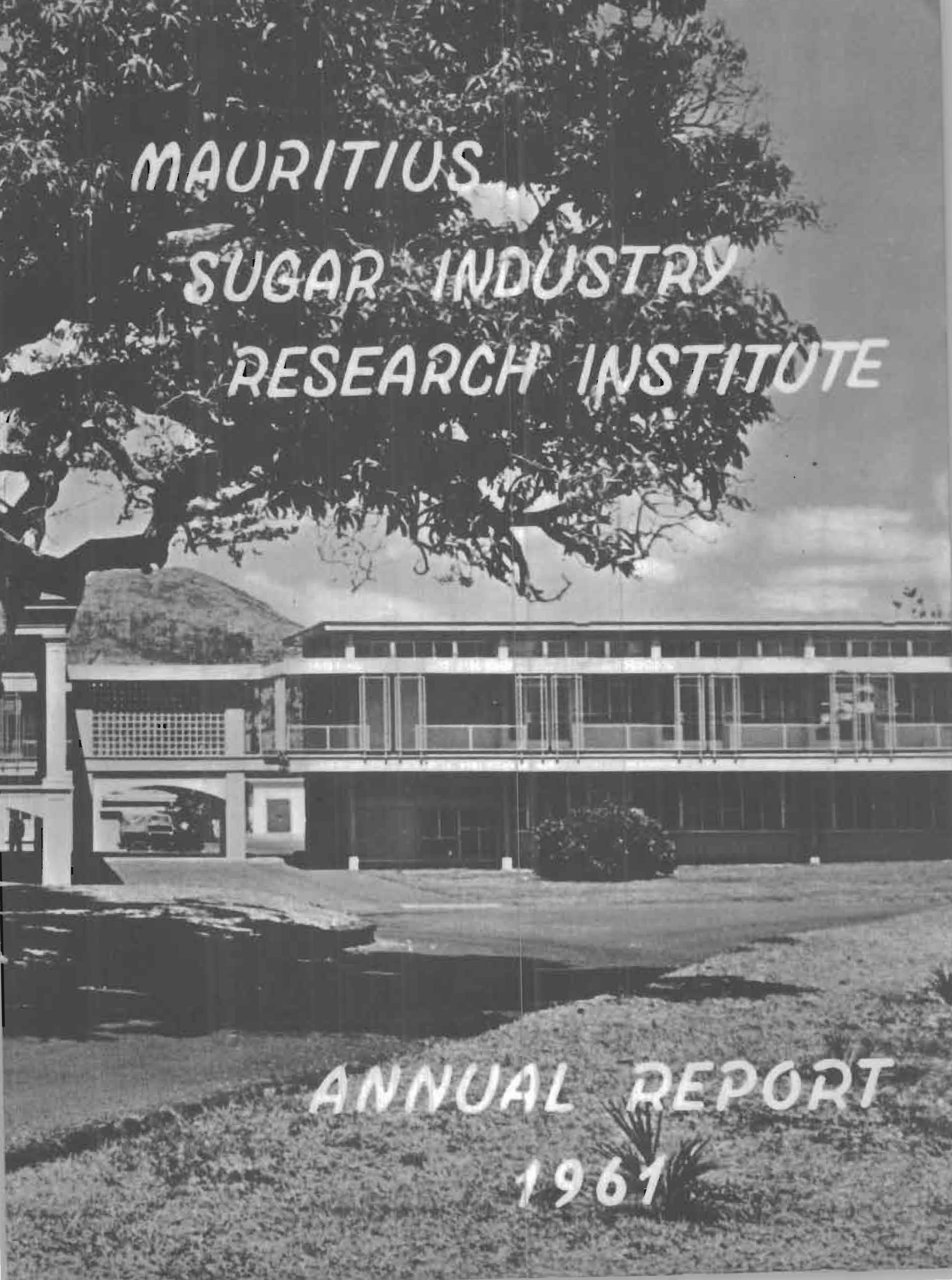
MAURITIUS
SUGAR INDUSTRY
RESEARCH INSTITUTE
ANNUAL REPORT
1961

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Photograph on the cover is of the main buildings of the M.S.I.R.I. at Réduit. (Phot. C. Mongelard).

MEMBERS EXECUTIVE BOARD

Mr. Raymond Hein, Q.C., *Chairman, representing the Chamber of Agriculture.*

Mr. A. North-Coombes, O.B.E., *representing Government, January to October.*

Mr. M. D. ffrench-Mullen, *representing Government, October to December.*

Mr Auguste Harel
Mr. L. de Chazal
Mr. G. S. de la Hogue
} *representing factory owners.*

Mr. Georges Rouillard, *representing large planters. Acting Chairman, 16th July — 31st December.*

Mr. M. Kisnah
Mr. S. Bunjun
} *representing small planters.*

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Dr. P. O. Wiehe, C.B.E., *Chairman.*

Mr. A. North-Coombes, O.B.E., *representing the Department of Agriculture, January to October.*

Mr. M. D. ffrench-Mullen, *representing the Department of Agriculture, October to December.*

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Mr. G. P. Langlois, *representing the Chamber of Agriculture.*

Mr. P. de L. d'Arifat
Mr. A. Wiehe
} *representing the Société de Technologie Agricole et Sucrière.*

and the senior staff of the Research Institute.

STAFF LIST

Director	P. O. Wiehe, C.B.E., D.Sc., A.R.C.S., F.L.S.
Agronomist	P. Halais, Dip. Agr. (Maur.)
Botanist	E. Rochecouste, Ph. D., Dip. Agr. (Maur.)
Asst. Botanist	C. Mongelard, B.Sc.
Chemist	D. H. Parish, B.Sc., M. Agr. (Q.U.B.), F.R.I.C.
Senior Asst. Chemist ...	S. M. Feillafé, Dip. Agr. (Maur.)
Asst. Chemist	L. Ross, Dip. Agr. (Maur.)
Plant Breeder	W. de Groot, M.Sc. (Wag. Holland)
Asst. Plant Breeder ...	G. Harvais, B.Sc. (Aberd.). (Resigned July 1961.)
Senior Asst. Plant Breeder ...	L. P. Noël, Dip. Agr. (Maur.) (as from 1.9.61) — *i/c Belle Rive Experiment Station.*
Geneticist	E. F. George, B.Sc., A.R.C.S.
Asst. Geneticist	J. A. Lalouette, Dip. Agr. (Maur.)
Plant Pathologist	R. Antoine, B.Sc., A.R.C.S., Dip. Agr. Sc. (Cantab.), Dip. Agr. (Maur.)
Asst. Plant Pathologist ...	C. Ricaud, B.Sc., D.I.C.
Sugar Technologist	J. D. de R. de Saint Antoine, B.S., Dip. Agr. (Maur.)
Associate Sugar Technologist ...	J. P. Lamusse, B.S. (Resigned on 28.2.61.)
	H. F. Wiehe, B.S., Dip. Agr. (Maur.) (as from 1.3.61.)
Associate Chemist (S.T.) ...	E. C. Vignes, M.Sc., Dip. Agr. (Maur.)
Asst. Chemist (S.T.) ...	M. Randabel, Dip. Agr. (Maur.)
Asst. Sugar Technologist ...	R. H. de Froberville, Dip. Agr. (Maur.)
Asst. Sugar Technologist ...	F. Le Guen, B.Sc.
Entomologist	J. R. Williams, M.Sc., D.I.C.
Chief Agriculturist	G. Rouillard, Dip. Agr. (Maur.)
Senior Field Officer ...	G. Mazery, Dip. Agr. (Maur.)
,, ,, ,, ...	P. R. Hermelin, Dip. Agr. (Maur.) — *i/c Réduit Experiment Station*
Field Officers:	
Headquarters ...	A. Lagesse, Dip. Agr. (Maur.). (Resigned May, 1961.)
	M. Mamet, Dip. Agr. (Maur.)
	R. Ng. Ying Sheung, Dip. Agr. (Maur.) (as from 1.7.61.)
North	R. Béchet, Dip. Agr. (Maur.) — *i/c Pamplemousses Experiment Station.*
South	F. Mayer, Dip. Agr. (Maur.) — *i/c Union Park Experiment Station.*
Laboratory Assistants:	
Chemistry ...	L. C. Figon
Entomology ...	M. A. Rajabalee
Foliar Diagnosis	Mrs. G. Caine
Sugar Technology ...	L. Le Guen
	C. Cavalot (as from 1.7.61)
Secretary-Accountant ...	P. G. de C. Du Mée
Asst. Secretary-Accountant ...	M. M. d'Unienville
Librarian	A. Jauffret (resigned 30.11.61)
	Miss M. Ly-Tio-Fane, B.A. (as from 1.12.61.)
Draughtsman-Photographer ...	L. S. de Réland
Clerks	Mrs. A. d'Espagnac
	Mrs. A. Baissac
	Mrs. J. Danjoux
	Mrs. M. Rae

REPORT OF THE CHAIRMAN

EXECUTIVE BOARD 1961

THE Board held 12 meetings during the year, two of which jointly with the Research Advisory Committee. The only changes on the Board were Mr. G. S. de la Hogue who replaced Mr. L. H. Garthwaite as representative of factory owners, and Mr. M. D. ffrench-Mullen who replaced Mr. Alfred North Coombes as Director of Agriculture in October.

During my absence overseas, from July to December, Mr. Georges Rouillard acted as chairman of the Board.

We wish to place on record our appreciation of the services rendered by Mr. North Coombes who has been serving on the Board on and off since May, 1954.

ESTABLISHMENT

There were four resignations in 1961, the vacant posts being filled immediately viz : Mr. H. F. Wiehe replaced Mr. J. P. Lamusse as Associate Sugar Technologist; Mr. R. Ng Ying Sheung succeeded to Mr. A. Lagesse as Field Officer while Mr. L. P. Noël was transferred from his function of Field Officer to that of Senior Assistant Plant Breeder to replace Mr. Harvais; Miss M. Ly-Tio-Fane was appointed Librarian in December to replace Mr. A. Jauffret. Mr. C. Cavalot was appointed Laboratory Assistant in the Sugar Technology Division in July.

Mr. F. Le Guen of the Sugar Technology Division returned to Mauritius on 4th July after spending fifteen months study leave in England and obtaining a Diploma in Instrumentation.

Dr. E. Rochecouste, our Botanist, must be sincerely congratulated on obtaining the Ph.D. degree of London University and it gives me great pleasure to do so.

We are also pleased to note that Mr. D. H. Parish, our Chemist, has obtained the Fellowship of the Royal Institute of Chemistry.

Messrs. A. Wiehe and J. Maurice Paturau were re-appointed Consulting Sugar Technologists.

BUILDINGS

The extension of the Biology wing to accommodate another laboratory for the Plant Breeding Division is practically completed and terminates the Institute's main building programme as far as can be foreseen.

As mentioned in last year's report, a house was built at Réduit and subsequently exchanged with Government for another house.

SPECIAL STUDIES FUND

The Special Studies Fund served to finance the studies of Messrs. F. Le Guen and de Réland. The former obtained the Post Graduate Diploma in Automatic Control at the Northampton College of Advanced Technology in London, while Mr. de Réland followed courses at the Byam Shaw School of Drawing and Painting in London, at the Kew Herbarium and also received training from Messrs. Leitz in Germany.

FINANCE

It is heartening to note that the temporary increase in cess to Rs. 4.50 per ton of sugar produced in 1961 has had the desired effect of re-establishing the Accumulated Funds of the Institute at the level reached at the end of 1959. However, it will be noted that the cash available amounting to Rs. 266,000. will not be sufficient to finance the Institute until the receipt in August of the first revenue from the 1962 crop.

From an examination of the 1961 accounts and balance sheet it appears that the Institute has reached a stage where further development cannot be envisaged with the present level of revenue. This creates a problem which will have to be carefully studied by my successor.

I would also like to stress once again the fact that capital development, since the Institute started, has been carried out entirely from revenue and that it has not been possible up to now to establish a cash reserve which could be used to tide the Institute over such difficult financial periods.

In closing this Report, I should like to express my gratitude to my friend Mr. Georges Rouillard who kindly accepted to replace me as Chairman during my absence from the Colony, and to all my colleagues of the Board for their most valuable assistance.

The staff is to be congratulated on its spirit of co-operation, and although it is now commonplace to refer to our Director's able administration, I feel I should be failing in my duty if I did not record my appreciation of his services.

Chairman.

25th January, 1962

REVENUE AND EXPENDITURE ACCOUNT

YEAR ENDED 31st DECEMBER, 1961

Running and Administrative Expenses ...	1,531,265.01	Cess on sugar exported	2,250,876.88
Interest paid	44,949.61	Miscellaneous receipts	70,217.57
Depreciation	112,224.98		
	1,688,439.60		
Excess of Revenue over Expenditure for the year, carried to Accumulated Funds ...	632,654.85		
Rs.	2,321,094.45	Rs.	2,321,094.45

BALANCE SHEET

AS AT 31st DECEMBER, 1961

ACCUMULATED FUNDS	1,486,791.41	FIXED ASSETS (At cost less depreciation and amounts written off)		
REVENUE FUNDS	64,227.46	Land and Buildings ...	1,697,535.69	
SPECIAL STUDIES FUND	6,402.27	Equipment and Furniture: Laboratories, Houses & Offices	46,245.05	
AIMÉ DE SORNAY FOUNDATION ...	25,000.—	Agricultural Machinery & Vehicles	22,007.—	
GROUND WATER RESEARCH FUND ...	353,502.43			1,765,787.74
LOAN FROM ANGLO MAURITIUS ASSURANCE SOCIETY LTD. ...	427,216.—	CURRENT ASSETS		
GOVERNMENT OF MAURITIUS (Purchase of Buildings)	166,035.35	Sundry Debtors ...	48,233.44	
AIMÉ DE SORNAY SCHOLARSHIP ...	92.50	Aimé de Sornay Foundation Account	25,000.—	
		Cash at Bank and in hand (Ground Water Research Fund Account)	353,502.43	
		Cash at Banks and in hand ...	336,743.81	
				763,479.68
Rs.	2,529,267.42	Rs.		2,529,267.42

AUDITORS' REPORT

We have examined the books and accounts of the Institute for the year ended 31st December 1961, and have obtained all the information and explanations we have required. In our opinion, proper books of accounts have been kept by the Institute so far as appears from our examination of those books, and the foregoing Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Institute's affairs as at 31st December 1961, according to the best of our information and the explanations given to us and as shown by the books and accounts of the Institute.

(sd) P. ESPITALIER-NOEL
(sd) D. FFRENCH-MULLEN } *Board Members*

(sd) P. O. WIEHE *Director*

Port Louis,
Mauritius,
25th January, 1962

(sd) P. R. C. Du MÉE
C.A.(S.A.), F.S.A.A.
p.p. de CHAZAL, DU MÉE & Co.
Chartered Accountants.

INTRODUCTION

THE activities of the Sugar Industry Research Institute in 1961 are reviewed and summarized in this 9th Annual Report.

At the close of the year the staff numbered 46, including six temporary junior assistants. Work in the various divisions progressed satisfactorily along the broad lines of an approved research programme. Close contact was kept with planters and producers and 1559 visits were made to plantations and factories during the year. The Department of Agriculture being the responsible body for technical advice to small planters, useful discussions were held with the Director of Agriculture in order that his extension officers may derive full benefit from the findings of specialists of this Institute.

Rehabilitation of the four field stations after the 1960 cyclone was completed and cane production in 1961 was at a normal level totalling 2285 tons as follows : Réduit 433, Pamplemousses 713, Belle Rive 737, Union Park 402.

THE 1961 SUGAR CROP

The area under sugar cane in 1961 was 200,000 arpents of which 51% was cultivated by millers and 49% by planters.

A record weight of cane was harvested in spite of a severe drought which occurred during the first four months of the growing season. The setback caused by this dry period is reflected in the cane elongation curve shown in fig. 1. Late rains on the other hand prolonged growth and helped to produce a slightly greater weight of cane than would otherwise have been the case. Climatic conditions prevailing in 1961 are illustrated in fig. 2. Rainfall was deficient during seven of the eight months of the growing season and was significantly higher than normal during the first two months of the maturation period. Both maximum and minimum temperatures which were above normal throughout the year contributed markedly to the production of more cane during the vegetative period, but reduced the sucrose content of the cane during the harvest season. It has been calculated that rainfall and temperatures have had the following quantitative effects on the production of the island as a whole :

Growing season, November 1960 — June 1961

(a) shortage of cane due to deficient rainfall :	—3.9	tons/arpent
(b) surplus of cane due to higher temperatures : ...	+1.5	tons/arpent
Overall effect ...	—2.4	tons/arpent

Maturing season, July — October 1961

(a) short fall on sugar manufactured % cane due to excess rainfall : ...	—0.61
(b) short fall on sugar manufactured % cane due to higher maximum and minimum temperatures	—0.53
Overall effect ...	—1.14

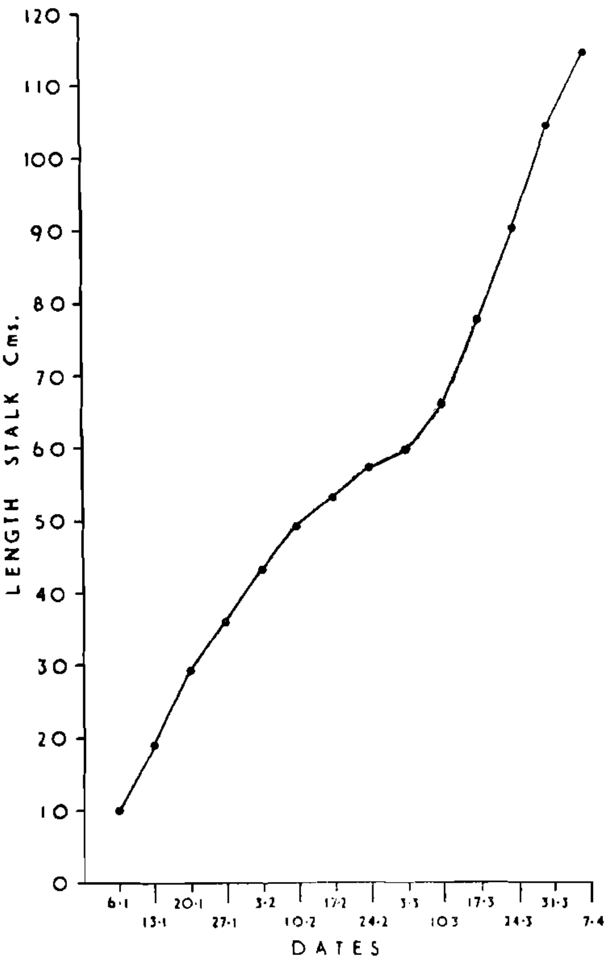

Fig. 1. Stalk elongation of sugar cane in 1961. Measurement at 8 sites distributed throughout the island.

It should be pointed out that these climatic effects on growth and maturity were more or less pronounced in the different sectors. Thus the coastal region in the isohyet of 50″ suffered proportionately more from drought, while normally high-rainfall localities (above 100″) benefited from the reduced rainfall.

The area harvested in 1961 was 93.2% of cane lands. Of the weight of cane reaped, ratoons accounted for 85% of the crop. Yield of canes ranged from 20.8 tons per arpent for planters to 32.2 tons for estates; in the latter group, yields fluctuated from 25.3 to 40.3 tons per arpent. Yields in virgins and ratoons in 1961 are compared to those for the period 1955—1959 in fig. 3, from which it may be observed that the yield of ratoon canes in 1961 was well over average.

As already indicated, conditions for cane maturity were bad, and in fact were made worse because the crop had to start early in order to fulfil export contingencies. Fluctuations in sucrose content from July to early December are shown in fig. 4, the highest average recorded being 13.92 in the north and the lowest 11.65 in the south. Sugar manufactured % cane was 11.18 equivalent to 8.9 tons

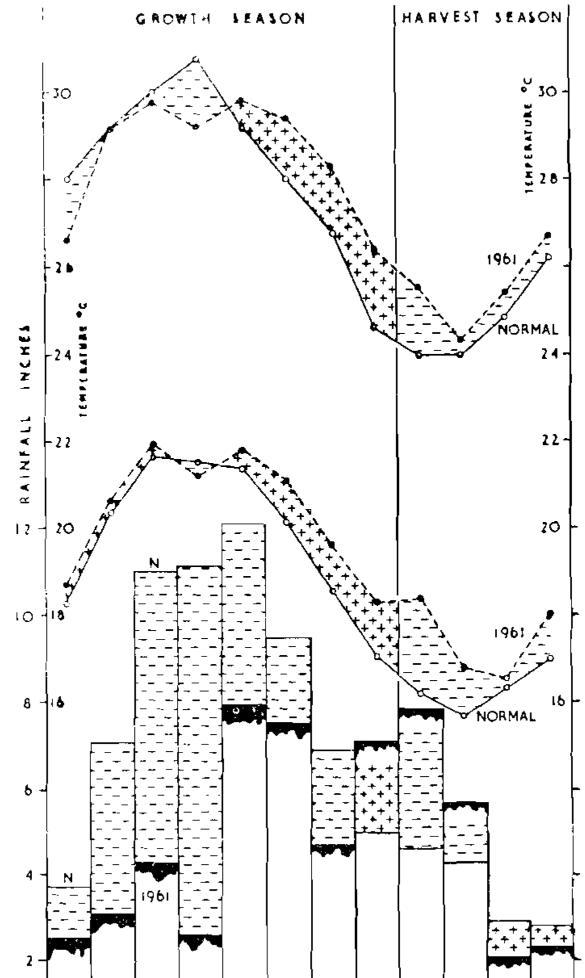

Fig. 2. Rainfall and temperatures (max. & min.) compared to normal during growing and harvest seasons of 1960-1961. The beneficial or deleterious effects on growth and maturity are indicated by + or — signs.

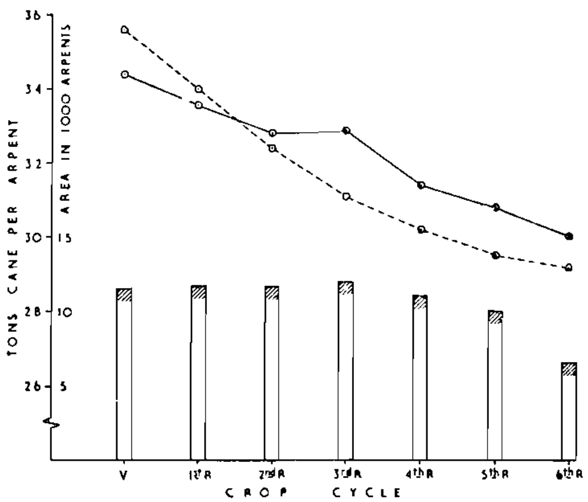

Fig. 3. Average yields of virgins and ratoons on estates. Plain line: 1961; broken line: average 1955-1959. Columns indicate approximate areas harvested.

of cane to make one ton of sugar. Yield of commercial sugar per arpent reaped amounted to 3.6 for estates and 2.3 for planters averaging 2.96 for the island as a whole. The deviations of cane and sugar yields from the average for the period 1955 – 1959 are indicated graphically for each sector of the island in fig. 5.

Comparative data for the 1960 and 1961 sugar crops are given below. They bear witness to the resilience of the sugar industry in the face of the extremely adverse conditions experienced in 1960.

	1961	*1960*
Area harvested ...	186,400	188,400
Weight of cane reaped...	4,943,000	2,393,000
Tons cane per arpent :		
Island	26.5	12.7
Estates ...	32.2	15.3
Planters ...	20.8	10.2
Tons cane/tons sugar ...	8.9	9.8
Tons commercial sugar/ arpent :		
Island	2.97	1.26
Estates ...	3.60	1.51
Planters ...	2.33	1.00
Metric tons sugar at 98.6 pol	552,700*	235,680

* Provisional figures.

Twenty-three factories operated during the year. Grinding started at the end of June and the last factory completed crushing after Christmas. The duration of crushing for all factories averaged 123 days, the shortest and longest periods being 83 and 147 days respectively. Output of sugar per factory ranged between 10,800 and 69,100 metric tons. A detailed analysis of factory work is given in the Appendix to this report but more essential data are summarized below in comparison with performance of factories in 1960.

	1961	*1960*
Harvest started	26th June	1st July
,, ended	29th December	28th Nov.
Tons cane crushed ...	4,942,974	2,393,541
Tons cane per hour ...	93.8 (51.8 to 222.4)	77.0 (44.4 to 156.5)
Sucrose % cane ...	12.81	11.83
Fibre ,, ,, ...	12.61	14.38
Molasses ,, ...	2.80	3.08
Purity mixed juice ...	85.2	83.5
Reduced Mill Extraction	95.8	95.2
,, Boiling house recovery	89.7	88.5
,, Overall recovery	85.9	84.3
Total losses sucrose % cane	1.78	2.11

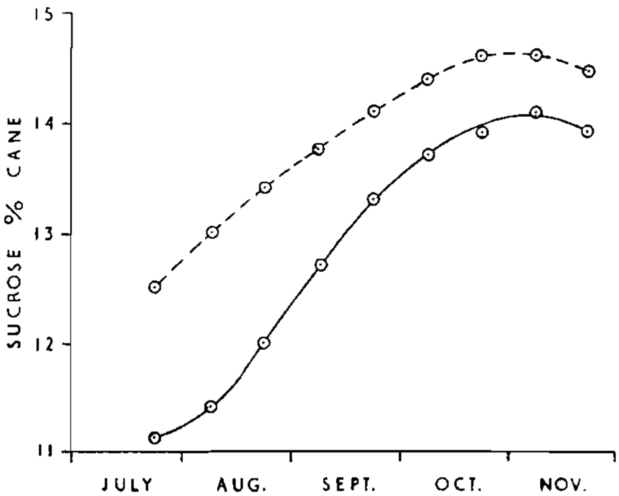

Fig. 4. Maturation curves, island average. Plain line: 1961; broken line: 1947-1959.

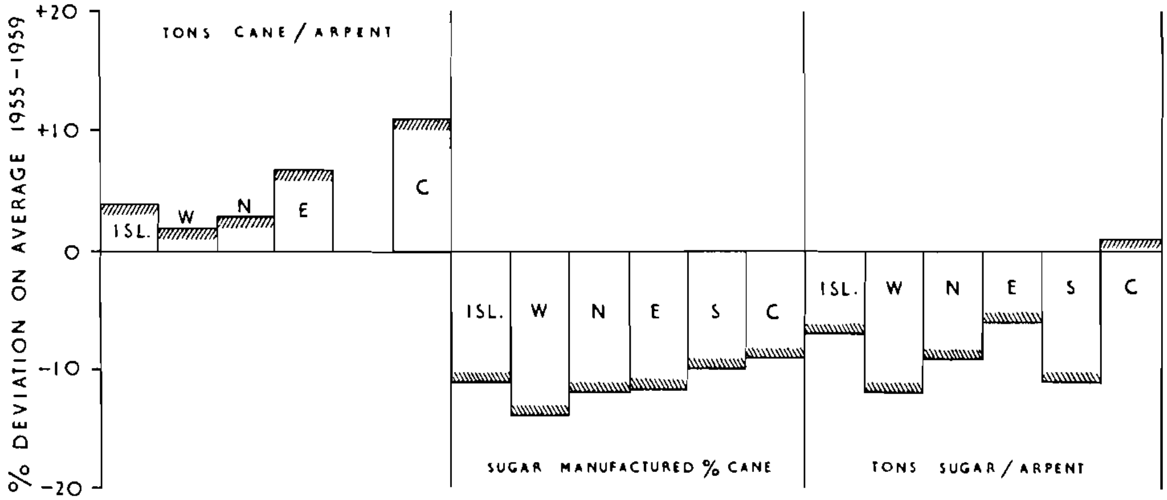

Fig. 5. Variation in cane and sugar yields in 1961 in different sectors of the island compared to the average during 1955 - 1959.

THE CANE VARIETY POSITION

The varietal composition of the 1961 crop is shown diagrammatically in fig. 6, from which the following points of interest may be noted. Ebène 1/37 produced over a quarter of estate canes ground for the island as a whole, the bulk of the production arising from the central sector where growth conditions for this variety were very near to the optimum. M.147/44 produced 21.5% of the total, a proportion below that of 1960 and which reflects to some extent its intolerance to dry conditions. M.134/32 has fallen to less than 20% of the canes ground for the island as a whole, but it was still the dominant variety crushed in the western and northern sectors. Barbados varieties B. 3337 and B. 37172 together accounted for about the same proportion as M. 134/32, B.3337 being important in the centre and south and B. 37172 in all sectors except the centre.

The approximate area under cultivation in different varieties in 1961 is given below, comparative figures for 1960 are shown in brackets to indicate present trends in varieties.

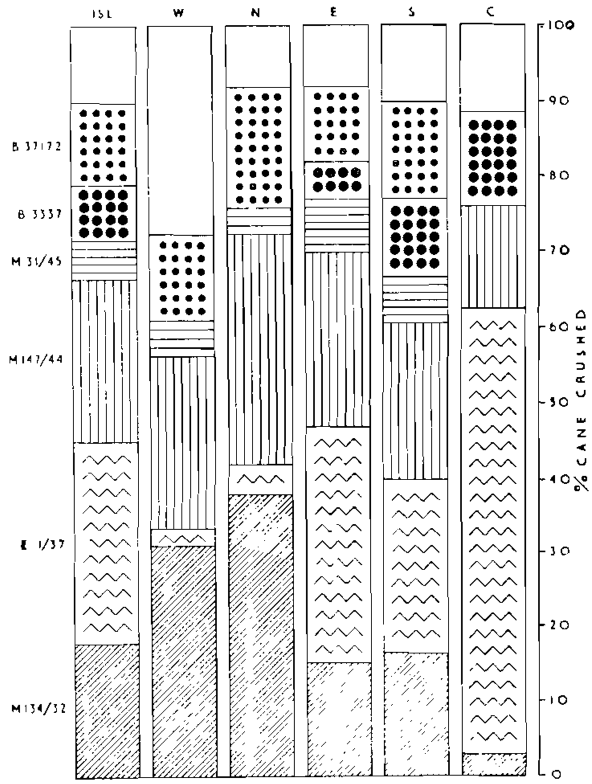

Fig. 6. Varietal composition of 1961 crop in different sectors (estate – grown canes).

	% area cultivated by estates	
M.134/32	19	(25)
M.147/44	22	(19)
M. 31/45	5	(5)
M.202/46	2	(—)
M. 93/48	1	(—)
M.253/48	1	(—)
Ebène 1/37	24	(25)
Ebène 50/47	1	(—)
B.3337	7	(6)
B.34104	2	(2)
B.37172	12	(10)
Others	4	(8)

The composition of plantations made in 1961 (fig. 7) shows that M.147/44 is the leading variety at present. Of 15,450 arpents planted, 30% was established under this variety reaching a maximum in the north (55%) and a minimum in the centre (9%). Ebène 1/37 occupied 13% of all plantations and was the dominant variety planted in the central plateau. Varieties which occupied more than 10% of the area planted in

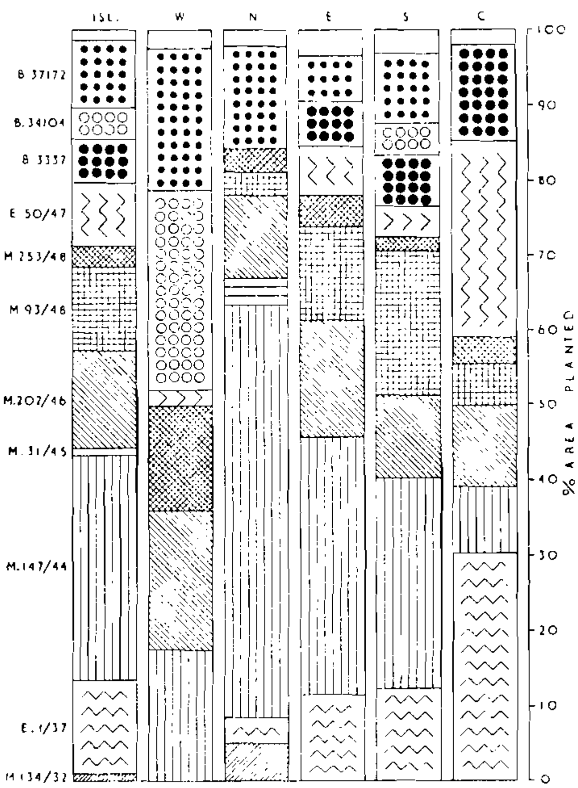

Fig. 7. Varietal composition of plantations made in 1961 on estates.

1961 are M.202/46 and M.93/48, while those occupying between 5 and 10% included B.3337, B.37172 and Ebène 50/47.

Deviations from the average yield of cane per arpent for all estates of the island has been calculated with the following results and are illustrated in fig. 8.

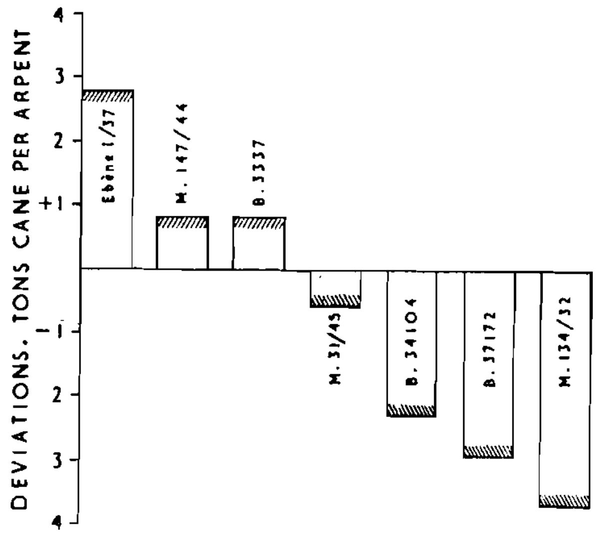

Fig. 8. Yield deviation of seven commercial cane varieties in 1961. Average yield all varieties = 32.3 tons per arpent.

All estates	100	= 32.2 Tons cane per arpent
Ebène 1/37	108.6	
M.147/44	102.4	
B.3337 ...	102.4	
M.31/45 ...	98.1	
B.34104 ...	92.9	
B.37172 ...	91.0	
M.134/32	88.5	

When studying these figures, the distribution of varieties in different climatic zones should be remembered. Thus, Ebène 1/37 and B.3337 are grown in the superhumid zone where climatic conditions were excellent for growth, while the other varieties which are distributed in the humid and subhumid regions were subjected to severe conditions of dryness early in the growing season.

The main agricultural characteristics of cane varieties under commercial cultivation in Mau-

Main characteristics of commercial cane

	M.134/32	M.147/44	M.31/45	M.202/46
Year of release	1937	1956	1956	1959
% Area cultivated in 1961 (†) ...	19 ↓	22 ↑	5 =	2 ↑
Optimum range of altitude and rainfall ...	Subhumid to humid < 800′ < 80″	Subhumid to humid < 800′ < 80″	Humid 300′ — 800′ 60″ — 80″	Humid
Habit	Semi-erect	Semi-erect; tends to lodge	Semi-erect	Semi-erect
Ratooning capacity	Good	Excellent	Fair	Good?
Relative stalk diameter	Medium	Thin	Medium	Thick
Relative arrowing	Medium	Shy	Very shy	Heavy
Trashing	Free	Clinging	Free	Free
Relative sucrose content	Medium	Low	High	Medium
Maturity	Medium-late	Early	Medium-late	Medium
Fibre content	Low	High	Medium	Medium
Reactions to :				
Cyclone damage	Susceptible	Very resistant	Susceptible	Very susceptible
Drought	Very resistant	Moderately resistant	Very susceptible	Resistant
Stalk borer (*Proceras Sacchariphagus*) ...	Moderately resistant	Moderately resistant	Very susceptible	Moderately resistant
Ratoon stunting disease ...	Highly susceptible	Moderately susceptible	Susceptible	Susceptible
Chlorotic streak	Susceptible	Susceptible	Susceptible	Susceptible
Red rot	Moderately susceptible	Resistant	Resistant	Resistant
Fiji disease (Madagascar) ...	Very highly susceptible	Susceptible	Highly resistant	? ←——

(*) Recommended for release.

(†) ↓ declining; ↑ increasing; = no change.

varieties cultivated in Mauritius in 1961.

M.93/48	M.253/48	*Ebène* 1/37	*Ebène* 50/47	B.3337	B.34104	B.37172
1959	(*)	1951	(*)	1953	1956	1953
1 ↑	1 ↑	24 =	1 ↑	7 =	2 =	12 =
Humid to superhumid	Irrigated	Superhumid > 800′ > 100″	Humid	Superhumid < 1200′ > 100″	Irrigated	Humid < 400′ < 80″
Semi-erect	Semi-erect	Semi-erect; tends to lodge	Erect	Erect	Semi-erect	Erect
Good?	Good?	Fair	Good?	Excellent	Fair	Fair to Good
Thick	Thick	Thick	Medium	Thin	Thin	Thin
Shy	Very shy	Medium	Free	Shy	Free	Shy
Free	Free	Free	Free	Clinging	Free	Free
Low	Low	High	Very high	Low	Medium	Medium
Medium-late	Late	Medium-late	Even	Late	Medium	Medium-late
High	Very low	Low	Medium	Very high	High	Very high
Very resistant	Moderately resistant	Very susceptible	Susceptible	Resistant	Moderately resistant	Resistant
Susceptible	Susceptible	Very susceptible	?	Resistant	Resistant	Moderately resistant
Moderately susceptible	Moderately susceptible	Susceptible	Moderately resistant	Resistant	Moderately resistant	Moderately resistant
Susceptible	Moderately susceptible	Moderately susceptible	Susceptible	Highly susceptible	Moderately susceptible	Highly susceptible
Susceptible	Highly susceptible	Highly susceptible	Susceptible	Highly susceptible	Susceptible	Susceptible
Resistant	Resistant	Moderately resistant	Susceptible	Resistant	Resistant	Resistant
? ——— Being tested ———→	?	?	?	Moderately susceptible	Highly susceptible	Highly susceptible

ritius are tabulated on pages 14-15. A similar summary was published in the 1957 Annual Report, but since then more information has become available and other varieties have been released for commercial cultivation. In this connection, the Cane Release Committee met in December and recommended to the Board of Agriculture, Fisheries and Natural Resources that M.253/48 and Ebène 50/47 should be included in the list of approved varieties.

The table referred to above is supplemented by charts (figs. 9 & 10) showing the maturity of commercial varieties. Some of these data refer to virgins harvested in 1961 and must therefore be considered only as a guide.

Brief notes based on experimental results, field observations and information supplied through the courtesy of estate managers, are given below for each of the 12 cane varieties under commercial cultivation. The varieties are grouped under their origin : M. series, Ebène series, Barbados series, within which they are listed according to date of release.

M.134/32. The "wonder cane" of Mauritius which attained its peak in 1953 has been in decline for several years, being displaced by more productive varieties in all the different ecological areas under which sugar cane is grown in Mauritius. M.134/32 produced high yields in several instances in 1961, even in 22nd ratoon on one estate. It has also withstood well the drought which prevailed during the growing

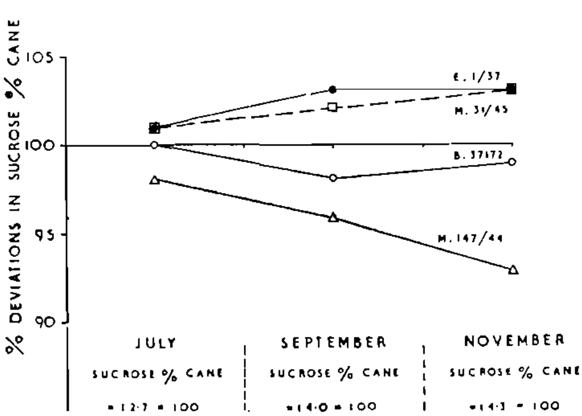

Fig. 9. Maturity curves of four varieties reaped at 12 months of age. Average of eight trials in 1st. ratoons (1959) and 3rd. ratoons (1961).

