

Important aspects.

1. Height of topping
2. Accuracy of topping - training

3. Topping methods

   3. 1 in the air
   3. 2 in the windrow
   3. 3 in small bundles

3. <u>Soil in cane</u>

1. Loading methods and soil in cane
2. Reducing soil in cane

   2. 1 cane rows/windrow
   2. 2 small bundles instead of windrow
   2. 3 hotter burns to eliminate weeds
   2. 4 windrow placement
   2. 5 ridging-up of rows
   2. 6 correct base cutting
   2. 7 pushpiler height
   2. 8 water control in fields
   2. 9 land smoothing
   2.10 equipment maintenance
   2.11 training

Dony / Siminge

4. <u>Rocks etc</u>

Removal of all rocks from fields before and after planting where possible.

Systems to reduce the chance of chains entering cane.

Tramp iron??

Incentives / output + quality for Indians.

MN/VJ
11 October 1982

SOUTH AFRICAN SUGAR ASSOCIATION

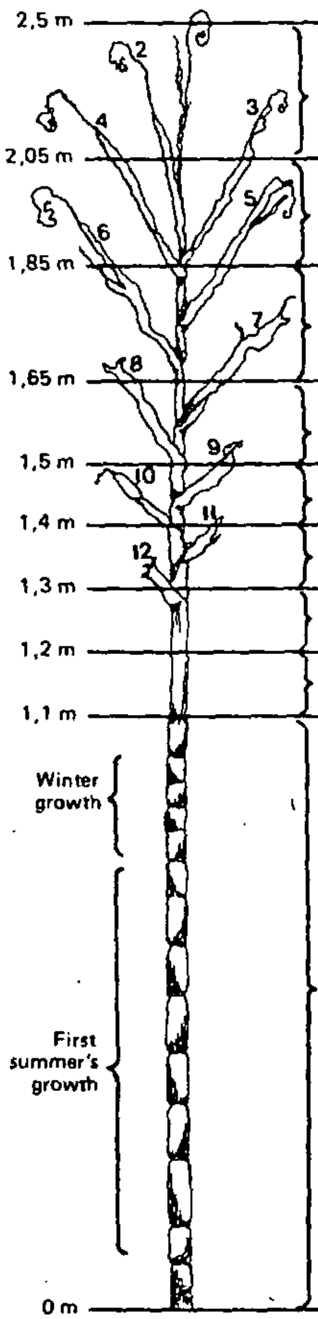
AGRONOMISTS' ASSOCIATION

CANE TOPPING

by QV Mann

TOPPING HEIGHT

Table I below sets out a section by section analysis of a sample of typical early season burnt cane.



Section	Mass	Pol %	Non-pol %	Fibre %
2,5 m – 2,05 m	25 g	0	3,0	16,6
2,05 m – 1,85 m	45 g	0	3,1	15,3
1,85 m – 1,65 m	55 g	0	3,6	14,6
1,65 m – 1,5 m	60 g	0	4,0	13,9
1,5 m – 1,4 m	65 g	1,5	9,1	13,3
1,4 m – 1,3 m	70 g	3,7	8,2	12,5
1,3 m – 1,2 m	70 g	8,8	5,8	12,7
1,2 m – 1,1 m	70 g	11,7	3,0	13,1
1,1 m – 0 m	780 g	14,2	1,8	13,3

Height	Topping height	Tons cane/ha	Pol % cane	Tons pol/ha	Ers % cane	Tons ers/ha
2,5 m	Not topped	124	10,4	12,9	8,2	10,1
2,05 m	Leaves only	121,5	10,6	12,9	8,4	10,2
1,85 m	Collar	117	11,0	12,9	8,8	10,3
1,65 m	Sheath	111,5	11,6	12,9	9,4	10,5
1,5 m	Meristem	105,5	12,2	12,9	10,0	10,6
1,4 m	6th node	99	12,9	12,8	10,9	10,8
1,3 m	8th node	92	13,6	12,5	11,8	10,9
1,2 m	10th node	85	14,1	12,0	12,5	10,6
1,1 m	12th node	78	14,2	11,1	12,6	9,9

(Yield conversions assume that there are 100 000 millable stalks like this per hectare)

Analysis of typical early season burnt cane grown in the midlands, showing various topping heights and their effects on yield and quality

Several statements of fact can be made from it:

1. Cane mass, or yield in tons cane per hectare increases very dramatically with increased topping height.

2. Pol percent cane decreases equally dramatically with higher topping.

3. Tons pol produced per hectare increases less and less with increased topping height until it reaches a maximum with topping near the meristem.

4. Tons ers per hectare is at a maximum if topping height is at about the sixth to eighth node and it decreases if topping is either higher or lower.

CONCLUSIONS

1. Because cane payment is at present based upon tons pol per hectare delivered, most cane is topped between about the sixth node to just above the meristem.