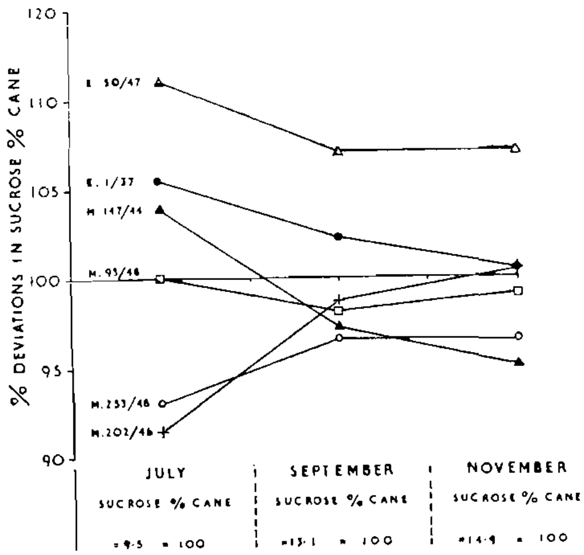

Fig. 10. Maturity curves of six varieties in ten trials reaped at three dates in 1961. Mean ages were 11 months in July, 13 months in September and 15 months in November.

season. There is no doubt, however, that other varieties are producing a significantly higher yield of sugar per arpent and whatever happens, it will never revert to its former pride of place.

M.112/34. This variety which never occupied a large area but possessed some notable qualities, such as high sugar, will probably be out of cultivation within the next two or three years.

M.147/44. Frequent complaints are heard about this variety. Some planters go as far as calling it in a desultory way "fodder cane". It is true that M. 147/44 is an untidy variety which is difficult to harvest because of its clinging trash. It appears also to be somewhat intolerant of dry conditions and its juice is of mediocre quality. In spite of these disadvantages it is extremely vigorous, is early maturing under normal weather conditions, is resistant to cyclones and to stalk borer, and ratoons exceedingly well. Finally, what is most important, it produces more sugar per acre than any other variety which has been under cultivation in Mauritius within the climatic zone receiving less than 100″ per annum and at medium to low altitudes. The performance of M.147/44 on one estate in 1961, virgins to 6th ratoons, was 4.9 tons of commercial sugar per arpent, exceeding the yield of the next best variety by 600 kgs, of a monetary value equivalent to Rs. 250 per arpent.

M.31/45. Although nearly 5% of the 1961 crop was made up of this variety, M.31/45 has an erratic performance and may be the cause of sad disillusionments if conditions do not fall exactly within its requirements. Apart from the fact that its extreme susceptibility to the stalk borer is notorious, M.31/45 is intolerant of any adverse growth factor. For these reasons it is unlikely ever to occupy an important fraction of the area under cultivation. On the other hand, M.31/45 has distinct qualities, including high sucrose throughout the season. The results of eight final variety trials reaped in 1961 have shown that its sucrose content was superior to that of Ebène 1/37 and the yield of sucrose per arpent was the highest of the four varieties in these experiments which also included M.147/44 and B.37172. Finally, its paramount quality is that it is the only commercial variety of known reaction grown in Mauritius which is immune to Fiji disease.

M.202/46 and M.93/48. These two varieties are considered together because they were released in the same year and are being studied concurrently in trials and on estates. Both are vigorous and thick stalked, while they also ratoon well and have juice of fair quality. Both find their optimum environment in the humid zone, but M. 202/46 appears to have a wider range of tolerance extending from moderately dry to fairly humid conditions. M. 93/48, on the other hand, has produced sugar yields equivalent to Ebène 1/37 in the superhumid zone. It should be recalled that M. 202/46 tends to flower relatively profusely but in 1961 this characteristic was not apparent, as arrowing was generally much below normal. Although high sugar yields, exceeding 6 tons per acre, were on record on several estates, it is doubtful whether these varieties will outyield M. 147/44 when planted on a large scale. On the other hand, since both varieties are much easier to cultivate and to harvest, it is conceivable that, on this score alone, they will tend to displace M. 147/44 from the position it occupies at present.

Attention should be drawn to the poor germinating capacity of the variety M. 93/48 under field conditions. Experiments are in progress on the effect of different growth substances on germination of cuttings of this variety.

M. 253/48. The Cane Release Committee recommended that this variety should be released for commercial cultivation. The results of the 1961 crop confirmed the opinion expressed previously that M. 253/48 is best suited to irrigated conditions. Exceptionally heavy yields (85 tons cane and 7 tons sugar per arpent for 15 month-old virgins) were recorded on one estate. M. 253/48 is a thick-stalked, free-trashing variety. Its main faults, compared to present commercial varieties, are low sucrose content and low juice purity early in the season and is typically a late maturer. Its susceptibility to chlorotic streak should also be emphasized. Since evidence has been obtained of the rapid spread of this disease under irrigated conditions, it is most important that cuttings should receive the short hot water treatment before planting.

Ebène 1/37. Little can be added to what has already been written about this variety: susceptible to cyclones and chlorotic streak, it is however one of the highest sugar producing varieties in elevated and humid regions, where it may still be considered the standard cane. Approximately 812,000 tons of estate-grown Ebène 1/37 were crushed during the crop while approximately the same acreage produced 250,000 tons in the cyclone year of 1960. These figures indicate its outstanding power of recovery.

Ebène 50/47. Together with M. 253/48, the Cane Release Committee recommended to the Board of Agriculture, Fisheries and Natural Resources, that Ebène 50/47 should be added to the list of varieties approved for commercial cultivation. It is the second variety bred by Highlands S. E. which attains the rank of a commercial cane. Notes on its pedigree are given elsewhere in this report. The most noteworthy feature of this variety is its high sucrose content throughout the harvest season and in the different climatic zones in which it has been tested up to now. Few data are available as yet on its ratooning capacity. The information available so far is inadequate to enable us to conclude under which conditions this variety performs best, but the indications are that it is best suited to regions receiving from 80 to 100 inches of rain per annum. Ebène 50/47 is an erect, medium-stalked, free-trashing variety which may flower freely. It has greenish-yellow spiky leaves. It is resistant to gummosis and leaf scald but susceptible to ratoon stunting disease, chlorotic streak, red stripe, eye spot and pokkah boeng. With regards to its sensitivity to the stalk borer, it appears to occupy an intermediate position between the susceptible Ebène 1/37 and the resistant M. 147/44.

B. 3337. This variety occupies 7% of the area under cane. It is grown almost exclusively on inferior land of the superhumid regions where it has performed very well during the last five years. It is possible that a competitor under these conditions will be M. 93/48.

B. 34104 is restricted to the irrigated areas of the west and is also grown on a fairly large scale in limited areas of the southern sector. The area cultivated under B. 34104 occupies 2% of the total and has shown little fluctuation in recent years.

B. 37172 occupies 12% of the cane area of the island and is grown on a fairly large scale in all sectors except the central plateau, where it fails completely. Its juice quality is excellent even late in the season. Fairly severe attacks of root disease in the subhumid area will probably cause its decline in popularity.

CANE BREEDING AND SELECTION

1961 was a year of low flowering intensity, in fact showing the lowest figure recorded since an annual survey was started several years ago. A small number of flowers, ideal from the point of view of commercial cultivation, rendered crossing especially complicated. Despite this major difficulty, 700 crosses were made during the year which yielded 105,000 seedlings. The number of different parents employed was 108, a marked increase over previous years, and in line with the current policy of the Institute of incorporating new parents into the breeding programme and evaluating the merits of their progenies.

The transplanting of the young seedlings was improved this year by the wider use of pots made from very thin gauge polythene. Growth in these plastic pots was observed to be superior to that in straw pots. Seedlings were mainly transplanted in bunches and were established at Réduit and Pamplemousses Experiment Stations, at F.U.E.L. and Britannia estates.

Investigational work of the Plant Breeding Division centered chiefly on measurements of progenies in contrasting environments and on the calculation of these results. Sufficient experience has been gained in such work to suggest suitable methods of evaluating the breeding potential of new parent varieties. Factorial selection and progeny experiments were started with this end in view. Experiments were also continued on marcotting and crossing techniques and a series of photoperiodic experiments performed in 1959 were repeated with comparable success. The number of seedlings and varieties now at various stages of selection is summarised below. At stage (v) below, the same variety is included in first selection trials under two environments: humid and superhumid.

(i)	Seedlings raised in 1961 for selection in 1962 and 1963 :		
	(a) planted singly ...		9,287
	(b) No. of bunches of from 7 to 10 seedlings initially ...		10,774
(ii)	Seedlings raised in 1960 for selection in 1962 ...		63,500
(iii)	Seedlings raised in 1959 and 1960 now in bunch selection plots to be selected in 1962 and 1963.		5,044
(iv)	1957, 1958, 1959 seedlings now in propagation plots. ...		3,137
(v)	Varieties (1954 to 1958 series) in first selection trials. ...		482
(vi)	Varieties in multiplication plots for planting trials on estates in 1962 (1954-1957 series)		71
(vii)	Varieties in variety and pre-release trials on estates :		
	(a) M'46 to '57 series	113	
	(b) Ebène ,,	9	
	(c) Foreign varieties	11	133

In order to obtain early information on the possible drought resistance of new varieties, two observation plots have been started at Mon Trésor and St. Antoine and include at present about 20 varieties.

The results of variety and pre-release trials are reviewed elsewhere. Reference should be made however to several varieties, some of which had been mentioned in earlier reports :

M. 305/49. The results obtained in 1961 were not outstanding although this variety performed well in the humid area.

M. 272/52 and **M. 423/51**. Both varieties have produced better yields than Ebène 1/37 in superhumid areas but were markedly inferior to the standard variety, M. 147/44, in subhumid, humid and irrigated localities. It appears also that M. 423/51 is susceptible to the stalk borer.

M. 409/51. This variety had shown promise in 1959. Its sucrose content is high, but it will have to be studied more closely in view of the inferior results obtained in two trials.

M. 81/52. It is disappointing to record that this promising variety which performed well so far, is susceptible to leaf scald. Its release for cultivation is therefore very doubtful.

M. 13/53. Has given good results on irrigated lands.

M. 658/51. Promising for humid zone.

R.397. This is the first Réunion variety to be tested in Mauritius. It is thought from the results of pre-release variety trials that it may have a useful place in subhumid areas. R. 397 flowers abundantly.

N. Co. 310. This variety which is grown on a large scale in many sugar producing countries is very disappointing under Mauritius conditions and has performed particularly badly in the superhumid zone.

B. 41227, PR 1000. Both these varieties have been included in trials under varying climatic conditions of the island but appear to be of no commercial interest.

In order to diversify the genetical material available for crossing and to extend further the choice of commercial varieties, an intensive programme of introductions from abroad was decided upon several years ago. The 48 cane varieties now undergoing quarantine will be released in March 1962, and it is hoped to start another quarantine cycle a few months later.

SOILS AND FERTILIZERS

Soil Survey. The preliminary classification of Mauritius soils was completed during the year and the great soil groups mapped on a scale of 1: 100,000. In this connection, the kind assistance received from the Department of Overseas Survey, where the map is being printed, is gratefully acknowledged.

The map shows the boundaries of the soil groups, the 30% slopes and the degree of rockiness and stoniness which, because of their local importance, have been stressed by suitable markings.

Twelve major mapping units are distinguished : low humic latosol, humic latosol, humic ferruginous latosol, latosolic reddish prairie, latosolic brown forest, dark magnesium clays and grey hydromorphic clays, low humic gleys, mountain slope complexes, alluvial soils, lithosols and regosols, the only examples of the latter in Mauritius being the calcareous sands. Work also progressed on the description of soil families within each great soil group. Mapping on the scale of 1: 25,000 was also started and fertility surveys were carried out by several estates whose chemists worked under the supervision of the Chemist of the Institute during the intercrop period.

The first results of mineralogical analyses have been received from the Rothamsted Experiment Station, England, and are presented with general comments in this report.

Nitrogen. Conclusive evidence was presented several years ago* that urea was inferior to sulphate of ammonia as a nitrogen source for sugar cane when the fertilizers were applied on the stool. As this is the normal practice in Mauritius, it was recommended that planters should not use urea. It

* *Ann. Rep. M.S.I.R.I., 1959, 1960.*

is gratifying to find confirmation of our work and recommendations from Jamaica and British Guiana, both countries having discouraged the use of urea for sugar cane due to the poor results obtained. However, because of the low weight of urea per unit of nitrogen, it is cheap to transport and handle and is a potentially useful material. If its efficiency could be improved, it could once again become of interest to the sugar industry.

Experiments are in progress, therefore, in which attempts are being made to improve the efficiency of urea by burying it in 'poches' or watering it on to the cane in dilute solutions, comparison with ammonium sulphate being made at the same time. Both fertilizers are being used at 30 and 60 Kgs N per arpent. It is too early yet to give any results of this work, but the experiments have amply confirmed previous investigations which showed that surface-applied urea compares unfavourably with sulphate of ammonia as a nitrogen source for cane.

Three experiments were also laid down during the year using sodium nitrate and ammonium sulphate as nitrogen sources, the aim of the experiments being firstly to study the loss of nitrate through leaching and secondly to assess the extent of soil acidifying effects of sulphate of ammonia when applied at heavy rates over several years.

Phosphate. In view of the large quantities of rock phosphate now being used locally and the fact that for the first time an alternative material to guano phosphaté is on the market, work was started this year on the influence of various factors which may affect the availability of rock phosphate. Subjects selected for study were fineness of grinding, softness of the rock and the citric acid solubility. These investigations have so far shown that although the preparation of guano phosphaté leaves something to be desired, there are no indications that the material itself is inferior to any other form of rock phosphate.

The effect on cane yields of form of phosphate, that is, mono-calcic, tri-calcic and ammonium phosphates, when applied on the trash or cane row has been studied fairly intensively and five experiments are still running. The experiments although giving erratic results for placement, show that significant yield responses can often be obtained when phosphate is applied to ratoon crops in fields deficient in this element.

Six trials were laid down to study the phosphate and calcium requirements of cane and possible interactions between these two nutrients.

Potash. Many estates, on which foliar diagnosis had indicated a satisfactory level of potash, have reduced the rates of application of this element during one crop cycle to very low levels.

It should be borne in mind that the amount of potash returned to a field in the form of molasses and potassic fertilizers should not be allowed to fall much below the total amount of potash removed from the soil. The quantity of potash removed in millable stalks and in cane tops used for fodder can be assessed fairly accurately but, in addition, leaching losses of unknown quantity occur. The rate of potash application even under conditions of high potassium fertility should therefore remain at a fairly high level.

Studies on leaching losses are in progress and when the results of this work are known more specific recommendations concerning the level of potassic fertilization to be applied will be made.

Basalt. The results of experiments on basalt were reviewed in the Annual Report of this Institute for 1958.

Taking all the data then available, it was felt that the beneficial effect of basalt was probably due to physical effects although research on the subject was to be continued.

Recent work appearing in the scientific literature has shown that silica uptake and manganese toxicity are closely interrelated. It had already been observed that one of the effects of applying crushed basalt to our humic ferruginous soils results in an increased uptake of silica by the cane. A new line of research has thus been opened up which may possibly explain in part, at any rate, the marked improvement in yields following basalt dust application.

If the value of one ton of cane at the factory is taken at Rs. 30, an apparently permanent benefit of approximately Rs. 90 per arpent per year follows the application of 100 tons of basalt powder to the humic ferruginous latosols.

Before this practice can be generally recommended, however, information will have to be obtained on the cost of producing and applying the basalt dust at such high rates and on the effects of fineness of grinding. Possible alternative ways of effecting this improvement in cane yield will also have to be studied.

As it is essential, for both economic and scientific reasons, that as much information as possible should be available on the application of basalt dust to the soils of the superhumid region, one new trial was therefore laid down in 1961, while further experiments are to start early in 1962.

Foliar Diagnosis. The severe drought which prevailed early in 1961 coincided with the grand period of growth for sugar cane ratoons. The sampling of leaves could not therefore be carried out on the usual scale on either experimental plots or sugar plantations. It is interesting to note that since 1947, when foliar diagnosis was started on a large scale in Mauritius, sampling has been hindered by droughts on only three occasions, namely : 1947, 1948 and 1961. Furthermore there was practically no leaf sampling undertaken in 1960 on account of the two cyclones.

The number of leaf analysis made in 1961 was as follows :

Nutrients	*No. of leaf samples*	*No. of determinations*
N P K	2100	6300
P K	4100	8200
N	300	300
Totals	6500	14800

Two main improvements, which are described in detail elsewhere, have been introduced for the sampling of leaves of ratoon canes during the critical hot and wet period extending from the middle of December to the middle of April. The first is related to moisture conditions and elongation of the cane in the three-week period preceding leaf sampling, the second is a correction factor for the age of the ratoon at the time of sampling.

Germination in relation to potassic fertilization. Three experiments were carried out in order to determine whether increased potassic fertilization of canes which are to be used as planting material, has an effect on germination of cuttings. Potash in the form of KCl was applied at rates of 0, 50, 100 kgs per arpent, one month and two months before the preparation of cuttings. Cuttings prepared from those fields received the usual fungicidal treatment before planting. Counts of germinated buds were made three months after planting, while total growth of shoots was also measured. No significant difference between treatments was observed.

Root System Investigations. The development of root systems of different sugar cane varieties in different soil types was studied by the excavation technique described by LEE. This consists in recording root dry weight in measured volumes of soil, and in this study root volume in the different soil layers was also determined. Investigations on the root system of varieties M. 147/44 and Ebène 1/37 were made in the following soil types : low humic latosol (Réduit, Pamplemousses), dark magnesium clay (Magenta), humic ferruginous latosol (Belle Rive) and latosolic brown forest (Union Park). Four excavations were made for each variety in the respective soil type. From the data obtained with different varieties, a linear relationship was established between root volume and root dry weight. It was also found that there could be appreciable differences in root development of the same variety in different soil types. For example, in the dark magnesium clay soil of Magenta, root development was confined mostly to the first foot of soil below the surface, possibly because of the compact nature of this soil. Further investigations are in progress on this subject.

CANE DISEASES

The main pathological problems which confront the sugar industry of Mauritius are ratoon stunting disease and chlorotic streak, both of which undoubtedly reduce the overall sugar yield of the island. In consequence, emphasis continues to be given to these diseases in the research programme.

It is probable that root disease is also the cause of marked but insidious losses in yield, particularly when growth conditions are unfavourable. The screening of pathogenic soil fungi was therefore continued and 60 isolates have been identified.

Mention should be made here of two major bacterial diseases, gummosis and leaf scald, which are kept under control by the cultivation of resistant varieties. Much work, however, has to be done on these two diseases, not only in studying the reactions of promising varieties, but also in investigations of a more fundamental nature on the variations of the pathogens. The existence of strains of different virulence of these organisms creates an additional problem in plant quarantine since it is now known, for example, that host susceptibility and resistance to gumming disease are not the same in Réunion and in Mauritius. In this connection, it should be recalled that our primary line of defence in relation to other diseases of major importance — Fiji, downy mildew and mosaic, which do not occur in the island — is through the quarantining of cane varieties imported for breeding and other purposes. This primary line of defence extends at present to Madagascar, where the presence of Fiji disease on the east coast is an ever threatening menace to Mauritius. Close co-operation continued during the year between the agricultural and research authorities in that territory and ourselves.

Ratoon Stunting Disease. The results of trials harvested during the year have shown average reductions in yield in virgins ranging from 11% in Ebène 1/37 to 41% in M. 202/46 at Belle Rive Experiment Station. Under drier conditions at Pamplemousses, losses have fluctuated in ratoons from 7% in B. 37172 to 20% in B. 37161. These results confirm previous observations that the disease is more serious in superhumid than in humid areas.

The long hot water treatment installation at the M.S.P.A. station at Belle Rive worked below its capacity and approximately 2500 tons of cuttings were treated. Good germination was obtained earlier in the year but severe failures were also registered and out of 375 arpents of nurseries planted, only 243 arpents were maintained to provide healthy material for the 1962 plantations. The heat treatment of cuttings is regarded with much disfavour in some quarters because of the poor germination which is sometimes experienced. It should be emphasized once more, however, that the ratoon stunting disease problem is still with us, and that appreciable improvement in sugar yields could be achieved if healthy cuttings were used for all new plantations. A project is being studied for establishing a central nursery from which healthy planting material would be available for secondary nurseries on estates.

Chlorotic Streak. In spite of the short hot water treatment, chlorotic streak remains the important disease of the superhumid zone and in some restricted areas of the subhumid zone associated with certain soil factors. The substantial losses in yield due to the disease have been demonstrated in the past and preliminary experiments have shown that it is likely that the disease is transmitted in the soil. In an attempt to elucidate factors involved in the transmission of chlorotic streak, a carefully planned experiment is in progress at Belle Rive. Canes, initially healthy, are grown in insect-proof cages containing sterilized soil free from nematodes; the canes are subjected to a combination of factors which have been designed to provide an explanation for some of the many questions which have to be solved as a preliminary to a better control of the disease.

Fiji Disease in Madagascar. Reactions of commercial canes important to Mauritius have been assessed in 1st ratoons in the first trial established at Brickaville in 1959, in co-operation with the *Institut de la Recherche Agronomique de Madagascar* as follows :

Highly susceptible	:	M. 134/32, B.34104, B. 37172
Susceptible	:	M. 147/44
Moderately susceptible	:	B. 3337, B. 37161
Highly resistant	:	M. 31/45.

The variety M.112/34 is being tested in the 2nd trial planted in July 1960. The experiment has been harvested and results will be obtained in 1st ratoons next year.

M. 202/46, M. 93/48 and Ebène 1/37 are at present in the 3rd trial planted in December 1961 and M. 253/48 and Ebène 50/47 are undergoing quarantine in Madagascar and will be included in the 4th trial scheduled to be planted in November 1962.

After the discovery of Fiji disease on the east coast of Madagascar, one of the measures adopted for the protection of neighbouring countries was the prohibition of the entry and sale of canes in the town of Tamatave. The authorities in the province of Tamatave had been pressing very hard for some time for the lifting of the prohibition. An agreement has now been reached whereby the entry and sale of cane in the town of Tamatave will be authorized only after the setting up of a control organization whose duties have been defined. The measures recommended include the maintenance of two inspection teams within the perimeter of the port of Tamatave, whose duty is to ensure that no part of the sugar cane plant is taken into that area. The Governments of Mauritius and Réunion have agreed to pay the expenses involved.

The co-operation of the Minister for Agriculture in Madagascar is once more gratefully acknowledged.

CANE PESTS

Apart from moth borers which as usual were the most important pests during the year, attacks by thrips, scale insects and army worms occurred. The outbreak of thrips (*Fulmekiola serrata* Kob.) was in the north and many fields were affected, some quite severely.

Research was centered upon the stalk borer, *Proceras sacchariphagus*, and progress was made with studies on the biology of the moth. The object of this work, which will be extended later to other aspects of the insect's activities, is to provide information upon such subjects as the reproductive capacities and habits of the moth and the nature of their association with sugar cane and its varieties. For example, the moths vary in size and egg-laying capacity, while cane variety may influence fecundicity by affecting larval diet. Again, the insect appears to be monophagous in Mauritius, attacking no other plant, and the reason for this lies presumably with host-plant stimuli which condition adult behaviour.

The most notable item of work in connection with the stalk borer was the introduction of the larval parasite, *Diatraeophaga striatalis* Towns., from Java. The parasite is the only Tachinid fly known to attack *Proceras sacchariphagus* and, like its host, it is native to Java where it appears to be quite an important natural enemy of the borer. Several hundred flies were liberated in the north during June and July, but it is not known if the parasite has become established. The insect is accordingly being reared in the laboratory in an effort to obtain more individuals for release in the field. This is the first time that the parasite has been artificially reared.

An assessment of the incidence of parasites in *Proceras* larvae collected during the year showed that *Apanteles flavipes* Cam. is the only common larval parasite. Its incidence in borers collected varied from 0 to 50% and the insect is evidently often of considerable value in cane fields. However, the fact that only one larval parasite appears to exert any appreciable control on the borer emphasizes the importance attached to seeking other species abroad.

The intensity of stalk borer attack on varieties Ebène 50/47, M.202/46, M.93/48 and M.253/48 was observed in commercial plantations and in variety trials. M. 202/46 seems to be the least attacked by borers and in this respect compares favourably with M. 147/44. M.253/48, on the other hand, is probably the most susceptible of these varieties, with Ebène 50/47 and M.93/48 occupying intermediate positions.

Other work during the year included the identification of weeds which harbour the pink borer (*Sesamia*) and experiments to clarify the effect of army worm attack on young ratoon cane.

WEED CONTROL

Substituted Ureas and Triazine Compounds. Investigations on the herbicidal value of the substituted ureas and triazine compounds were carried out in plant canes in the humid and subhumid localities. These herbicides were used alone and in combination with sodium chlorate and TCA. All applications were made in pre-emergence of the weeds, a week after planting, in fields receiving either surface or overhead irrigation. The substituted ureas and the triazine compounds gave generally comparable results and the addition of TCA and sodium chlorate did not increase their efficacy. It must also be pointed out that these herbicides did not give satisfactory results consistently and that in some trials they did not prove superior to the standard formulation used.

Atratone, Urox. These herbicides were tested in pre-emergence application in comparison to DCMU at the two Experiment Stations of the superhumid locality at dosage rates 4 and 2.4 lb active material per acre. A weed survey made two months after spraying showed that DCMU gave a better control of the weed population at both rates of application.

New herbicides. For the evaluation of new herbicides the logarithmic spraying technique was used. The herbicides Thiuron, Dichloral urea and Prometone were evaluated with respect to DCMU in pre-emergence treatment. From the data obtained DCMU was found to give more satisfactory results. On the other hand, Paraquat proved more effective than Prometone in post-emergence of the weeds. It must be observed, however, that Paraquat at the dosage rates used caused injury to the cane plant.

IRRIGATION

The irrigation experiment* started at Médine S.E. (Palmyre) in 1957 has now been pursued during four years and it is desirable at this stage to give a brief account of the results obtained and to review the development of overhead irrigation in the island generally.

In both the latosolic reddish prairie soils ("gravelly") and the low humic latosols ("free"), there has been no significant difference in cane yields between fields irrigated by the standard surface method and by overhead spray. On the other hand, water economy by spray irrigation has been considerable. Indeed, the gravelly soils require such a large amount of water when irrigated by surface that it is only under exceptional circumstances that this method can be used. It should be pointed out that during the course of this experiment, the limited equipment available together with unavoidable irregularities in the water supply, made it impossible to cope in time with the water requirements of the various experimental plots. As a consequence, it is probable that yields lower than those which would otherwise have been obtained were recorded in some of the sprayed plots, particularly those on gravelly soils.

The results which are summarized below represent an average for the period 1958—1961 (1960 excluded because of cyclone effects). Together with growth measurements and soil moisture determinations, which were obtained at weekly intervals throughout the duration of the experiment, they confirm the opinion that in the subhumid zone of Mauritius, optimum results should be obtained with 50″ of water per annum applied at the rate of 2″ to 3″ per irrigation depending on type of soil and condition of the land.

* For a description of this experiment, see *Ann. Rep. M.S.I.R.I., 1958*, p. 82.

Type of Soil	Average 1958—1961 (1960 excluded) Low humic latosol (free soils)		Latosolic reddish prairie (gravelly soils)	
Type of irrigation	Overhead (semi-permanent)	Surface	Overhead (mobile equipment)	Surface
Number irrigations per annum	12	12	11	11
Amount of water, inches, applied per arpent per annum ...	30	72	28	209
Yield of cane, tons per arpent ...	37.6	38.8	29.1	28.9
Cost of irrigation per annum : Rs. per arpent ...	216	98	275	145
Rs. per ton cane ...	5.74	2.26	9.45	5.00

Apart from the basic information which this series of experiments has provided, it has helped considerably in focussing the attention of planters on the possibilities of overhead irrigation. The mobile equipment used for irrigating gravelly soils will be transferred to another estate in 1962 in order to compare the merits and limitations of overhead and surface irrigations on dark magnesium clay soils. The experiments on free soils will continue at Palmyre however and I should like once more to take this opportunity of expressing my gratitude to the Manager of Médine S. E. for his kind assistance.

When the Palmyre experiments were started in 1957, there was only one overhead irrigation installation in Mauritius to irrigate about 150 arpents. At the end of 1961 a total area of 3700 arpents was under spray irrigation as follows : West 1150, North 700, East 1150, South 700. This area represents about 18% of the total irrigated area. Several estates have plans for a further extension of overhead irrigation with semi-permanent installations.

Another important contribution to the development of spray irrigation is undoubtedly the introduction of the "Boom-O-Rain" sprayer. This machine, which has rotating arms with a span of 140′, is provided with devices for compensating to some extent the adverse effect of wind on spray distribution. Its long range renders it highly suitable for use in sugar cane plantations because it eliminates the necessity of penetrating into the cane fields for placement of the sprinklers and facilitates night work considerably. The machine requires roads spaced at intervals of 220′. This additional cost, however, seems to be compensated by the increased efficiency of the irrigation resulting from longer working hours and better water distribution.

GROUND WATER

The electrical resistivity survey started in 1960 by the *Compagnie Générale de Géophysique* at Plaines Wilhems, Black River, Flacq and Grand Port was completed early in the year and the broad conclusions which these investigations have revealed are summarized below. This work was extended later in the year to cover an approximate area of 120 sq. kms. at Nouvelle Découverte, in the south east of Flacq, Midlands and Chamarel.

Meanwhile the programme of core sampling, bore hole drilling and pumping tests follow-

Average 1958—1961 (1960 excluded)

Type of Soil	Low humic latosol (free soils)		Latosolic reddish prairie (gravelly soils)	
Type of irrigation	Overhead (semi-permanent)	Surface	Overhead (mobile equipment)	Surface
Number irrigations per annum	12	12	11	11
Amount of water, inches, applied per arpent per annum ...	30	72	28	209
Yield of cane, tons per arpent ...	37.6	38.8	29.1	28.9
Cost of irrigation per annum : Rs. per arpent ...	216	98	275	145
Rs. per ton cane ...	5.74	2.26	9.45	5.00

Apart from the basic information which this series of experiments has provided, it has helped considerably in focussing the attention of planters on the possibilities of overhead irrigation. The mobile equipment used for irrigating gravelly soils will be transferred to another estate in 1962 in order to compare the merits and limitations of overhead and surface irrigations on dark magnesium clay soils. The experiments on free soils will continue at Palmyre however and I should like once more to take this opportunity of expressing my gratitude to the Manager of Médine S. E. for his kind assistance.

When the Palmyre experiments were started in 1957, there was only one overhead irrigation installation in Mauritius to irrigate about 150 arpents. At the end of 1961 a total area of 3700 arpents was under spray irrigation as follows : West 1150, North 700, East 1150, South 700. This area represents about 18% of the total irrigated area. Several estates have plans for a further extension of overhead irrigation with semi-permanent installations.

Another important contribution to the development of spray irrigation is undoubtedly the introduction of the "Boom-O-Rain" sprayer. This machine, which has rotating arms with a span of 140′, is provided with devices for compensating to some extent the adverse effect of wind on spray distribution. Its long range renders it highly suitable for use in sugar cane plantations because it eliminates the necessity of penetrating into the cane fields for placement of the sprinklers and facilitates night work considerably. The machine requires roads spaced at intervals of 220′. This additional cost, however, seems to be compensated by the increased efficiency of the irrigation resulting from longer working hours and better water distribution.

GROUND WATER

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Meanwhile the programme of core sampling, bore hole drilling and pumping tests following the electrical survey was continued by Messrs. George Stow as contractors with Sir Alexander Gibb & Partners as consultants. The results obtained so far are briefly reviewed below. The areas surveyed together with sites of corings and borings are indicated in fig. 11.

Electrical survey of Plaines Wilhems, Black River, Grand Port and Flacq. It has been possible to define clearly the main axes of the recent lava flows which have filled up the depressions of older geological formations.

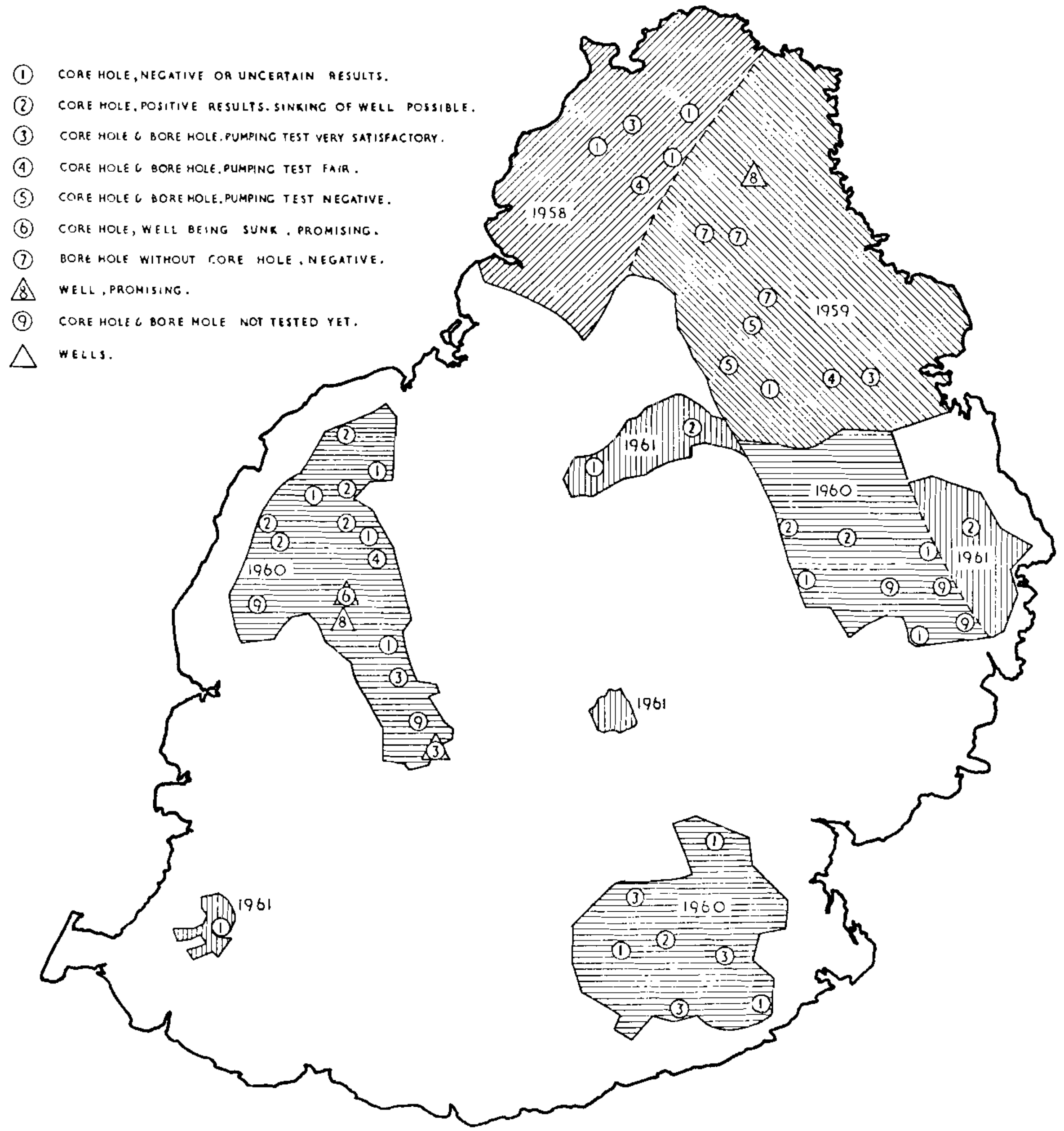

Fig. 11. Map of Mauritius showing areas surveyed by electrical resistivity (shaded). Sites of core holes, bore holes and wells are indicated.

The first results obtained from the bore holes in the northern plain confirm the hypothesis that the best water outputs are likely to be obtained from the recent lava formations.

In each sector sites have been selected for reconnaissance bore holes in order to assess the possibilities of the different volcanic systems.

In Plaines Wilhems and Black River the existence of old weathered strata were found. They constitute a threshold which links up, well below the surface, the bases of the old mountainous formations. These thresholds should be very important with respect to the hydrology of the region because they appear to be only slightly permeable and act as underground dams.

However, from the geological standpoint, the existence of these thresholds substantiates the theory according to which the central region of the island is what remains of the collapse of a large primary volcanic cone.

Six systems of recent lava flows have been differentiated in the region and sixteen sites have been selected for reconnaissance work. A well is being sunk at one of these sites and core samples have been obtained from four others.

In the sector of Flacq, three extensive groups of lava flows have been brought to light, the most important one being that of Camp de Masque Pavé – Caroline which has filled the depression between Montagne Fayence and Montagne Blanche and acts as a channel for most of the water in the Trou d'Eau Douce area. Northwards, the system of Rivière du Poste – Unité – Queen Victoria has filled small localized depressions which existed in the old formations of the upper regions. Three sites have been selected for reconnaissance work in these depressions. Finally towards the south east, the system Sébastopol – Petit Bel Air is probably the eastern limit of an important flow. A total of nine boring sites have been selected. A core sample already obtained from Camp de Masque Pavé, and located in the higher part of the central system, has confirmed the great permeability of the strata.

In the sector of Grand Port, the main recent lava flows have run across the sector from north west to south east, filling on the way a series of small depressions or basins in the ancient topography. Four of these depressions seem worthy of further investigations by means of borings or well sinking.

Seven sites altogether have been selected in this sector for reconnaissance work.

From the results of the electrical survey of these sectors, it has been possible to draw up a programme of borings and pumping tests which, together with hydrological data, will provide a better knowledge of the possibilities of each sector. A total of thirty-two sites have been selected which will give indications as to the best zones which should be chosen for future large scale exploitation of ground water.

Drilling and Pumping Tests. At the end of 1961 the following number of core drills and bore holes had been made.

	Core drills	*Bore holes*
Depth from	136′ to 350′	54′ to 250′
North ...	16	14
Flacq ...	8	3
Grand Port ...	5	2
Pl. Wilhems/Black River	16	6
	—	—
Total ...	45	25

In addition, four wells have been sunk by sugar estates at sites indicated by the *Compagnie Générale de Géophysique.* Three of these wells yield a large volume of water while work on the fourth is not yet completed.

Twelve pumping tests have been made so far, of which ten have given satisfactory results. It was decided in December to stop the tests in view of the exceptional rainfall which occurred early and late in this month. They will be resumed during the dry period, that is from September to November, 1962.

Observations on the water table were continued at 130 sites in order to obtain complementary information on seasonal fluctuations and movements of ground water. The investigations on ground water will probably be concluded at the end of 1962.

FIELD EXPERIMENTATION

The number of field trials harvested during the year was 151, of these 111 were on estates and 40 on stations. Experiments standing for the 1962 harvest are distributed according to subjects studied, as follows :

Variety trial (one date of harvest) ...	20
Pre-release variety trials (three dates of harvest)	13
Ratooning capacity	2
Final variety fertilizer trials (three dates of harvest)	18
Growing period of cane	2
Clean v/s selective cutting	12

Fertilization and amendments :

(i)	Form and mode of application of nitrogen	15
(ii)	Form of phosphate	1
(iii)	Phosphate on ratoons	6
(iv)	Calcium & phosphate	6
(v)	Form of potassium	2
(vi)	Gypsum	2
(vii)	Basalt	3
(viii)	High & low fertilization (demonstration)	2
(ix)	Balanced & unbalanced fertilization (demonstration) ...	2
(x)	Bagasse amendment	3
(xi)	Organic matter	11

Diseases :

(i)	Ratoon stunting	6
(ii)	Gumming	1
(iii)	Leaf scald	3
(iv)	Chlorotic streak	2
(v)	Soil microflora	1

Pests :

(i)	Varietal resistance to stalk borer ...	4
(ii)	Chemical control of *Clemora* ...	2
(iii)	Control of army worm ...	1

Effect of herbicides on cane growth ...	3
Germination studies	3
Root studies	1

SUGAR MANUFACTURE

Research. The main research projects studied during the year are briefly reviewed below, a full account appearing elsewhere in this report.

(a) **Curing of low grade massecuites in high speed centrifugals.** Prior to the 1961 crop, one factory (Mon Loisir) installed a battery of five fully automatic 48″x 30″ ASEA centrifugals, two of which run at 1700 RPM whilst the three others have a maximum speed of 1450 RPM. The machines are fitted with the Ward-Leonard system whilst the reheating of the massecuite is obtained with the help of a closed circuit installation in which the temperature and throughput of the heating water can be raised within limits.

A series of experiments with these machines were carried out during the crop with the object of studying the effects of rate of acceleration, of top speed and of temperature of water used for reheating on the purging of low grade massecuites. The results obtained have shown that :

(i) provided power is available, it is advantageous to bring the machines to top speed in three instead of four minutes, as the higher rate of acceleration does not affect the porosity of the bed of sugar crystals and results in a gain in centrifugal capacity of about 6 per cent,

(ii) a 48″ x 30″ centrifugal running at 1700 RPM has 25 to 30% more capacity than a machine of the same dimensions, but running at 1450 RPM. For reasons described fully elsewhere, the 1700 RPM may be expected to cause a reduction in the sugar lost in molasses,

(iii) sucrose losses by re-solution may be appreciably curtailed if water at 60°C instead of 70 to 72°C is used for reheating low grade massecuites prior to centrifugalling.

(b) **Cooling of A and B massecuites.** Further experiments were carried out during the crop on the cooling of A and B massecuites in crystallizers, a practice which is not followed in most other sugar producing countries. The results have confirmed those obtained last year* and will be presented at the forthcoming I.S.S.C.T. Congress.

(c) **Determination of retention in Oliver filters.** In 1961 seventeen out of twenty-three factories were equipped with rotary vacuum filters. These filters offer numerous advantages over filter presses, but their juices cannot be fed directly to the evaporator and must be sent back to the mixed juice. Thus, if the amount of impurities going through with the filtered juice becomes excessive, a heavy load is placed on the clarifiers, and clarification trouble may result.

The best way to judge the performance of a vacuum filter is to calculate its retention. As the chemists of several factories have found it difficult to calculate retention figures correctly, a study has been made of the various methods that may be used.

(d) **Determination of comparative sucrose % cane values for agronomic purposes.** In order to determine the performance of new cane varieties grown on an experimental scale, under varying environmental conditions prevailing on an estate, the yield of commercial sugar per arpent should be compared to that of standard varieties.

Different methods which may be used for the determination of cane quality for agronomic purposes with the equipment normally available in sugar factories are briefly reviewed and their advantages and disadvantages discussed. The method recommended is one based on the Java ratio corrected for fibre. It is simple and yields comparative sucrose % cane values that fall well within the limits of accuracy set for agronomic purposes.

(e) **Refractometer v/s densimeter Brix for the chemical control of sugar factories.** As a result of preliminary studies carried out at the end of the 1960 crop, it was decided to work out dual chemical control figures on three factories throughout the crop, one set based on densimeter and the other on refractometer Brix values. Unfortunately the precision refractometers ordered were received late in the year so that comparisons could only be made for one week at one factory, two weeks at another and four weeks at a third.

The results obtained in 1961 confirm previous findings and it is suggested that refractometers should replace densimeters in all the factories at an early date. However, it is recommended that all laboratories be equipped with refractometres for the 1962 crop so as to allow the carrying out of parallel chemical controls in each factory throughout the crop in order that the laboratory personnel may become acquainted with the new equipment. In addition, the factory staff would become familiar with the higher purity values resulting from the use of the refractometer, especially with low grade products. After this transition period of one crop, densimeters could be entirely discarded and the chemical control based on refractometric Brixes only.

(f) **Hein Lehmann continuous centrifuge.** A limited number of tests were carried out late in the crop with a Hein Lehmann continuous centrifuge installed at Mon Loisir factory for the curing of A and B massecuites. The machine was placed close to the battery of conventional batch centrifuges so that it was possible to compare the sugar produced by the continuous centrifuge and by the batch machines when fed with the same massecuite. The massecuite and sugar throughputs of the Hein Lehmann centrifugal were also measured during the tests.

The continuous machine consistently yielded, both with A and B massecuites, sugars of much lower polarisation and higher moisture content than those from the batch centrifugals. Further the capacity of the Hein Lehmann is much smaller than that of a conventional machine. It should be pointed out, however, those both the cost and the power consumption of the former are much lower than that of the latter. Continuous centrifugals of the type used for the tests stand little chance of competing with high speed modern centrifugals for the curing of A and B massecuites in raw sugar manufacture, but it is reported that they have been used with success for affination work in refineries.

(g) **Power consumption of cane mills.** Mon Loisir factory is equipped with a five – mill tandem in which each mill is independently driven by an electric motor. Advantage of this installation

* See *Ann. Rep. M.S.I.R.I., 1960.*

was taken to measure, with the help of a recording wattmeter, the power consumption of each mill under operating conditions during periods of 24 hours or more.

The power consumption of each mill when running free was also measured. Finally, on the last day of the crop, the tail bars were removed and the power consumptions of the prime movers and gearings of three mills were recorded.

It was unfortunately not possible during this crop to vary operating conditions such as hydraulic load, mill speeds, settings, etc. and to study the influence of these factors on power consumption, but it is intended to take further measurements during the 1962 crop with a view to interpreting the results more fully.

(h) **Filterability of raw sugar.** A number of average raw sugar samples from most factories of the island were analysed for starch, silica, gums, wax and phosphates with a view to determining the cause of the poor filterability of some of the raws produced. The filterability values were determined by the Nicholson and Horsley method.

It seems that, under Mauritius conditions, starch is the main cause of poor filterability of certain consignments of raws. The deterioration observed in this connection during the past few years appears to coincide with the extension of new cane varieties containing more starch.

A comparison was also made between the Elliot, and the Nicholson and Horsley methods for the determination of filterability. The results obtained indicate that the latter method is more reliable and should be adopted if a better assessment of the refining qualities of Mauritius raws is to be achieved.

(i) **Study of the microflora of raw sugars.** In a report issued in 1959*, it was shown that heavy financial losses are incurred annually on the raws exported from Mauritius. These losses were attributed mainly to the action of micro-organisms on raws of poor keeping quality.

In 1960 a note was received by the Mauritius Sugar Syndicate from Messrs. Tate & Lyle Co. Ltd. concerning the deterioration, by highly fermentative osmophilic yeasts, of a parcel of 4,300 tons of Mauritius raws which had been stored in a large silo and reclaimed several months later. It was stated that two distinct types of yeasts had been isolated from the sugar and tested. One was of the normal osmophilic type and contained no invertase, but the second was highly fermentative and contained invertase. This second species of yeast was present in considerable number and had not been encountered before in raw sugar.

It was therefore decided to take up the question during the 1961 crop in order to ascertain whether osmophilic yeasts are normally found in Mauritius raws and, if so, in what numbers. Earlier in the year it was arranged that, while on leave in Europe, Mr. Antoine, Pathologist, and Mr. de Froberville, Assistant Sugar Technologist, should obtain as much information as possible on this question. The problem was discussed with Dr. Scarr of Tate & Lyle Research Laboratories while Mr. Antoine visited the Centraalbureau voor Schimmelcultures at Delft in Holland. The valuable assistance received from these organizations is gratefully acknowledged.

A preliminary screening of sugars from the 23 factories started in October, followed by fermentative tests and plate counts on osmophilic agar. Of the yeasts encountered in some of the sugar samples, *Saccharomyces rouxii* was the commonest, but six other species were also identified. Yeast content of massecuites as discharged from the vacuum pans, of the massecuite fed into centrifugals after cooling, of sugar and molasses, was determined in several factories. It appears at this stage that contamination by osmophilic yeasts takes place in the crystallizers. Recommendations on suitable precautions will be made as soon as the results of investigations now in progress become available.

Advisory Work. Several studies were carried out and a number of recommendations made

* Weight and polarization changes of raw sugars exported to the U.K. *Technical Circular No. 12, M.S.I.R.I.* mimeo, 20 p.

on various aspects of sugar manufacture and items of machinery, including modification to juice heating system, mud filtration, cane knives installation, boiling house work, froth fermentation in molasses, reheating of final massecuites, control of temperature in juice heaters, chemical control and boiling house work, control of sugar in boiler water and chemical control.

Mr. F. Le Guen resumed duty in July after spending one year in England where he specialized in Instrumentation Engineering at Northampton Polytechnic. Throughout the crop his advice or services were often sought in relation to instrumentation work, in particular that connected with the checking, calibrating and setting of pH controllers, the repairing of cuitometers, the setting of laboratory pH meters, of vacuum and temperature recorders and of thermo-regulators.

Miscellaneous. As during the previous years, routine work included the compilation of weekly chemical control figures, the analysis of 3354 cane samples from the experimental plots of the Institute, the standardization of a large number of hydrometers during the intercrop and the dilution and standardization of hydrochloric acid for distribution to laboratories.

The Chemical Control Manual of the *Société de Technologie Agricole et Sucrière* has been partly revised.

BY – PRODUCTS

Protein extraction from cane juice. Further work was carried out in 1961 on the extraction of protein from cane juice with the object of reducing the fibre content of the coagulate, thereby increasing its protein content and obtaining sufficient material for conducting feeding trials.

As a result of modifications brought to the installation, it was possible to obtain a coagulate containing about 23% protein and 12.5% fibre on a dry matter basis. Over one ton of the product was separated during the crop, half of which was used in feeding trials on milch cows.

Two trials were carried out, and in each of them the "coagulate" replaced entirely luzerne meal which constituted 20% of the basic ration. The results of these trials have shown that milk production was not affected by the substitution of cane juice protein. Further work is in progress on both the method of extraction of the protein and its dietary value.

It should be pointed out that this project which was initiated in 1960 was primarily orientated on the production of a high protein meal in a form suitable for animal or even human consumption. But the whole question of utilizing cane juice protein, which is at present used as fertilizer in the form of factory scums, is of interest. For this reason, detailed analyses of scums from several factories were made and their potential value as livestock feed is discussed elsewhere in this report. Experiments to compare the value of cane juice coagulate and factory scums as a source of animal food are also in progress.

By-Products Committee Report. The By-Products Committee completed their survey during the year and finalized the preparation of a report issued as Technical Circular No. 18 of the M.S.I.R.I. It is hoped that the large amount of information which has thus been made available will be of practical value in indicating possible future avenues of development. The report also sets forth local factors which have militated against the success of several attempts to develop by-products of the sugar industry in Mauritius in the past.

I should like to take this opportunity of thanking members of the Committee, in particular the Chairman, Mr. M. Paturau, for their valuable contribution.

LIBRARY

Since its inauguration in September 1960, the Bonâme Hall which houses the library of the Institute, has been open to readers interested in the sugar industry and many members of the staff of sugar estates, sugar planters and manufacturers have come for information and documentation.

The library receives 298 periodicals, 139 by direct subscription and 159 by exchange of publications of the Institute with other institutions. These cover a wide field of knowledge and include journals on general science, soil science, chemistry, botany, entomology, genetics, plant breeding and pathology. There are now 70 titles on sugar cane agriculture and technology and 97 on agronomy.

During the year, a serious effort was made to complete our sets of periodicals and much progress has been done in this respect through the courtesy of the British National Book Centre, the United States Book Exchange and numerous libraries over the world whose help we gratefully acknowledge. The library stock amounts to 6012 volumes. There were 827 new accessions during the year and 949 volumes were bound.

A complete card catalogue of the library collection is now available. A microfilm reader is available and bibliographies are also being compiled to facilitate research work.

THE MAURITIUS HERBARIUM

During the year 130 specimens have been laid in. About 30 of these were not represented in the Herbarium and included some new records for Mauritius. They also included a batch of 53 Réunion plants collected and presented by Mr. J. Bosser. Some valuable material was received from the Conservator of Forests and his staff, comprising some fine examples of the rare endemic montane species of *Cylindrocline* and *Vernonia.*

Among visitors to the Herbarium from overseas, we were glad to welcome Professor Harold St. John, University of Hawaii, Honolulu, who spent two months in Mauritius and Réunion collecting and studying in the field the genus *Pandanus.* Professor St. John is at present engaged on a world monograph of this genus. Mr. J. Bosser from the *Institut de Recherche Scientifique de Madagascar* worked on the *Gramineae* of the Mascarene Islands.

Work continued on the weed flora of Mauritius and leaflet No. 5 *Artemisia vulgaris* was published. Progress with this series has been rather slow owing to the absence of the authors on overseas leave and also to the need for obtaining accurate determinations of the weeds to be included in the leaflets.

While overseas the Curator, Dr. R. E. Vaughan, worked at the Kew and British Museum Herbaria. A number of undetermined species which had been accumulating in the Mauritius Herbarium were named and about seventy photo-copies of rare and little known Mascarene plants not represented in the collections here were obtained.

Serious consideration has been given to the need for a modern Flora to bring up to date the standard work on Mauritius plants, namely Baker's *Flora of Mauritius and the Seychelles* published in 1877. As a preliminary step it is proposed that a check-list of all flowering plants indigenous, naturalized, and commonly cultivated should be prepared and published. It would also be necessary to describe the new plants discovered during recent years and to monograph certain families and genera of which our knowledge has considerably increased since the appearance of Baker's *Flora.* When this has been done, a well illustrated, definitive Flora could be undertaken. At the moment families receiving special study are the Ebenaceae Orchidaceae and Cyperaceae.

The services of the Herbarium have been increasingly used during the past year by Government Departments, schools and the public, and it is hoped that these contacts will extend still further when the work and resources of the Herbarium become better known.

Some of the more important recently published books and original papers concerned with Mascarene vegetation are given below :

BERNARDI, LUCIANO (1961). La mort de Bérénice. *Musée de Genève* No. 18 : 12 – 14.

GHATAK, J. & MANTON, I. (1961). A note on a cytogenetic relationship between *Adiantum confine* Fée from Africa and *Adiantum rhizophorum* Sw. from Mauritius. *J. Linn. Soc. (Bot.)* **58** : 79 – 85, t.1.

HODGKIN, E. P. & MICHEL, C. (1960). Zonation of Plants and Animals on rocky shores of Mauritius. *Proc. R. Soc. Arts Sci. Mauritius*, **2** : 121 – 146, t.4.

LEMOINE, MARIE (1961). Une Squamariacée frutescente *Peyssonnelia frutescens* nov. sp. *Rev. algol.* N.S. **5** : 173, t. 16 – 17.

LEROY, JEAN F. (1961). Sur les trois Caféiers endémiques de l'Archipel des Mascareignes. *J. Agric. trop. Bot. appl.* **8** : 21 – 29.

RIVALS, R. (1960). Sur la vie et les problèmes de la destruction *d'Oxalis latifolia* Kunth. *J. Agric. trop. Bot. appl.* **7** : 398 – 405.

SAUER, JONATHAN (1961). *Coastal Plant Geography of Mauritius.* Louisana State University Press.

PUBLICATIONS

Annual Report for 1960. 105, xxxviii p., illus. An abridged French version was also issued. (Reprint from *La Revue Agricole et Sucrière de L'Ile Maurice*, **40** : 65 – 93).

Occasional Papers

No. 5 ROCHECOUSTE, E. Botanical and agricultural characters of sugar cane varieties of Mauritius. I) Ebène 1/37 and M.147/44. 7 p., 2 col. pl.; figs.

No. 6 WILLIAMS, J. R. Studies on the nematode soil fauna of sugar cane fields in Mauritius. 5) Notes upon a parasite of root-knot nematodes. (Reprint from *Nematologica* 5 (1960) : 37 – 42).

No. 7 WILLIAMS, J. R. *comp.* A bibliography of sugar cane nematology. 12 p.

No. 8 WILLIAMS, J. R. *and* MAMET, J. R. The insects and other invertebrates of sugar cane in Mauritius and Réunion. 23 p.

No. 9 GEORGE, E. F. An experiment to compare the selection of sugar cane varieties from seedlings bunch planted in two different ways and from others singly planted. 35 p.; figs.; tabs.

Leaflet

No. 5 ROCHECOUSTE, E. *and* VAUGHAN, R. E. Weeds of Mauritius. 7. *Artemisia vulgaris* Linn. (Brède Chinois). 3 p.; figs.

Technical Circulars

No. 17 ANTOINE, R. La lutte contre la maladie du rabougrissement des repousses. 10, ii p.; diagrs.

No. 18 By-Products of the Sugar Industry of Mauritius. 280 p., figs.

Private Circulation Report.

No. 15 Report on the 7th International Congress of Soil Science and Visits to Soil Research Centres in Europe and U.S.A., by Sydney M. Feillafé. April, 1961. 78 p.

Article in «La Revue Agricole et Sucrière de l'Ile Maurice».

ROUILLARD, G. La sucrerie de Labourdonnais; notes historiques. **40** : 8 – 11.

GENERAL

1. **11th Congress of the I.S.S.C.T.*** Much time was spent on the varied aspects of organizing the 11th Congress of the I.S.S.C.T. which will be held from 24th September to 12th October, 1962. The headquarters for the Conference will be at the M.S.I.R.I. where the opening session

* Since going to press, several changes have had to be made in the organization of the 11th Congress as a result of the severe cyclone which struck Mauritius on the 28th February. The Congress will be held from the 24th September to 5th October. P.O.W.

will be held on Monday, 24th September. Thereafter, field and factory delegates will separate for a comprehensive programme of visits both in Mauritius and Réunion. Technical sessions will begin on the 4th October and will continue until the 11th. The closing plenary session is scheduled for Monday the 12th October. Films on various aspects of mechanical harvesting and the transport of sugar cane have been obtained from several sugar countries, and an exhibition featuring basic recent agricultural and manufacturing information on participating countries will be held during the Congress.

2. **Meetings.** In addition to meetings of the Research Advisory Committee which were held on three occasions, the following lectures were given in the Bonâme Hall :

26th January, 1961 — «La lutte contre la maladie du rabougrissement des repousses» by Mr. Robert Antoine. The lecture was repeated at Belle Rive under the auspices of the M.S.P.A. on 12th May.

28th April, 1961 — «Les applications de l'énergie atomique à l'agriculture» by Mr. P. Pelegrin, Head of Section of Applied Agronomy, Nuclear Research Centre at Saclay.

23rd May, 1961 — Review of M.S.I.R.I. Annual Report for 1960; an account, by the Director, of the work carried out by the Institute in 1960.

30th May, 1961 — Review of the work carried out by the Sugar Technology Section of M.S.I.R.I. in 1960, by J. D. de R. de St. Antoine.

12th July, 1961 — «The growth of a volcano in the South Pacific and the development of its vegetation» by Mr. Harold St. John, Emeritus Professor of Botany in the University of Hawaii, given under the auspices of the Royal Society of Arts and and Sciences, Mauritius.

3. **College of Agriculture**. Courses of lectures of the College of Agriculture continued according to arrangements made last year, namely in Sugar Technology, Plant Pathology, Botany of the Sugar Cane, Statistics and Field Experimentation and Sugar Cane cultivation.

4. **Staff Movements.** The following officers went on overseas leave during the year, Messrs. Antoine, Béchet, de Froberville, Mayer, Parish, Rochecouste and Rouillard. Arrangements were made for these officers to visit agricultural and other research centres engaged in work of particular interest to them. The assistance received from the authorities concerned is gratefully acknowledged.

Mr. Antoine spent two weeks in Madagascar in February and again in November when he was accompained by the Director in connection with the control of Fiji disease on the east coast of Madagascar.

Mr. S. Feillafé spent a week in Réunion in connection with soil studies.

The Director was absent from the end of August to early October visiting the Chagos Islands and the Seychelles.

The assistance given by sugar estate managers and their personnel has been as usual of the greatest value and it is a very pleasant duty to record my own appreciation and that of the staff for the help received in the execution of field and factory experiments.

Finally, I should like to thank all members of the Staff for their loyal co-operation during the year.

Director

9th February, 1962.

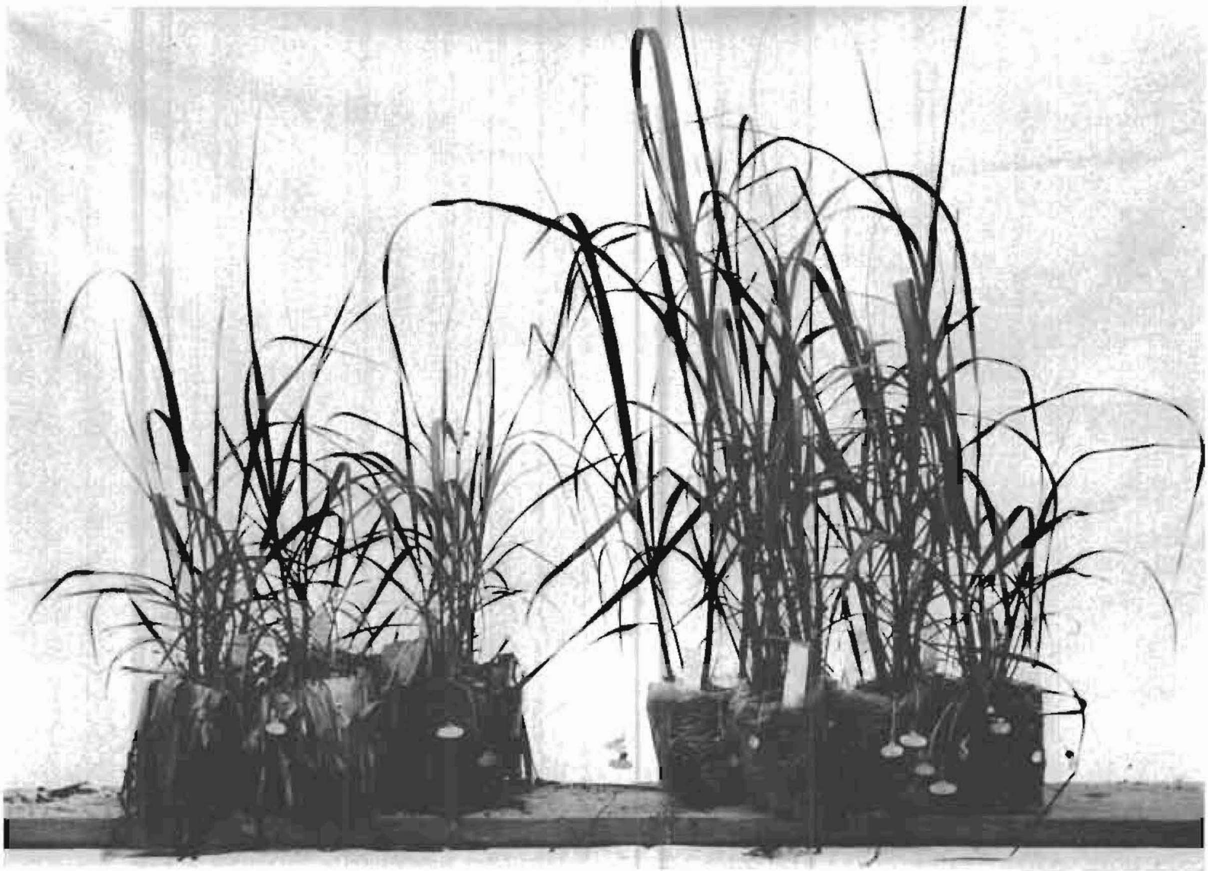

Fig 12. *Top.* Some of the self-sown seedlings from a natural cross discovered at Union Park at the end of the year. The two large seedlings in the centre are about 18 inches high.

Bottom. The marked difference in seedling growth in cane leaf pots (left) and polythene pots. Tags on individual shoots are to record survival.

CANE BREEDING

E. F. GEORGE & W. de GROOT

1. ARROWING

(i) Conditions in 1961.

THE estimates of the percentage flowering in various commercial cane varieties have now been made since 1956 with the valuable help of estate managers. This year's results from the counts of flowers in estate fields are given in Table 1, while recent annual fluctuations in the flowering of three major varieties are given in Table 2.

The flowering percentages of 1961 were very low, even compared with 1960, a year which from the breeders' point of view was thought to be the worst possible. This result is almost certainly due to the severe drought early in 1961, which caused a retardation in growth (cf. fig. 1 on page 10), so that the canes were too small at the critical time for flower-initiation.

The variation in percentage of arrowing with years is certainly due to weather conditions before and during the time of initiation. However, a method to predict the amount of flowers from weather characteristics has not yet been found as the results from normal years are still too scarce.

The variation in percentage of arrowing with the date of harvest of the canes the year before could not be determined, as the differences were too small at this low flowering intensity.

A few arrows emerged in the field at Réduit in early January. As far as is known this was the first time that out-of-season flowering has occurred in Mauritius. The varieties which flowered were chiefly *S. spontaneum* selfs, but one normal flower was found of C.B.38-22. This was crossed with a self of *S. spontaneum* and gave rise to 50 seedlings.

Due to lower mean temperatures the development of an inflorescence could be expected to be slower in the spring than is normal in the autumn. This means that induction of the flowering stimulus probably took place in September 1960 at approximately the same daylength as would be inductive in the autumn but in lengthening days. It is sometimes stated that progressively shortening daylengths are necessary for floral induction in sugar cane.

Table 1. Average percentage arrowing in 1961 *

Variety	North	South	East	West	Centre	Average
Ebène 1/37 ...	2,15	1,66	2,06	—	1,62	1,87
M.147/44	0,78	1,01	1,16	1,29	0,13	0,94
M.134/32	1,44	0,52	1,00	0,79	(0,00)	1,05
B.37172	0,36	0,22	0,36	—	(0,00)	0,31
B.3337	—	0,15	0,15	—	(0,17)	0,15
M.31/45	—	0,38	0,26	—	—	0,32
M.202/46	—	(1,95)	—	—	—	(1,95)
B.34104	—	—	—	(1,04)	(0,00)	(0,71)
M.93/48	—	(1,55)	—	—	—	(1,55)
Ebène 50/47 ...	—	—	—	—	(0,00)	(0,00)
M.112/34	(0,00)	—	—	—	—	(0,00)
B.37161	(1,95)	(0,33)	(0,00)	—	—	0,91

* Results derived from less than 5000 canes are placed in brackets.

Table 2. Average arrowing percentage of different varieties over the whole island.

Year	M.134/32	M.147/44	Ebène 1/37
1956	22,5	—	13,1
1957	9,3	—	10,1
1958	5,4	4,6	6,1
1959	6,9	3,0	6,4
1960	2,1	1,7	1,5
1961	1,0	0,9	1,9

(ii) Control of flowering.

Several photoperiodic experiments which were carried out on the variety C.P. 36-13 in 1959 were successfully repeated during the year. Cyclones in 1960 severely damaged treated canes so that results were not reliable.

These experiments have indicated that the processes of flower induction and subsequent development are not entirely independent. Extra light at night given to canes at an appropriate time of the year had an effect on three related phenomena : the time at which an inflorescence is first formed, the time of arrow emergence and the intensity of flowering. These effects of extra light treatment have a very close parallel in the differences in flowering habits between varieties of sugar cane in the field. For example, extra light treatment in C.P. 36-13 caused a delay in the formation of inflorescences, a further delay in their eventual emergence and a reduction in flowering intensity. Varieties which do not flower heavily in Mauritius also exhibit a delay in inflorescence formation and emergence relative to freely flowering varieties. These changes, following light treatment in the variety C.P. 36-13, and subsequent on genetic control in shy arrowing varieties, very probably have a common cause which may be due, in the simplest explanation, to a reduced concentration of flower-promoting substances.

Several other experiments to induce or retard flowering were executed during the season, but as the flowering intensity was low, no valid comparisons could be made.

2. CROSSING

(i) Programme.

The scarcity of flowers, as indicated by the low percentages of arrowing in commercial varieties, made the execution of a normal crossing programme difficult. However a large number of crosses was made, although the number of combinations between the various parents was slightly less than the year before, which in itself was a bad year.

The marcotting techniques described in the Annual Report for 1960, were again used for the isolation of canes for crosses inside the greenhouse. Some further experiments on the techniques which have been evolved were conducted and the results obtained were in agreement with those from last year.

The method to induce rooting before external signs of flowering are visible, was unsuccessful, in so far that no flowers were obtained in the 500 stalks brought into the greenhouse. This method only seems applicable during years in which flowering is normal, when a fair amount of arrows in the treated stalks can be expected. Canes marcotted in the field which had formed sufficient roots before the flower protruded, were afterwards cut and transplanted into concrete or iron pipes. It is found that subsequent growth and development is better if transplantation is employed. Many canes this year had to be used for crossing as soon as they were seen to flower in the field and with no prior treatment. In this case, marcottes were applied after severance of the stalks and the cut ends were placed in an SO_2 solution.

This last mentioned technique was shown to be justified by the results of an experiment conducted during the season. From four varieties 4 flowering canes were marcotted and 4 not. All the stalks were placed in 4 gallon drums (4 canes per drum) with an SO_2 solution, which was changed every other day. All the flowers were pollinated by the same male variety in one area cross. Marcotted canes did produce significantly more viable seeds than non-marcotted ones. (Table 3).

It has been reported from Barbados that rain water is better than tap water for the preservative solution. This too was tested in the experiment but no difference in seed setting was found attributable to water from either source.

The total number of crosses made this year was 701, from which 252 were made in the open. A summary of the crossing work is given in Table 4, while the list of crosses can be found in the Appendix (Table XXIII). The number of parents used in the programme was enlarged with some varieties of the M./57 series. Again during selection, new parent varieties were planted in the breeding plots.

About 50 seedlings of unknown parentage, resulting from natural crosses, were discovered at Union Park S. E. S. in December having established themselves at the edge of a field (fig. 12). They were transplanted for subsequent assessment.

Table 3. The number of seedlings produced experimentally from female stalks marcotted and not marcotted and placed in tap water or rain water.

Cross	Rain water		Tap water	
	Not marcotted	Marcotted	Not marcotted	Marcotted
P.R.1000 × 47R2777	3630	2300	2310	3060
	80	2100	330	3590
Ebène 1/37 × 47R2777	29	2360	460	1420
	—	1030	—	920
C.B.38-22 × 47R2777	1140	—	270	340
	330	370	140	160
M.241/40 × 47R2777	620	3750	290	2810
	51	—	1380	500
TOTAL	5880	11910	5180	12800

Total rain : 17790
Total not marcotted : 11060

Total tap : 17980
Total marcotted : 24710

Table 4. Summary of crossing work in 1961.

Station	No. crosses made		No. seedlings obtained			No. seedlings planted	
	inside	outside	inside	outside	total	singly	bunched*
Réduit	449	129	47319	35160	82479	5431	137
Pamplemousses ...	—	123	—	23539	23539	4156	6257
F.U.E.L.	—	—	—	—	—	—	2685
Britannia	—	—	—	—	—	—	1690
TOTAL	449	252	47319	58699	106018	9587	10769

* In a bunch 7-8 seedlings are potted together ; at the time of planting approximately 5 seedlings/bunch are still alive.

(ii) Transplantation of seedlings.

As in 1960 most of the seedlings were bunch planted. The value of polythene pots was again tested. Seedlings from 7 different crosses were bunch planted in both straw and polythene pots so that a comparison could be made on the effect of both types of container on subsequent growth. This experiment was extended so that the survival of individual seedlings in bunches could also be observed. Individual seedlings were ringed from a very early stage and a subsequent record kept of survival, length and tillering until the time seedlings were established in the field. The average growth rate of the seedlings in polythene pots was, in all the 7 progenies, superior to that in staw pots. This can be seen from Table 5.

Table 5. The average shoot length of seedlings of different crosses all measured on the same date

Cross No.	Average length of seedlings	
	Straw pots cms	Polythene pots cms
61—684	46.0	62.8
—438	51.8	78.3
—710	33.2	34.4
—602	43.0	53.8
—442	35.7	62.2
—591	51.7	65.0
—461	69.5	73.5

Shoot length was significantly better in polythene pots (P = 0.001).

Fig. 12 shows the marked difference between the seedlings of cross 61—438 in the two types of pots.

Table 6. The mean number of seedlings surviving and the mean number of shoots per pot.

Cross No.	Surviving seedlings/pot		Mean no. shoots/pot	
	Straw	Polythene	Straw	Polythene
61—684	5.3	7.7	8.0	16.0
—438	4.2	4.0	7.0	7.5
—710	2.3	2.5	4.0	5.7
—602	5.3	6.2	8.5	11.7
—442	3.2	4.8	4.7	7.5
—591	4.7	4.8	6.0	10.5
—461	5.3	4.2	9.8	7.0
Weighted means	4.3	4.9	6.7	9.4

From Table 6 it is also revealed that survival is not significantly different in polythene pots but that the number of shoots per pot tends to be higher.

It therefore appears that polythene pots will in general give better seedling growth and consequently they will probably be used exclusively in the future.

3. STUDIES ON SEEDLING POPULATIONS

(i) Selection in bunch planted seedlings.

The result of an experiment started in 1956 and mentioned in the Annual Reports for 1958–1960 have finally been calculated and sent to press. This emphasises the great deal of time required for evaluating the results of this type of biometrical experiment. The actual measurements taken in the field, although fairly time consuming, are small in proportion to the work involved in their interpretation.

The experiment referred to, compared the selection of varieties from seedlings bunch planted in two different ways and from others singly planted. It was found that selection in first ratoon from both methods of bunch planting was effective and resulted in a similar selection rate as was obtained from singly planted seedlings.

In the seedlings which were studied, selection for weight of cane and all contributing factors was most effective from those which had been singly planted originally, the pots afterwards being placed together (7 in one bunch) in the field. The same selection rate was obtained as from single planting. Seedlings normally bunch planted gave an inferior selection rate for these characters. Very probably, if sugar content had not been negatively correlated with yield components in the seedlings studied, then bunch potting, as the new method was called, would have been the better technique. As it was, many of the high yielding selections from bunch potting were of low brix and were discarded bringing the eventual selection rate back to a figure comparable with bunch planting.

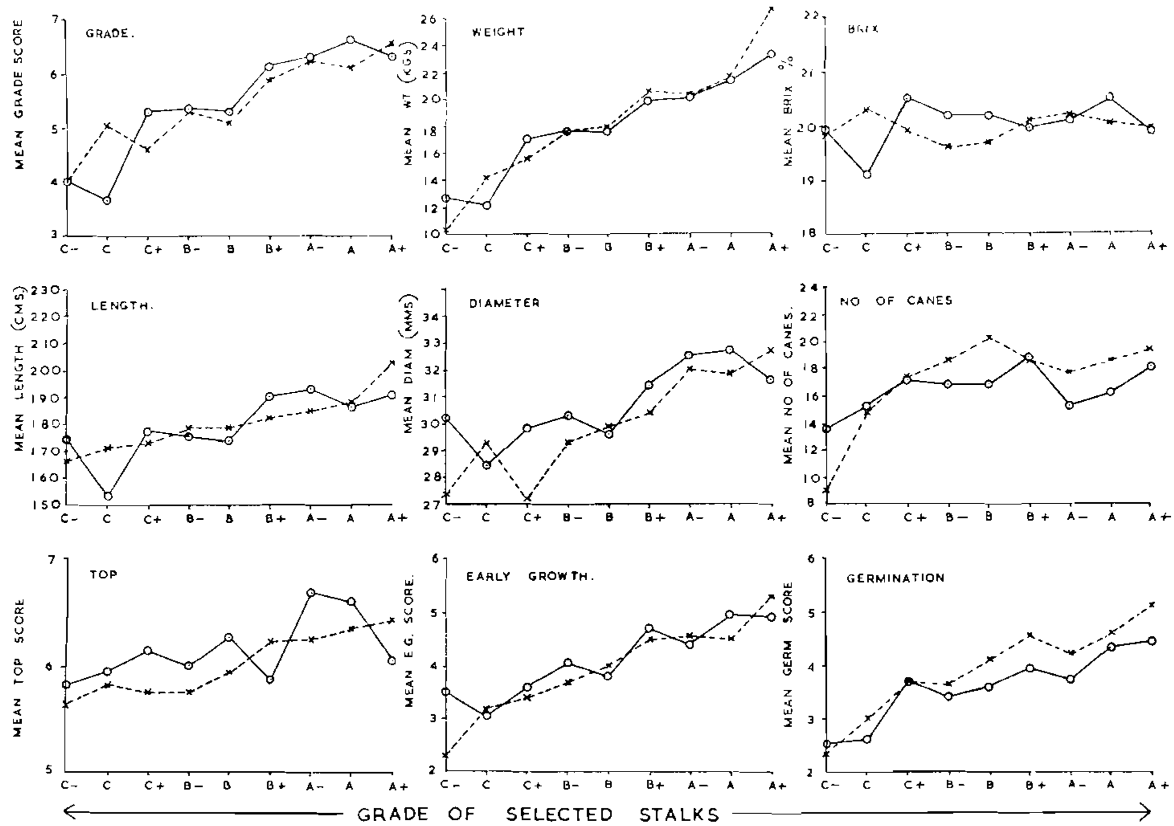

Fig. 13. The selection which could be achieved in nine measured characters by choice of stalks of different grades from bunch planting and bunch potting.

Open circles, plain line; within the varieties from bunch planting.

Crosses, broken line; within the varieties from bunch potting.

The efficiency of selection practised by the choice of stalks of different calibres from either bunch planting or bunch potting is illustrated in fig. 13. The nine graphs in this figure correspond to the characters measured in the bunch selection plot. In each, the mean value of groups of varieties is plotted against the various grades of selected stalks from which the members of each group were derived. Thus the slope of the regressions of y on x (bunch selection plot value on single stalk grade), calculated separately for the bunch planting and bunch potting samples, gives a figure for the respective efficiency with which selection could be practised in each character by the choice of stalks of different qualities in the previous generation.

Measurements were made in the field during the year on another bunch planting experiment designed to measure the superiority which would be expected in random selections from bunch planting if seedlings of poor quality are discriminately eliminated. Results have yet to be calculated.

(ii) Progenies in contrasting environments.

Seedlings of six crosses planted during 1959 at the 4 Experiment Stations in randomised designs with two standard varieties were measured during the year. Special thanks are due to those students of the College of Agriculture who helped with this work which was a more refined repetition of an earlier experiment (GEORGE, 1960) and endeavoured to assess adaptation exhibited by seedling progenies. At the time of writing most of the results of this work have been calculated. Among the findings which will be published elsewhere, estimates are given of the expected efficiency of selection in each environment for the characters, average length, average diameter, number of canes, flowering intensity, brix and grade (the selector's appraisal of the worth of each seedling). These estimates are being checked in two other experiments which were planted with the seedlings showing the best expression of the above characters in each cross and in each environment. The response to selection will be measured in comparison with a random choice of varieties from the six progenies at each place.

These studies have suggested that a very useful method of parent-progeny evaluation would be a factorial set of crosses where several females are crossed with the same males. Accordingly one such experimental comparison has been planted in the field at Réduit this year with progenies from the varieties Ebène 1/37, C.B. 38-22, N.Co. 376, P.R. 1000, M. 212/56 crossed with M.147/44 and 47R 2777.

4. SELECTION

During the year canes grew well and most of the trials could be harvested, resulting in many selections. Recent changes in the programme, as described in the Annual Report for 1960, were incorporated in the selection-scheme for the first time. All seedlings, of the M./59 series selected from single plantings at the 4 Experiment Stations (a total of 1100), were each propagated in two plots; one in the warm humid area (Réduit and Pamplemousses S.E.S.) and one in the superhumid region (Belle Rive and Union Park S.E.S.)