2. More sugar could be recovered by transporting and crushing less cane if it was topped lower.

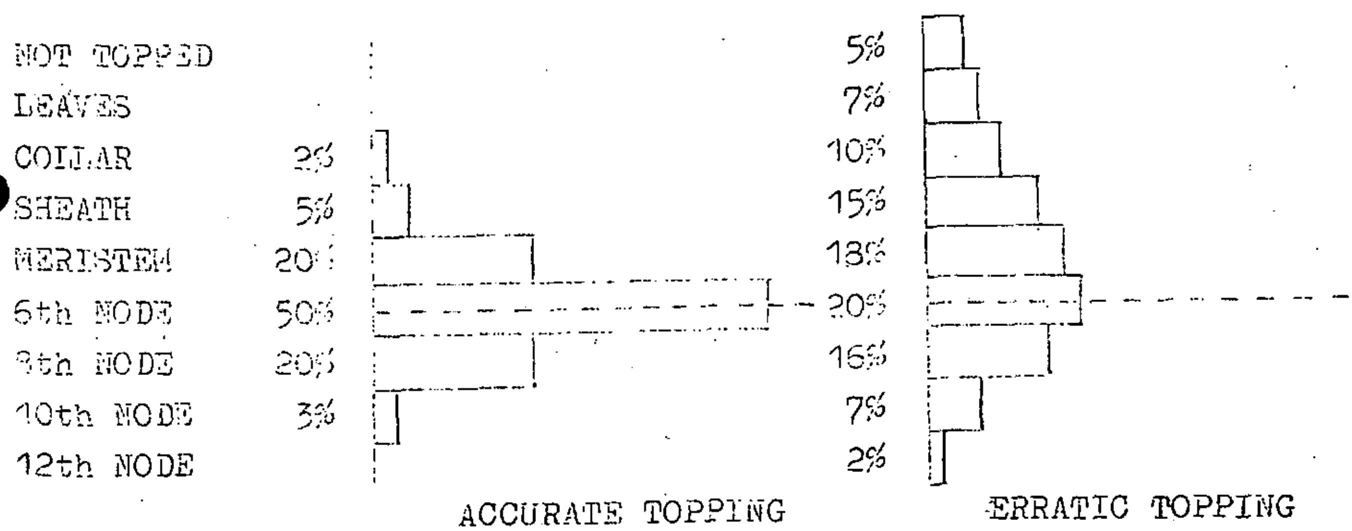
3. Even under the present system in the industry, cane entering the two co-op mills and all miller-cum-planter cane should be topped lower than all other cane to maximise profit from both the field and the mill together.

TOPPING ACCURACY

Commercially harvested cane cannot all be topped at the exact optimum point. Average topping height therefore varies about a mean depending upon the accuracy of the operation. Cane topped by hand in the air is usually the most accurate method. Cane topped on the ground in a windrow is less accurate but can be greatly improved by correct placing of the cane in the windrow. Cane topped by most mechanical harvesters is the least accurate except where there is good uniformity of stalk length particularly within a single stool. Mechanical topping devices based on the natural breaking joint of cane can be more accurate.

Let us attempt to quantify the effects of topping accuracy on cane quality by examining the two typical distributions set out in the following table.

TOPPING ACCURACY.



From both Table I and the above distributions in Table II the following calculations can be made:

TABLE III TOPPING HEIGHT AND ACCURACY

	Tons cane	Tons pol	Tons ers
High and accurate (Meristem)	105,9	12,87 (99,8%)*	10,61 (97,3%)
Accurate (Sixth node)	99,5	12,74 (98,8%)	10,75 (98,6%)
Low and accurate (Eighth node)	92,6	12,44 96,4%	10,77 98,8%
High and erratic (Meristem)	109,7	12,84 (99,5%)	10,48 (96,1%)
Erratic (Sixth node)	104,1	12,71 (98,5%)	10,57 (97,0%)
Low and erratic (Eighth node)	98,1	12,49 (96,8%)	10,58 (97,06%)

* The figure in brackets represents the % of the maximum that could be obtained

On average accurate topping versus erratic topping reduces the tonnage of cane to be transported and crushed by 4,63 tons cane per hectare. At the same time it hardly affects the tons pol but increases the tons ERS by 0,17 tons/ha. The difference between low accurate topping and high erratic topping is 17,1 tons/ha less cane to transport and crush which at the same time gaining an extra 0,29 tons ERS/ha.

Finally at an arbitary sucrose price of R150 per ton with its equivalent ers price of R177.52 per ton, and arbitary transport and crushing costs of say R2 per ton each, accurate low topping is worth R119.88 per hectare more than erratic high topping.

check on % yield from N. ivy areas

Very still condns could cause
uneven distrib.

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

CHEMICAL RIPENERS

by
Rob Donaldson

- The problem of low quality cane

  The long milling season includes months at the begining and end during which cane growth is vigorous and cane quality is consequently low.

- The potential of today's chemical ripeners

A. Northern irrigated areas (± 13% of R.S.A.'s production).
   1. Suitable months for spraying and harvesting.

	F	M	A	M	J	J	A	S	O	N	D	J
				Milling season								
Polado spraying		⊙	⊙	⊙	⊙				⊙	⊙		
Polado harvesting				⊙	⊙	⊙				⊙	⊙	⊙
Ethrel spraying	•	•	•									
Ethrel harvesting				•	•	•						

   2. Responses to ripeners (Polado in early season- mean of four ratoons) at Pongola on NCo 376

	Tons cane/ha	Sucrose% cane	Tons sucrose/ha	difference (tons suc/ha)
Control	146	11,6	16,8	
Polado	144	13,8	19,8	3.

Costs: Chemicals: R23/ha + Application: R18/ha = R41/ha

Gain : 3 tons sucrose/ha at R158/ton = R474

Net profit = R433/ha

   3. Estimated area sprayed (ha) 1980 season.

      6000 hectares sprayed with Ethrel

      3000 hectares sprayed with Polado

B. Rainfed areas- Coastal and Midlands (+ 87% of R.S.A.'s production)

   1. Possible months for spraying and harvesting

	F	M	A	M	J	J	A	S	O	N	D	J
				Milling season								
Polado spraying		⦿	⦿						⦿	⦿		
Polado harvesting				⦿	⦿						⦿	⦿
Ethrel spraying	•	•	•									
Ethrel harvesting				•	•							

2. Responses to ripeners (Polado, early season at Shakaskraal on NCo 376)

	Tons cane/ha	Sucrose% cane	Tons sucrose/ha	difference (tons suc/ha)
Control	84	10,5	8,9	
Polado	85	11,8	10,0	1,1

3. Factors influencing the use of ripeners

- Temperature

  Fewer months suited to ripeners because of longer and more severe winters in the Coastal and Midlands area.

- Moisture

  Unpredictable rainfall. Adequate moisture is essential for the effective use of Polado.

- Soils

  Sufficient soil moisture must be available to maintain vigorous growth up to a few days before harvest.

  eg TAM of 180mm (Hutton series) will provide moisture for 40 days (about 6 weeks) if loss of water through evapotranspiration is 4,5mm per day.

  But soil with TAM of 85mm (Waldene series) will provide moisture for 19 days only.

  - Hectares sprayed: about 1000 sprayed mostly with Polado.

- Varieties

All varieties respond to ripeners.

Low surose varieties are not made into high sucrose varieties, but they tend to respond better than high sucrose varieties.

Hazards

(a) Selection of suitable well-grown, unstressed cane

(b) Mixing of chemicals; water and dosage.

(c) Weather conditions- calm, early morning, no rain imminent

(d) Application- clear demarcation of areas

(e) Irrigation /drying off only to allow infield transport

(f) Topping height- adjust

(g) Harvest within time limits.

NUTRITION AND CANE QUALITY

by RA Wood

Of the three major nutrients N, P and K, nitrogen is generally regarded as the most important from the point of vew of crop production. In a crop like cane where increase in quantity may be associated with a reduction in quality, it is important to establish an economic balance with regard to the quantity of fertilizer N to be applied in order to obtain the maximum amount of sugar and not merely cane per unit time and area.

Nitrogen

In general, applications of fertilizer N tend to lower sucrose % cane as they serve to stimulate growth. This particularly applies to cane cut during periods of rapid growth or when it is young. The presence of unusually high levels of N in the plant prior to harvest implies higher moisture levels within the cane, higher reducing sugars and lower sucrose content.

In a recent N/K fertilizer trial in a Vimy series soil in Swaziland, increasing amounts of N up to 200 kg/ha resulted in increased yield in tons cane/ha but the responses were offset by a linear decrease in sucrose % cane of 0,3 units per 40 kg/ha increment. The response in terms of sucrose yields to applied N was therefore not worthwhile (see Figure 1). Sometimes, however, the decline in sucrose % cane with increasing N levels does not occur.

Wherever extra N can be effectively used to produce more cane which will still be mature at harvest then usually N does not have a negative effect on sugar recovery. Fritz (1974) says that increasing amounts of N decrease the sucrose % because they increase percentage moisture in cane whilst sucrose percent dry substance remains the same.

Currently a comprehensive series of field trials is being conducted by the Experiment Station to determine the optimum amounts of N required to ensure maximum sucrose yield for ratoon cane grown on a wide range of soils- To date the results have emphasised the need for some means of more accurately assessing the N status of different soils as a guide to N fertilizer practice.

The results from several trials (see Fig. 2) show that sugar yields from treatments where no N was applied ranged from 7-15 tons sucrose/ha/annum. This is due primarily to the fact that the capacity of the soils to supply N to the crop through mineralization of soil organic matter (N) covers a wide range <70 kg N - > 140 kg N per hectare. As the curves in Fig. 1 show, this release of soil N must be taken into account or sucrose yields may decline on certain soils due to over application of fertilizer N. The evaluation of soil N release, together with the appropriate use of tissue analysis, in assessing the active N status of the crop offers a means of exercising control over N fertilizer use.

Recent data have indicated that the probability of a response to applied N increased as soils decline in organic matter. Soils with high (>4%) moderate (2-4%) and low (< 2%) organic matter contents have been associated respectively with relative responses to applied N of $\pm$ 10%, 25% and 45% (see Fig. 3). Excess vegetative growth due to overapplication of N may cause lodging which can indirectly lead to a decline in sucrose.

Nitrogen carriers

Reporting on a number of trials comparing the efficacy of different N carriers, du Toit (1967) noted that on average there was little or no difference in yield when ammonium sulphate and urea were applied at rates of 110 and 220 kg N/ha. Where gains occurred in yield of cane/ha when using sulphate of ammonia over those obtained from urea, these were offset by a higher sucrose percent cane from urea. Essentially though, N carriers generally produce no significant differences in sucrose concentrations.

Potassium

An application of K fertilizer to a soil deficient in this element, may significantly increase both cane yield and quality as shown in Table 1.

Cane, sucrose % and sucrose yields (13 R)
Trial FT11N/74 - Pongola - Hutton form soil - 114 ppm K

kg K/ha applied	t/ha cane	Suc % cane	t/ha sucrose
0	120	10,9	13,0
75	126	11,2	14,1
150	134	11,4	15,3
LSD (0,05)	5,2	0,45	0,65

In many of the current N/K fertilizer trials, however, a response to K in terms of yield and sucrose has not been accompanied by an increase in sucrose % cane as shown in Table 2.