Normal bunch planted seedlings of the 1960 series were selected in virgins at Pamplemousses S.E.S. and at F.U.E.L. sub-station and the selected stalks were planted in bunch selection plots at the same places. As selection in bunches is merely visual, well developed plantations can be selected in virgins. However growth at Réduit S.E.S. and at Britannia sub-station was not satisfactory and selection there had to be postponed until the canes have ratooned in 1962.

During this season it was concluded from results obtained from propagation plots, that selection in virgins in these trials is not reliable. The present policy of selecting original plantations in ratoons, does not seem to be a sufficient safeguard against canes with weak ratooning capacity entering propagation plots. A definite assessment of at least the ability to grow well in first ratoons is necessary and apart from a few varieties which look very promising, no variety will be planted in first selection trials until the results of ratoons in propagation plots are available.

A total of 125 selections of propagation plots were planted in 6 first selection trials on the 4 stations. 16 first selection trials were harvested, from which 32 selections were made. Some of the more promising selections, now in multiplication plots for planting in trials on estates in 1962 are the following:

M.17/55 (M.311/41 × M.423/41). A variety selected from a first selection trial at Réduit S.E.S. High yielding cane although sugar content is inferior. This variety grows erect, trashes easily and until now no flowers have been observed.

M.69/55 (B.34104 × M.63/39). Cane of medium thickness and good growth habit; outyielded the standard (M.147/44) at Réduit.

M.217/55 (B.34104 × M.213/40). Selected at Pamplemousses S.E.S. The variety gave a high yield in 1st ratoons and sugar content was good.

M.255/55 (B.34104 × M.63/39). Selected in 1st ratoons at Belle Rive S.E.S. where it gave a very high yield (25% more than Ebène 1/37); sugar content was only slightly below that of the standard. The variety trashes easily and growth habit is semi-erect. Germination is fair. Some flowers have been observed in propagation plots in 1959.

M.303/56 (Ebène 1/37 × M.213/40). Selected at Union Park S.E.S. in first ratoons. A semi-erect cane trashes easily and is of medium thickness. Sugar content was quite good and yield was about the same as from Ebène 1/37.

A summary of selection is given in Table 7.

Table 7. Summary of selection work in 1961

Station		No. of stalks planted in B.S.P.	No of seedlings selected	No. of selections made in Prop. plots	No. of selections made in F. Sel. Trials.
Réduit	...	133	172	37	13
Pamplemousses	...	2014	287	20	10
Belle Rive	...	—	464	44	5
Union Park	...	—	175	24	4
F.U.E.L.	...	1407	—	—	—
Britannia	...	—	—	—	—
Total	...	3554	1098	125	32

5. VARIETY AND PRE-RELEASE TRIALS.

During the year 1961, 10 variety trials and 3 pre-release trials were planted, while a total of 36 trials (26 and 10 respectively) were harvested. Six trials have been abandoned after the result of the 1961 crop were known. The distribution of the various trials over the island is given in Table 8. A total of 114 varieties (97 M. varieties, 7 Ebène varieties and 10 imported varieties) are being tested in these trials.

Table 8. Distribution of trials

Year of planting	Region				Total
	Subhumid	Humid	Superhumid	Irrigated	
1957	—	2	2	—	4
1958	1	5	1	2	9
1959	1	3	5	2	11
1960	—	2	2	2	6
1961	2	5	4	2	13
Total	4	17	14	8	43

Some of the promising varieties in these trials gave the following results in 1961:

M.305/49 — Results of trial P.B. 6/59 in 1st ratoons at Riche en Eau in the superhumid region indicate that this variety might produce well during a normal year in the humid region. Sugar content was quite good, but yield was on the low side.

	Ebène 1/37	B.3337	M.305/49
T.C.A. ...	35.9	47.0	40.9
I.R.S.C. ...	9.6	9.7	10.4
T.S.A. ...	3.44	4.55	4.28

Maturity was good in the middle of the season. In other regions, due to dry weather early in 1961, yields were not so satisfactory.

M.442/51 — Results from 2 trials in ratoons seem to indicate that this variety can produce a fair amount of cane.

P.B. 4/57 Humid region
Ratoons (Average 1st & 3rd)

	Ebène 1/37	*M.442/51*
T.C.A. ...	39.2	51.7
I.R.S.C. ...	10.3	8.5
T.S.A. ...	4.02	4.40

P.B. 12/59 Irrigated region
1st Ratoon

	M.147/44	*M.442/51*
T.C.A. ...	29.5	31.8
I.R.S.C. ...	11.0	11.0
T.S.A. ...	3.25	3.50

M.442/51 is now planted in pre-release trials in the 4 main regions of the island from which more data will be available after harvest in 1963.

M.658/51. This variety grows well in the humid region. In a trial at The Mount S.E., P.B. 3/57, the following results were obtained in 1961 (3rd ratoons) :

	M.134/32	M.658/51
T.S.A. ...	35.7	48.9
I.R.S.C. ...	11.3	11.0
T.S.A. ...	4.02	5.38

The variety must be multiplied and tested in other regions before its value can be assessed.

M.117/55 which gave very promising yields in virgins, was disappointing in ratoons.

From the imported varieties, **R.397** gave good results in pre-release trials under warm conditions where a fair amount of water was available. In the subhumid area, results were the same as for the standards M.147/44 **and** B.37172.

6. RELEASE OF THE VARIETIES EBENE 50/47 AND M.253/48

The Cane Release Committee decided in December that the varieties Ebène 50/47 and M.253/48 should be recommended for release for commercial cultivation.

Ebène 50/47. This variety was bred at Highlands S.E., and as far as is known its ancestry is as follows :

P.O.J. 2878 × Uba Marot
↓
B.H.10/12 × unnumbered seedling
↓
M.134/32 × unnumbered seedling
↓
Unnumbered seedling × unnumbered seedling (P.O.J. 2878 x Co. 301)
↓
Ebène 50/47

Material of this variety for planting in trials became available in 1958 and was multiplied and tested during the following years. Results obtained so far indicate that it is a high yielding cane with excellent sucrose content throughout the harvesting season. Flowering is medium to free; the cane is of medium thickness, has an erect habit of growth and trashes easily. Information about ratooning capacity is not yet available.

The cane is susceptible to ratoon stunting disease, chlorotic streak, red stripe, pokkah-boeng and eye spot; resistant to gumming and leaf scald, while resistance to stalk borer (*Proceras*) is intermediate.

A summary of results of the variety in trials on estates is given in Table 9.

Table 9. The percentage superiority of Ebène 50/47 over the standard in variety trials.

The actual results of the standard are given in brackets

Trial	P.B.15/58		P.B.9/59	P.B.12/59
Region	Humid		Superhumid	Irrigated
Standard	Ebène 1/37		Ebène 1/37	M.147/44
No. of Ratoons	1*	2	1	1
T.C.A.	341% (2.23)	106% (44.69)	120% (14.12)	86% (29.50)
I.R.S.C.	146% (5.70)	121% (9.17)	109% (8.60)	117% (11.00)
T.S.A.	485% (0.13)	128% (4.10)	131% (1.22)	102% (3.25)
Fibre	129% (9.87)	110% (9.70)	100% (9.79)	89% (13.87)

* Results cyclone year 1960.

Table 10. Percentage superiority of M. 253/48 over the standard variety in pre-release trials

The actual results of the standard are given in brackets.

Trial	P.B. 5/58	P.B. 7/58	P.B. 3/59	P.B. 6/59
Region	Humid	Sub-humid	Humid	Super-humid
Standard	Ebène 1/37	M.147/44	Ebène 1/37	Ebène 1/37
Ratoons	2	2	1	1
T.C.A.	115% (20.82)	110% (28.0)	132% (28.9)	124% (35.9)
I.R.S.C.	101% (10.3)	91% (10.8)	101% (9.9)	107% (9.6)
T.S.A.	115% (2.16)	100% (3.02)	132% (2.87)	133% (3.44)
Fibre	85% (12.9)	74% (14.6)	88% (10.7)	99% (8.8)

M.253/48 — This variety, derived from the cross B.34104 × M.213/40, is planted now on an area of about 800 arpents after the decision of the Committee in 1959 to advise cultivation under certain conditions. It has now been to decided to recommend M.253/48 for release because of its continued success in irrigated areas.

Selected in 1950 and subsequently tested at the Pamplemousses S.E.S., the growth of this variety in trials was good compared to M.134/32, while sugar content, estimated by hand refractometer brix, seemed to be reasonable. In 1954 the variety was planted in a variety trial. Results of subsequent pre-release trials are given in Table 10.

Canes of M.253/48 are thick and the trash is easy to remove. The variety is vigorous and capable of giving high yields especially in irrigated regions.

Sugar content is low at the beginning of the crop, but improves towards the end of the season. Fibre content is very low and purity is good. M.253/48 is resistant to gumming, leaf scald, red rot and pokkah boeng, very susceptible to chlorotic streak and susceptible to ratoon stunting disease and stalk borers (*Proceras*).

The cultivation of M.253/48 in areas other than those irrigated or receiving high rainfall coupled with plentiful sunshine and high temperatures, cannot be recommended. This variety is best adapted to only a small range of the environments met with in Mauritius.

The maturity behaviour of both Ebène 50/47 and M. 253/48, as obtained from virgin canes in all sectors of the island, is shown diagramatically in Fig. 14.

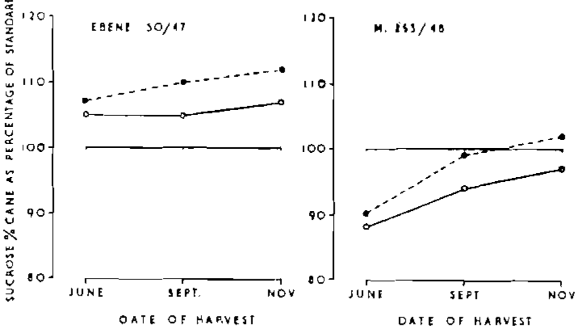

Fig. 14. Maturity behaviour of released varieties.
Average of 10 final variety trials harvested in virgins.
Open circles; compared to Ebène 1/37.
Close circles; compared to M. 147/44.

REFERENCE

GEORGE, E. F. 1960. Effect of the environment on components of yield in seedlings from five *Saccharum* crosses. *Proc. int. Soc. Sug. Cane Tech. 10*: 755 — 765.

NUTRITION AND SOILS

1. MINERALOGICAL COMPOSITION OF SOME LOCAL SOILS.

D. H. PARISH & S. M. FEILLAFÉ

THE work of CRAIG[2], and CRAIG & HALAIS[3] on the chemical composition of local soils led to the conclusion that with increasing rainfall the amount of silicate clay minerals in the soils diminished and that the large increase in 'combined water' with increasing rainfall indicated increasing amounts of the hydrated oxides of iron and aluminium.

No specific identification and assessment of the minerals of local soils was however made. As finally, an accurate picture of these minerals is essential to the full understanding of the pedogenic processes, the opportunity was taken of having a few exploratory X-ray analyses of some local soils carried out at Rothamsted Experiment Station. The results of these analyses are given in Table 11, and the opportunity is taken here to express our thanks to Dr. A. Muir, Head of the Soil Survey of England and Wales, who arranged for the samples to be analysed and to Mr. G. Brown for actually carrying out the analytical work.

Table 11. X - Ray Analysis of the Clay Fraction of Some Local Soils.

Great Soil Group		Site	Kaolin	Montmorillonite	Goethite	Haematite	Gibbsite
Latosolic Reddish Prairie	...	Mapou	dominant	—	present	—	present
Low Humic Gley	...	Petrin	,,	—	,,	—	,, *
Dark Magnesium Clay	...	Plaine Lauzun	v. little	dominant	—	—	—
Humic Ferruginous Latosol	...	Chamarel	dominant	—	present*	—	present*
Humic Ferruginous Latosol	...	Belle Rive	v. little	—	,, **	—	,, ***
Low Humic Latosol	...	Réduit	dominant	—	,, **	—	,,
Latosolic Reddish Prairie	...	Petite C. Noyale	,,	—	,, *	—	—
Low Humic Latosol	...	Solitude	,,	—	,,	present*	—
Low Humic Latosol	...	Anse Jonchée	,,	—	,, *	—	—
Humic Latosol	...	Ferney	moderate	—	,, **	—	present**
Latosolic Brown Forest	...	R. Belle	v. little	—	,, **	—	,, **
Latosolic Brown Forest	...	Melrose	moderate	—	,, *	—	,, **

For the Al silicates

v. little	=	5 — 10%
little	=	11 — 25%
moderate	=	26 — 50%
dominant	=	> 50%

For the iron oxides, and gibbsite :

present	=	< 5%
present * / ,, **	=	5 — 50%
present ***	=	> 50%

The results for the aluminium silicate minerals have been more precisely defined than is the case with the iron and aluminium oxides, as these latter materials present some difficulties in quantitative X-ray work.

Apart from the dark magnesium clay great soil group, which as is well known, is a predominantly montmorillonitic clay, 2 : 1 lattice clays apparently do not occur in the free draining soils of Mauritius.

The typical titration curve[4] of soils from the Mapou area gives an inflexion around pH7 and in view of the fact that the pH of these soils is around neutrality and the solum contains numerous particles of the parent doleritic basalt, it was felt that, even though the soils are free draining, possibly some montmorillonitic clay had been formed. This opinion was supported by the work of SHERMAN and UEHARA[6] who found that montmorillonite was formed in cavities in the parent rock and particularly immediately underneath the boulders where the soil is protected to some extent from excessive leaching.

The X-ray analyses of the clay fraction of the Mapou soil however have not demonstrated the presence of montmorillonite.

In Table 12 the soils have been divided into two groups, immature and mature and then arranged in order of increasing rainfall. Chemical data obtained during the soil survey and the estimated average mineralogical composition taken from the data in Table 11 are given.

The table shows clearly the rapid decline in silica content with increasing rainfall and the complementary decrease in the ratio of silica to aluminium oxide. The most important point from the mineralogical data is the increase of the aluminium oxide – gibbsite – at the expense of kaolin ; the goethite content also tends to increase with increasing rainfall but not so markedly as gibbsite.

These X-ray analyses are only of an exploratory nature and the whole subject of the mineralogical composition of local soils will have to be studied in detail later. The data obtained so far, however, are interesting in that they confirm the broad interpretations which have been made of the chemical data.

Table 12. The effect of increasing rainfall and age on the chemical composition of the whole soil and the estimated mineralogical composition of the clay

MATURE SOILS.

	Average yearly	*Soil*			*Clay*	
Site	Rainfall	SiO_2 %	SiO_2/Al_2O_3	Kaolin	Goethite	Gibbsite
Solitude	50″	32	2.0	> 50	< 5	nil
Anse Jonchée	60″	30	1.8	> 50	15	nil
Réduit	70″	24	1.5	> 50	35	< 5
Ferney	90″	14	0.8	35	35	35
Belle Rive	170″	10	0.5	7	35	> 50

IMMATURE SOILS.

	Average Yearly	*Soil*			*Clay*	
Site	Rainfall	SiO_2 %	SiO_2/Al_2O_3	Kaolin	Goethite	Gibbsite
Petite Case Noyale Mapou	40″ 40″	32	2.0	> 50	< 25	< 5
Melrose Rose Belle	140″ 150″	15	1.0	11 — 50	11 — 50	26 — 50

Agricultural significance of the data presented.

From the point of view of agriculturists, perhaps the most significant point of the results so far available is the low level of silicate material occurring in the soils of the superhumid zone, and particularly so for the mature soils of the area.

Sugar cane is known to take up large amounts of silica and the amount taken up by a healthy crop is directly related to the silica content of the soil, and therefore to rainfall.

The application of crushed basalt to the highly leached mature soils of the superhumid zone, soils which have a very low content of kaolin, has given big increases in cane yields[5]. Comparisons of the mineral composition of the cane crops grown on basalt-treated plots and control plots have so far shown only one marked difference, namely that the level of silica in the crops from the basalt-treated plots is much higher than in the controls. This increased uptake of silica is very highly correlated with the increase in yields obtained.

As a high level of silica in the leaves is known to exert a counteracting effect on manganese toxicity[7], it could well be that part, at any rate, of the effect of adding crushed basalt to these low aluminium silicate soils is due to the increased uptake of silica by the cane crop and resultant elimination of some metal toxicity.

Results from Hawaii[1] have shown that some soils give improved cane growth when sodium meta-silicate is applied and this may be taken as supplementary evidence to the view that although silica is not considered as an essential plant nutrient, it nevertheless seems to play a physiological role under certain conditions.

In view of these findings, experiments have been laid down in which the relationship of silicon to other inorganic constituents of plants is being studied.

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2. IMPROVEMENTS IN LEAF SAMPLING TECHNIQUE FOR FOLIAR DIAGNOSIS

PIERRE HALAIS

Two major improvements have been introduced for the regular sampling of ratoon cane leaves during the critical hot and wet period between mid-December and mid-April prior to cane flowering. They are :

1. **Adequate Moisture**

If the weekly elongation of adequately fertilized primary stalks is 10 cm or more, then it is considered that the cane has not suffered from moisture stress and leaves can therefore be sampled.

In order to save the considerable work involved in making elongation measurements, a moisture index has been worked out from data obtained during the 1961 summer drought at eight representative sites.

The correlation coefficient between elongation and rainfall is +0.85 and its significance exceeds the 1% level. The regression equation calculated is as follows :

E (elongation in cms) = 0.081 R + 1.64

where R is the total rainfall of the preceding three weekly periods, with the proviso that should the rain exceed 50 mm in any week, then the surplus is not considered and only 50mm are credited. The maximum value of R is therefore 150 mm and the requirement for 10cm growth is 100 mm.

Taking 10cm as the required elongation, then from the equation it is seen that a valid leaf sample can be taken when a well distributed rainfall of 100mm or more, i.e. four inches or more, has occurred in the three weeks preceding sampling. If the value of E does not reach 10 cm, then sampling should be postponed until the moisture index is sufficiently high for at least two consecutive weeks.

2. Age of ratoons

The basis of foliar diagnosis is the level of nutrients in leaves from ratoon cane of five months growth. The work of INNES[1] in Jamaica has shown that the nutrient contents of leaves change in a systematic fashion with age and using his data it is possible to sample leaves on ratoon cane from 3 months up to 7 months old and to correct the analytical data obtained to a standardized age of five months (Table 13).

Table 13. Age correction for nutrients levels to obtain standardized data

	Age in months of ratoon crop				
			Normal age		
	3 mths.	4 mths.	5 mths.	6 mths.	7 mths.
N % D.M. ...	—0.32	—0.09	1.95	+0.08	+0.15
P_2O_5 ...	—0.08	—0.02	0.48	+0.01	+0.03
K_2O ...	—0.03	—0.00	1.50	+0.06	+0.14

These correction factors, therefore, now allow a wider latitude in sampling age without loss of accuracy.

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3. COMPARATIVE ROOT STUDIES OF SUGAR CANE VARIETIES GROWING IN DIFFERENT SOIL TYPES.

C. MONGELARD & E. ROCHECOUSTE

Investigations on the comparative development of root systems of sugar cane varieties growing in different soil types were started this year. The object was to determine the growth response of root systems of the same variety and also of different varieties to different conditions of soil, climate and fertilizer treatment. The excavation technique of LEE (1926) which consisted in determining root dry weight distribution in different layers of soil was adopted in these studies.

Root distribution of the variety M. 147/44 was studied in the two soil types : low humic latosol (Réduit and Pamplemousses) and dark magnesium clay (Magenta), and that of the variety Ebène 1/37 in the latosolic brown forest soil type (Union Park) and in the humic ferruginous soil type (Belle Rive). The investigations were carried out in first ratoon canes 6 to 7 months old.

Experimental

A 5-foot cane row was selected in the field and on either side all the roots under a surface area of 12½ sq. ft. were removed from pre-determined layers of soil along the profile. In each operation a volume of soil 5 ft long by 10 in. wide and 3 in. deep (see hatched portion in fig. 15) was carefully removed, placed on a gunny bag and the roots sorted out. The roots from each soil layer were then brought to the laboratory and their volume determined; they were then oven-dried at 80°C. Four replicate excavations were made for each variety growing in the different environmental conditions.

Results

The general distribution of a root system as determined by the excavation technique adopted is illustrated in fig. 16 for the variety M. 147/44 grown at Réduit. From this diagram it will be observed that there is a greater root development in the row than in the interrow at all depths along the profile.

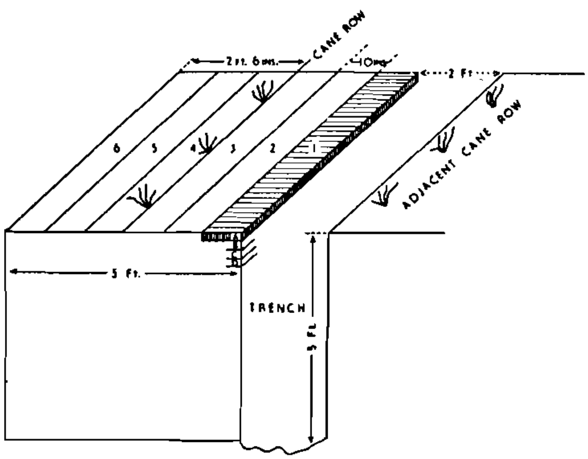

Fig. 15. Illustration of the digging procedure.

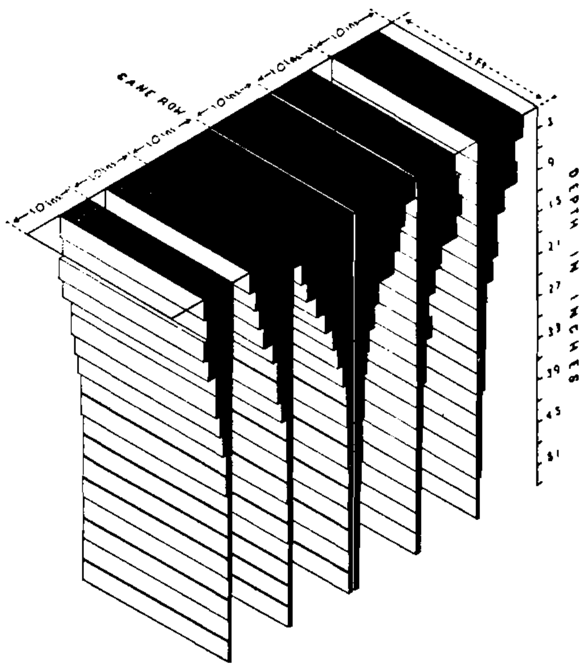

Fig. 16. Block diagram to show distribution of root dry weight of the variety M.147/44 in measured volumes of soil in the Réduit locality.

A linear relationship was found between mean volume and mean dry weight of roots for both varieties in the different soil types. The relationship for the variety M.147/44 is shown in fig. 17.

Root distribution of the same variety was found to differ in the same soil type. For example, in the variety M. 147/44 the root system at Pamplemousses (fig. 18) did not penetrate as deeply in the soil as it did at Réduit (fig. 18). This was accounted for by the presence of a hard soil pan at a depth of about 3 ft in the Pamplemousses soil type. In the dark magnesium clay soil, however, root distribution of the same variety, M. 147/44 was mainly confined to the top 12 inches of soil. The peculiar root distribution of this variety at Magenta was attributed to the compact nature of this soil type.

On the other hand, the variety Ebène 1/37 showed a greater development of roots in the superficial soil layers in the humic ferruginous soil type at Belle Rive, whereas in the latosolic brown forest soil type at Union Park a more uniform root distribution was observed (fig.18).

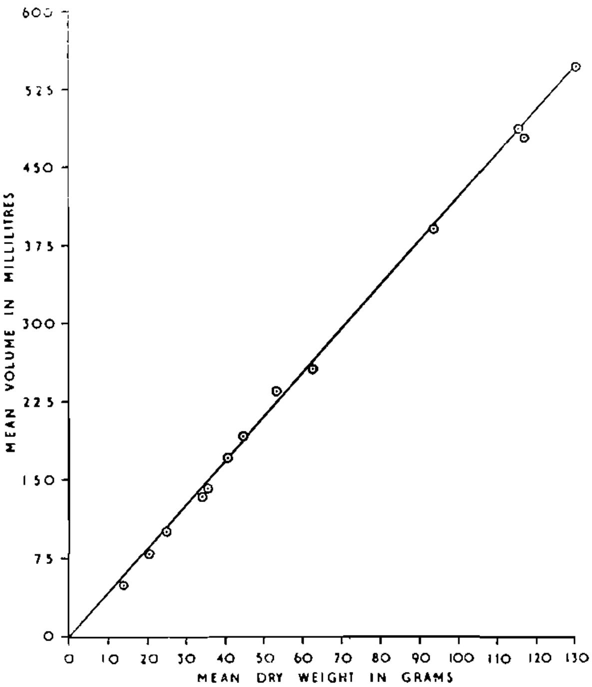

Fig. 17. Linear relationship between volume and dry weight of sugar cane roots (Data from variety M.147/44 in Réduit soil type).

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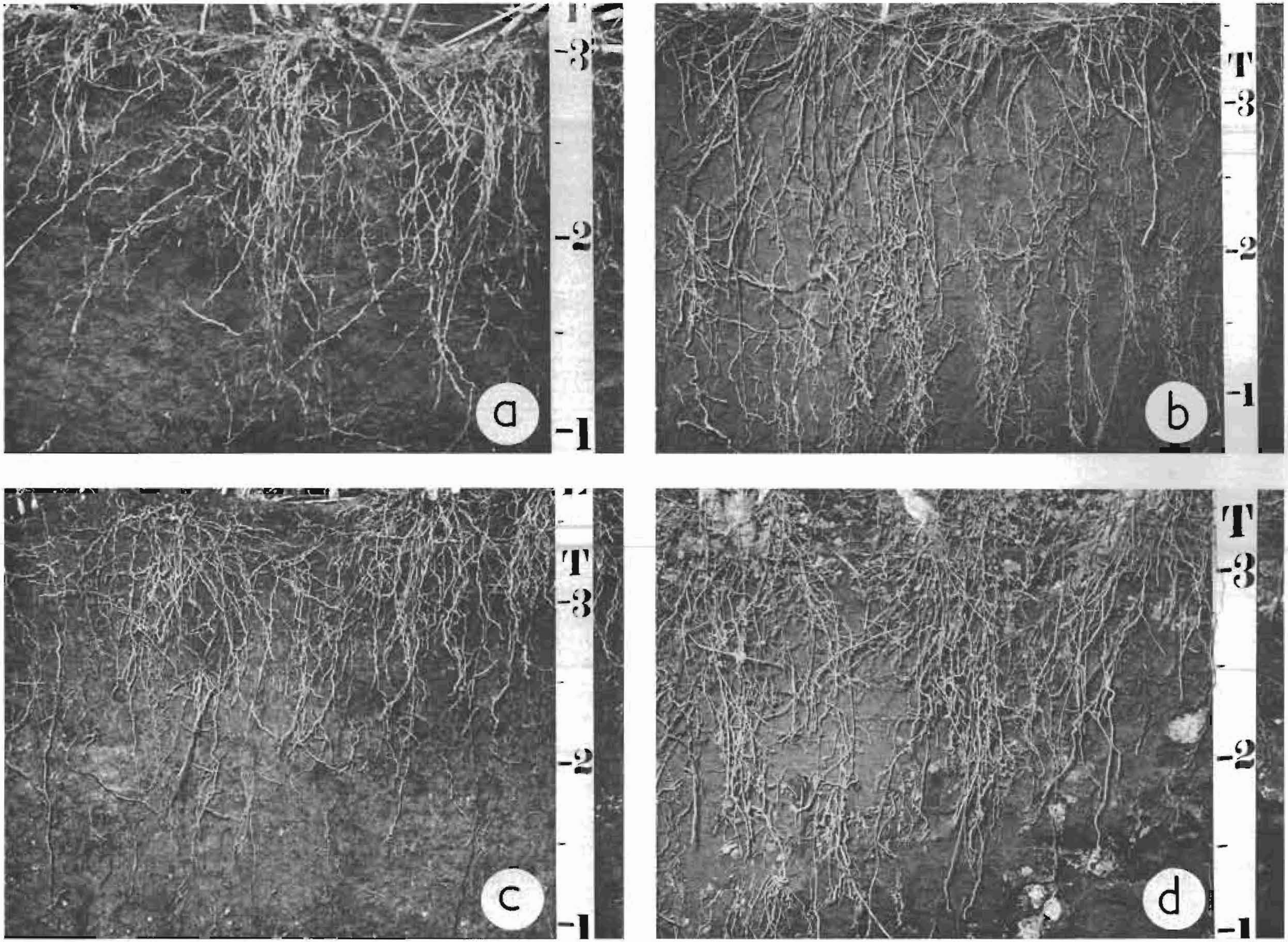

Fig. 18. Root systems of sugar cane varieties as seen in soil profile in different localities: (a) Pamplemousses (M147/44) (b) Réduit (M147/44) (c) Belle Rive (Ebène 1/37) (d) Union Park (Ebène 1/37).

Fig. 19 Dwarf or multiple bud disease on B.37172

CANE DISEASES

R. ANTOINE & C. RICAUD*

1. GENERAL CONSIDERATIONS

EXPERIMENTAL work during the year was concentrated mainly on the two major pathological problems, ratoon stunting and chlorotic streak.

Minor outbreaks of other diseases were observed of which first mention should be made of Cytospora rot (*Cytospora sacchari* Butler), recorded on a seedling cane at Pamplemousses Experiment Station as a new addition to the list of diseases present in the island.

The perfect stage of the red rot fungus (*Physalospora tucumanensis* Speg.) was observed for the first time in lesions on midribs of leaves of the new variety Ebène 50/47. The perithecia developed on leaves kept in a moist chamber and in cultures on corn meal agar.

Several cases of pokkah-boeng (*Gibberella moniliformis* (Sheldon) Wineland) were reported during the period of active growth, the disease being more conspicuous on the variety Ebène 50/47. The attacks, however, were more spectacular than dangerous although a few cases of top rot were observed.

The promising cane M.81/52, particularly adapted to the subhumid area, again showed acute symptoms of leaf scald (*Xanthomonas albilineans* (Ashby) Dows.) in resistance trials and experimental plots. The release of the variety for commercial plantings is unlikely.

An outbreak of eye spot (*Helminthosporium sacchari* (Breda de Haan) Butler) was observed in a young plantation of Ebène 50/47 during the cooler months in the superhumid zone.

The screening of pathogenic soil fungi was continued during the year and 200 isolates obtained of which 60 have been identified. As a corollary to the work, the rhizosphere of plants suspected of suffering from root disease, particularly the variety B.37172, is being studied.

A spectacular, yet localized, attack of dwarf or multiple bud disease (fig. 19) was observed in plantings of B. 37172. It is contemplated to study the etiology of the disease.

2. RATOON STUNTING DISEASE

The resistance trials, as already reported, were badly damaged by the 1960 cyclones. The Pamplemousses trials are still standing but the Belle Rive trial had to be replanted. Experimental results were obtained this year for 1st and 3rd ratoons at Pamplemousses and for virgins at Belle Rive. Table 14 gives a summary of results obtained in the Pamplemousses resistance trial planted in November, 1957. No data were collected in 1960.

* C. Ricaud has contributed sections 5 and 6.

Table 14. Summary of results obtained in a ratoon stunting disease trial laid down at Pamplemousses in 1957.

Varieties	Crop		TONS CANE/ARPENT			TONS SUGAR/ARPENT		
			Treated	Untreated	Reduction %	Treated	Untreated	Reduction %
M. 134/32	Virgin		24.5	19.1	23	4.73	3.54	25
	1st ratoon	...	29.5	26.7	9	4.84	4.33	11
	3rd ,,	...	25.7	21.2	18	3.44	2.73	21
	Average	...	26.6	22.3	16	4.34	3.53	19
M. 112/34	Virgin	...	25.7	24.5	5	4.79	4.54	5
	1st ratoon	...	36.9	29.4	20	5.90	4.49	24
	3rd ,,	...	26.7	25.4	5	3.39	3.23	5
	Average	...	29.8	26.4	11	4.69	4.09	13
M. 147/44	Virgin	...	33.7	29.3	13	6.26	5.39	14
	1st ratoon	...	38.6	35.9	7	5.74	5.62	2
	3rd ,,	...	30.3	24.0	21	3.45	2.54	26
	Average	...	34.2	29.7	13	5.15	4.52	12
M. 31/45	Virgin	...	34.3	28.5	17	5.91	4.95	16
	1st ratoon	...	39.6	35.2	11	6.41	5.55	13
	3rd ,,	...	27.3	24.1	12	3.22	3.16	2
	Average	...	33.7	29.3	13	5.18	4.55	12
Ebène 1/37	Virgin	...	24.5	21.9	11	4.65	3.81	18
	1st ratoon	...	34.2	29.6	13	5.43	4.74	13
	3rd ,,	...	28.4	23.2	18	3.64	3.04	16
	Average	...	29.0	24.9	14	4.57	3.86	16
B. 34104	Virgin	...	27.3	24.7	10	5.14	4.63	10
	1st ratoon	...	31.3	28.8	8	4.98	4.45	11
	3rd ,,	...	28.3	24.4	14	3.45	2.83	18
	Average	...	28.9	25.9	10	4.52	3.97	12
B. 3337	Virgin	...	30.3	26.3	12	5.49	4.75	14
	1st Ratoon	...	37.5	34.2	9	6.14	5.30	14
	3rd ,,	...	30.1	26.8	11	3.04	3.11	2
	Average	...	32.6	29.1	11	4.89	4.39	10
B. 37161	Virgin	...	23.1	17.1	26	4.17	3.02	28
	1st ratoon	...	29.5	26.1	12	4.91	4.43	10
	3rd ,,	...	32.2	25.3	21	3.90	2.91	25
	Average	...	28.3	22.8	19	4.33	3.45	20
B. 37172	Virgin	...	31.5	28.0	11	5.79	5.19	10
	1st ratoon	...	37.0	35.6	4	6.18	5.80	6
	3rd ,,	...	25.7	25.1	2	3.14	3.09	2
	Average	...	31.4	29.6	6	5.03	4.69	7

The results for 1st ratoons at Pamplemousses are given in Table 15.

Table 15. Effects of ratoon stunting disease on yields in cane and sugar in 1st ratoons at Pamplemousses Experiment Station

Varieties	TONS CANE/ARPENT Treated	TONS CANE/ARPENT Un-treated	TONS CANE/ARPENT Reduction %	TONS SUGAR/ARPENT Treated	TONS SUGAR/ARPENT Un-treated	TONS SUGAR/ARPENT Reduction %
M. 202/46 ...	30.4	26.8	12	3.89	3.16	19
M. 93/48 ...	29.3	26.1	11	3.72	3.42	8
M. 253/48 ...	36.0	34.0	6	4.46	4.25	5

Table 16 gives the results for virgins in the superhumid zone.

Table 16. Effects of ratoon stunting disease on yields in cane and sugar in virgins at Belle Rive Experiment Station

Varieties	TONS CANE/ARPENT Treated	TONS CANE/ARPENT Un-treated	TONS CANE/ARPENT Reduction %	TONS SUGAR/ARPENT Treated	TONS SUGAR/ARPENT Un-treated	TONS SUGAR/ARPENT Reduction %
M. 147/44 ...	29.2	23.8	18	3.42	2.78	19
M. 31/45 ...	16.2	12.2	25	1.85	1.35	27
M. 202/46 ...	30.8	19.2	38	3.73	2.19	41
M. 93/48 ...	19.6	15.8	19	2.29	1.80	21
M. 253/48 ...	19.6	17.0	13	2.31	2.04	12
Ebène 1/37 ...	27.2	24.0	12	3.43	3.05	11
Ebène 50/47 ...	31.6	24.8	22	4.65	3.37	28
B. 3337 ...	21.6	19.0	12	2.64	2.32	12
B. 37172 ...	20.6	17.8	14	2.74	2.40	12

The average reduction in yield of sugar for virgins, 1st and 3rd ratoons at Pamplemousses ranged from 7% in B. 37172 to 20% in B.37161. The varieties released more recently showed reductions in yield of sugar for 1st ratoons, in the same locality, varying from 5% in M. 253/48 to 19% in M. 202/46. In the superhumid zone, in virgins, losses have fluctuated between 11% in Ebène 1/37 and 41% in M. 202/46. The results confirm the observation that the disease is more damaging in the superhumid zone.

3. HEAT TREATMENT OF CUTTINGS

The central hot water treatment installation at Belle Rive worked fairly smoothly during the first part of the year, but later the plant operated well below capacity with the result that 2,456 tons of cuttings were treated in 1961. The good germination obtained early in the year was followed in certain cases by severe failures which may be attributed mainly to abnormally wet conditions at planting time. The result was that heavy recruitings had to be made and in the end only 375 arpents of nurseries were planted, giving the unusually high rate of 6.5 tons of cuttings per arpent. Of that area, 65% or 243 acres of nurseries were maintained in order to provide healthy material for the 1962 plantings (Table 17).

Table 17. Nurseries established in 1961.

Sector		Area planted (Arpents)	Area maintained (Arpents)	Area maintained %
East-Centre	...	102	62	61
West	...	42	23	55
South	...	116	66	57
North	...	115	92	80
Total	...	375	243	65

The varietal composition of nurseries established in 1961 is given in Table 18.

Table 18. Varieties established in nurseries in 1961.

Variety		Area planted (Arpents)	Area maintained (Arpents)	Area maintained %
M.147/44	...	121.9	86.5	71.0
M. 202/46	...	64.0	42.9	67.0
B. 37172	...	48.2	44.7	92.7
M. 93/48	...	33.6	10.5	31.2
M. 253/48	...	33.5	16.7	49.8
Ebène 1/37	...	30.8	15.0	48.7
B. 34104	...	15.8	11.0	69.6
Ebène 50/47	...	9.5	4.5	47.4
M. 134/32	...	8.0	5.8	72.5
B. 3337	...	5.2	0.7	13.5
M. 31/45	...	4.4	3.4	77.3
M. 305/49	...	0.5	0.5	100.0
R. 397	...	0.5	0.5	100.0
Total	...	375.9	242.7	64.8

In an attempt to intensify the campaign against ratoon stunting disease, a scheme for the establishment of a central nursery is at present under study. The healthy stock provided would serve for planting secondary nurseries on estates.

4. CHLOROTIC STREAK

The short hot water treatment of cuttings only mitigates the effects of chlorotic streak, which is still the major disease of the high rainfall region and which, although absent generally from drier areas, prevails in some restricted localities on heavy soils with poor drainage. Although the heat-treatment inactivates the pathogen in the cutting, the stool derived from such cutting will, when planted in an area in which the disease prevails, be liable to infection.

Results from previous work having shown that chlorotic streak is apparently transmitted in the soil and that contaminated water could be infective, investigations were pursued in an attempt to elucidate the factors involved in the transmission of the disease.

Canes derived from heat-treated cuttings,

Fig 20 Insect-proof cages for the study of the transmission of chlorotic streak.

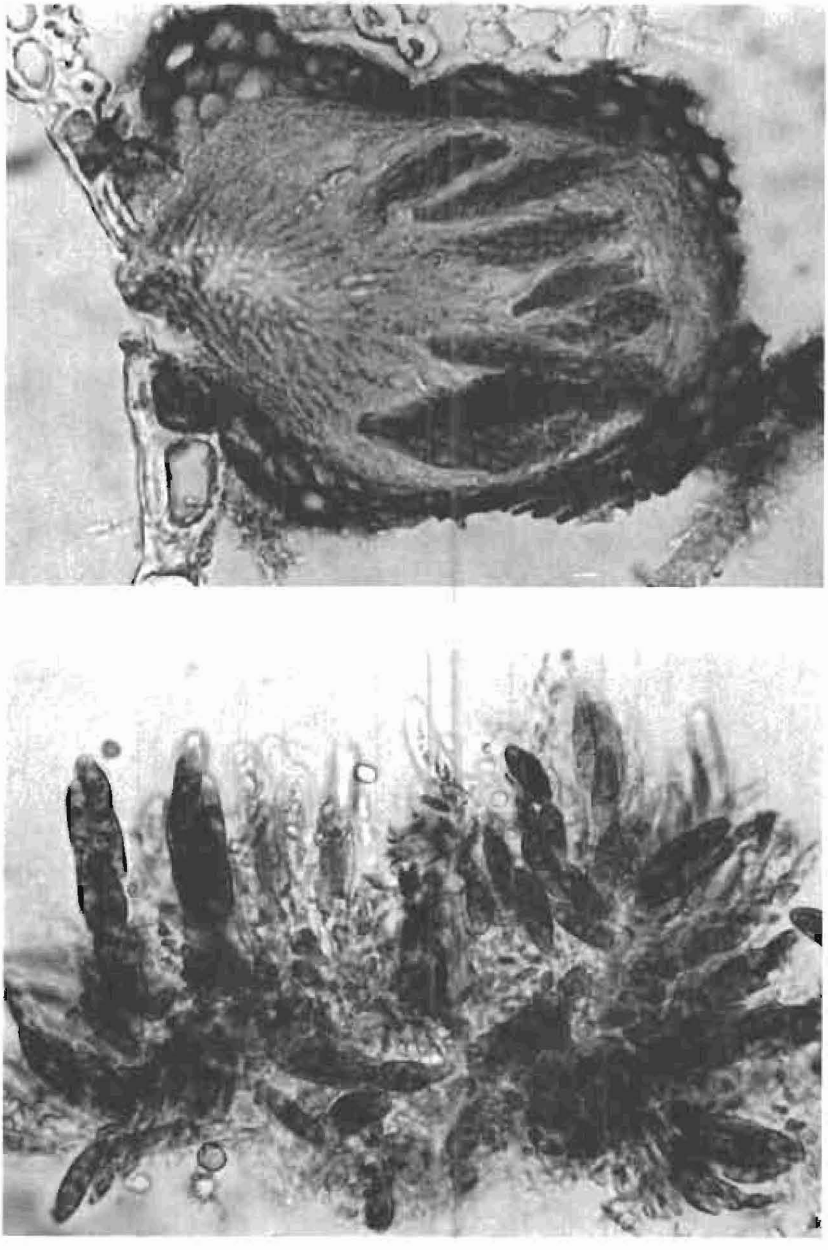

Fig. 21. Perfect stage of the red rot fungus (*Physalospora tucumanensis* Speg.)

Top. Cross section of perithecium.

Bottom Asci and ascospores in a crushed perithecium.

obtained from an apparently disease-free area, are grown in concrete containers under insect-proof individual cages (fig. 20). The soil medium was either (a) unsterilized from a diseased area or (b) sterilized by heat and fumigated. The sterilized soil was (i) left as such, to provide the healthy control, (ii) watered with filtered leachate from an infected soil and (iii) watered with unfiltered leachate.

Infected cuttings planted in unsterilized soil, to provide the diseased control, grew relatively well and showed abundant leaf symptoms under the conditions of the experiment.

The nematode fauna of the soil in the containers is being regularly assessed. The results from the experiment will be submitted for publication elsewhere.

As it seems reasonable to assume that chlorotic streak is transmitted in the soil, the task of controlling the disease appears more difficult. In Mauritius, the high number of ratoons taken further complicates the problem and it seems that, in order to combat the disease efficiently, a direct approach to the production of resistant varieties will have to be made. With that aim in view, the reactions to the disease of all breeding canes used in Mauritius are being assessed.

The attention of planters is once more drawn to the high susceptibility of M.253/48, a variety which, although cultivated in the sub-humid area, has to be given the short hot water treatment whenever cuttings cannot be obtained from healthy fields.

5. RED ROT

Red rot lesions are very common on the midribs of the leaves of the variety Ebène 50/47. Affected leaf portions were collected from various localities, during a survey of the variety and kept in a humidity chamber. After 10 to 15 days, numerous small black perithecia had developed in the dried-up leaves.

The perithecia were embedded in the leaf blade with the ostioles protruding through both lower and upper epidermis. They were also present in the midrib. Others, more conspicuous, were on the surface of the leaf tissue, having developed from the aerial mycelium produced in the moist atmosphere.

The perithecia were sub-spherical, averaging in size $138\mu \times 102\mu$. The asci measured $51\mu \times 11\mu$ and the ascospores $18\mu \times 6\mu$. (fig. 21).

Examinations of old, drying-up leaves of Ebène 50/47 bearing the characteristic lesions on the midribs and also of the trash failed to reveal the production of perithecia in the field. Furthermore, the midrib lesions of leaves of Ebène 50/47 did not always produce perithecia, when kept in the humidity chamber. Similar material collected from leaves of B.3337, a variety which also shows abundant leaf lesions, failed to give fructifications.

The red rot fungus, *Physalospora tucumanensis* Speg., being homothallic, it may be that certain conditions in the host plant interfere with the production of the perithecia. That would account for their presence in one variety alone. That assumption together with the inconspicuous nature of the perithecia produced in the dried-up leaves and trash, would probably explain the failure in the past to discover the perfect stage of the fungus in Mauritius.

Perithecia were also obtained on corn meal agar cultures made by streaking conidia pricked off acervuli on material that produced perithecia in moist chamber. Cultures made on potato carrot agar and Wilbrink's medium did not yield fructifications. Measurements of the perithecia, asci and ascospores, whether obtained in culture or leaf lesions, agreed with those reported from other sugar cane countries for *P. tucumanensis*.

6. A METHOD FOR INOCULATING LEAF SCALD IN FIELD TRIALS

In leaf scald resistance trials, the assessment of varieties generally involves the direct inoculation of the canes under test and the observation of their reaction. Suspensions of fresh cultures of the bacterium (*Xanthomonas albilineans* (Ashby) Dows.) usually enriched by a maceration of infected leaves and stalks provide the inoculum.

Several methods have been used. They involve the inoculation of the sett or the growing stalk. Contamination of the sett is effected by the cutting knife, by immersion in the inoculum or by injection under pressure. The stalks are inoculated by means of a hypodermic syringe just below the growing point or by smearing with the inoculum and stabbing the stumps of freshly cut canes. The ratings obtained in the trials have not always agreed with the field reaction of the varieties. In Mauritius, greater importance is attached to an assessment of the behaviour of new varieties in pre-release trials established under different climatic and soil conditions. Resistance trials are conducted in which four-row plots of varieties under test are flanked by inoculated rows of susceptible cane. However, the method used which consists in inoculating stumps of freshly cut canes has not resulted in a satisfactory rate of infection. Such a condition being essential in order to obtain reliable results in the trial, experimentation has led to the development of a new method of inoculation with promising results.

The inoculum was prepared by disintegrating leaves and stalks of infected cane in a Waring blender followed by maceration with sufficient water for 6 hours. In the trial, the stalks were cut just before the inoculation which was carried out in the afternoon. All the shoots, mature stalks as well as tillers were cut, the former at the base, the latter above the growing point. Inoculation was made by pouring the inoculum over the freshly cut surface which was then stabbed and covered with a pad of cotton wool soaked in the inoculum. The inoculated rows were then covered with trash.

After a month, when the young ratoons had developed, it was found that the rate of infection was exceptionally high. Examination revealed that infection was almost restricted to the young tillers which had been cut and inoculated just above the growing point. Numerous characteristic white lines had developed from the cut end running right down the leaf. Similar results were obtained at three experiment stations under different climatic conditions.

A second experiment was conducted at Réduit in order to test further the method of inoculation. Two rows, fifty feet long, of the susceptible M.112/34, were inoculated in the stump of the mature cane and in the young tillers above the growing point, as described. After three weeks 50% of the shoots inoculated in the tillers showed severe disease symptoms as compared to 2% in the stumps. Two months after inoculation, the disease had become systemic in 25% of the inoculated tillers shown by symptoms in newly developed leaves, as compared to 5% in stump inoculation.

7. GUMMING DISEASE

The unusually dry conditions which prevailed during the early part of the year may have been unfavourable to the spread of the gumming disease organism (*Xanthomonas vasculorum* (Cobb) Dows.). In the variety collection, symptoms were rare in canes known to be susceptible and developed unusually late in the resistance trial. Nine varieties showed signs of gummosis and the promising ones will be tested again.

Gumming disease has been kept under control in Mauritius through the cultivation of resistant varieties. However, the existence of different strains of the pathogen and the presence of the disease in various host plants set an important problem which is now under study in cooperation with the Commonwealth Mycological Institute and pathologists in Réunion, Madagascar and Natal.

Following the discovery that sugar cane varieties reacted differently to infection under field conditions in different countries and to inoculation with the pathogen from various sources, Dr. A. C. Hayward, of the Commonwealth Mycological Institute, has started a study of *Xanthomonas vasculorum* isolates obtained from Mauritius, Réunion, Madagascar and Natal. The results of these findings have been submitted for publication in the Occasional Paper Series of the M.S.I.R.I. Brief mention, however, will be made of his general conclusions.

(a) *X. vasculorum* isolates from the sugar cane in Réunion and Mauritius are undistinguishable on the basis of morphological and physiological properties. They can be differentiated by host reaction.

(b) Isolates from Réunion and Mauritius on the one hand differ in cultural and physiological characteristics from those obtained from Natal, Southern Rhodesia and Madagascar on the other. These appear to be geographical variants as distinct from variants which differ only in pathogenicity or virulence.

(c) There are two distinct populations of bacteria in Mauritius: one causing gummosis of the sugar cane and the other the endemic disease on *Thysanolaena maxima* which had been attributed to the sugar cane gumming disease pathogen. The affinity of the sugar cane strain for *T. maxima* is probably very low, the converse being equally true.

(d) Unlike Mauritius, Réunion has no endemic disease of *T. maxima*. The disease resembling gummosis on *T. maxima* in Réunion, which was reported only once, was due to the sugar cane strain of *X. vasculorum*; the cyclonic conditions which had prevailed had probably induced the temporary passage of the pathogen from cane to *T. maxima*.

8. FIJI DISEASE IN MADAGASCAR

Final results have been obtained in ratoons in the first trial established at Brickaville, on the East Coast of Madagascar, in 1959 in co-operation with the *Institut de Recherche Agronomique de Madagascar.*

The assessment is as follows :

(a) *Very highly susceptible* (— —)
M. 134/32, Q. 42, B. 37172, Pepecuca, B. 34104, PR. 1000, N : Co. 310, Q. 49.

(b) *Highly susceptible* (—)
Q. 47, P.O.J. 2878, M. 147/44.

(c) *Moderately susceptible to moderately resistant* (= — to = +)
B. 3337, B. 37161, Atlas, Vesta.

(d) *Highly resistant* (+)
R. 366, R. 383.

(e) *Very highly resistant* (++)
Pindar, Q. 57, S. 17, M. 31/45, Ragnar, Trojan.

It will be noted that, of all the varieties which have been tested, M. 31/45 is the only one of the commercially important canes in Mauritius to have reacted as resistant to the disease. As the cane has also shown resistance to the strain of the gumming disease pathogen in Réunion Island, the cultivation of that variety, even on a limited scale, should be continued.

The variety M. 112/34 is being tested in the second trial planted in July, 1960. The experiment has been harvested and results will be available in 1962. M.202/46, M. 93/48 and Ebène 1/37 are at present in the third trial planted in December 1961 and M. 253/48 and Ebène 50/47 are undergoing quarantine in Madagascar and will be included in the fourth trial scheduled to be planted in November, 1962.

After the discovery of Fiji disease on the east coast of Madagascar, several measures were adopted by the authorities in that country aiming at the protection of neighbouring countries. One of the measures prohibited the entry and sale of the sugar cane in the town of Tamatave, consequently the port itself, from which there is a regular shipping service to Mauritius and Réunion islands.

As nearly 3 tons of cane were being sold daily, for chewing purposes, in the markets of Tamatave, the authorities in Madagascar have been anxious for some time to have the prohibition lifted. An agreement has now been reached whereby the entry and sale of cane in the town of Tamatave will be authorized after the setting up of a control organization whose duties have been defined. The measures include the registration of planters authorized to sell their canes in Tamatave, the entry and sale of the resistant variety Pindar alone in the town and the maintenance of inspection teams within the perimeter of the port of Tamatave, whose duty is to ensure that no part of the sugar cane plant is taken into that area. The Governments of Mauritius and Réunion have agreed to pay the expenses involved in the control work.

An accidental introduction of Fiji disease in Mauritius would be a major catastrophe to the sugar industry. The understanding and unfailing co-operation of the Minister for Agriculture in Madagascar is once more gratefully acknowledged.

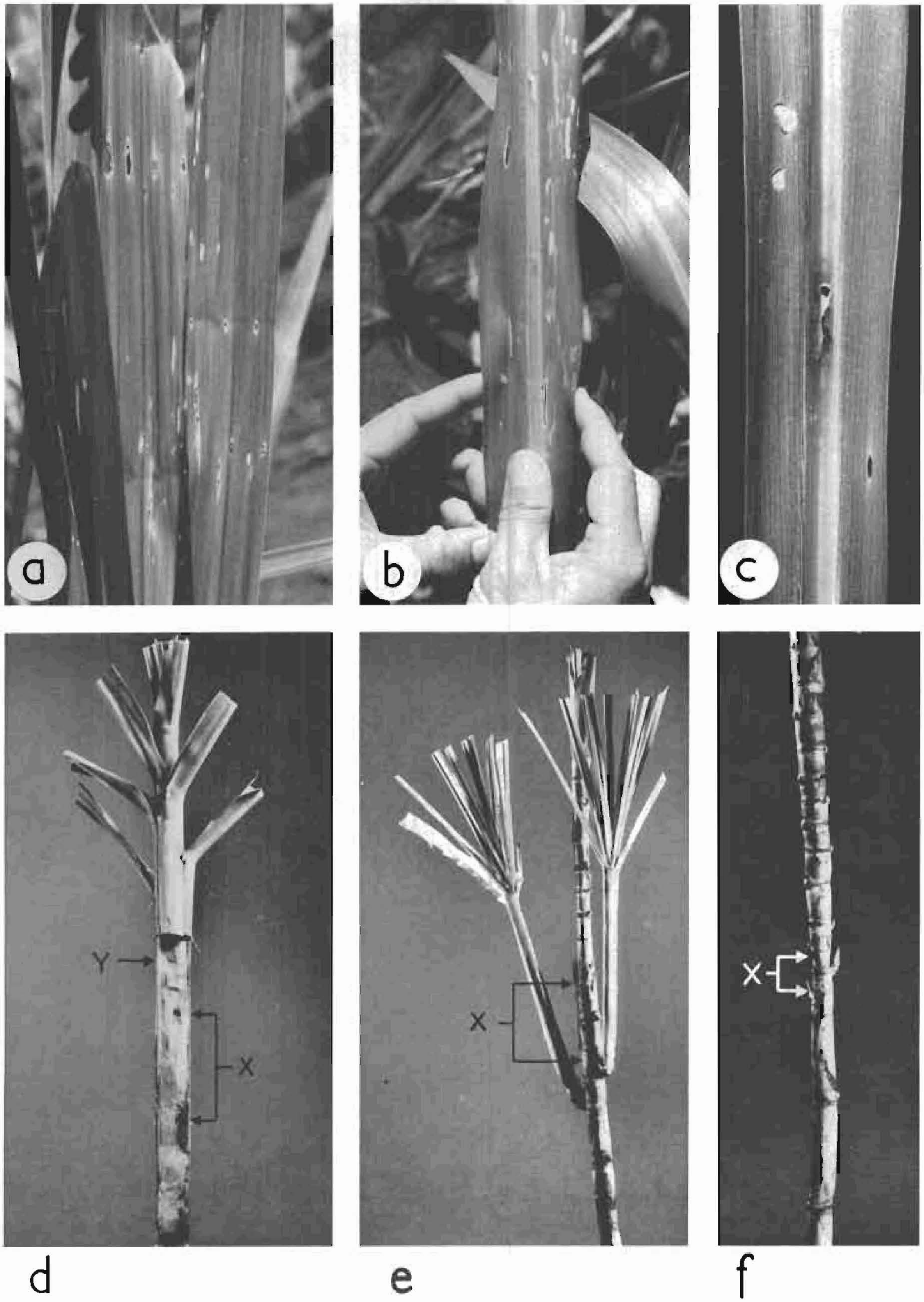

Fig 22

664 flies, all in good state and about half of them females, was released. The number of female flies which had mated before their release is not known but all had been retained in organdie cages with males for 1 to 5 days and mating was observed on several occasions. From October onwards, periodic attempts were made to recover the parasite, by searching for the adults and by collecting borers, but none had been found by the end of the year and it is not known if the insect is established.

Breeding the parasite in the laboratory was begun in July with the object of maintaining a culture which could provide more flies for release in the field. Meanwhile, efforts to establish laboratory cultures were also being made at the C.I.B.C. stations in Pakistan, India and Trinidad, using material received from Java.

At the outset of this work, details of the biology of *Diatraeophaga* were not known although the insect was presumed to be a larvipositing form with a similar life-cycle to *Lixophaga* and the other Neotropical Tachinid parasites of *Diatraea*. This proved to be so and the well-known breeding technique used for these species was employed successfully. However, although a laboratory culture was established and was in its 4th generation at the end of the year, the insect has not been easy to breed and the culture could not be built up sufficiently to provide flies for release in the field. Efforts to improve the breeding technique are continuing, particularly in view of the fact that the fate of the flies originally released is uncertain and further liberations may be necessary to establish the insect in the field. The main difficulty encountered during breeding is the reluctance of the flies to mate in captivity, a factor which led to the failure of cultures initiated at the C.B.I.C. stations mentioned above.

The salient features of the life cycle of *Diatraeophaga* and of the breeding technique employed are as follows. The adults, which usually emerge from the puparia before midday, are confined in organdie cages 2 ft. square supplied with cane sugar and water. Other foods, e.g. honey, split canes, raisins, although often provided, seem unnecessary. Warmth and sunshine activate the flies and they seem to mate more readily in strong, diffused sunlight. The females will mate shortly after emergence, when the integument has hardened, and in the laboratory, at least, if they fail to mate within three days of emergence they generally will not mate at all. Mating lasts 10 to 30 minutes and one mating apparently provides all the sperm necessary to fertilize a female's full complement of eggs. A gestation period of 6 to 9 days, depending upon temperature, follows mating and the female is then ready to begin deposition of eggs which hatch immediately. Frequently however, a female will deposit larvae which have hatched within its body. The deposition of eggs or larvae is stimulated by any surface or materials which have been in contact with a borer and a female stimulated periodically will deposit its eggs or larvae over a period of about three days. For breeding purposes, the young larvae were obtained either by inducing a female to deposit and later dissecting it to obtain any larvae remaining in the uterus or by retaining a mated female, without stimulating it, for 11 to 12 days or until it died and then removing the uterus. About 300 young larvae may be obtained from one female although in practice, as will be described fully elsewhere, a proportion are often lost as the procedure is delicate and requires a certain amount of judgment. One to three parasite larvae are placed on a borer, the number depending upon the size of the latter. The «inoculated» borers are then placed separately in plastic pill-boxes with pieces of sugar cane and a little dry bagasse to absorb excess moisture. Development of the parasite within the borer is completed 10 to 16 days later, according to temperature. The fully grown parasite larva then leaves its host, which by that time has died, and pupates. The maximum number of parasites obtained from one borer is three. Flies emerge from the puparia generally after 13 to 16 days so that the complete life cycle, from mating of the parent flies to emergence of their adult progeny, is about 30 and 45 days in the hot and cool seasons, respectively.

CANE PESTS

J. R. WILLIAMS

1. THE STALK BORER

IN accordance with the research programme of the Institute, entomological work during the year was centred upon the stalk, or spotted, borer (*Proceras sacchariphagus* Boj.).

(a). Parasite introduction

Much use has been made in tropical America of Tachinid parasites to control stalk borers of the genus *Diatraea* but attempts made some years ago to use the same species against *Proceras* in Mauritius were not successful. The only Tachinid fly known to attack *Proceras* naturally is *Diatraeophaga striatalis* Towns. and, like its host, it is native to Java. Further, this parasite does not apparently exist elsewhere and its introduction into Mauritius has been a long-desired experiment which was made possible during the year through the assistance of the Commonwealth Institute of Biological Control.

Early in May, Dr. M. A. Ghani of the Pakistan station of the C.I.B.C. arrived in Java to collect *Diatraeophaga* for despatch to Mauritius. Despite many difficulties, he eventually located a fairly good source of material in the vicinity of Pasuruan and between May 19th and July 7th sent a total of 3,918 field-collected puparia to Mauritius. In addition, specimens of other parasites which might be of future interest were collected and forwarded. His task completed, Dr. Ghani left Java in August and his very able services are gratefully acknowledged.

Mortality of the insects during air transit between Java and Mauritius was unavoidably high and accounted for about 70% of the material sent. The greatest loss resulted from emergence of flies from the puparia while *en route*, a difficulty which could not be overcome since the puparia, collected in the field, were of different ages when despatched. The detailed results of the air shipments were as follows :

Number of shipments ...	25
Number of puparia sent ...	3918
Flies emerged and died in transit	1887
Flies emerged in transit but received alive ...	**713**
Puparia received intact ...	1318
Flies emerged from above puparia ...	**463**

Thus, a total of 1176 live flies were obtained, but some of those which had emerged in transit died shortly after their receipt bringing the number down to approximately 850 flies which could be used for field liberations and for breeding in the laboratory.

A cane field in the north, in a region highly infested with borers, was selected as a site to attempt colonization of the parasite and between June 15th and July 17th a total of

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Fig. 22. Characteristics of injury to sugar cane caused by the stalk borer, *Proceras sacchariphagus* Boj.

Young borer larvae feed upon the leaves and three types of leaf damage can be recognised — (a) boring into the unrolled leaves of the spindle results in rows of holes across the leaf surface after the leaves expand, (b) patches are gnawed out of the upper leaf surface but the lower epidermis is left intact, (c) galleries in leaf midribs may contain one or several larvae.

Older borer larvae feed within the stalk — (d) they live only in the soft tissues (X) a little below the growing point (Y) in that part of the stem which is enveloped by the leaf sheaths. Stem deformities result as shown in (e) and (f). These comprise side shooting or sprouting of buds at or slightly below the damaged nodes (X), and constriction of the stalk and shortening of the internodes at and above the injured point.

(b) Biology

Progress was made with a study of the biology of the moths of *Proceras*. The reproductive capacities of the sexes are the features of adult life which have been under investigation and although this work, as yet incomplete, will form the subject of a separate account, the following summarizes some of the data obtained to date.

1. The moths, which are nocturnal, generally emerge from the pupae within four hours of sunset. They are not attracted by sugary materials, ordinary electric light or by mercury vapour lamps.

2. Mating may occur on the night of emergence or during subsequent nights. Males may mate more than once during their lives; several were induced during experiments to mate twice, on successive nights, but none could be induced to mate for a third time. One mating appears always to provide a female with enough sperm to fertilize all her eggs, even if the male has mated before. Female moths, once mated, would not mate again.

3. A female, at emergence, has very few or no ripe eggs in the ovaries but many ripen quickly and are ready for deposition on the following night. The number of eggs laid on each successive night by a mated female is governed by the rate at which eggs ripen in the ovaries. Normally, a female lays her full complement of eggs within seven or eight days of emergence and dies a day or two later.

4. A female withholds her eggs if mating does not occur but if mating is delayed too long the pressure of the accumulating ripe eggs in the ovaries forces her to deposit some of them. Such eggs are, of course, infertile.

5. The total number of eggs laid by a moth varies considerably according to its size at emergence and by use of a regression equation it is possible to determine the average number which will be laid by females of any given size.

6. The moths have functional mouth parts and females require water to drink if they are to attain their maximum fecundicity. Food, in the form of sugar, is not required and has no influence on fecundicity. Even without water the females are able to lay a considerable number of eggs, the fertility of which is not impaired.

7. The actual number of eggs laid by females of different sizes and under different circumstances cannot yet be quoted but the average number laid per female in the field is probably about 550.

(c) Incidence of larval parasites

Both items of work recounted above necessitated regular collections of *Proceras* larvae and altogether about 8000 were obtained from various localities during the year. The opportunity of assessing larval parasitism in the field was taken by recording the number of these borers which were parasitized and the parasite species involved.

Apanteles flavipes Cam. was found to be the only common larval parasite and its incidence was recorded on 3000 borers collected during the first six months of the year. The percentage of borers parasitized varied, with each batch collected, from 0 to 50% with an average of 10.7%. There were no apparent differences in the incidence of parasitism from month to month, but on the other hand, borers originating from localities in the superhumid zone, mostly from Belle Rive and Union Park, were consistently the most heavily parasitized. *Apanteles* is evidently a parasite of much value in cane fields particularly, it appears, in the superhumid zone.

Other larval parasites were scarce and are apparently of little value. The parasitic nematode worm, *Mermis* sp., was found only in three borers. *Agathis stigmatera* (Cress.), an introduced species recovered for the first time from *Proceras* last year, as stated in the 1960 Annual Report, was not found at all. *Enicospilus* sp., a fairly common parasite of the pink borer (*Sesamia*), was found to occasionally attack *Proceras*, contrary to previous belief.

(d) Varietal resistance

The intensity of stalk borer in varieties Ebène 50/47, M. 202/46, M. 93/48, and M. 253/48 was observed in commercial plantations and in variety trials. Of these varieties, M. 202/46 seems to be the least attacked by borers and compared favourably with M. 147/44. M.253/48, on the other hand, is probably the most susceptible of these varieties with Ebène 50/47 and M. 93/48 occupying intermediate positions. Including M. 147/44 and Ebène 1/37 as standards, the varieties are provisionally placed in the following order with regard to their relative resistance to borer, beginning with the most resistant : M. 147/44, M. 202/46, Ebène 50/47, M. 93/48, M. 253/48, Ebène 1/37.

2. THE PINK BORER

Various weeds, in and around cane fields, were examined early in the year to determine the species which harbour the pink borer (*Sesamia calamistis*) and from which the insect migrates to young sugar cane shoots. An exhaustive search was not possible but the borer was recorded from the following host-plants for the first time :— *Paspalum paniculatum* Linn. (Herbe duvet), *Paspalum conjugatum* Berg. (Herbe créole), *Paspalum urvillei* Stend. (Herbe codaya), *Pennisetum purpureum* Schum. (Elephant grass), and *Phalaris arundinacea* Linn. (Herbe mackaye). The borer eggs, more difficult to find, were seen only on the latter. The reported occurrence of the borer in the following grasses was confirmed : *Coix lachryma-jobi* Linn. (Herbe collier), *Panicum maximum* Jacq. (Fataque), *Sorghum verticilliflorum* Stend. (Millet sauvage).

A few small consignments of the Tachinid parasite, *Sturmiopsis inferens* Tns., were received from the Indian station of the Commonwealth Institute of Biological Control. The flies were released in the field but it is improbable that the number released is enough to enable the insect to establish itself. It is hoped to obtain more material of this species.

3. ARMY WORMS

For the third successive year, after a period of nine years without reported attacks, army worms appeared in several cane fields, all in the south of the island. The circumstances of the outbreaks were similar to those which occurred in 1959 and 1960. It is now thought that the attraction of moths to burnt fields is due to the strong smell of fermentation which usually persists in the fields for some days after burning and emanates from cut stumps and rejected stalks lying on the ground. The attractiveness of fermenting materials to night flying moths is well known to lepidopterists who make such use of a technique called «sugaring». This consists of smearing fermenting mixtures of syrup, rotten fruit, stale beer, etc. on fences or tree trunks to attact nocturnal lepidoptera, notably Noctuid moths. It seems that burning a cane field inadvertently results in «sugaring» on a large scale causing a concentration of army worm moths which happen to be in the vicinity.

It is not considered that complete defoliation of ratoon cane when 3 to 5 weeks old has any appreciable effect on ultimate cane yield. However, this point needs to be ascertained and some replicated plot experiments are in progress.

4. MISCELLANEOUS

The despatch of *Apanteles flavipes* Cam. to Madagascar, begun in December 1960, at the desire of the *Institut de Recherches Agronomiques de Madagascar* was discontinued in July. During this period, 45 consignments comprising about 17,000 cocoons were sent by air. It is believed that the parasite has now become established on *Proceras sacchariphagus* in the region of Ambilobe.

WEED CONTROL

E. ROCHECOUSTE

1. HERBICIDAL VALUE OF SUBSTITUTED UREAS AND TRIAZINE COMPOUNDS IN THE HUMID AND SUBHUMID AREAS

FOLLOWING up the work carried out in the superhumid areas with the substituted ureas DCMU and CMU and the triazine compounds Simazine and Atrazine, experiments were laid down with these chemicals this year in the humid and subhumid areas of the island. It must be observed, however, that in these regions chemical weed control is of lesser importance than in the superhumid zone. The main reasons are (i) the canes shade the interlines fairly rapidly thus setting up conditions unsuitable to weed growth, (ii) the trash lined up on the interlines after harvest assists in controlling the establishment of weeds owing to its slow decay.

The object of these trials was to determine whether in these drier areas the use of herbicides of low solubility such as the substituted ureas and the triazine compounds would not prove an economic proposition in comparison to the synthetic plant growth regulators MCPA and 2, 4 – D. Investigations were carried out in plant canes and ratoon canes.

Plant Canes

The substituted ureas DCMU (Karmex) and CMU (Telvar) and the triazine compounds Simazine and Atrazine (5 lb) were used alone and in combination with sodium chlorate (10 lb) and TCA (10 lb) and were compared to a standard formulation consisting of an MCPA or 2, 4 – D derivative (4 lb a.e.) TCA (10 lb) and sodium chlorate (10 lb). The herbicides were applied in pre-emergence spray about a week after planting at the above rates of the commercial product per arpent. The experiments were conducted in non-irrigated fields as well as in fields with surface or overhead irrigation. Weed assessment was made by the frequency-abundance method 4 months after herbicide application.

Ratoon Canes

In ratoon canes the substituted ureas DCMU and CMU and the triazine compounds Simazine and Atrazine (2 – 3 lb) were used in combination with sodium chlorate (2 – 3 lb) and TCA (5 lb) and were compared to a standard formulation consisting of an MCPA or 2, 4–D derivative (2 lb a.e.), sodium chlorate (2 – 3 lb.) and TCA (5 lb). Rates of application were in pounds of the commercial product per arpent of ratoon canes and weed assessment was made by the frequency-abundance method 3 months after herbicide application. In these experiments the trash was lined up on alternate interlines and the herbicides applied on the cane rows and on the interlines free of trash.

Results

In plant canes although differences were observed between the individual treatments yet on the average the substituted ureas DCMU and CMU and the triazine compounds Simazine and Atrazine gave very comparable results. Further it was found that the addition of sodium chlorate and TCA to these herbicides did not consistently improve their efficacy. In ratoon canes, a relatively similar observation was recorded.

Effects on weeds

Perennial weeds were in general not affected by the different treatments and the high scoring in some of the plots was mainly due to the presence of perennials such as *Oxalis debilis*, *Cyperus rotundus* and *Paederia fœtida*. Annual grasses were in general better controlled by DCMU and of these *Panicum maximum* and *Brachiaria reptans* may be mentioned. Of the broad leaved annuals, *Plantago lanceolata* and *Argemone mexicana* were the least affected by the different treatments.

Conclusions

Experimental work with the substituted ureas DCMU and CMU and the triazine compounds Simazine and Atrazine in the humid and subhumid sugar cane zones has shown that these herbicides were not consistently better than a formulation consisting of an MCPA or 2, 4–D derivative, TCA and sodium chlorate. Such an observation is of importance for it indicates that the use of these chemicals in those areas where rainfall is inadequate may prove uneconomic unless the aim in view is to eradicate a specific annual resistant to the MCPA and 2, 4–D derivatives.

From an economic view point, however, it must not be overlooked that during the warm wet season, January to March, when rainfall is not deficient, the use of these herbicides in the humid and subhumid areas may give very satisfactory results.

Table 19. Comparative efficacy of substituted ureas and triazine compounds in plant canes (4 months after herbicide application)

TREATMENTS (Rates in lb of the commercial product per arpent in 60 gallons of water)	WEED INFESTATION % STANDARD FORMULATION					
	Surface Irrigated		Overhead Irrigated		Non Irrigated	
	Locality Médine	Locality Amitié	Locality Cascade	Locality St. Antoine	Locality Bel Ombre	Locality Crève Coeur
CMU (5) ...	40	52	170	43	95	97
DCMU (5) ...	39	60	98	65	75	51
Simazine (5) ...	57	57	98	72	99	68
Atrazine (5) ...	—	—	—	45	83	—
CMU (5) + Sodium Chlorate (10) ...	57	50	86	40	49	119
DCMU (5) + Sodium Chlorate (10) ...	37	47	42	36	48	81
Simazine (5) + Sodium Chlorate (10) ...	50	60	48	60	52	111
Atrazine (5) + Sodium Chlorate (10) ...	96	—	—	49	65	—
CMU (5) + TCA (10) ...	78	70	190	32	53	54
DCMU (5) + TCA (10) ...	63	52	125	18	46	40
Simazine (5) + TCA (10) ...	74	52	90	43	44	97
Atrazine (5) + TCA (10) ...	64	—	—	38	49	—
CMU (5) + TCA (10) + Sodium Chlorate (10) ...	83	55	94	29	35	78
DCMU (5) + TCA (10) + Sodium Chlorate (10) ...	59	47	70	38	33	59
Simazine (5) + TCA (10) + Sodium Chlorate (10) ...	102	37	86	35	65	77
Atrazine (5) + TCA (10) + Sodium Chlorate (10) ...	85	—	—	25	73	—
RAINFALL						
Total rainfall (inches) during experiment ...	3.17	3.72	1.71	8.20	13.50	12.14
No. of rainy days ...	21	26	27	54	45	36
IRRIGATION						
Surface (4) — 2 inches per irrigation at monthly intervals ...	8.0	8.0	—	—	—	—
Overhead (8) — 1 inch per irrigation at fortnightly intervals ...	—	—	8.0	8.0	—	—
RAINFALL + IRRIGATION	11.17	11.72	9.71	16.20	13.50	12.14

Table 20. Comparative efficacy of substituted ureas and triazine compounds in ratoon canes (3 months after herbicide application)

TREATMENTS (Rate in lb of the commercial product per arpent in 60 gallons of water)	WEED INFESTATION % STANDARD FORMULATION — LOCALITIES: Union Ducray (1)	Union Ducray (2)	Terracine (1)	Terracine (2)
CMU (3) + Sodium Chlorate (3)	67	64	54	55
DCMU (3) + Sodium Chlorate (3)	84	52	69	17
Simazine (3) + Sodium Chlorate (3)	96	120	64	23
Atrazine (3) + Sodium Chlorate (3)	104	104	120	27
CMU (2) + Sodium Chlorate (2)	88	100	105	39
DCMU (2) + Sodium Chlorate (2)	80	48	82	33
Simazine (2) + Sodium Chlorate (2)	80	100	115	39
Atrazine (2) + Sodium Chlorate (2)	92	124	136	37
CMU (2) + Sodium Chlorate (2) + TCA (5) ...	68	56	67	27
DCMU (2) + Sodium Chlorate (2) + TCA (5) ...	48	36	64	30
Simazine (2) + Sodium Chlorate (2) + TCA (5) ...	60	60	113	47
Atrazine (2) + Sodium Chlorate (2) + TCA (5) ...	56	56	95	47
RAINFALL				
Total rainfall (inches) during experiment ...	9.84	8.08	6.59	10.64
No. of rainy days	32	33	31	44

2. EVALUATION OF NEW HERBICIDES

The logarithmic spraying technique has been adopted by the Institute for the evaluation of new herbicides because useful information can be obtained by this method in a relatively short time both with regard to the weeds and crop.

Two logarithmic trials were laid down this year with Prometone 2,4–bis (isopropylamino) – 6 – methoxy – 1,3,5 triazine and Paraquat 1, 1^1 – dimethyl 4, 4^1 bipyridylium di (methyl sulphate) in post emergence application of both canes and weeds. The herbicides were sprayed in plant canes one and two months old, and before their application the weed population on the logarithmic strips was assessed by the frequency-abundance method. One month after spraying each 15 yards of logarithmic plot was subdivided into 3 yard sub-plots. The effects of the chemicals on the individual weed species were assessed in each plot by a points system. The results obtained have been worked out in terms of 'overall effects' by the method described elsewhere by the writer (1959).

Results and conclusions

The annuals predominant in the plots at the time the sprayings were made were : *Solanum nigrum*, *Digitaria timorensis*, *Ageratum conyzoides*, *Crepis japonica*, *Oxalis repens* and *Plantago lanceolata* and of the perennials only *Kyllinga monocephala*, *Oxalis latifolia* and *Oxalis debilis* were fairly well distributed. At equivalent dosage rates Paraquat was found to be more effective on the general weed population than Prometone (table 21). However, while Prometone did not apparently affect cane growth, Paraquat produced a scorching effect on the cane foliage characterized by irregular reddish brown spots. At the higher rates of application, the herbicide caused more injury to the canes than at the lower rates and it affected one-month old canes more severely than two-month old canes.

REFERENCE

ROCHECOUSTE, E. (1959). Evaluating herbicides in sugar cane cultivation. *Proc. int. Soc. Sug. Cane Tech.* 10 : 549 — 55.

Table 21. Effect of Prometone and Paraquat on weed infestation (Assessment of weed mortality — 4 weeks after treatment)

Treatments	Weeds : One month old — Mortality abundance rating Dosage range per arpent (lb active) per 3 yard logarithmic strip					Weeds : Two months old — Mortality abundance rating Dosage range per arpent (lb active) per 3 yard logarithmic strip				
	5.0—3.8	3.8—2.8	2.8—2.1	2.1—1.6	1.6—1.2	5.0—3.8	3.8—2.8	2.8—2.1	2.1—1.6	1.6—1.2
Paraquat	97.0	96.3	96.3	97.0	95.5	96.7	94.9	94.2	94.1	94.2
Prometone	59.8	56.4	55.3	53.2	50.5	47.1	43.8	42.8	40.3	41.3

3. COMPARATIVE EFFECTIVENESS OF UROX, ATRATONE AND DCMU.

The herbicides Urox (3(p-chlorophenyl) 1,1–dimethylurea trichloroacetate), Atratone (2 - ethyl - amino - 4 - isopropylamino - 6 - methoxy-1,3,5 - triazine) and DCMU (N - (3, 4 - dichlorophenyl) $N^1.N^1$ - dimethyl urea) were evaluated in pre-emergence application at Belle Rive and Union Park of the superhumid zone. They were applied at the rates of 2.4 and 4.0 lb of active material per arpent just after planting and before weed emergence. Plot size was 1/150 arpent and the treatments were randomized with fourfold replications. The cane cuttings of the variety Ebène 1/37 were used and observations on cane germination and growth were made at regular intervals. Weed assessment was made by the frequency-abundance method 3 months after herbicide application.

Results

No effect on cane germination was observed in all treatments and the chemicals did not apparently affect cane growth. In both trials DCMU proved more effective than Urox and Atratone at equivalent dosage rates of applications (table 22). On the other hand Urox and Atratone gave very comparable results. However, it must be observed that *Oxalis repens*, a common annual of the superhumid localities, was more effectively controlled by Urox than by Atratone.

Table 22. Comparative effectiveness of Urox, Atratone and DCMU.