Table 2 Cane yield sucrose % and sucrose yield (4R)
Trial FT10NK/80 - Esperanza - Mayo soil form - 96 ppm K

kg K/ha applied	t/ha cane	Suc % cane	t/ha sucrose
Nil	81	14,6	11,8
125	90	14,4	13,0
250	106	14,5	15,5
LSD (0,05)	6,3	0,3	0,9

In Australia between 1961 and 1964 Yates (1965) reported that of 34 K trials showing a response in cane yield of applications of K fertilizer at rates of 0,92 and 184 kg K/ha, in no case had cane quality been significantly affected.

Increasing rates of K in the absence of a K response seem generally to have had little effect on cane quality. There was an indication in one N/K trial in the Midlands of a depression in sucrose % cane (reduced from 13,1 to 12,6) where a very high level of K (375 kg K/ha) was applied, but this was not significant. Stewart (1969) also reported a significant depression in sucrose % cane following application of 183 kg K/ha to a soil with an exchangeable K content of 155 ppm.

N/K interactions and cane quality

It is sometimes thought that depression of sucrose in cane juice resulting from heavy applications of N fertilizer can be obviated by applications of potash. This would only seem to be the case however, in soils having a low K level where a response to K can be expected.

Interactions between N and K under these conditions were observed in a number of RFT trials, the best example being one on a TMS (Cartref series) soil containing 64 ppm K, and reported by Stewart (1969). In this trial the application of N fertilizer in the absence of potash steadily decreased sucrose % cane. However, as shown in Table 3, the addition of K counteracted this trend, producing a good response in terms of sucrose % cane at high levels of N.

Table 3 The interaction between N and K in terms of sucrose % cane and tons sucrose/ha from RFT trial

kg K per ha	kg N per hectare							
	0		110		220		440	
	Suc %	t/ha suc	Suc %	t/ha suc	Suc %	t/ha suc	Suc %	t/ha suc
0	17,3	10,9	16,6	9,6	16,2	9,0	15,7	8,0
92	17,0	12,4	18,3	17,1	17,3	16,4	16,4	13,3
184	17,3	11,5	17,3	18,1	17,6	16,2	17,6	17,8
368	17,4	11,5	17,6	17,4	17,1	17,8	17,4	14,0

NB. The increase in sucrose content due to potash application is largely a function of potash yield response and it would be quite wrong to assume, that because potash on the average increases sucrose content that it will also do so when the K status of the crop is satisfactory. Where K is adequate no such increases can be expected.

Phosphorus

An application of a phosphatic fertilizer to a soil highly deficient in P may significantly increase both cane yield and quality as shown in the plant crop results of two experiments on Inanda series soils (see Table 4).

Table 4 Response to superphosphate - plant cane

Treatments	INANDA			MELMOTH		
	t/ha cane	Suc % cane	t/ha suc	t/ha cane	Suc % cane	t/ha suc
Control - No P	66,7	13,4	8,9	19,9	15,7	3,1
Supers - 1 100 kg/ha	166,4	14,9	24,8	95,6	17,5	16,8

Much of the time though the application of P whilst increasing yields and tons sucrose/ha, does not affect sucrose % cane significantly as evidenced by results from the P fertilizer trials conducted by the Experiment Station in the Midlands and reported by Meyer and Dicks (1979). In one of these trials however, high yielding broadcast treatments resulted in a significant lowering of ERS % cane when compared with treatments which received no broadcast supers (see Table 5).

Table 5 Cane yield, ers % cane and tons ers/ha.
Trial FT9P - Harden Heights, Inanda series soil

Treatments	t/ha cane	ERS % cane	t/ha ers
50 kg P in furrow	90	8,4	7,5
100 kg P in furrow	93	7,9	7,4
50 kg P (cf) + 124 kg P (bc)	98	7,3	7,1
50 kg P (cf) + 249 kg P (bc)	109	7,5	8,1
LSD (0,05)	14,4	0,9	1,4

du Toit (1962) reported that where ratoons had received somewhat excessive amounts of phosphate, the effect of P in lowering sucrose percent cane was most pronounced particularly in later ratoons which had received the top-dressing more often.

P carriers

Wyatt (1969) concluded that there was little or no difference in the efficiency of the different P fertilizers used for cane in so far as their effect on yield or quality was concerned.

A notable exception however, is filtercake which is used primarily as a phosphatic fertilizer. When applied in large quantities, excellent responses to P have been obtained especially on Midlands soils which fix P strongly, but in many cases cane quality has been significantly depressed due to the presence of excessive amounts of N, which is also supplied by the filtercake.

As with potassium, P fertilizer may in some instances prevent the depression of cane quality caused by excessive application of N fertilizer.

Lime and cane quality

Large responses in cane yield to liming have been obtained on Midlands soils, in many cases without significant influence on cane quality. However, one experiment indicated that on average liming had significantly depressed sucrose % cane from 13,4% to 12,4%. This decline was accompanied by a general increase in leaf N values and it seems likely that increased mineralization of N which follows the liming of acid soils can lead in some instances to a decline in sucrose content of cane grown in the Natal Midlands. This is one reason why N fertilizer recommendations for this region are likely to be adjusted. Davidson (1965) noted a similar decrease in juice quality where lime was used on acid soils in Louisiana.

Minor elements and cane quality

Generally it seems that minor element fertilizers produce no significant increases or decreases in sucrose content. In our zinc trials there have been significant responses in yield to zinc application but none of those examined showed any significant effects on sucrose content.

In the case of iron however, there was a significant increase in sucrose percent cane where chlorotic cane was sprayed with ferrous sulphate, as well as a substantial increase in yield and tons sucrose (see Table 6).