Herbicides (Rates in lb active per arpent)	Weed Infestation % Control — Locality Belle-Rive	Locality Union-Park
Urox (4)	62.5	31.4
Atratone (4)	65.6	44.0
DCMU (4)	25.0	19.8
Urox (2.4)	64.1	42.6
Atratone (2.4)	78.1	49.5
DCMU (2.4)	53.1	31.0

CULTIVATION, IRRIGATION, CLIMATE

1. COMPARATIVE STUDY OF SPRAY IRRIGATION AND SURFACE IRRIGATION ON GRAVELLY & FREE SOILS

G. MAZERY

THIS experiment was initiated in 1957*, the required funds being provided at the earlier stages by Government and by the Sugar Industry Reserve Fund. The site for the experiment was selected at Palmyre by arrangement with Médine S. E.

The main object of the experiment was to compare, under dry conditions, the merits of overhead and surface irrigation methods on latosolic reddish prairie – «gravelly soils» – and low humic latosol – «free soils» – from the agronomic and economic standpoints and to determine the relative advantages of the fully portable and the semi-permanent spraying systems.

The original plan comprised an area of about 56 arpents in gravelly soils and 65 arpents in free soils. Subsequently, however, it was found necessary to curtail these figures to 47 arpents and 36 arpents respectively. This change in the experimental layout was made necessary owing to the impossibility for the limited spraying equipment available to cope with the work during the drier periods when water supply proved inadequate and long working hours impracticable.

Irrigation was started with the fully portable equipment in March 1958 on the gravelly soils and the semi-permanent installation three months later on the free soils.

Frequency of irrigation depended on soil humidity as determined by plaster of Paris cells.

Sprayed plots received 2.5 inches of water per irrigation. Surface irrigated plots received varying amounts depending on soil types.

During the course of the experiment, data were collected on water consumption and cost of the different systems of irrigation and, in addition, meteorological observations and growth measurements were recorded.

1. Growth Aspects

Exploratory work in 1959 having shown that optimum growth was obtained with sprays of about 2.5 inches of water per irrigation, this regime was maintained subsequently throughout the duration of the experiments.

It will be observed (fig. 23) that on gravelly soils, spray irrigation has produced better cane growth than surface irrigation. On free soils, on the other hand, both methods of irrigation were comparable (fig. 24).

In general, surface irrigation and spray irrigation had the same effect on cane yields as indicated by figures given in Table 23.

* For a description of this experiment and equipment used, see *Ann. Rep. M.S.I.R.I., 1958*, p. 82.

Table 23. Tons cane per arpent* under spray and surface irrigation.

	Free Soils				Gravelly Soils			
	1958	1959	1961	Average	1958	1959	1961	Average
Spray Irrigation ...	33.6	41.0	38.3	37.6	27.7	29.1	30.5	29.1
Surface ,, ...	35.7	43.3	37.5	38.8	27.3	31.2	28.1	28.9

* The cane yields have been corrected for initial fertility differences existing in the fields prior to experimentation.

Gravelly soils

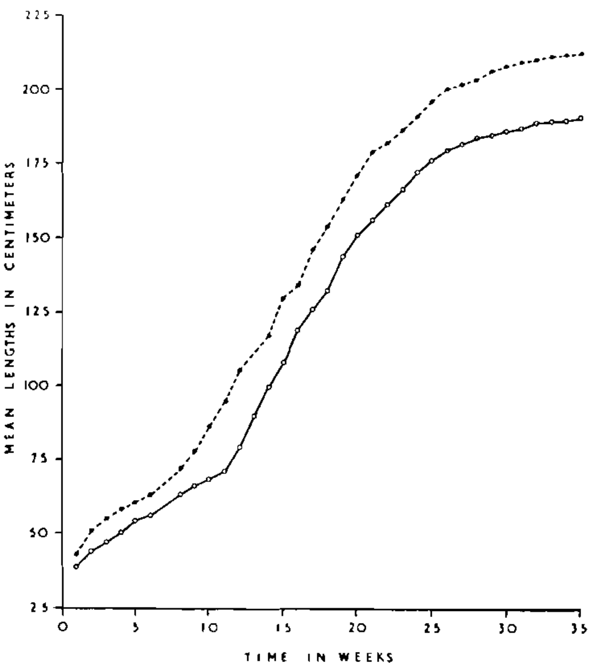

Fig. 23. Elongation, weekly intervals
Dotted line : overhead irrigation
Plain line : surface irrigation

Free soils

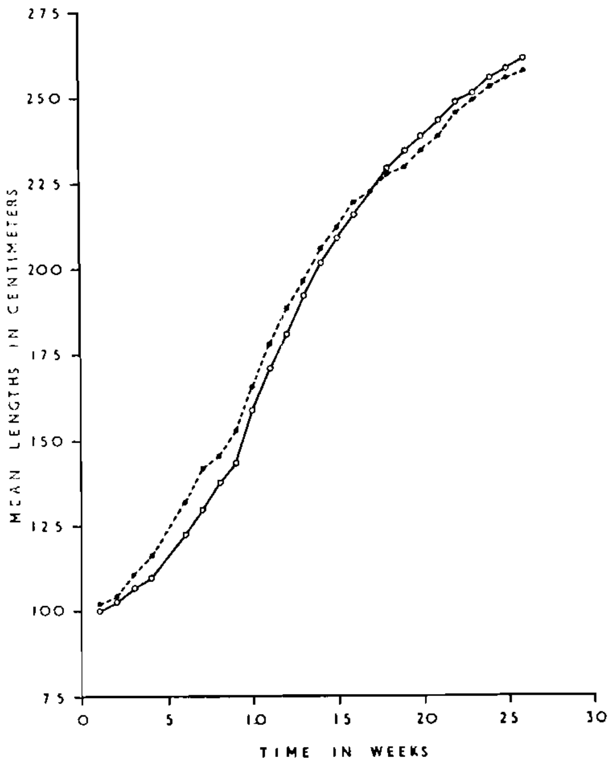

Fig. 24. Elongation, weekly intervals
Dotted line : overhead irrigation
Plain line : surface irrigation

2. Determination of Water Requirement

(a) *Bouyoucos Method.* Plaster cells were placed in the experimental fields at depths of 6 inches and 12 inches in order to use the variations in soil moisture as a guide to irrigation needs. It was observed that while there was a close relation between soil humidity at a depth of 6 inches and growth rate of the canes, the soil moisture at 12 inches gave no indication as to the water requirement of the plant. In many cases, however, when the Bouyoucos cells at a depth of 6″ indicated 60% available moisture, growth rate decreased, revealing a water shortage.

Further studies are being carried out in order to determine the depth at which the plaster cells should be placed in different soil types.

Under local conditions, however, the use of plaster cells in connection with large scale irrigation schemes is of limited value due to the fact that short inconspicuous leads have to be used so as to reduce theft by field labourers, and this renders the regular moisture readings difficult for the irrigation officer.

(b) *Water Balance Method.* This method is based on the assumption that water lost by evapotranspiration can be estimated by measuring the evaporation from an open water surface under similar conditions of environment.

It is difficult to establish a correction factor for converting the evaporation measurements into corresponding evapotranspiration because on one hand, the water removed from the soil depends on the physiological condition of the plant as well as on the coverage of the leaf canopy and, on the other hand, the evaporation figures depend on the type of evaporimeter used.

Comparative data have been obtained from three types of evaporimeters, viz. (1) the Standard Tank of the Research Committee Institute of Civil Engineers recommended by Penman; (2) the U. S. Weather Bureau Standard Tank (3) the «Irrigation Indicator» made by Wright Rain Limited.

On dry days, the evaporation obtained from the Penman Evaporimeter varied from 85% to 91% of those obtained from the U. S. Standard Evaporimeter during the periods June – July and October – December respectively. During the same periods, the corresponding figures obtained from the «Irrigation Indicator» have been 60% and 50% respectively. These differences may be due to the effect of wind on the instruments which vary considerably in shape, size and exposure.

In principle, water should be added to maximum field capacity when the water removed by evapotranspiration has brought the available moisture to 50% maximum retention capacity, due allowance being made for the rainfall during the period under consideration. However, it appears from the above that this technique needs further investigation before its practical value can be assessed.

3. Economics of the different Irrigation Systems

The comparative costs of water application by means of semi-permanent and fully mobile spraying equipments are given in Table 24.

Table 24. Cost of Spray irrigation.

	Semi-Permanent System Cost per arpent inch Rs. c.	100% Mobile System Cost per arpent inch Rs. c.
1. Depreciation of Diesel pumping unit ...	1 22	1 56
2. Maintenance	0 44	0 68
3. Fuel consumption	2 10	2 63
4. Lubricating oil	0 32	0 39
5. Depreciation of permanent equip. ...	0 42	—
6. Depreciation of mobile equip.	0 70	1 56
7. Labour including mechanic	1 76	2 76
8. Cost of water valued Rs. 1.00/16000 cu. ft. ...	0 24	0 24
TOTAL COST : ...	7 20	9 82

If allowance is made for the slightly less efficient pumping unit used with the fully mobile equipment, the difference in favour of the semi-permanent system is brought from 36 % to about 29 %.

The cost of surface irrigation has varied considerably from free soils to gravelly soils as illustrated by the following average figures (Table 25).

Table 25. Cost of Surface Irrigation.

		Free Soils	Gravelly Soils
Water required for one operator to work-cusecs	...	1.0	1.5
Area irrigated by one operator in 8 hours work arpents	...	1.3	0.6
Water applied per irrigation cu. ft. per arpent	...	22.000	72.000
Water applied per irrigation — inches ...	...	6	19
Number of irrigations per year ...	...	12	11
Cost of water valued at Rs. 1.00/16000 cu. ft. Rupees per arp. per year	...	16.50	49.50
Cost of labour — Rupees per arp. ...	...	31.20	55.00
Maintenance of channels – Rupees per arp. per year	...	40.00	40.00
TOTAL COST: Rupees per arp. per year ...	...	87.70	144.50

It must be pointed out that the average number of irrigations both overhead and surface has been on the low side due to the prolonged drought experienced in 1961.

The economics of various irrigation systems tried on free soils and on gravelly soils are summarized in Table 26.

Table 26. Summary of Results.

	Free Soils		Gravelly Soils	
Method of Irrigation	Spray (semi-permanent equipment)	Surface	Spray (mobile equipment)	Surface
Number of irrigations per year ...	12	12	11	11
Total water applied — inches per year	30	72	28	209
Cost of irrigation — rupees per year per arp.	216.00	97.70	274.96	144.50
Yield of cane — tons per arpent per year	37.6	38.8	29.1	28.9
Cost of irrigation — rupees per ton cane	5.74	2.26	9.45	5.00

It will be observed from the above figures that while spray irrigation allows a considerable saving of water, especially on gravelly soils, the higher cost of water application is not accompanied by a corresponding increase in cane yield.

The value of spray irrigation in any one case depends therefore entirely on the specific conditions prevailing in that particular case.

On free soils, when water is available, it is clear that surface irrigation is to be recommended. However, when land is available but water is the limiting factor, spray irrigation offers a distinct advantage. Such conditions are encountered generally in the western part of the island. On the very gravelly soils of the north and part of the eastern and southern coasts, where plantations are often severely affected by drought, spray irrigation should prove economical especially when a cheap source of energy is available.

I wish to acknowledge the valuable co-operation of the Manager and Staff of Médine S.E. in all circumstances during the course of the experiment.

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2. NOTES ON CLIMATIC CONDITIONS OF THE 1961 CROP YEAR

PIERRE HALAIS

The meteorological data systematically collected during the last 13 years, at first on three representative stations for the north, south and central sugar cane sectors were extended as from November 1959 to all five, west, north, east, south and central sectors, thus covering more fully the whole sugar cane area of the island.

The rainfall data have always been collected on the same eighteen key stations.

Minor corrections were applied to bring earlier temperature and wind recordings in line with present day data.

Figures 25 and 26 have been drawn to present a continuous picture of the changes which occurred during the three critical four months periods which constitute each yearly crop season. A distinction is being shown between the two sub periods of four months which normally make up the eight months vegetative period. This change in the presentation of meteorological data was thought adequate in order to set off the particular conditions which occurred during 1961. The maturation period extends from July to October.

A close study of the figures demonstrates that for the eleven consecutive years, that is between 1949 and 1959, no important changes relative to air temperature and wind velocity occurred. Consequently, moisture was the dominating factor in influencing cane and sugar production, as already stated in previous annual reports of the Institute.

Those moisture fluctuations, and their consequences on both cane tonnage and quality, should be considered as normal; however, the whole picture was altered after 1960, when wind and temperature changes brought about a more confused situation which eventually will turn out to contribute to a much better understanding of this complex problem.

The crop year 1960 was dominated by destructive cyclonic winds which caused considerable damage to the canes as described at length in last year's annual report of the Institute.

The first quarter of the 1961 crop season was notable for one of the most severe summer droughts in the history of Mauritius. November to February rainfall only reached 12.5 inches

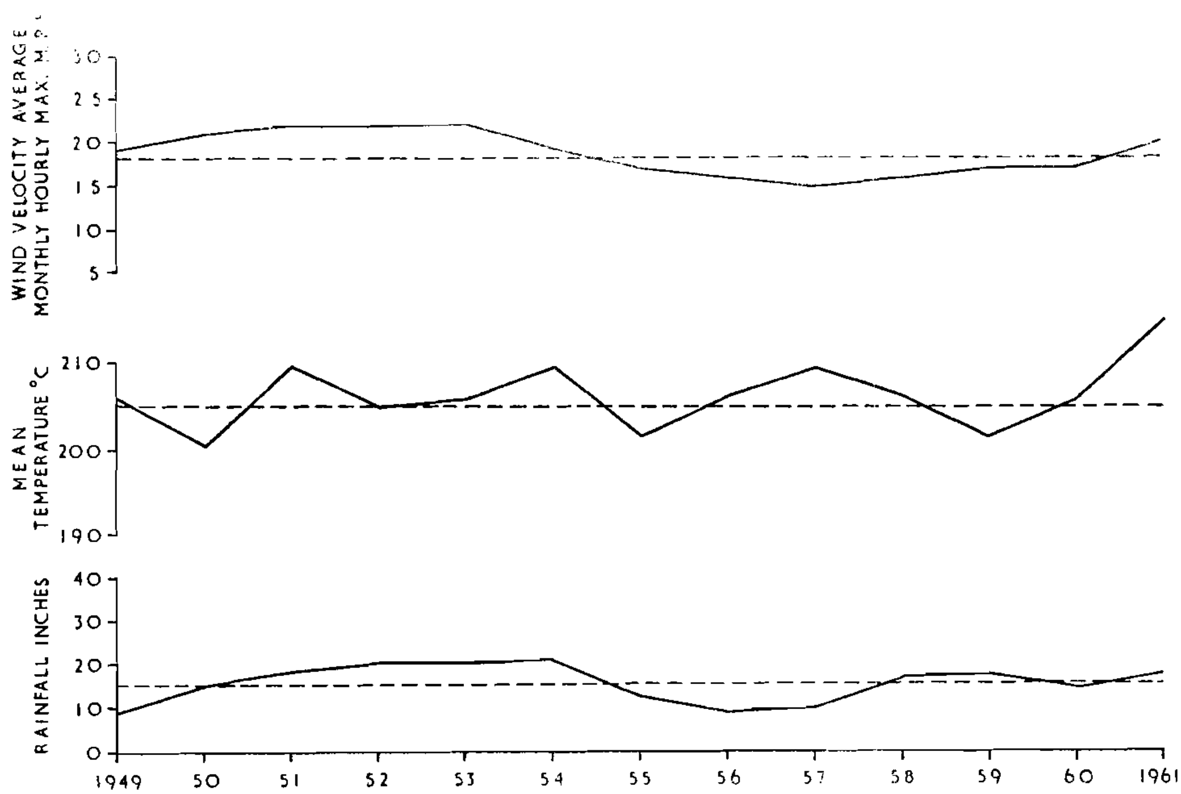

Fig. 25. Annual variations in rainfall, mean temperature and wind velocity during the maturation period July to October. The average values for these factors from 1949 to 1959 are indicated in dotted lines.

against an average of 31.0 for the years 1949 to 1959. This drought caused cane stalk elongation to come to a complete standstill in the drier sectors and to a significant slowering in the normally wetter parts of the island, for at least a month prior to the reappearance of rains at the end of February.

In consequence, the standing canes were in one of the worst conditions on record and crop prospects looked gloomy. However, the second half period of vegetation, from March to June, proved so favourable from the point of view of climatology, that a remarkable recovery of the canes took place, due to the combination of the three following factors :

(a) Sufficient and well distributed rainfall, amounting on an average for the sugar cane area of the island to 7.96 inches in March, 7.58 in April, 4.70 in May and 7.13 in June.

(b) Average air temperatures went steadily up and in excess of 1.1°C for the period over the average recorded between 1949 and 1959. It was the first time that this occurred since extensive air temperatures are being recorded locally.

(c) Wind slowed down gradually so that an average maximum of 14 miles per hour was registered as against 20 miles per hour, the normal value for the period 1949 to 1959. Again, such low figures were never recorded before.

Naturally, cane growth responded admirably to those ideal conditions, and the 1961 crop, instead of a disastrous one turned out passable.

The maturity period for 1961 came also as a surprise ; the rainfall for the period was above normal : 17.8 inches against 15.5, and the wind was also stronger than usual with 20 miles per hour against 18.6. A third operating factor weighed down maturity to a very low level as air temperatures were higher than normal by 0.9°C during the four months between July and October.

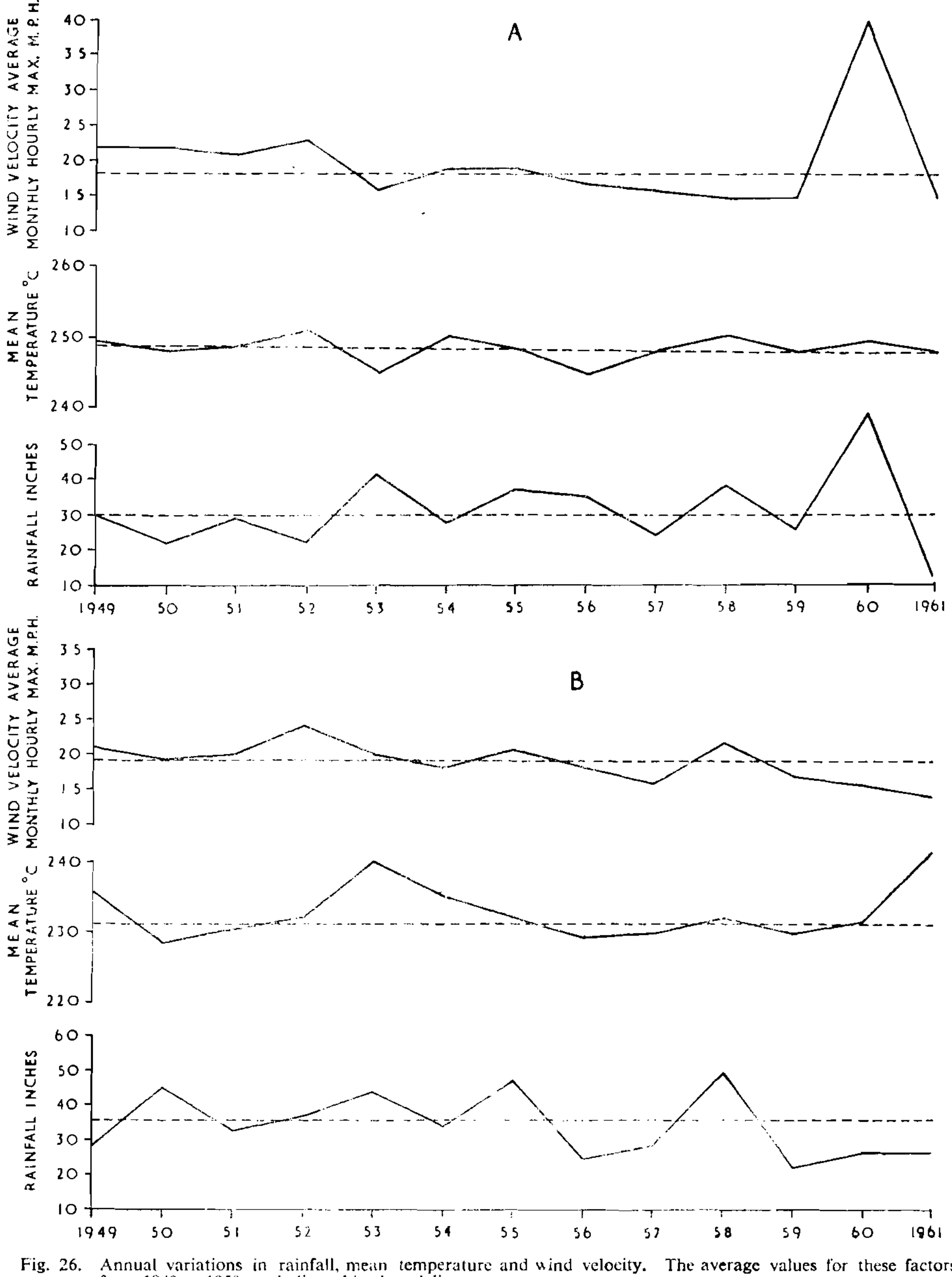

Fig. 26. Annual variations in rainfall, mean temperature and wind velocity. The average values for these factors from 1949 to 1959 are indicated in dotted lines.
A. First growth period, November to March.
B. Second growth period, April to June.

SUGAR MANUFACTURE

1. THE PERFORMANCE OF SUGAR FACTORIES IN 1961

J. D. de R. de SAINT ANTOINE

WITH the closing down of Labourdonnais, only 23 factories were in operation in 1961. A synopsis of the chemical control figures of these factories is given in tables XVII (i) – (v) of the Appendix.

Cane and Sugar Production.

In spite of a severe drought which prevailed during the first months of the growing season, a record weight of cane amounting to close to five million tons was harvested, partly as a result of the late rains that fell during the maturity period. These late rains, however, had a very marked effect on cane quality so that the tonnage of sugar manufactured was some 28,000 tons short of the 1959 record. Table 27 gives the area harvested, cane crushed and sugar production figures for the past five years.

Table 27. Area harvested (thousand arpents) cane crushed and sugar produced (thousand metric tons).

	1957	1958	1959	1960	1961*
Area harvested	169.6	176.7	183.1	186.0	186.4
Cane crushed	4,343.8	4,329.0	4,743.3	2,393.5	4,943.0
Sugar produced 98.5° Pol	562.0	525.8	581.0	236.1	553.4

Cane Quality.

As already pointed out, cane quality was poor in 1961, averaging 12.81 for the island as a whole, with a minimum figure of only 11.65 recorded at one factory for the crop.

The low sucrose content of the cane in 1961 results not only from a wet maturity period but also from the fact that a number of factories had to start crushing early in order to meet export quotas. Thus, three factories started late in June and by the 15th of July thirteen were in operation. Further, the duration of the crop was very long, averaging 123 days as against a figure of 108 days for the period 1956–59; thus, whereas most factories normally terminate their crop by the end of November, in 1961, eighteen factories were still crushing in December.

Sucrose content figures for the various sectors of the island are given in Table 28 for the period 1957–61 whereas average fibre per cent cane and mixed juice Gravity Purity for the same period are given in Table 29.

* Provisional figures.

Table 28. Sucrose per cent cane, 1957 - 61.

	Island	West	North	East	South	Centre
1957	14.59	14.87	15.53	14.33	14.16	14.33
1958	13.77	13.99	14.53	13.76	13.25	13.62
1959	13.76	14.09	14.67	13.66	13.23	13.66
1960	11.83	12.69	12.32	11.63	11.29	11.58
1961	12.81	13.06	13.46	12.53	12.42	12.91

Table 29. Fibre per cent cane and mixed juice Gravity Purity, 1957-61.

	Fibre % cane	*Mixed Juice Gravity Purity*
1957 ...	11.86	87.8
1958 ...	12.21	87.2
1959 ...	11.96	87.3
1960 ...	14.38	83.5
1961 ...	12.61	85.2

The increase in fibre content from 12.0 for the period 1957 – 59 to 12.6 in 1961 may be attributed mainly to the crushing of an increased tonnage of the high-fibre varieties M.147/44, B. 37172 and B. 3337. Table 30 shows the percentages of the most important varieties harvested on estate lands in 1959 and 1961.

Table 30. Percentage of varieties harvested on estate lands, 1959 and 1961.

	1959	**1961**
M.134/32 ...	33.8	18.1
Ebène 1/37 ...	28.0	27.0
M.147/44 ...	13.0	21.4
B.37172 ...	6.6	10.5
B.3337 ...	5.0	7.7

Thus, of the two low-fibre varieties grown on a large scale, M.134/32 is losing ground year after year, and the other, Ebène 1/37, is more or less at a standstill, whereas the high fibre varieties are steadily gaining ground, M.147/44 in particular.

Mixed juice purity was more than two units lower than normal in 1961. Its influence on boiling house work will be discussed later.

Milling.

A synopsis of crushing data and milling figures for the period 1957 – 61 is given in Table 31.

Table 31. Milling results, 1957 - 61.

	1957	**1958**	**1959**	**1960**	**1961**
No. of factories	26	25	24	23	23
No. of crushing days ...	105	108	110	89	123
No. of net crushing hours/day ...	20.89	19.50	20.32	14.92	18.86
Hours of stoppages/day* ...	0.80	0.89	0.82	0.57	0.80
Time efficiency	96.3	95.6	96.1	96.3	95.8
Tons cane/hour	76.1	82.5	87.7	77.0	92.8
Tons fibre/hour	9.03	10.07	10.49	11.07	11.70
Imbibition % fibre	231	217	230	209	222
Sucrose % bagasse	2.63	2.50	2.32	2.21	2.09
Moisture % bagasse	47.5	48.2	48.3	49.8	48.6
Reduced mill extraction ...	95.3	95.3	95.7	95.2	95.8
Extraction ratio	37.1	38.5	34.1	39.6	33.3

* Exclusive of stoppages due to shortage of cane.

The 1961 crop was the longest obtaining for a number of years, average number of crushing days per factory amounting to 123, with minimum and maximum figures of 83 (Mon Loisir) and 147 (Britannia) respectively. It should be pointed out that this long crop is not so much the result of the record tonnage of cane harvested but of inadequate cane supply. Thus the number of net crushing hours per day, exclusive of stoppages due to breakdowns, have dropped to a low 18.86 as against an average of 20.24 for the period 1956–59.

On the other hand, milling capacity keeps increasing year after year, average metric tons of cane ground per hour in 1961 having amounted to 92.8, equivalent to 11.70 tons of fibre per hour. Thus the situation is most paradoxical since the main object of incurring heavy capital expenditure to increase milling capacity is to reduce crop time and benefit from a higher average sucrose content of cane. It is also paradoxical that in an overcrowded island where the rate of increase of population amounts to some 20,000 yearly, it should not be possible to supply cane to factories more adequately. The problem is doubtless a complex one, but should be carefully studied. Reducing crop time would not only cut down running expenses and result in greater benefit from capital expenditure incurred to increase factory capacity, but would mean more sugar in the bags, hence more money into the country.

Milling work has been particularly good in 1961, average reduced mill extraction recorded amounting to 95.8, corresponding to an extraction ratio of 33.3. The best milling efficiency was obtained at Riche en Eau with a reduced mill extraction of 97.1, whilst Beau Champ and The Mount recorded 96.8. Bagasse moisture was low on the average, with a minimum of 45.90 at Riche en Eau, and eleven factories out of 23 recording less than 48 per cent moisture as against eight out of 24 in 1959 and ten out of 25 in 1958.

The Rivière imbibition system was used with success at Belle Vue, Solitude and Union Flacq but it was unfortunately not possible to assess exactly the benefits derived from the installation. Belle Vue, which did not operate in 1960, completed the installation of its milling tandem which now consists of two Fives-Cail and two Walkers units each independently driven by a steam turbine.

Processing

Juice clarification was easy and caused no problem in 1961. The first Prima-Jep clarifier to be installed in Mauritius functioned satisfactorily at Belle Vue.

Several more filter presses were replaced by rotary vacuum filters so that 17 factories out of 23 were equipped with the latter for the crop. As a result, sucrose per cent cake and sucrose lost in cake per cent cane decreased slightly as compared to the figures obtained the previous year. Yet, as already pointed out in the 1959 issue of this report, filter operation in Mauritius still suffers from inadequate control in many factories. Thus, very few chemists calculate filter retention and cannot therefore evaluate filtration efficiency. It is with the object of improving this situation that a study, which is published further in this report, was carried out during the crop on the various methods that may be used for the determination of retention.

Boiling house work was a little better in 1961 than in the previous years. As may be seen from Table 32, magma purity was higher and A–massecuite purity was only 3.3 units below syrup purity, as against 7.0 for the period 1957–59, indicating less boiling back. Purity drops between massecuites and molasses were also higher. Partly as a result of the installation, in many factories, of good low-head calandria vacuum pans it was possible to boil heavy final massecuites of a high crystal content.

Gravity purity of final molasses averaged 35.7, the lowest figure on record to date. It should be pointed out, however, that the relatively higher reducing sugars content was conducive to better exhaustion.

It will be observed from Table 33 that, in spite of this lower purity, sucrose losses in final molasses were higher in 1961 than during the previous years, disregarding the abnormal 1960 crop. This results from

Table 32. Syrup, massecuites and molasses, 1957-61.

	1957	1958	1959	1960	1961
Syrup purity	88.2	87.3	87.9	83.6	85.3
A massecuite purity	79.6	81.0	81.7	79.7	82.0
Purity drop, A. massecuite	20.7	20.8	20.1	20.6	22.3
,, ,, B. ,, ...	21.1	20.8	21.1	19.5	22.2
,, ,, C. ,, ...	22.3	22.7	23.6	21.6	24.6
Crystal % Brix in C massecuite ...	33.4	34.1	35.3	33.2	36.0
Magma purity	82.1	81.0	81.5	81.8	82.3

Table 33. Final molasses, losses, and recoveries.

	1957	1958	1959	1960	1961
Final molasses: Gravity purity ...	37.7	37.9	36.7	37.2	35.7
Red. Sug. % Brix ...	16.2	15.8	14.6	14.6	16.6
Tot. Sug. % Brix ...	53.9	53.7	51.3	53.4	52.4
Wt. % cane @ 95° Brix ...	2.45	2.59	2.53	3.08	2.81
Sucrose loss in final molasses % cane ...	0.92	0.93	0.88	1.09	0.96
Undetermined losses % cane	0.23	0.17	0.16	0.26	0.21
Industrial losses % cane	1.22	1.18	1.13	1.43	1.24
Boiling House Recovery	91.3	91.1	91.4	87.1	89.9
Reduced Boiling House Recovery ...	89.0	89.3	89.6	88.5	89.7

the fact that, with the low mixed juice purity prevailing, molasses per cent cane was appreciably higher in 1961 than during the previous years.

For the first time in Mauritius, fully automatic 48″ x 30″ centrifugals running at 1700 R.P.M. were installed at Mon Loisir for the curing of C massecuites. The machines, manufactured by ASEA – Landsverk are equipped with Ward-Leonard drives. A series of experiments were carried out during the crop with them, the results of which will be published elsewhere*. However, a summary of the results obtained is given in the introduction of this report.

In at least two factories, froth fermentation caused the loss of important quantities of final molasses in storage. The main reasons for molasses foaming are believed to be the use of excessive amounts of lime in clarification and of too high temperatures during the boiling of the final massecuites. Hence the practice often resorted to of blowing steam into the molasses to facilitate pumping should be strongly condemned. Further, since the destruction of several hundred tons of molasses represents an important monetary loss, piping systems should be installed in all storage tanks and compressed air blown through the molasses at regular intervals to keep foaming from setting in.

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* *Proceedings 11th Congress, I.S.S.C.T.*

2. TWO-BOILING v/s THREE-BOILING SYSTEM

by

H. F. WIEHE

With a view to simplifying the boiling process and securing a better control over the boiling house operations, a two-boiling system was started in one of the sugar factories of the island towards the end of the 1959 crop. The process was studied more fully and followed throughout the whole 1960 campaign during which the following average figures were obtained:

	Brix	Apparent purity
Syrup ...	52.2	82.6
A massecuite ...	97.0	72.9
A molasses ...	85.6	51.8
C massecuite ...	99.9	58.3
Final molasses ...	97.0	36.6

Although simpler, the process adopted proved less flexible and seemed to require more equipment than the three-boiling system. In spite of the high pan capacity of the factory, 3.5 tons/T.C.H., quite often bottle-necks occurred and the crushing rate had to be slowed down to allow partial liquidation.

The purpose of the present article is to study the equipment capacity involved for the two-boiling process adopted as compared to that required for the three-boiling process normally used in Mauritius.

In Table 34 are given Brix and purity figures from which a solids balance has been worked out for each of the boiling schemes.

Table 34. Average Brix and purity figures for the two-boiling and three-boiling systems.

	Three-boiling system		Two-boiling system	
	Brix	Apparent purity	Brix	Apparent purity
Syrup	60	87	60	87
A massecuite	95	85	96	73
A molasses	—	61	—	49
B massecuite	96	70	—	—
B molasses	—	47	—	—
C massecuite	99	55	99	55
Final molasses	—	31	—	31
A & B sugars	—	99	—	99
C sugar	—	87	—	87
Magma for A & B footings ...	—	87	—	87
Syrup and A molasses for C footings	—	69	—	69

A summary of the solids balance worked out for each of the systems is given hereunder.

Table 35. Summary of solids balance.

	Three-boiling system	Two-boiling system
Kilos solids in syrup	100,000	100,000
,, ,, ,, A massecuite	105,800	170,400
,, ,, ,, A molasses	38,900	88,600
,, ,, ,, B massecuite	35,100	—
,, ,, ,, B molasses	19,600	—
,, ,, ,, C massecuite	30,800	30,800
,, ,, ,, Final molasses	17,600	17,600
,, ,, ,, A and B sugars	82,400	81,800

Using the Brix figures given in Table 34 and assuming a specific weight of 40 kg/cu. ft. for A, B and C massecuites, the volumes of strikes to be processed in the two boiling schemes can now be calculated.

(a) *Three-boiling system*

$$\text{Volume A massecuite} = \frac{105800}{0.95 \times 40} = 2784 \text{ cu.ft}$$

$$\text{Volume B massecuite} = \frac{35100}{0.96 \times 40} = 914 \text{ cu.ft.}$$

$$\text{Volume C massecuite} = \frac{30800}{0.99 \times 40} = 778 \text{ cu.ft.}$$

4476 cu.ft.

(b) *Two-boiling system*

$$\text{Volume A massecuite} = \frac{170400}{0.96 \times 40} = 4438 \text{ cu.ft}$$

$$\text{Volume C massecuite} = \frac{30800}{0.99 \times 40} = 788 \text{ cu.ft.}$$

5216 cu.ft.

Assuming that the time required to boil a strike (including graining, discharging and steaming) is as follows :

	Three-boiling system	*Two-boiling system*
A massecuite	4 hours	6 hours
B massecuite	6 hours	—
C massecuite	10 hours	10 hours

the number of strikes per pan per 24 hours will be :

(a) *Three-boiling system* :

A massecuite : 24 ÷ 4 = 6
B massecuite : 24 ÷ 6 = 4
C massecuite : 24 ÷ 10 = 2.4

(b) *Two-boiling system* :

A massecuite : 24 ÷ 6 = 4
C massecuite : 24 ÷ 10 = 2.4

The pan capacity required for the two processes can now be determined :

(a) *Three-boiling system* :

A massecuite : 2784 ÷ 6 = 464 cu. ft.
B massecuite : 914 ÷ 4 = 229 cu. ft.
C massecuite : 778 ÷ 2.4 = 324 cu. ft.

1017 cu. ft.

(b) *Two-boiling system* :

A massecuite : 4438 ÷ 4 = 1110 cu. ft.
C massecuite : 778 ÷ 2.4 = 324 cu. ft.

1434 cu. ft.

Additional pan capacity required for the two-boiling system as compared to the three-boiling system

$$= \frac{1434 - 1017}{1017} \times 100 = 41\%$$

Additional crystallizer and centrifugal capacity required for the two-boiling system as compared to the three-boiling system

$$= \frac{5216 - 4476}{4476} \times 100 = 17\%$$

From the standpoint of equipment capacity, the above figures clearly show that the three-boiling process, as practised in Mauritius, is more economical than the two-boiling process discussed above. This results from the fact that in the latter process the A massecuite purity is only 73, as against a syrup purity of 87. In other words, a considerable amount of boiling back has to be resorted to.

The question then arises whether it would be practical and economical to adopt a two-boiling system when, as a result of unfavourable climatic conditions for instance, the syrup purity is abnormally low, say, 82°. If the A massecuite purity were to be kept at 73 as in the two-boiling process discussed, the amount of boiling back would no doubt be reduced, but it can nevertheless be shown that, even then, the boiling scheme would require 20% more pan capacity and 4% more crystallizer and centrifugal capacity than the three-boiling system.

On the other hand, it should be noted that with a syrup of low purity the two-boiling process might prove beneficial if a first massecuite of 80 instead of 73 purity were aimed at, being given the appreciable reduction in boiling back. The main difficulty, however, would probably reside in graining and building the final strike on runnings of 56 purity assuming a purity drop of 24° between A massecuite and A molasses. Mention should here be made that such a scheme has already been studied by NOEL (1959) who has shown that, apart from an increase in graining time of 15 to 20%, the use of molasses of 56 - 57 purity as footing for the C massecuite was not a serious drawback under the conditions prevailing and with the equipment available at St. Antoine factory in 1958.

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3. FILTERABILITY OF RAW SUGAR

E. C. VIGNES

Introduction

The filterability of a raw sugar is of particular interest to the refiner. Poor filtering sugars are difficult and costly to refine. In the first place, they quickly block up filter presses and, secondly, impair the rate of flow of liquor through char filters, resulting in loss of efficiency.

All raw sugars contain a certain amount of undesirable impurities. These occur as colloid material or as particles too large to be truly colloidal in nature. Some authorities believe that the filtration-impeding effect of these particles are primarily caused by their size rather than their chemical nature. At all events, the percentage of insoluble solids has a direct bearing on the filtering characteristics of raw sugar. The film of molasses surrounding sugar crystals does contain some of the unwanted constituents but it is well known that non-sugars are fairly uniformly distributed throughout the crystals as well. Although affination removes the surface film, that part of the impurities which has found its way inside the sugar crystal must be blamed for bad filtration.

Non-sugars like silica, starch, gums, waxes etc. have all been described at some time or other as the cause of poor filterability. The problem has held the attention of sugar technologists for a long time but in spite of the large amount of research carried out so far, much of it is still not quite understood.

The fact that raw sugar manufacturers cannot predict the behaviour of their sugars under refinery conditions constitutes a great handicap. Polarisation and ash content do not give any indication. Very often good polarising sugars with low ash give extremely troublesome melts. On the other hand, all the usual filterability tests are of doubtful help in evaluating refining qualities. The more commonly employed test, namely the Elliot test, is empirical and has little to recommend it. There is no satisfactory evidence that it will give reliable and reproducible results when applied by different individuals to a variety of raw sugars. Moreover refiners, whether in U.K., U.S.A. or Australia, have abandoned the method since, from their experience, it is of little value to refiners using high efficiency affination machines and carbonatation plants.

Therefore it is becoming increasingly clear that a test, which will give filterability values in the laboratory having a satisfactory correlation with refinery observations made on Mauritius raws, must be found. With this aim in view the method, described by NICHOLSON & HORSLEY (1956), was selected as affording the greatest possibilities and investigated accordingly. This test has been claimed as being of value in picking a sugar that is likely to filter badly in a carbonatation process. Undoubtedly it has certain obvious advantages over the Elliot method; namely, the use of a definite Brix, a pH close to that prevailing during refining and the use of a smaller amount of filter aid. These features simulating more closely the actual working conditions, it is not unreasonable to expect more realistic values of filterability. In particular, the smaller amount of filter aid is important, as in practice it has been shown that large quantities tend to obscure differences in the behaviour of sugars by "swamping" the effect of the impurities.