Table 6 Cane yield, sucrose % and tons sucrose (2R)
Iron chlorosis trial - Clansthal series sand

Treatments	t/ha cane	suc % cane	t/suc ha
Control	67,4	15,0	10,1
$FeSO_4$ - 13 kg/ha split app.	86,9	15,6	13,5
$FeSO_4$ - 6,5 kg/ha split app.	82,9	15,7	13,0
$FeSO_4$ - 6,5 kg/ha single app.	81,5	15,5	12,7
LSD (0,05)	25,7	0,6	4,1

Other considerations

Effect of soil soluble salts on juice quality

Fogliata and Aso (1965) reported that an increase in soluble salts in the soil causes a consequent accumulation of salts in the cane juice which in turn lowers purity and the sucrose percentage (see Table 7)

Table 7 Effect of soil salts on the quality of sugarcane juice

Soil salts %	Juice salts %	Juice chloride %	Brix %	Sucrose %	Purity %	Glucose %
0,062	0,060	0,019	21,2	20,1	95,0	0,39
0,145	0,099	0,047	21,0	19,2	91,2	0,56
0,147	0,140	0,068	19,0	16,1	84,6	0,63

The effects of cane grown in saline fields is related to the inhibitory effect of the chloride ion on N and P absorption resulting in poor foliage.

The influence of fertilizers on available sugar components

Samuels and Landrau (1956) have some comments to make on this subject, which are of importance to us.

Table 8 The influence of fertilizers on available sugar components

Treatment No.	Fertilizer treatment per acre of -			Available 96° sugar juice	Available 96° sugar in cane	Polarization	Brix	Extraction	Purity	Relative cane tonnage yields
	N	P_2O_5	K_2O							
					Nitrogen[2]					
	Pounds	Pounds	Pounds	Percent	Percent	Degree	Degree	Percent	Percent	Percent
1	0	300	300	16,39**	11,71**	68,8**	18,9**	71,4*	86,5**	52**
2	125	300	300	17,56	12,68	73,7	19,8	72,2	88,4	83**
3	250	300	300	17,66	12,75	74,1	20,0	72,4	88,0	100
					Phosphorus[3]					
4	300	0	300	15,71*	11,41*	67,8	19,1	72,4	82,0*	82**
5	300	150	300	16,39	12,03	69,8	19,4	73,3	84,4	98
6	300	300	300	16,40	11,93	70,4	19,8	72,7	82,7	100
					Potassium[4]					
7	300	300	0	15,09**	11,17**	68,7**	19,7**	69,9	81,3**	88**
8	300	300	150	16,77	11,67	71,2*	20,0	69,6	83,8	97
9	300	300	300	16,98	11,87	72,7	20,2	69,9	83,9	100

1 The asterisks used in the table indicate that the treatment used significantly decreased the value as compared to that value for the treatment which follows: * indicates significant decrease at the 5-percent level, ** indicates significant decrease at the 1-percent level.

2 Average of 10 experiments

3 Average of 5 experiments

4 Average of 8 experiments

FERTILIZERS AND SUCROSE-PERCENT-CANE

Nitrogen

Where the available sucrose-percent-cane was increased by the nitrogen applications, there was also an increase in polarization, Brix, purity, and percent-extraction (table 8). The average increase in polarization and Brix was highly significant to the first increment of nitrogen application to the soil (125 pounds N per acre) over the no-nitrogen treatment. The use of 250 pounds per acre instead of 125, however, did not give any appreciable increase (table 8) although cane yields were significantly increased up to 250-pounds-N-per-acre level.

Phosphorus

The phosphorus-deficient cane showed significantly lower values in available sugar in juice and cane, purity, and relative yields (table 8). Variations in phosphorus applications did not significantly influence polarization, Brix, or extraction.

Potassium

Significantly lower values were obtained for all factors except percent-extraction when potash fertilizers were not used (table 8). Polarization values were affected strongly and gave significant increases at all fertilizer levels. Percent-extraction showed a smaller variation for different potassium levels than it did for either nitrogen or phosphorus.

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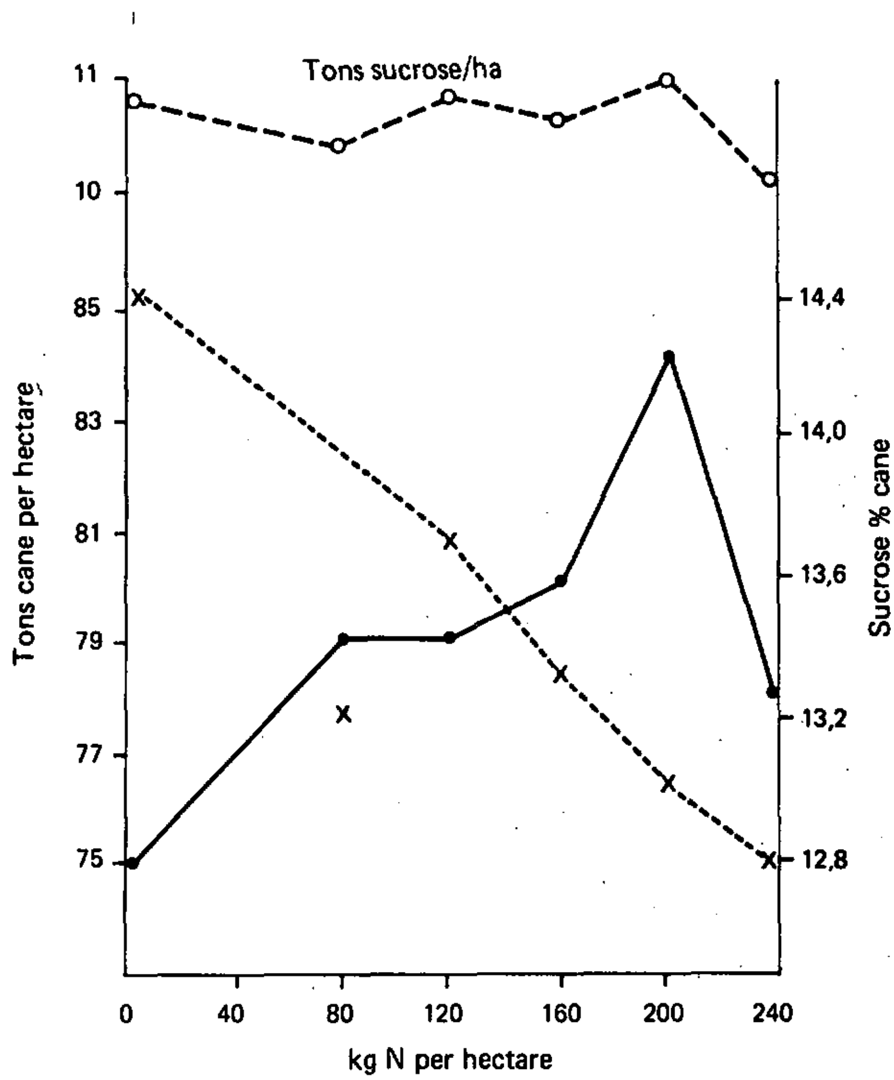

Fig. 1. Increase in cane yield offset by a decrease in sucrose per cent cane.

(NK fertilizer trial – Vimy series soil – Swaziland)

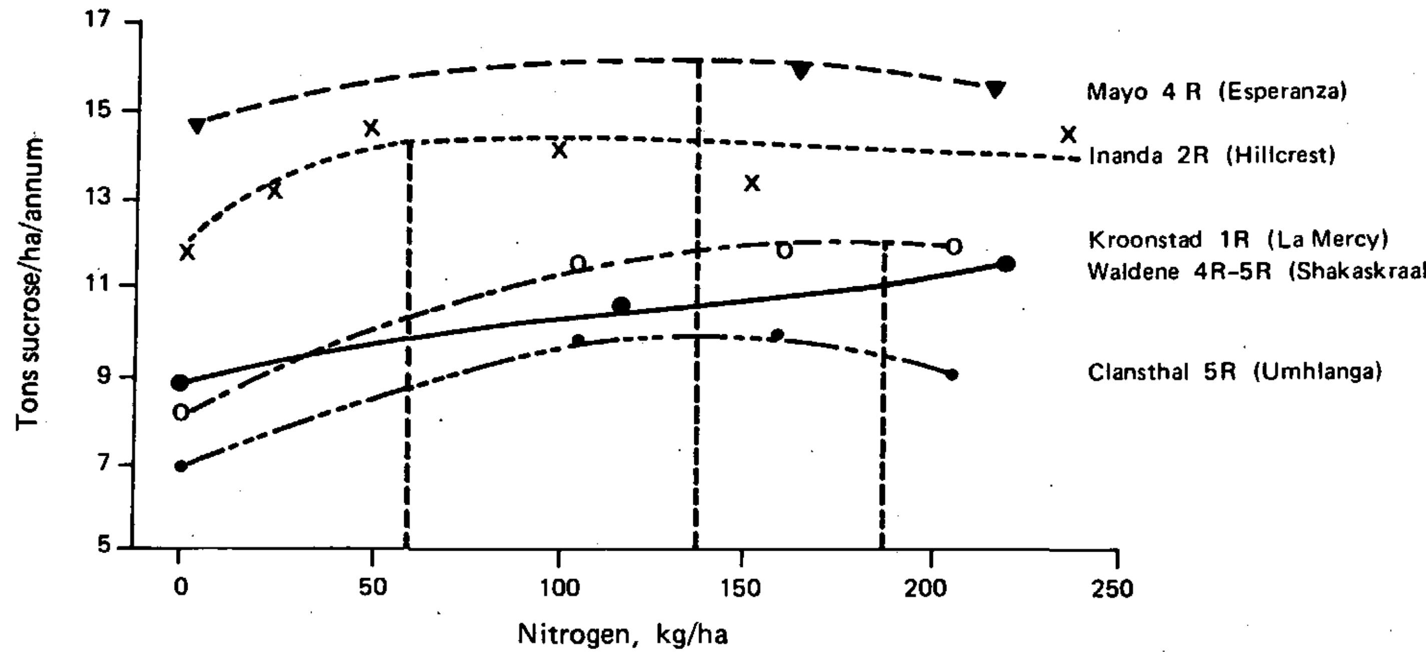

Fig. 2. Response to nitrogen in tons sucrose/ha/annum in the rainfed areas of Natal.