The object of this study was to determine what factor has the greatest influence on filtration. Accordingly, samples of export sugars were examined for silica, starch, gums, wax and phosphates by well-known methods. The results were analysed statistically in an endeavour to determine the degree of correlation existing between filterability values and amounts of specific impurities. Finally, filterabilities, obtained by both Elliot and Nicholson methods, were compared.

EXPERIMENTAL

Equipment.

The apparatus has been described by NICHOLSON & HORSLEY (1956). Celite 505 was used as filter-aid and calcium acetate ethanolamine mixture as buffering agent. The syrup was filtered through a Whatman No. 54 paper under a constant pressure of 50 lbs./sq. in. Filtration rates were reported as percentage of the rate for pure sugar syrup. Sufficient syrup was used to fill the whole body of the apparatus. Following is a description of the actual working conditions.

Procedure

A mixture of 330 g. sugar and 220 ml. water is stirred until the sugar is completely dissolved. Brix is then adjusted to 60° using a refractometer and pH to 9.0 with calcium acetate/ethanolamine buffer using a glass electrode. The mixture is stirred for 3 minutes, left standing for 20 minutes, stirred again for one minute and poured into the apparatus. Next, the temperature of the mixture is taken, the head of the apparatus is screwed on and pressure applied. After allowing the filtrate to run to waste for the first 2 minutes, the filtrate flowing for the next 6 minutes is collected in a graduated cylinder, the volume collecting in each minute interval being noted. Pressure is afterwards released, the head of the apparatus removed and the temperature of the residual contents of the filter taken. The rise found in practice was never higher than 0.5°C.

Filterability figures after 6, 7 and 8 minutes, at the average temperature of the test, were determined as described in the method. The three values obtained were averaged to give the filterability of the raw sugar.

Calibration

This was carried out in a constant temperature room. The filter disc employed was calibrated at three different temperatures, namely 20.1°C, 23.0°C and 25.1°C using Tate and Lyle refined sugar. Calibration curves were obtained by plotting volume of filtrate collected at the end of each minute against temperature. Straight lines were obtained.

Reproducibility.

The filterability of a sample of Mauritius raw sugar was determined on nine different occasions and the following values found : 15.4, 16.9, 15.2, 16.8, 15.5, 15.3, 15.1, 15.0, and 15.4 giving an average of 15.6. The maximum difference between two values is 1.9, in other words reproducibility is well within the 15% difference allowed by the method.

Experimental Data

Filterabilities, using the Nicholson method, were determined on all samples examined. It was possible to analyse only eleven samples for their phosphate content. Twelve other samples were available for the determination of wax and gums. In addition, Elliot filterability values were also obtained on these twelve samples. Twenty-one samples were examined for starch and thirty-two for silica. The results obtained were subjected to statistical analysis. All data obtained are shown in Tables 36 – 39.

Since the suitability of a routine test depends as much on its practicability as on its technical soundness, the time consumed during the test was carefully noted. From observations made, one worker supplied with the necessary equipment can easily perform 8 to 10 determinations per day.

Methods of Analysis Followed.

Wax — As described by BROWNE and ZERBAN in *Sugar Analysis*, 3rd. edition, p. 1092.

Phosphate — The well known colorimetric method using a Lumetron Colorimeter.

Starch — The colorimetric method as described in *S.A.S.T.A. Proceedings, 1954.*

Silica — The colorimetric method as described in *S.A.S.T.A. Proceedings, 1957.*

Gums — As described by BROWNE and ZERBAN in *Sugar Analysis* 3rd. edition, p. 1093.

Results.

Table 36. Effect of Starch on Filterability.

Filterability (Nicholson)	Starch %	Filterability (Nichloson)	Starch %
28.4	0.0225	28.3	0.0150
23.7	0.0255	27.7	0.0195
35.8	0.0185	17.5	0.0275
33.6	0.0165	27.3	0.0215
29.5	0.0260	34.5	0.0175
16.2	0.0265	22.0	0.0215
4.1	0.0395	38.6	0.0185
19.7	0.0150	11.1	0.0200
2.5	0.0280	17.0	0.0310
29.8	0.0135	32.1	0.0215
15.5	0.0240		

Table 37. Comparison between Filterabilities. Gums and Wax content of Raw Sugars.

Filterability (Nicholson)	Filterability (Elliot)	Gums %	Wax %
35.4	75.8	0.1013	0.0134
37.9	75.8	0.2193	0.0122
38.6	91.5	0.1260	0.0081
34.0	78.2	0.1713	0.0116
29.6	78.6	0.1280	0.0162
29.8	66.5	0.1460	0.0117
42.0	76.7	0.1620	0.0093
39.3	82.9	0.1233	0.0063
33.8	79.9	0.2413	0.0104
37.6	84.6	0.2280	0.0056
28.0	80.8	0.2527	0.0096
29.8	68.7	0.1513	0.0064

Table 38. Filterability and Silica Content of Raw Sugars.

Filterability (Nicholson)	Silica %	Filterability (Nicholson)	Silica %
28.4	0.0130	22.0	0.0110
23.7	0.0138	38.6	0.0195
35.8	0.0118	11.1	0.0146
33.6	0.0145	32.1	0.0103
29.5	0.0130	35.4	0.0105
16.2	0.0138	37.9	0.0115
4.1	0.0105	38.6	0.0075
19.7	0.0220	34.0	0.0160
2.5	0.0153	29.6	0.0155
29.8	0.0149	29.8	0.0160
15.5	0.0113	42.0	0.0085
28.3	0.0121	39.3	0.0115
27.7	0.0120	33.8	0.0150
17.5	0.0215	37.6	0.0095
27.3	0.0180	28.0	0.0140
34.5	0.0140	29.8	0.0145

Table 39. Filterability, Phosphate and Starch Content of Raw Sugars.

Filterability (Nicholson)	Phosphate ppm	Starch %
29.5	8.4	0.0260
16.2	8.4	0.0265
19.7	5.4	0.0150
15.5	6.7	0.0240
28.3	4.8	0.0150
35.8	9.0	0.0185
4.1	5.4	0.0395
29.8	7.2	0.0135
2.5	10.5	0.0280
17.5	6.7	0.0275
27.3	10.0	0.0215

Statistical analysis of results tabulated gave the following relationships. Correlation coefficient :

(i) For 21 pairs between Filterability and Starch. r=0.645, significant at 1% level.
(ii) For 12 pairs :
 (a) Between Filterability and Gums : r=0.211, not significant.
 (b) Between Filterability and Wax : r=0.344, not significant.
(iii) For 11 pairs :
 (a) Between Filterability and Phosphate : r=0.144, not significant.
 (b) Between Starch and Phosphate : r=0.086, not significant.
(iv) For 32 pairs between Filterability and Silica : r=0.248, not significant.

Discussion.

Data obtained reveal a direct relationship between filterability and starch content. Therefore, the results of the present study lead us to believe that the latter is probably the main cause of bad filterability in Mauritius raws. This is precisely what had already been deduced from practical experience gained during refining. It would appear that filtration of melts starts to give difficulties as soon as the amount of starch in the raw sugar reaches 150 ppm. The deterioration of local sugars coincides with the planting of new varieties of cane rich in starch as reported by de SAINT ANTOINE and PARISH (1960). Other workers have also noted that there is a definite correlation between starch in sugars and filtering characteristics. Thus BUCHANAN (1959) finds that filtration rate varies inversely with the concentration of starch in the sugar solution. According to this author, starch hinders filtration in two ways, namely by blocking of the filter cake by starch particles and by exerting a viscosity effect during filtration. Moreover, starch has a stabilizing effect on colloids as well as affecting the particle size of calcium carbonate precipitate formed inside a sugar solution. Consequently, it is probably no coincidence that raw sugars, e.g. from Natal and Australia, which have the reputation of being difficult to refine (BOYES, 1958), also have starch contents of well over 150 ppm. (INUMA, 1956, ALEXANDER, 1957). In this connection, POWERS (1959) reports that cane varieties under certain climatic conditions retain a significant amount of starch degradation products and yield raw sugars giving filtration difficulties to refiners using carbonatation; a considerable portion of this impurity occurs as inclusion inside the crystal itself, no amount of washing or affination having any effect on the filterability.

It will be noticed that no correlation has been found between filterability and silica. This appears to be in opposition to conclusions reached by certain authors (ALEXANDER, 1957, CHU & CHU, 1961); but as pointed out by DOUWES DEKKER (1960), the difficulty in the interpretation of results of various investigations is that each worker uses his own technique and different techniques may show different results.

As was to be expected, a comparison between Elliot and Nicholson tests shows no constant factor to translate Elliot values into Nicholson values or vice versa.

The results of the study reviewed above indicate that the Nicholson method of determining filterability of raw sugars is more reliable than Elliot's method.

The adoption of this method in Mauritius should result in a better assessment of the refining qualities of Mauritius raws.

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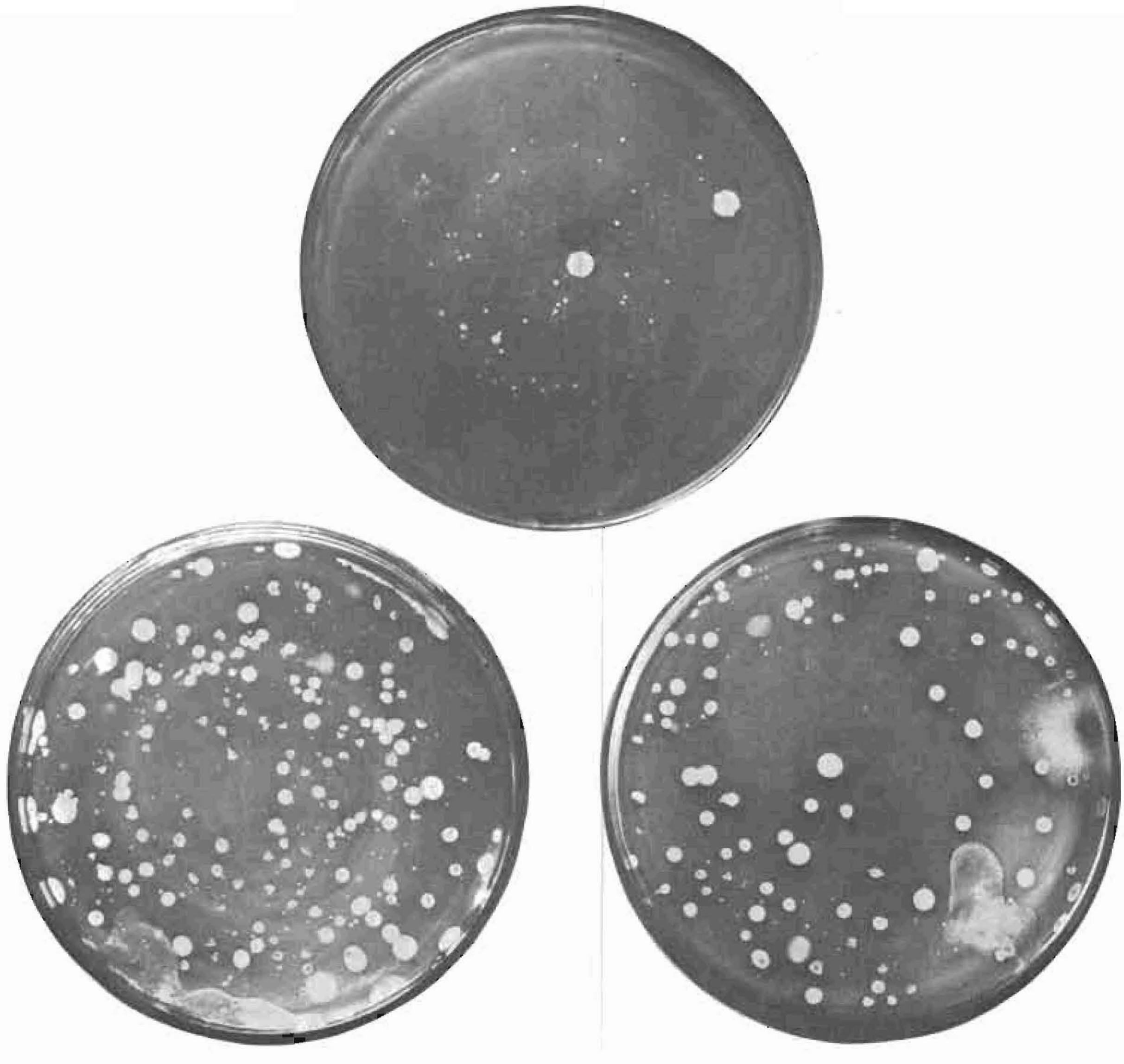

Fig. 27. Isolates on osmophilic agar derived from : *top* — massecuite discharged from the vacuum pan (bacterial colonies only) ; *bottom* (yeast colonies), *left* — massecuite after cooling in the crystallizer, *right* — raw sugar.

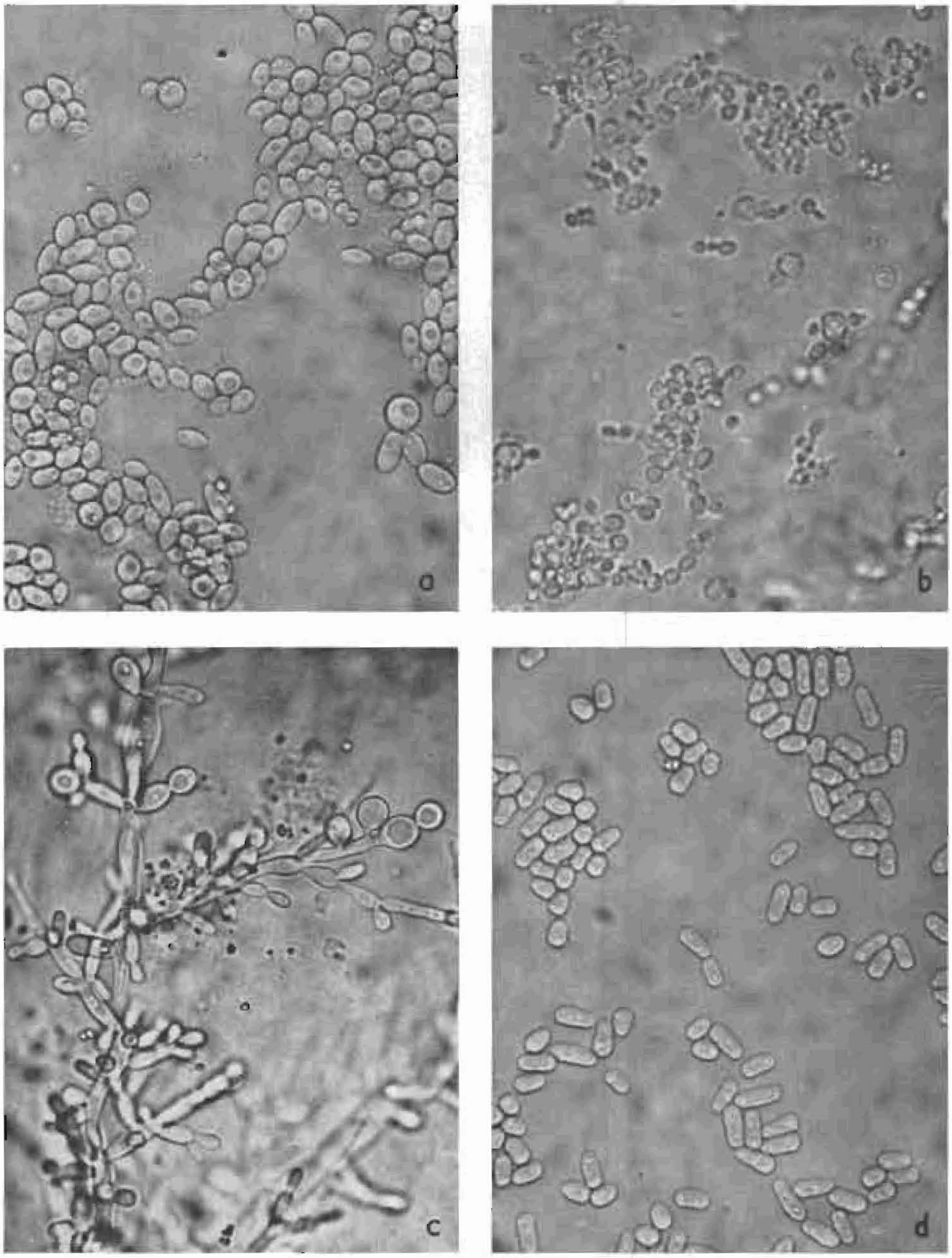

Fig. 28. Yeast cells from raw sugar. (a) *Saccharomyces rouxii* (b) *Torulopsis versatilis* (c) *Candida tropicalis* (d) *Schizosaccharomyces pombe.*

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4. PRELIMINARY NOTE ON THE PRESENCE OF OSMOPHILIC YEASTS IN RAW SUGARS

R. ANTOINE, R. de FROBERVILLE & C. RICAUD

In 1960, the Mauritius Sugar Syndicate was informed by Messrs. Tate & Lyle Co. Ltd. that, on emptying a large silo in which 4,300 tons of Mauritius raws had been kept for several months, it was found that the sugar had stored badly. The analysis of the reclaimed raw showed that the polarisation had dropped 2.7° and examination revealed the presence of two distinct types of yeasts. One contained no invertase and was of the normal osmophilic type commonly encountered; but the other, allied to the brewing yeasts, was highly fermentative, contained invertase and had not been seen before in raw sugars.

The first two authors who visited during the year the Tate and Lyle Research Laboratories in Kent had an opportunity of discussing the problem and planning the experimental work. The senior author visited the Centraalbureau voor Schimmelcultures at Delft in Holland in connection with the identification of the yeast cultures. The valuable assistance received from Dr. Pamela Scarr of Tate & Lyle and Mrs. N. J. W. Kreger-Van Rij of Delft is gratefully acknowledged.

Experimental work started during the 1961 crop in order to assess the yeast flora of Mauritius raws and their effect upon the keeping qualities of the sugars.

A preliminary screening of sugars from the 23 factories began in October. The investigations were conducted on (a) fermentation tests and (b) plate counts on osmophilic agar in order to locate the factories with the highest yeast flora. Representative factories were then selected and the yeast content of (a) the massecuite as discharged from the vacuum pan, (b) the same massecuite fed into the centrifugal after cooling and (c) the sugar and (d) the molasses derived was determined.

Yeasts were not encountered in (a) but were present in increasing amounts in (c), (b) and (d) respectively (fig.27). It appears, at this stage that contamination by yeasts takes place in the crystallizer.

The morphological and physiological studies of the yeasts encountered were conducted and after comparison with type cultures and tentative identification the isolates were forwarded to the Centraalbureau voor Schimmelcultures for final identification.

Saccharomyces rouxii (fig. 28(a)) was the osmophil most commonly encountered. The others isolated include : *Schizosaccharomyces pombe* (fig. 28 (d)), *Saccharomyces roseus* and probably *Candida tropicalis* (*fig.* 28 (c)), *Torulopsis etchellsii*, *T. versatilis* (fig. 28 (b)) and *Endomycopsis ohmeri.*

5. CHEMICAL CONTROL NOTES

(a). FURTHER STUDIES ON THE USE OF THE REFRACTOMETER FOR ROUTINE CHEMICAL CONTROL

F. LE GUEN & M. RANDABEL

Following the preliminary work carried out by LAMUSSE (1960), it was decided to study more thoroughly the use of the refractometer instead of hydrometers for the routine chemical control of sugar factories. The original project was to carry out parallel controls with the refractometer and the hydrometers in three factories over the whole of the 1961 crushing season. Unfortunately the Bausch and Lomb precision refractometers were not received until the early days of November when the crushing season was nearly completed. Hence it was possible to carry out parallel controls for only one week at Factory A, two weeks at Factory B and four weeks at Factory C.

Comparisons were made during these periods with first expressed juice, mixed juice and final molasses. The analytical methods used for the densimetric Brix and sucrose determinations were the standard ones followed in Mauritius for routine chemical control. For the determination of refractometer Brixes and corresponding sucrose determinations in molasses, the methods adopted were those used in Hawaii and described in the *Official Methods of the Hawaiian Sugar Technologists for Routine Control of Cane Sugar Factories.* The Hawaiian method of determining sucrose in juices differs very little from that used in Mauritius since in the case of juices no dilution is necessary. It was therefore deemed preferable for the purpose of the experiment to use the latter method which involves the removal of excess lead with potassium oxalate.

The results of these analyses are published in Table 40 from which it may be seen that the refractometer Brix is usually lower than the densimetric Brix and hence the sucrose value calculated from the pol reading and the refractometer Brix is usually slightly larger than the

Table 40. Comparison of Brix, Sucrose and Purity Values obtained with densimetric and refractometer controls.

	First Expressed Juice			Mixed Juice			Final Molasses		
FACTORY	A	B	C	A	B	C	A	B	C
PERIOD	1 week	2 weeks	3½ weeks	1 week	2 weeks	4 weeks	1 week	2 weeks	4 weeks
No. of samples for Brix ...	45	137	329	45	137	368	9	11	18
Range of differences in Brix (Ref—Dens)	—0.02 to —0.91	+0.38 to —0.85	+2.14 to —2.09	—0.02 to —0.87	+0.80 to —0.98	+1.51 to —1.84	—3.3 to —8.0	—6.2 to —8.5	—3.1 to —10.7
Mean densimetric Brix ...	20.35	20.17	21.03	14.85	14.22	15.71	96.0	96.1	97.0
Mean refractometer Brix ...	19.98	19.97	20.53	14.56	14.02	15.46	88.85	88.17	89.61
No. of samples for Sucrose % gm.	6*	12*	23*	6*	12*	23*	9	11	18
Range of differences in Sucrose % gm (Ref—Dens)	0.02 to 0.04	0.00 to 0.03	0.02 to 0.07	0.01 to 0.03	0.01 to 0.02	0.00 to 0.04	—0.20 to —1.80	-1.48 to +1.66	—1.90 to +2.11
Mean densimetric Sucrose % gm	17.92	18.01	18.42	12.88	12.41	13.40	31.20	34.62	34.85
Mean refractometer Sucrose % gm	17.95	18.03	18.45	12.89	12.42	13.41	30.37	34.21	34.87
Range of differences in Purity (Ref—Dens.) ...	1.5 to 2.1	0.6 to 1.6	0.9 to 3.0	1.5 to 2.1	1.1 to 2.1	0.4 to 3.5	0.6 to 2.7	1.4 to 4.8	—0.1 to 6.0
Mean densimetric purity ...	88.1	89.3	87.6	86.7	87.3	85.3	32.5	36.0	35.9
Mean refractometer purity	89.8	90.3	87.9	88.5	88.6	86.8	34.2	38.8	38.9

* *Composite samples.*

one calculated from the pol reading and densimetric Brix. For simplification, the former value is henceforth called refractometer sucrose and the latter densimetric sucrose. Both of these effects result in refractometer purities being higher than densimetric purities.

The differences between refractometer and densimetric Brixes are far from being constant. They vary with the nature of the product and also from sample to sample of the same sugar product according to the nature and amount of inorganic impurities and the amount of suspended matter present in the sample. The latter, in particular, affects the hydrometer to a much greater extent than the refractometer.

For the analysis of molasses two methods were used : the densimetric Brix was read from a 1 : 10 (wt/vol) solution and a sample of this dilute solution was taken for the sucrose determination as is the general practice in Mauritius. The refractometer Brix was obtained from a 1 : 6 (wt/wt) solution which was also used for the determination of sucrose, this being the practice followed in Hawaii. The sucrose % molasses, therefore, was not calculated from the same polarimeter readings and in many cases refractometer sucrose in molasses is lower than densimetric sucrose. At Factory C, however, over the span of four weeks the mean values obtained were very close being 34.85 for densimetric sucrose % molasses and 34.87 for the refractometer value. Corresponding figures for Factory B were 34.62 and 34.21 and for Factory A over only one week 31.20 and 30.37.

Thus at both Factory A and Factory B densimetric sucrose % molasses was higher than refractometer sucrose % molasses. This would not have been possible if the sucrose % molasses had been calculated from the same polarimetric readings since the refractometer Brix was always lower than the densimetric Brix. It is felt that these apparent abnormalities were due to random analytical errors which evened out at Factory C over four weeks but were still noticeable at Factories A and B.

From the figures obtained, it was possible to calculate the recoveries and profit and loss accounts for each test period. The results obtained are given in Tables 41 and 42.

Table 41. Comparison of Boiling House Performance figures for densimetric and refractometer controls.

	Period	Tons Sucrose in Mixed Juice		S.J.M. Recovery			Tons Recoverable Sucrose at 100% B.H.E.		Tons Sucrose in Sugar made	Boiling House Recovery			Boiling House Efficiency		
Factory	No. of weeks	Dens.	Ref.	Dens	Ref.	Diff.	Dens.	Ref.	Based on True Wt. stock taking	Dens.	Ref.	Diff.	Dens.	Ref.	Diff.
A	1	977.390	978.149	93.1	93.7	0.6	909.950	915.814	890.997	91.2	91.1	—0.1	98.0	97.2	—0.8
B	2	2654.202	2656.341	92.3	92.4	0.1	2449.828	2454.459	2391.328	90.1	90.0	—0.1	97.6	97.4	—0.2
C	4	6120.339	6124.906	90.9	90.9	0.0	5563.388	5567.540	5497.581	89.8	89.8	0.0	98.8	98.7	—0.1

Table 42. Comparison of Losses % Cane with densimetric and refractometer controls.

	Period	Sucrose % cane			Sucrose Extraction % cane	Total Losses % cane			Sucrose Losses in molasses % cane			Undetermined Losses % cane		
FACTORY	No. of weeks	Dens.	Ref.	Diff.		Dens.	Ref.	Diff.	Dens.	Ref.	Diff.	Dens.	Ref.	Diff.
A	1	14.59	14.60	.01	12.71	1.88	1.89	.01	0.67	0.65	—0.02	0.35	0.38	0.03
B	2	14.37	14.38	.01	12.31	2.06	2.07	.01	1.05	1.04	—0.01	0.25	0.27	0.02
C	4	14.72	14.73	.01	12.51	2.22	2.23	.01	0.77	0.77	0.00	0.62	0.63	0.01

From the tables it is noticed that, since the refractometer sucrose % mixed juice is higher than the corresponding densimetric value by 0.01, there appears to be very slightly more sugar in the mixed juice of the refractometer control, and this results in a Boiling House Recovery figure lower by a maximum of 0.1. At Factories B and C, the refractometer S.J.M. recoveries were between 0.0 and 0.1 higher than the densimetric values, this difference being due to the fact that suspended solids in the mixed juice affect the hydrometer to a much greater extent than the refractometer. As a result of this difference in S. J. M. recovery and of the difference in B.H.R., the refractometer Boiling House Efficiencies were lower than the densimetric values by 0.2 at Factory B and 0.1 at Factory C. Since it happens every now and then that Boiling House Efficiencies higher than 100% are obtained with densimetric control, the lower values obtained with refractometer control are more realistic.

At Factory A, over the short period of one week, the difference in the S.J.M. recoveries was much greater, namely 0.6. This large difference was mainly due to the fact that refractometer sucrose % molasses was lower than the densimetric value. At the three factories the amount of recoverable sugar at 100% B.H.E. was slightly lower for the densimetric figures since both refractometer sucrose % mixed juice and refractometer S.J.M. recoveries were higher than the corresponding densimetric values.

Refractometer sucrose % cane being 0.01 higher than the densimetric value, total losses were consequently 0.01 higher too. At Factory C, the sucrose content of the molasses being nearly equal for the two controls, sucrose losses in molasses % cane were also equal for both. At the other two factories, that was not the case, and differences of 0.01 and 0.02 respectively were obtained. Hence, a difference of 0.03 in undetermined losses occurred at Factory A, 0.02 at Factory B, and 0.01 at Factory C.

The refractometer offers several advantages over hydrometers, the most important of which are :

(a) it yields more accurate Brix values that lie closer to the dry substance than corresponding hydrometer values,
(b) it is simpler to use,
(c) it necessitates only a small sample,
(d) the Brix determination is carried out much more quickly than with the hydrometer.
(e) it is a robust apparatus of a long life span.

In view of these advantages, it is recommended that as from next year all factories should be equipped with precision refractometers. In order to enable the staff to become familiar with the range of values of Brixes and purities encountered with the refractometer, parallel control with the refractometer and hydrometers should be carried out during several weeks before the hydrometers are discarded.

This will moreover provide for each factory a set of data that should be useful for comparisons of factory performance in years before and after the transition from densimetric Brixes to refractometer Brixes.

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(b). THE DETERMINATION OF RETENTION IN VACUUM FILTERS

J. D. de R. de SAINT ANTOINE & E. C. VIGNES

In 1961, seventeen out of twenty-three factories were equipped with rotary vacuum filters. Although these filters offer numerous advantages over filter presses, yet their juices cannot be sent directly to the evaporator but must be pumped back to the mixed juice. If the amount of mud solids going through with the filtrate is excessive, these solids tend to build up in the clarifier, and as already pointed out (SAINT ANTOINE and LAMUSSE, 1959) may lead to clarification difficulties which are sometimes wrongly attributed to juice refractoriness.

The best way of judging the performance of a vacuum filter is to determine its retention daily, retention being the percentage of the total mud solids present in the filter feed which is retained in the cake.

The percentage of mud solids in filter feed or cake may best be determined directly by the use of a centrifuge. The method, as described in the fourth edition of the *Laboratory Manual for Queensland Sugar Mills* (1961), reads as follows :

«For a mud (filter feed) or filter cake, 100 g. of material are taken and washed on a 100 mesh screen until no trace of mud is left in the bagacillo. The washings are made up to 2,000g. and, after effective stirring, a subsample of about 1,000 g. is poured off and weighed. The subsample is then centrifuged and the solids are redispersed, centrifuged again, dried and weighed. For a filtrate, 100 g. are centrifuged and the solids are redispersed, centrifuged again, dried and weighed.»

When mud solids are determined directly retention is calculated as follows :

$$\text{Retention} = 100 - \frac{\text{mud solids per cent filtrate}}{\text{mud solids per cent filter feed}} \times \frac{\text{Brix filtrate feed}}{\text{Brix filtrate}} \times 100$$

The Brix terms are introduced in the above equation to compensate for filtrate dilution during washing of the cake.

Unfortunately, sugar factory laboratories in Mauritius are not equipped with centrifuges. Consequently, sugar chemists must resort to some indirect method for the determination of mud solids and the calculation of retention. However, mud solids, when obtained indirectly, may be determined by different methods and the object of the present study was to compare the retention values obtained by several of these indirect methods with a view to deciding which one, if any, is suitable for the industrial control of filtration, under the conditions obtaining at present in the laboratories of the island.

In all the methods described hereunder, retention was calculated from the bagacillo ratios of feed and cake on the assumption that all the bagacillo present in the feed is retained in the cake. Then,

$$\text{Per cent retention} = \frac{\dfrac{\text{mud solids in cake}}{\text{bagacillo in cake}}}{\dfrac{\text{mud solids in feed}}{\text{bagacillo in feed}}} \times 100$$

The methods used for the comparisons were the following :

Method No. 1.

This method, in which mud solids are obtained directly by filtration, was adopted as the standard method for comparing the results obtained with the indirect methods.

(a) Mud solids

Filter feed (50g) or cake (20 g) is weighed and washed over a 200 mesh sieve until the water runs clear. All the washings, which amount to 3 to 4 litres are collected, measured and well mixed. A one-litre aliquot portion is taken, 2 to 4 g Celite filter aid are added and stirred in, and the mixture filtered in a Buchner funnel through a tared filter paper. The latter is then washed well with distilled water and dried to constant weight in an oven at 105°C. Mud solids per cent in the original amount of feed or cake is then calculated from the increase in weight of the filter paper after deduction of the amount of filter aid added.

(b) Fibre

Filter feed (50 g) or cake (20 g) is weighed and washed over a tared 200 mesh sieve until the water runs clear. Excess water is drained off and the sieve and contents dried in an oven at 105°C to constant weight. Fibre per cent is calculated from the increase in weight.

Method No. 2.

In this method and in the following ones, mud solids are obtained from the relation

Mud solids % = dry substance % — fibre % — Brix %

(a) Dry substance

Calculated by drying a weighed amount of feed or cake to constant weight at 105°C.

(b) Fibre

Determined as in Method No. 1 above.

(c) Brix

Brix of feed is calculated from the expression

$$\text{Brix} = \frac{\text{Pol \% feed}}{\text{Pty. clarified juice}} \times 100$$

where Pol % feed is obtained by the same analytical procedure as that currently used for the determination of pol in cake, and purity

$$\text{clarified juice} = \frac{\text{Pol \% g clarified juice}}{\text{Brix (dens.)}} \times 100$$

Brix of cake is calculated from the expression

$$\text{Brix} = \frac{\text{Pol \% cake}}{\text{Pty. 60/40 mixture}} \times 100$$

where the 60/40 mixture is one containing 60 per cent of cloudy filtrate and 40 per cent of clear filtrate. The purity of the mixture is given by the relationship.

$$\frac{\text{Pol \% g 60/40 mixture}}{\text{Brix (dens.)}} \times 100$$

Method No. 3.

This method is similar to Method No. 2 above, but instead of assuming a 60/40 mixture, a certain amount of cake is placed in a piece of calico cloth and juice expressed. The purity of the expressed juice is calculated from the relationship

$$\frac{\text{Pol \% g expressed juice}}{\text{Brix (dens.)}} \times 100$$

and the Brix of the cake obtained by dividing pol % cake by purity of expressed juice and multiplying by 100.

Method No. 4.

This method is similar to Method No. 2 except that the Brix of feed and cake, instead of being obtained by calculation, are measured directly with the help of a refractometer. For this purpose a little feed is filtered through cotton wool whilst a few millilitres of juice are expressed from the cake with the help of a piece of calico cloth.

Method No. 5.

The only difference between this method and No. 2 lies in the Brix calculation of the feed and cake. Instead of determining the purity of a 60/40 mixture, feed is strained in a calico cloth and the pol and densimetric Brix of the filtrate are measured.

Then,

$$\text{Purity of juice in feed} = \frac{\text{Pol \% g. filtrate}}{\text{Brix (dens.)}} \times 100$$

$$\text{and Brix of feed} = \frac{\text{Pol \% feed}}{\text{Pty. juice in feed}} \times 100$$

The Brix of the cake is obtained, as in Method No. 3 by dividing pol % cake by purity of expressed juice and multiplying by 100.

A number of retention figures were calculated by each of the above methods and the results obtained are given in Table 43.

Table 43. Comparison of retention figures determined by different methods.

Run No.	Method No. 1	Method No. 2	Method No. 3	Method No. 4	Method No. 5
1	44	58	53	69	—
2	59	65	62	69	—
3	65	71	66	67	—
4	88	94	92	96	—
5	75	63	60	70	—
6	74	74	73	101	75
7	79	77	74	87	80
8	80	86	82	100	89
9	67	68	64	76	71
10	81	82	78	111	93
11	75	80	74	84	82
12	60	66	63	71	69
Av. runs 1 – 12	70	74	70	83	—
Av. runs 6 – 12	74	76	73	90	80

Of the four indirect methods used for the determination of retention in vacuum filters, Methods 4 and 5 yield inflated values. Methods 2 and 3, the latter in particular, give results which are, on the average, in close agreement with the mean value found by Method 1. It should however be stressed that individual retention values, when obtained indirectly, cannot be very reliable as they are affected by too many sources of error. But if retention is calculated twice daily, and the average of the twelve results obtained for the week is worked out, the factory chemist will be in a position to evaluate the efficiency of filtration from week to week.

As already pointed out, the best method to utilize for the determination of mud solids and the calculation of retention in vacuum filters is that in which the mud solids are centrifuged, dried and weighed. Centrifugation is to be preferred to filtration, as employed in Method 1, which is delicate, tedious and time consuming and cannot consequently be used for the industrial control of filtration.

In conclusion, it is recommended that Method 3 be adopted in all the sugar factory laboratories of the island for the calculation of retention. Two determinations should be carried out daily and the average value worked out for the week. This recommendation, however, is only temporary and will no longer be valid as soon as sugar chemists have centrifuges at their disposal. They will then be in a position to determine mud solids directly and more accurately.

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6. QUALITY DETERMINATION OF CANE IN THE FACTORY

J. D. de R. de SAINT ANTOINE

It is often necessary to obtain information on the quality of cane grown on the various sections of sugar estates. For instance, when a variety is released for commercial production, its yield of sugar per arpent should be calculated for the different sections of every estate where it is grown and the results compared with those of the standard varieties grown.

Several methods are available for the determination of cane quality. A reliable one is the so-called «long test» which is an indirect method and in which the weights of cane, mixed juice and imbibition water are carefully noted and the sucrose and fibre per cent cane values calculated with the help of analytical figures. The long test is not practical, however, as it necessitates large tonnages of cane equavalent to about one hour of crushing time.

Direct methods of analysis, such as the Cane Chipper – Rietz Disintegrator method adopted at this Institute, must therefore be resorted to. The latter method, however, cannot be used at present in sugar factory laboratories, through lack of equipment. Further, whereas sampling of cane stalks from the latin squares of small experimental plots can be fairly representative, it would be extremely difficult to obtain a representative sample of some thirty canes only, say, from a commercial field of several arpents. Hence it would be a much better proposition to sample the knifed or shredded cane, throughout the crushing of the consignment to be tested, and to analyse a sub-sample directly for sucrose and fibre. This direct analysis, however, calls for a large and robust disintegrator which is often not available and which suffers from two major disadvantages :

(a) The long duration of the disintegration period which amounts to about 45 minutes (HARRIS *et al.*, 1959).

(b) The difficulty in obtaining an accurate juice purity figure, because of the large volume of water and consequent juice dilution that must be used for the disintegration.

It is true that juice dilution will not affect the sucrose and fibre calculations and that the main criteria governing the choice of a cane variety are its yield and its sucrose content. Yet a better assessment of the variety is made when juice purity is determined concurrently since sugar recovery in the factory is greatly influenced by the amounts of soluble non-sugars present in the cane.

When a sample of even a few tons of cane is crushed in a factory, it is an easy matter to obtain a representative juice sample Should it be possible to correlate the analysis of 1st expressed juice, say, with sucrose per cent cane, it would then be easy to assess the quality of various cane consignments. As a matter of fact, the ratio Pol % g 1st expressed juice to sucrose % cane, or so-called Java Ratio, is used in South Africa to assess the quality of planters' cane.

The Java Ratio method of determining sucrose per cent cane has the big advantage of being simple and of using a product, 1st expressed juice, which can be easily and representatively sampled. Unfortunately it suffers from the major drawback that it does not take into consideration the fibre content and cannot therefore determine accurately the sucrose contents of canes having different fibre percentages.