Fig. 3. PROPOSED SYSTEM FOR RECOMMENDING N ON PLANT AND RATOON CANE

Soil group	Main diagnostic A horizon(s)	Organic matter status (%)	Estimated N mineral capacity (kg/ha)	Parent material	Main soils		N recommendation	
					Form	Series	Plant (kg N/ha)	Ratoon (kg N/t cane)
I	Orthic (weak)	Low < 2	Low <70	Recent Sand	Fernwood	Fernwood	120	1,6 : 1 (eg. 160 kg N/100 t)
				TMS (Ord)	Cartref	Cartref		
				Dwyka Tillite	Longlands Glenrosa	Waldene Williamson		
				Granite	Glenrosa	Glenrosa		
				Alluvium	Katspruit	Katspruit		
II	Melanic Vertic Orthic (good)	Medium 2–4	Medium 70–140	Lower Ecca Shale	Milkwood	Milkwood	90	1,25 : 1 (eg. 125 kg N/100 t)
				Middle Ecca Sedt	Swartland	Swartland		
				Granite	Mayo	Mayo		
				Dolerite	Shortlands	Shortlands		
					Arcadia	Rydalvale		
				Alluvium	Hutton	Shorrocks		
				TMS (Ord)	Hutton	Farningham		
III	Humic Orthic (Humic phase)	High > 4	High >140	Dolerite	Hutton	Balmoral	60	0,8 : 1 (eg. 80 kg N/100 t)
					Inanda	Sprintz		
				TMS (Mist)	Inanda	Inanda		
					Nomanci	Nomanci		
				Middle Ecca	Clovelly	Balgowan		
				Dwyka Tillite	Griffin	Farmhill		

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

VARIETIES AND CANE QUALITY

by

Geoff Inman-Bamber

It is customary in our industry to express the quality of our commercial varieties as the difference between their mean sugar content and the mean content of NCo 376. Although this expression of relative sugar content is a more stable varietal trait than is relative cane yield, it does vary in response to changes in several factors. The most familiar of these are 1) time of year (season) 2) cane age 3) water availability 4) lodging 5) pests and diseases.

1. Time of year

Maximum sugar content in all varieties occurs in spring. However there are small variations in the sugar accumulation and dissipation rate that can be exploited (Fig. 1). The difference in sugar content of NCo 310 and NCo 376 is greatest in August while J59/3 and NCo 376 differ most in May and June. Varieties with an inherently low sugar content are best cut in spring when they differ least with the other varieties in regard to sugar content.

2. Cane age

Although we do not have commercial varieties that 'mature' at different ages our high sucrose varieties are regarded as early maturing simply because they have considerably more sugar per unit stalk mass than the low sucrose varieties, when young. Varieties with a lower sugar content are 'late maturing' in that they will tend to differ less in time with the high sucrose varieties. Season effects are usually greater than age effects.

3. Water availability

Samples taken each month during three five month periods prior to harvest have shown that sugar content can fluctuate considerably with water availability. For example (Fig. 2) sugar contents of all varieties in a droughted trial decreased sharply when some relieving rain fell in April but then rose again as the soil dried once more. The sucrose content of some varieties (notably NCo 376) decreased considerably with further desiccation of the cane. The poor performance of NCo 376 in drought can be ascribed to rapid deterioration in its quality under such conditions.

4. Lodging

The cane quality of some varieties seems to suffer more than that of others as a result of lodging. Lodging occurs readily in both N11 and J59/3 for example but the quality of N11 is affected more often than is the case with J59/3. However stalk breakage which commonly occurs in J59/3 and N52/219 could lead to a more serious loss in quality if the interval between harvest and milling is substantial.

5. Pests and diseases

Eldana borer probably has the greatest effect of all pests and diseases on the quality of cane and marked varietal differences have been observed in this regard as the following figures show.

Difference in sugar content with NCo 376

	N52/219	J59/3	N12	N13	N14
Healthy	+0,8	1,9	0,9	0,3	-0,6
Eldana*	-1,2	-0,5	+2,4	-1,6	+1,5

* Where eldana per 100 stalks exceeds 20.

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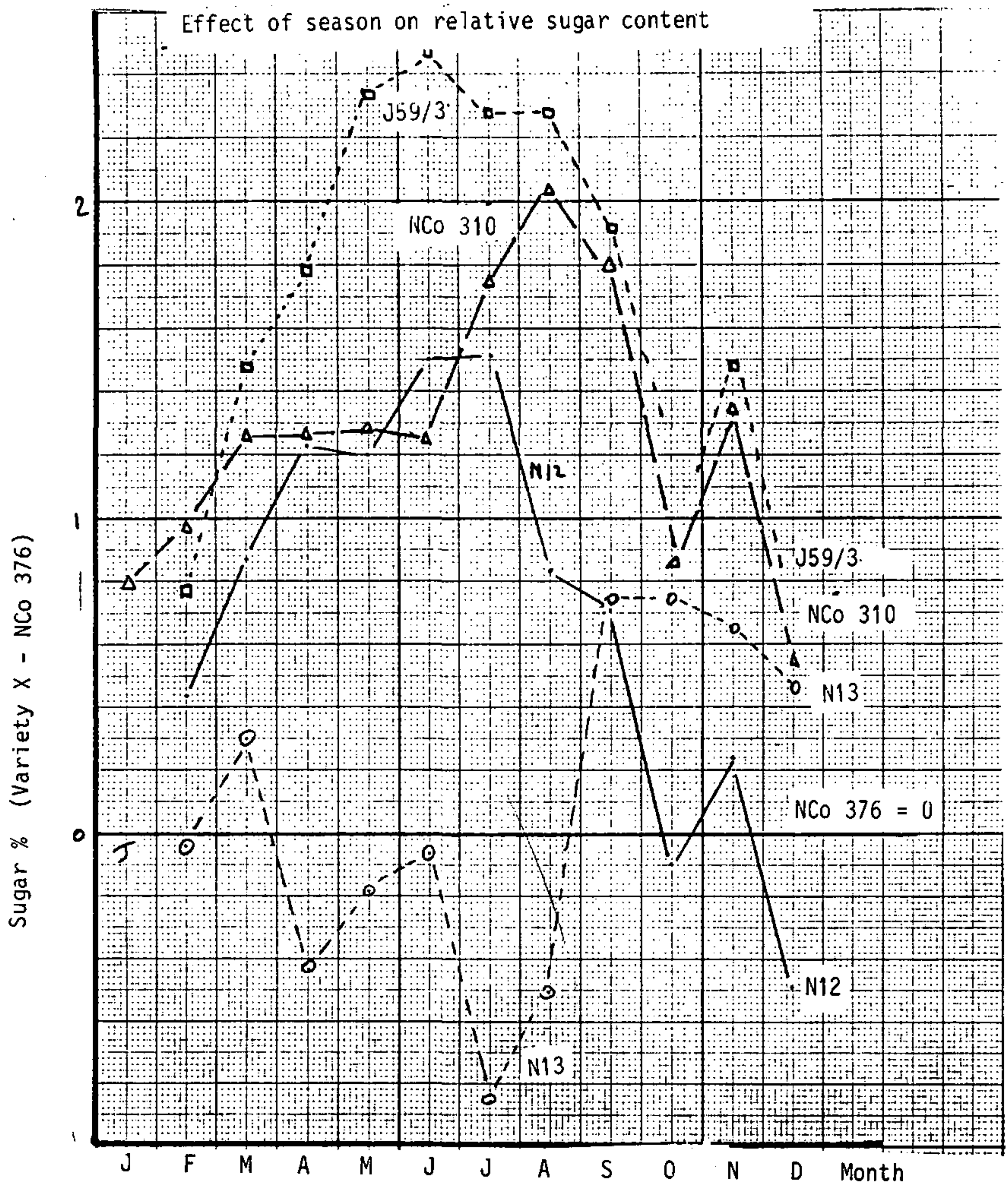
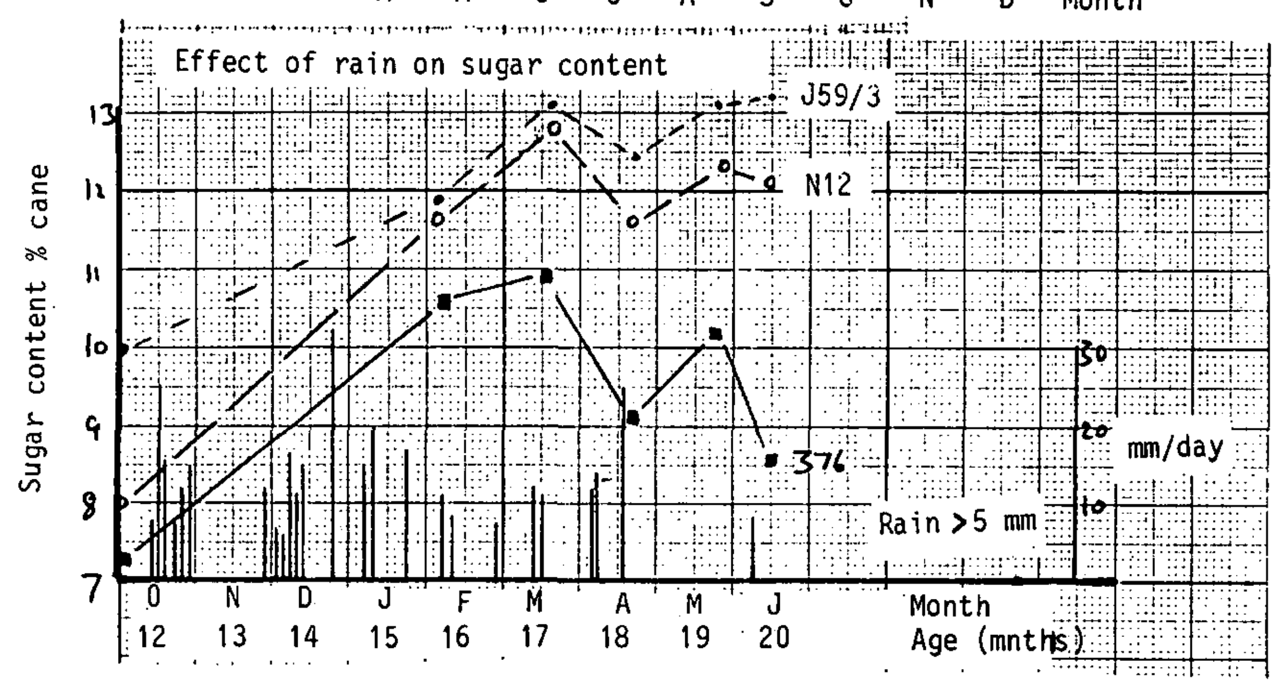

Effect of season on relative sugar content
Sugar % (Variety X - NCo 376)
2
1
0
J59/3
NCo 310
N12
N13
NCo 376 = 0
J
F
M
A
M
J
J
A
S
O
N
D
Month


Effect of rain on sugar content
Sugar content % cane
13
12
11
10
9
8
7
J59/3
N12
376
30
20
10
mm/day
Rain >5 mm
O
N
D
J
F
M
A
M
J
Month
12
13
14
15
16
17
18
19
20
Age (mnths)