Should it be possible to correct the Java Ratio for fibre, the accuracy of the assessment of cane quality would be greatly enhanced and would no doubt meet the needs of agronomic requirements at least. A step in this direction is made by those chemists who use the Central Board's method of calculation of the sucrose content of planters' canes for assessing the quality of the cane varieties grown on the various sections of estates. In this method, which has been fully described elsewhere

(SAINT ANTOINE, 1959) the 1st expressed (or 1st mill) juice is analysed for Brix and Pol whilst fibre % cane is determined with the help of a Cutex fibrator on a sample of 30 canes picked at random from the cane carrier during the test. Purity of absolute juice is obtained by deducting from that of 1st expressed (or 1st mill) juice the difference that exists between the absolute and 1st expressed juice (or 1st mill juice) purities of all the canes crushed by the mills during the week. Brix of the absolute juice is calculated by the arbitrary relationship

$$B_A = 0.89\ B_1 + 1.3$$

and an arbitrary sucrose content of the cane under test calculated with the help of the formula.

$$\text{Sucrose \% cane} = \frac{B_A \times P_A\ (100 - F_C)}{10{,}000}$$

where B_A = Brix of absolute juice
P_A = Purity ,, ,,
F_C = Fibre % cane

The same calculation may be used for all the canes crushed by the factory during the week and an arbitrary sucrose per cent value also figured out for those canes. The difference between the two arbitrary values is then applied to the actual sucrose per cent of all the canes crushed during the week as given by the weekly bulletin of the laboratory. This step, however, is often omitted as it only serves to bring the figures to a more realistic value, but does not affect the differences in sucrose contents measured.

Whereas the above method, with further refinements such as the calculation of fibre and sucrose balances, suits the purpose of the Central Board, it cannot be recommended for the assessment of the relative quality of canes grown on different sections of estates for the following reasons:

(a) It is not correct to assume that the same relationship between B_A and B_1 holds for all the canes tested. It would be more logical to use the relationship B_A/B_1 actually obtaining for all the canes crushed during the week, but it would still not be possible to use different ratios in different tests.

(b) Similarly, it is incorrect to assume the same difference between P_1 and P_A for all the tests carried out during one week.

(c) The influence of fibre on sucrose % cane in the so called Central Board method is governed solely by the factor (100 — F). In the method proposed hereunder the relationship between Java Ratio and fibre is derived from practical results only, and thus any other factor involved is automatically taken into account in the calculation of sucrose % cane.

(d) Thirty canes picked at random from the cane carrier cannot yield a representative sample for the determination of fibre.

(e) As already demonstrated (SAINT ANTOINE and LE GUEN, 1960) it is not possible to obtain reliable fibre values when using the Cutex fibrator.

In view of these important sources of error, it is recommended that the following method which is based essentially on practical results and which makes use of a Java Ratio corrected for fibre, be adopted instead.

If the weekly Java Ratios obtaining in a factory for all the canes crushed is plotted as a function of corresponding fibre per cent cane values, a straight line relationship is obtained, as shown in fig. 29. The figures used for drawing this graph were obtained at Mon Trésor factory during the 1961 crop and are given in Table 44. The equation of the straight line has been worked out and reads as follows :

$$\text{J.R.} = 103.26 - 1.66\ \text{F \% C}$$

Now, if this equation is used to calculate weekly Java Ratios and hence sucrose per cent cane, it will be seen, as shown in Table 44, that the calculated sucrose per cent cane values lie very close to the true values. Thus in the case of Mon Trésor maximum deviations were —0.17 to + 0.20, the correlation coefficient being 0.88 (significant at 0.1 per cent level).

Table 44. Mon Trésor sugar factory 1961 crop, actual and calculated analytical figures.

Week No.	Pol. % g 1st Exp. juice	Sucrose % cane actual	Fibre % cane	Java Ratio actual	Java Ratio calculated	Sucrose % cane calculated	Difference in sucrose % cane
1	13.11	11.06	11.95	84.4	83.42	10.94	0.12
2	13.21	11.02	12.71	83.4	82.16	10.85	0.17
3	13.69	11.21	12.54	81.9	82.44	11.29	—0.08
4	14.00	11.63	12.17	83.1	83.06	11.63	0.00
5	14.20	11.76	12.20	82.8	83.01	11.79	—0.03
6	14.27	12.02	11.78	84.2	83.71	11.94	0.08
7	14.91	12.39	11.77	83.1	83.72	12.48	—0.09
8	14.96	12.43	12.77	83.1	82.06	12.28	0.15
9	15.49	12.68	12.15	81.9	83.09	12.87	—0.19
10	15.88	13.16	12.60	82.9	82.34	13.07	0.09
11	16.39	13.52	12.23	82.5	82.96	13.60	—0.08
12	16.89	13.94	12.32	82.5	82.87	13.99	—0.05
13	17.10	13.94	12.81	81.5	82.00	14.02	—0.08
14	17.35	14.05	13.32	81.0	81.15	14.08	—0.03
15	17.47	14.11	13.59	80.8	80.70	14.10	0.01
16	17.76	14.17	13.55	79.8	80.77	14.34	—0.17
17	18.07	14.45	13.80	80.0	80.35	14.52	—0.07
18	18.20	14.62	13.78	80.3	80.39	14.63	—0.01
19	18.80	15.02	13.90	79.9	80.19	15.07	—0.05
20	17.89	14.59	13.40	81.6	81.02	14.49	0.10
21	18.29	14.46	14.11	79.1	79.84	14.60	—0.14
22	16.61	13.48	14.04	81.2	79.95	13.28	0.20

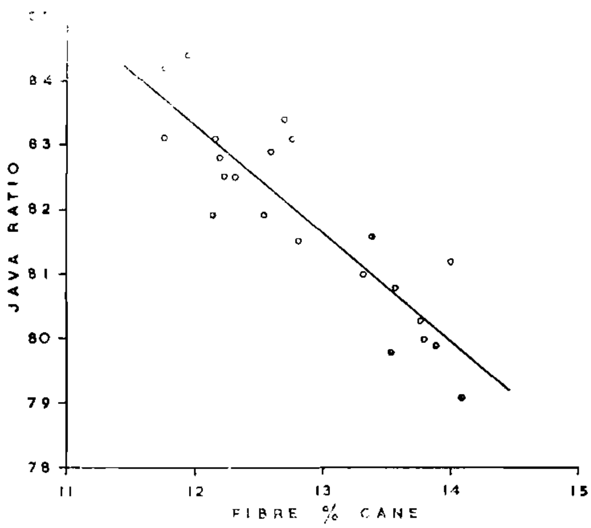

Fig. 29. Java Ratio as a function of fibre in cane Mon Trésor, 1961 crop.

Graphs have also been drawn, figs. 30 and 31, and equations worked out for two other factories, Mon Désert and Union Flacq, for the 1961 crop. The relationships found are :

Mon Désert : J.R. = 99.43 — 1.56 F % C
Union Flacq : J.R. = 91.56 — 0.82 F % C

The maximum deviations obtained in calculated v/s true sucrose are respectively —0.26 to +0.13 and —0.15 to + 0.13, and the correlation cœfficients being 0.93 and 0.89 (both significant at 0.1 per cent level).

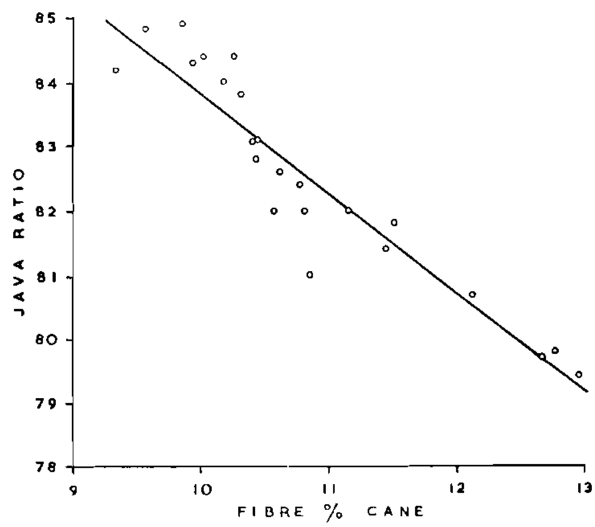

Fig. 30. Java ratio as a function of fibre in cane, Mon Désert, 1961 crop.

It is recommended that the method outlined above be adopted in future by factory chemists for the assessment of cane consignments from various sections of estates. Since the results of the tests are generally not needed by the Manager before the end of the crop, it is better to wait till that time before plotting the graph and calculating the relationship for a particular year and a particular factory. Should it however be necessary to obtain results earlier in the crop, it would still be possible after, say, eight weeks crushing, to calculate a provisional relationship for the purpose.

An important point to stress, however, is the sampling and analysis of cane for fibre. For agronomic purposes, it is a much better proposition to sample the cane in the fields than on the cane carrier. Five contiguous canes should be picked at random from at least six different spots in the field, sub-sampled in thirds in the usual manner, and taken to the laboratory for analysis. If a robust disintegrator is available, however, it would be more accurate to sample the cane after the knives or shredder throughout the duration of the test and to use a sub-sample for the fibre determination, in spite of the disadvantage that complete disintegration would take about 45 minutes, as already pointed out.

In the absence of a heavy disintegrator, the Chemist would have to resort to the Cane Chipper-Rietz Disintegrator method, which yields accurate and consistent results. The equipment is unfortunately not available as yet in sugar factory laboratories. Until such time as

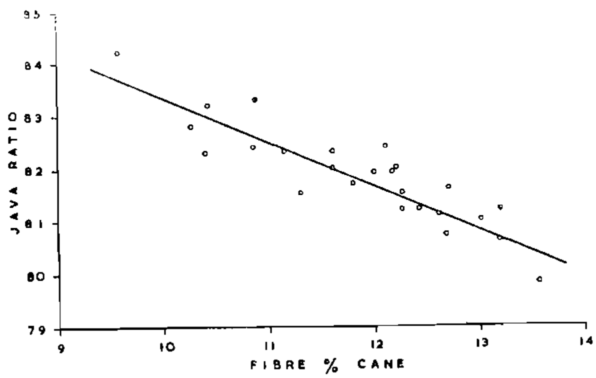

Fig. 31. Java ratio as a function of fibre in cane, Union Flacq, 1961 crop.

it is, or a heavy disintegrator is at hand, the only alternative is to use the Cutex fibrator, although it has already been shown that fibre per cent cane cannot be determined accurately with the help of this machine. However, the influence of fibre on the calculation of sucrose per cent cane by the proposed method is not excessively large. If, for instance, actual fibre is 12.0 per cent, an error of one unit in fibre would affect the calculated sucrose per cent value as shown in Table 45 for each of the three cases studied. A value of 16.0 is assumed throughout for pol. % g. 1st expressed juice.

Thus an error of one unit in fibre results in a discrepancy of 0.14 to 0.27 in sucrose per cent cane. These values are possibly not excessively high for agronomic purposes, but since errors of more than one fibre unit are often encountered when the Cutex fibrator is used, it is strongly recommended that a more accurate method be adopted for the determination of fibre in cane.

Table 45. Influence of accuracy of fibre determination on calculated sucrose per cent cane

Factory	*Fibre % cane*	*Sucrose % cane*
	11.0	13.60
Mon Trésor	12.0	13.33
	13.0	13.07
	11.0	13.16
Mon Désert	12.0	12.91
	13.0	12.66
	11.0	13.21
Union Flacq	12.0	13.07
	13.0	12.94

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BY-PRODUCTS

1. THE COMPOSITION OF SCUMS AND HEAT COAGULATES FROM CANE JUICE IN RELATION TO THEIR NUTRITIVE VALUE TO ANIMALS

D. H. PARISH

SEED proteins form the basic food protein source of the Mauritian population, and even these low biological value proteins are consumed at such low levels that dietary protein deficiency is extremely common. The proteins of high biological value, meat, milk, fish and eggs are expensive and moreover a large part of them are imported.

It is essential, therefore, that any local source of protein shall be exploited to the full, particularly as a rapid increase in population is taking place without concurrent increase in national wealth.

This problem of protein shortage is not peculiar to Mauritius, however, the carbohydrates, starch and sugar, are in plentiful supply as extremely high yielding crops producing these materials are widely grown, whilst fats, the alternative source of metabolic energy can be fed without any ill effect over a wide range of levels depending on their availability. Diets poor in vitamins can be supplemented with small quantities of high vitamin food or with the now cheap artificially produced materials, and mineral supplementation of any diet is cheap and simple. Protein, however, remains the centre of dietary requirements; it must be fed at fairly high levels, its chemical constitution must be adequate for body needs and it cannot be replaced by any other material.

The elimination of protein as a limiting factor can be made in two ways: increased production of high quality protein and increased efficiency in its utilization.

Increased production is a slow and highly capitalized procedure, particularly where malnutrition is already a problem, but increased efficiency of utilization can be cheaply and simply obtained.

As has been pointed out, the normal vegetable sources of human dietary protein are grains and pulses both of which contain low value proteins. The next dietary sources are the animal proteins synthesized basically from the proteins of plants. Leafy materials although they contain protein of high biological value cannot be used directly by human beings because of the high levels of fibre.

The indirect utilization of plant proteins through stock rearing is inefficient as shown by the data (Table 46) from LEITCH and GODDEN (1952).

Table 46. Efficiency of domestic animals in the conversion of vegetable protein to animal's protein.

	Efficiency %
Milk — whole life	18.1
Beef — Baby (to 7 cwt)	15.3
Fat bullock (12—15 cwt)	8.7
Lamb	13.2
Pork	19.0
Poultry — table	21.0 — 26.0
Medium light bird	
(1 egg daily)	39.7
(200 eggs a year)	26.4

Beef production is seen to be the most wasteful way of converting vegetable protein to animal protein, pork production is better and egg production, particularly with high laying strains, the best ; high yielding milch-cows are fairly efficient protein converters but low yielding animals will not be. Apart from the high performance laying hen, however, the efficiency of conversion of vegetable protein to animal protein is poor, being only about one sixth.

If leaf protein is taken as being the dietary equivalent of animal protein, then the whole system of converting leaf protein to human food is extremely inefficient and PIRIE (1942), conscious of this inefficiency, has been the motivating force behind much of the work in progress on the separation of leaf protein from fibre with the final aim of preparing a material suitable for direct human consumption. The preparation of a low fibre leaf protein for use in pig and particularly in poultry rations would, however, be helpful in increasing the efficiency of leaf protein utilization and could be considered as a first step.

The only crop of importance in Mauritius is sugar cane and although the green tops could be used as a source of protein, [PIRIE (1960b)] the dietary utilization of the protein in cane juice has been neglected.

BONAME (1897) stressed the value of scums as a potential fodder and pointed out that they were used in the West Indies as food for oxen and pigs, whilst PRINSEN GEERLIGS (1921) speaks of the use of filter press cake as food for animals and mentions that it was even eaten by the poor of the district.

Interest in scums or juice as a source of protein evidently declined as WIGGINS (1960), in a review of the sugar cane crop as a source of materials other than sugar, passes over the protein from the juice which is separated in the filter press mud as being unlikely to be of commercial interest.

PARISH (1960), however, drew attention to the fact that in Mauritius around 6,000 tons of plant protein were being dumped in fields in the form of filter cake in an island whose population are chronically short of dietary protein.

This paper has led to attempts to prepare a high protein meal by centrifuging heated cane juice [ST. ANTOINE and VIGNES (1962)] and has resulted in renewed interest in scums as a feeding stuff [STAUB and DARNÉ (1962)].

As all the protein in the cane juice is recovered in the scums, comparisons of the potentialities of scums and heat coagulates from cane juice as sources of dietary protein will be made on the basis of analytical data already published or recently carried out by the author.

The composition of scums and heat coagulates.

Interest in scums as has already been pointed out has centred around its value as a fertilizer and as a source of wax and therefore most of the data available on its chemical composition are restricted to N and P_2O_5 and wax contents.

The most detailed series of analyses available of Mauritian sugar factory scums are those of FEILLAFÉ (1953) based on work carried out during the crushing season of that year.

These data are presented in Table 47 together with analyses of scums from South Africa, [DU TOIT (1961)], Puerto Rico, [SAMUELS AND LANDDRAU (1956)], Java, Louisiana, Argentina and Cuba, [OWENS (1958)].

Table 48 gives the analyses of scums collected from a few factories of Mauritius towards the end of the 1961 crushing season together with the analyses of the coagulate prepared as described by VIGNES and FROBERVILLE (1961).

For the determination of fibre, the extractive free material (E.F.M.) was obtained by hot drip extraction of the dry material with constant boiling alcohol-benzene mixture for four hours, followed by a four-hour extraction with 95% w/w ethanol. The thimble and material were then air dried and finally extracted with boiling water for two periods of 4 hours.

By correcting the E.F.M. for protein and ash contents, an indirect figure for fibre has been obtained. This method of calculating the fibre has been necessary as it has proved impossible to obtain a reliable figure for lipids and fibre using direct methods analysis. The normal petrol ether extract gives low results and apparently no method of extraction is fully reliable with material which has been dried at a high temperature [PIRIE (1961)] and as both scums and the coagulate contain very fine particles of fibre the usual digestion methods for determining fibre or cellulose are not suitable.

The fibre figure obtained by the indirect method used will be higher than the true fibre content as it will include some pectates and other non structural polysaccharides, whilst the figures for crude fibre and sieved fibre will be low due to the finely divided nature of the bagacillo.

The NORMAN (1935) fibre which is in fact obtained by the pre-treatment used in the determination of lignin is probably the best indication of indigestible structural constituents.

DISCUSSION

The nutritive value of filter cake will be discussed in terms of its content of nitrogen, fibre, ash and lipids, in that order, and finally the value of the heat coagulate from cane juice will be compared with scums and the value and potentialities of these two materials assessed so far as is possible.

It should be noted that scums and heat coagulate will be almost devoid of the water soluble B vitamins, and therefore diets for poultry and pigs containing these materials will have to be reinforced by high vitamin foods or vitamin supplements.

Nitrogen.

As the nitrogen in filter cake is principally due to the protein precipitated from juice by heat and lime, then it is reasonable to speak of a crude protein (N x 6.25) content.

Table 47 which gives the level of nitrogen and crude protein occurring in dried filter muds from various countries shows that the material from Mauritius is higher in crude protein than that from any other country. The Puerto Rican filter muds at their best reach the same level of nitrogen as the best local samples but their average content is lower.

The average content of around seventeen per cent crude protein for Mauritius filter mud makes this material, so far as protein is concerned, very attractive, it being the equivalent of a good quality dried grass. Such a level of crude protein is high enough for most production rations and more than enough for main tenance rations.

Dried filter mud containing only 11% crude protein is of little nutritive interest to animals other than ruminants. Material richer in protein becomes progressively more interesting as food for pigs and poultry as the protein levels increase and the material from filter presses containing up to 20% protein is too good a feeding stuff to dump in the fields.

For ruminants, the amino-acid composition of the protein is of no great importance but if the material is to be fed to pigs and poultry then any amino-acid imbalance is a serious fault.

Determination of the amino-acid composition of filter muds and the heat coagulate has presented some difficulty, although the results so far obtained show the proteins to be typical plant proteins [PARISH AND FIGON. (1961)]

DUCKWORTH AND WOODHAM (1961) and DUCKWORTH, HEPBURN AND WOODHAM (1961) have shown that leaf protein concentrates fed to chicks and rats compare with soya-bean meal as a dietary protein source and when fed to newly weaned pigs were the equivalent of white fish meal. This confirms the opinions of PIRIE and others that leaf protein could be used as a substitute for animal protein in human diets. So far as cane juice protein is concerned, however, the levels of the amino-acids methionine, lysine, and tryptophane will have to be accurately assessed before the protein of scums or coagulates can be taken as fully the equivalent of leaf protein.

Table 47. Average N content % D.M. & crude protein content of filter cake from various countries.

Country	Average N % D.M.	Average Crude Protein N x 6.25	Range of crude protein
Louisiana	1.15	7.2	
S. Africa	1.25	7.8	4.4 — 9.6
Java	1.7	10.6	
Argentina	2.0	12.5	
Cuba	2.0	12.5	
Puerto Rico	2.19	13.7	6.7 — 19.7
Mauritius			
Rotary Filter	2.7	16.9	12.8 — 19.90
Filter Press	2.8	17.5	11.4 — 19.30

Table 48. The composition of the heat coagulate from cane juice and scums from six factories (average sample for last 6 weeks of crushing season 1961).

CONSTITUENT	COAGULATE	SCUMS					
% Dry Matter		Rotary Filter				Filter Press	
		1	2	3	4	1	2
Total Ash	8.9	14.7	9.0	12.7	14.3	11.0	13.7
— SiO_2	5.5	4.3	3.0	3.2	4.3	2.9	3.0
— CaO	0.2	3.5	1.8	3.0	3.1	2.5	3.9
— P_2O_5	0.8	1.4	1.1	2.5	2.8	1.8	1.9
— MgO	0.2	—	0.3	0.7	0.7	0.5	0.6
Crude Protein	23.0	12.1	11.9	13.2	14.0	15.7	15.3
Total Sugars	16.1	12.1	7.1	5.9	4.9	20.8	21.1
E. F. M.	24.9	43.4	—	—	—	34.0	—
Benzene Extract (Hot)	25.0	9.4	—	—	—	13.5	—
Crude Fibre	—	17.3	—	—	—	11.3	—
Fibre retained on 100 mesh sieve ...	Nil	14.8	—	—	14.3	—	9.6
Norman Fibre	13.7	25.9	—	—	—	21.5	—

Fibre and insoluble carbohydrate.

As has already been pointed out, it is difficult to obtain an accurate quantitative figure for the level of fibre in filter cake.

By using extractive free material an approximate figure for insoluble carbohydrate has been obtained but this figure probably includes materials which are digestible and could be therefore used as a source of energy.

The crude fibre figures indicate a level of about 17% for rotary filter cake and 11% for filter press cake whilst the material retained on a 100 mesh screen is about 15% and 10% respectively.

The crude fibre figure as an indication of dietary bulk is certainly low, whilst the insoluble carbohydrate is too high a figure.

More work will have to be done on the composition of scums before a proper fibre figure can be given but the result so far obtained shows that the ratio of bulk of rotary filter cake to filter press cake is around 3 : 2, and that so far as animals lacking a gut specially adapted for fibre digestion are concerned, the indigestible structural matter is possibly in the range of 20 to 30% depending principally on the type of filter used.

Ash.

The principal constituents of the ash fraction are the nutritionally unimportant silica and the essential nutrients, calcium and phosphorus.

The recommended dietary levels of calcium and phosphorus for cattle are around 0.3% Ca and 0.25% P [MAYNARD and LOOSLI (1956)] which is much lower than the level of these materials occurring in filter cake.

The ratio of calcium to phosphate in diets is also of interest and it is generally recommended that the ratio should not exceed the limits 2 : 1 to 1 : 2; however, with adequate supplies of vitamin D, ratios considerably wider than this can certainly be fed.

From Table 48 it is seen that the average ration of Ca: P for filter cake is 2.7:1 but the calcium and phosphorus levels of scums vary very widely and in fact for the few samples analysed the Ca: P ratio varies from over 4:1 to 1.8:1.

A high Ca and P content is not really important from the nutritional point of view as mineral supplementation with calcium phosphates and limestone is cheap. But, nevertheless, for laying hens in particular, the calcium and phosphorus content of scums is a useful mineral supplement.

Lipids.

The lipids of filter cake have been fairly intensively studied because of the interest in producing a commercial sugar cane wax from this source.

The level of lipids actually occurring in filter cake is difficult to determine as, particularly with material dried at high temperatures, fixation of lipid by the protein apparently occurs [PIRIE (1961)], but a level of around 15% seems to be the average.

The lipids vary from the nutritionally inert hard wax to soft oils containing palmitic, oleic and linoleic acids, and apparently, important quantities of sterols also occur.

Normally, digestible fat is equated as the energy equivalent of digestible carbohydrate x 2.3 but it would seem that fairly intensive studies on the lipids will have to be made before such a factor could be applied to the digestible lipids of filter cake. A high wax content is not a desirable feature as it is generally accepted that this can depress the digestibility of a ration, presumably by protecting food particles from enzymatic attack.

In addition to the sterols, some of which may be physiologically active, or activable as anti-rachitic factors, the lipids of scums contain some carotene [BALCH (1947)], however not in sufficient quantities to act as dietary supplements of this vitamin A precursor.

The nutritive value of filter cake.

Apart from the small amount of sugar (20% on filter press cake and 10% from rotary filter cake) and the unknown amount of digestible polysaccharide, the other energy source is the lipid fraction, which as has been pointed out, is probably of low value for this purpose.

The energy value of filter cake will decide at what level the material can be fed to non-ruminants.

The basic division of farm animals into ruminants and pigs and poultry separates those animals which can deal with bulky rations from those which cannot, and at the same time it separates the animals which can utilize poor quality protein, and in which the gut micro-flora synthesize the requirements of B vitamins, from those which need good quality protein and carefully balanced diets rich in water soluble vitamins.

From the analytical data presented in this paper, it is clearly seen that ruminants could benefit from fairly high dietary levels of scums both as a source of protein and energy.

Poultry, particularly laying hens, are efficient converters of dietary protein to animal protein but they can handle only limited quantities of fibre. With a protein of high biological value fed at a level of 15% which is the requirement for a laying hen, scums would have to be fed at high levels to replace most of the protein in the ration, and as the only source of energy is the digestible oil and the small quantity of sugar and digestible polysaccharide, the energy supplied will be fairly low and the bulk presumably high.

The calcium and phosphate would be adequate but much vitamin and some mineral supplementation of the filter cake would have to be made.

Grass can supply up to 20% of the ration of laying hens and presumably filter press cake could therefore supply up to 20% of the ration too; this would mean that about 1/4 of the protein requirements of the hen could be met by scums, which is a significant dietary contribution, as the protein of the filter cake is, presumably, of high biological value.

Perhaps this level of 20% replacement could be pushed higher, particularly if the lipids show a high digestibility; however, only egg laying trials will give the correct answer.

After the hen, the pig is the most profitable converter of plant protein to flesh; again, however, the presumably low energy value of scums and their fairly high fibre means that only low levels can be fed.

The difference in fibre levels between filter press cake and rotary filter cake means, as fibre is a limiting factor in the rations of pigs and poultry, that the level of consumption of rotary filter cake could only be at about 2/3 of the level of filter press cake fed.

For these reasons, it is the ruminant animal which will present the least problems in the extensive feeding of filter cake.

Molasses is a cheap source of energy and moreover would make the filter cake extremely palatable. BROWN *et al* (1959) studied the effect of feeding combinations of bagasse and molasses ranging from 45% bagasse + 25% molasses to 20% bagasse + 50% molasses. The remaining 30% of the ration was made up to supply protein, vitamins, minerals and additional energy.

All the rations were consumed and digested without any kind of digestive disturbance, but the most desirable level of bagasse was found to be 20% + 50% molasses.

Although these experiments showed that no adverse physiological effects occurred with any of the rations tested, a reduction in rumination when finely comminuted diets were fed has been noted [TYLER (1950)]. DAVIS & KIRK (1958) found that bagasse pith was well digested by older stock but state that it should not be fed to young animals.

To feed up to 20% bagasse would mean that filter press scums could be fed at more than 50% of the total rations and rotary filter scums up to 40%, but as for maximum efficiency up to 50% of molasses must be fed also, then properly balanced rations cannot be made by feeding at these high levels.

If the feeding of filter muds does not cause physiological defects such as preventing rumination, then a combination of molasses and scums which could be fed at high levels is certainly possible.

The low level of vitamin A precursor would have to be supplemented and it seems that a possibly ideal solution would be to mix chopped cane tops, scums and molasses and ensile. By a proper balancing of the constituents, an attractive cattle food could presumably be made cheaply and without inconvenience. The alternative is to dry the filter muds and blend with molasses to give a cattle-food which again could be fed at high levels.

of research that could lead to a better utilization of the protein contained in cane juice, and investigations were therefore initiated in 1960, both on the chemical and technological aspects of the problem (PARISH, VIGNES and de FROBERVILLE).

Cane juice contains very little protein, but as approximately five million tons are processed in the factories every crop, several thousands tons of crude protein could be recovered yearly. At present, most of the protein contained in the juice finds its way into the filter cake which is returned to the fields. Should it be possible to use this cake for the feeding of animals, its protein would be directly utilized and would replace, in the rations, more expensive sources of this body-building chemical.

A few references are found in sugar literature on the direct utilization of filter cake by animals. Thus BONAME, as far back as 1897, tried to encourage its use in feeding rations, whilst GEERLIGS mentions in the 1924 edition of his book *Cane Sugar and its Manufacture* that filter-press cake is sometimes used as stock feed, or even as food for the poorer classes of people.

In spite of these claims, it would appear that, for various reasons, filter cake has not since been used to any large extent for nutrition purposes. The main factors that must have greatly limited its use are probably :

(a) The highly fermentative nature of the cake which must be dried soon after production so as to prevent deterioration from setting in.

(b) The disorders that animals may suffer by the ingestion of certain chemicals used for juice clarification.

(c) The protein content of the cake which is lower than that of other concentrates and consequently necessitates the use of a bulky ration if the protein content of the latter is to be replaced by cane protein.

(d) A somewhat high fibre percentage — especially in the cake from the vacuum filters which are used in 17 out of 23 factories in Mauritius — which may limit the use of the product for the feeding of non-ruminants.

In August 1961, it was suggested by Mr. L. de Chazal, a member of the Sugar Industry Research Institute Board, that filter cake, in spite of the above-mentioned disadvantages, might yet be useful in feeding rations. A few months later, experiments were laid down at the Research Institute, the results of which are not yet available.

The ideal solution would be the production of a high protein, low bulk concentrate which could be used directly in pig and poultry rations — animals known to be efficient converters of food energy — and which could eventually be purified into a product suitable for human consumption. Should it be possible to extract juice protein in the form of a coagulate, the protein content of which would lie in the region of 25 per cent. or better, that coagulate could be used as the main source of protein material in the ration of animals without unduly increasing the bulk of the ration.

The value of a food protein depends primarily on its amino-acid composition and on its digestibility. PIRIE (1961) has shown that leaf protein has the value suggested by its amino-acid composition; it is better than most of the seed proteins and as good as those of fish.

Preliminary experiments carried out in 1960 at the Sugar Industry Research Institute have shown that it is possible to extract crude protein from juice on a pilot plant scale, using a Westphalia KG 10006 separator. The coagulate obtained was found to have, on the average, the following composition :

	Per cent dry matter
Protein (N x 6.25) ...	15.7
Ash ...	14.5
Wax (benzene extract) ...	14.9
Wax & fats (benzene alcohol extract) ...	21.0
Sugars ...	12.0
Cellulose fibre (by difference) ...	36.8

The amino-acid analyses of the hydrolised protein were also carried out and are published elsewhere [PARISH 1960, (b)]. These analyses have shown that the protein is a typical plant protein and could be well utilized as a foodstuff provided that nothing injurious is present in the material.

As however, the protein content of the coagulate was fairly low, amounting to only some 16 per cent., whereas its fibre and wax contents were high, it was thought that before the coagulate could be used as a feeding stuff, its protein content would first have to be raised and its fibre content lowered. Accordingly, pilot plant experiments were carried out at Médine Sugar Factory in 1961, after several modifications had been brought to the extraction process. The new procedure adopted was as follows : mixed juice from the mills, after passing through vibrating screens, was further strained through a 130-mesh stationary monel wire screen and collected in a tank fitted with a perforated steam coil. The juice was heated to about 90°C by steam injection and fed by gravity to the Westphalia separator. The coagulated proteins were allowed to build up in the annular chambers of the machine under the action of centrifugal force. Centrifuging was continued until the clarified juice ran cloudy, when the centrifuge bowl was full. The machine was then dismantled and the cake removed and dried.

It was thus possible during the crop to extract over one ton of coagulate which, on analysis, revealed a marked improvement over that obtained the previous year as far as protein and fibre contents were concerned, as may be seen from the following figures :—

	Per cent dry matter
Crude protein ...	22.8
Ash ...	9.0
Wax (benzene extract) ...	25.0
Wax & fats (benzene alcohol extract) ...	39.6
Sugars ...	16.1
Cellulose fibie (by difference) ...	12.5

Thus, the coagulate extracted in 1961 had a protein content of close to 23 per cent, whereas its fibre content was low. Further, this fibre was in a very fine state of division, having passed through a 130-mesh screen, and was presumably easily digestible. It was therefore believed that the coagulate, in spite of its high wax content, could be advantageously used as a feeding stuff, and it was decided to carry out preliminary feeding trials on milch cows. These feeding trials were conducted by Messrs. Serge Lionnet, Veterinary Surgeon, and Claude Delaître, Animal Husbandry Officer of the Department of Agriculture, and the following notes are taken from a report submitted by them.

Milking cows were selected in preference to other domestic animals because of their known sensitivity to various influences. Further, milk production is a reflection of the utilization of the protein in the diet.

Two similar lots of milking cows were chosen; two groups of seven Fresian crosses were used at Bénarès S. E. and two groups of Creole cows at the Government Farm in Curepipe. In each lot the animals chosen were approximately at the same stage of lactation and producing roughly equivalent amounts of milk. Nearly equal weights of rations could therefore be fed to both groups.

Two different rations were compounded, one was called "coagulate" and the other "control" and these terms are used throughout this paper. These rations were compounded as follows :—

	Coagulate	*Control*
Molasses ...	25.0	25.0
Groundnut ...	12.0	12.0
Cane juice coagulate	20.0	—
Lucerne meal ...	—	20.0
Cotton seed cake ...	13.0	13.0
Bran ...	10.0	10.0
Oats ...	5.0	5.0
Maize ...	14.0	14.0
Bone meal ...	0.5	0.5
Salt ...	0.5	0.5
	100.0	100.0

Both rations were supplemented, in the same proportion, with adequate amounts of trace minerals. The percentage of moisture, protein and fat in these rations were the following :—

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2. THE EXTRACTION OF CANE JUICE PROTEIN AND THE ASSESSMENT OF ITS VALUE AS A FEEDING STUFF

J. D. de R. de SAINT ANTOINE & E. C. VIGNES

In many overpopulated, economically under-developed countries, protein deficiency poses one of the most acute nutrition problems. With the alarming yearly increase in population in Mauritius and the island's limited sources of revenue, the prospects of an improvement in the situation are poor indeed. It is therefore imperative in our case to explore all the avenues

Nutritive value of coagulate from juice.

The composition of the heat-coagulate made from cane juice is given in Table 48.

The protein level of 23% and the insoluble carbohydrate of 25% give a low fibre to protein ratio: thus from the point of view of bulk, the coagulate can be fed at up to twice the level of rotary filter cake and will then supply about three times the quantity of protein.

For laying hens, therefore, there is a marked superiority of coagulate over scums when considered in terms of protein and fibre.

The coagulate is low in calcium and phosphorus but this is not a serious drawback; the level of lipids, however, is extremely high and analyses have indicated that one quarter of the material falls in this fraction. As it is not possible without further work to give an energy value to the lipid fraction, the value of the crude coagulate cannot be accurately forecast but it is almost certain that the high levels of wax will interfere with digestibility and so counteract any energy which may be available from other lipids.

No doubt the composition of the coagulate can be improved by pre-centrifuging the cold juice, which should remove most of the lipids, thereby giving an improved protein content, which would make the material readily acceptable for pig and poultry rations, and may even lead to direct human utilization.

CONCLUSIONS

Staub and Darné **(loc. cit.)** aware of the higher fibre levels in rotary filter scums than in filter press cake state that a change-over from the modern rotary filters to the old fashioned filter presses should be considered.

All scums are fairly low in protein, which is the main point of nutritional interest, and fairly high in fibre.

The simplest use of scums is as a direct feed for cattle for which low energy and large bulk are of little importance. This means that both types of filter mud can be fed, but the efficiency of utilization of the protein in terms of human interest is low.

The value of scums as a fertilizer to the sugar industry taking a production of 25,000 tons dried scums annually is around Rs. 2,000,000. If the industry were to revert to filter presses, the increased cost of production would have to be added to the value of the scums; in any case, the ratio of fibre in filter press cake to fibre in rotary filter cake of 2 : 3 is sufficiently close to make such a changeover of doubtful value nutritionally, let alone, economically.

Estates are already carrying an annual loss of about Rs. 25/acre as a result of the removal of cane tops for cattle fodder and it is unlikely that they would be prepared to subsidize the livestock industry of this country by giving away scums for feeding.

The arguments put forward in this paper are based mainly on analyses carried out in 1953, and the protein levels of filter muds occurring then may not be exactly the same today.

Detailed work on the composition and feeding value of local filter cake will be carried out during the 1962 crushing season, and research on the production of a high protein coagulate from juice is to continue.

The centrifugation of juice to prepare a high protein meal is expensive but the material undoubtedly has more potential nutritional interest than filter cake; filter cake, however, is readily available and is undoubtedly a valuable food-stuff.

In the end, economics will decide which is the most suitable means of exploiting the protein from cane juice but there is no doubt that the interest now being taken in the feeding of protein from cane juice, either as coagulate or as scums, will lead to an improved livestock foodstuff situation in Mauritius with concurrent benefits to the whole island.

	Coagulate	Control
Moisture ...	12.8	13.4
Protein (N x 6.25) ...	25.7	24.4
Fat (ether extract) ...	7.0	3.4

Both at Bénarès and at Curepipe, the animals had been feeding on the same concentrate mixtures for several months prior to the beginning of the test. The milk production of each group was first recorded for a period of ten days while the cows were on their standard rations. The experimental rations were then fed by gradual substitution over a period of four days.

After seven days on the experimental rations, the animals feeding on the coagulate were given gradually increasing amounts of the control rations, and vice versa, the change over taking place in three days. After a further period of seven days, the two groups of each lot were again gradually returned to their pre-experimental mixture, and milk records were kept for a subsequent period of ten days to enable the checking of any possible after effects.

Throughout the test, the animals at both places were fed on the same lines, each animal receiving 3/4 lb of ration per kilo of milk produced. Fodder was quite abundant and at Bénarès consisted of a mixture of cane tops with small amounts (one-fourth to one-fifth) of Setaria grass, whereas at Curepipe it consisted of sugar cane tops only. The cows were provided with fodder **ad lib**. and consumed daily about 70 kg each at Curepipe; at Bénarès each cow received about 40 kg of fodder per day, the balance being made up by providing one pound of either coagulate or control mixtures daily.

The animals in each group were weighed prior to the test, and the total weights of each batch were fairly comparable, namely :

Bénarès	— Group A	6131 lbs	
	,, B	6092 ,,	
Curepipe	— Group A	5915 ,,	
	,, B	6230 ,,	

The groups were reweighed after the test and it was observed that no appreciable changes in weight had taken place. Throughout the test all the animals were regularly examined for general condition and appearance, and no external changes were observed. Milk was also examined regularly, and no unusual colouring or tainting was noticed.

No difficulties were experienced as regards feeding; the rations were palatable and accepted at once by the individuals under test. Full rations were regularly eaten.

The high wax content of the juice coagulate does not seem to have had any deleterious effect on the animals. An average sample of dung excreted by one group of cows fed on the coagulate showed a wax content of 3.9 per cent, whereas a comparative sample from the control cows of the same lot yielded 2.5 per cent wax. It would thus appear that the waxy compounds in the coagulate are mostly inert.

Graphic illustrations of average milk production per cow during the trial periods are given in Figs. 32 and 33. As may be observed from these graphs, milk production was not adversely affected by the replacement of all the lucerne meal of the ration, namely, 20 per cent by weight, by juice coagulate. Although the cost of production of the latter has not yet been worked out, the separator used for experimental purposes being a small discontinuous machine, there is no doubt that, should the coagulate be produced continuously on an industrial scale, its cost per unit of protein would be much lower than that of lucerne meal which has to be imported and sells at about Rs. 325 per ton.

Another interesting aspect of the result obtained lies in the fact that it widens the scope of research in the field of nutrition. Whilst the value of the coagulate with regard to the growth of young livestock is well worth testing, it would also be necessary to try the product in rations compounded for other animals, in particular poultry and pigs. Unfortunately, most of the coagulate left over from that separated during the last sugar crop was accidentally destroyed by fire so that with the very limited quantity left, it will not be possible to carry out more than one digestibility trial, on sheep. It is intended, however, to separate more coagulate in 1962 in order to carry out an extensive programme of experimentation both on the intrinsic value of the coagulate and in comparison with dry scums.

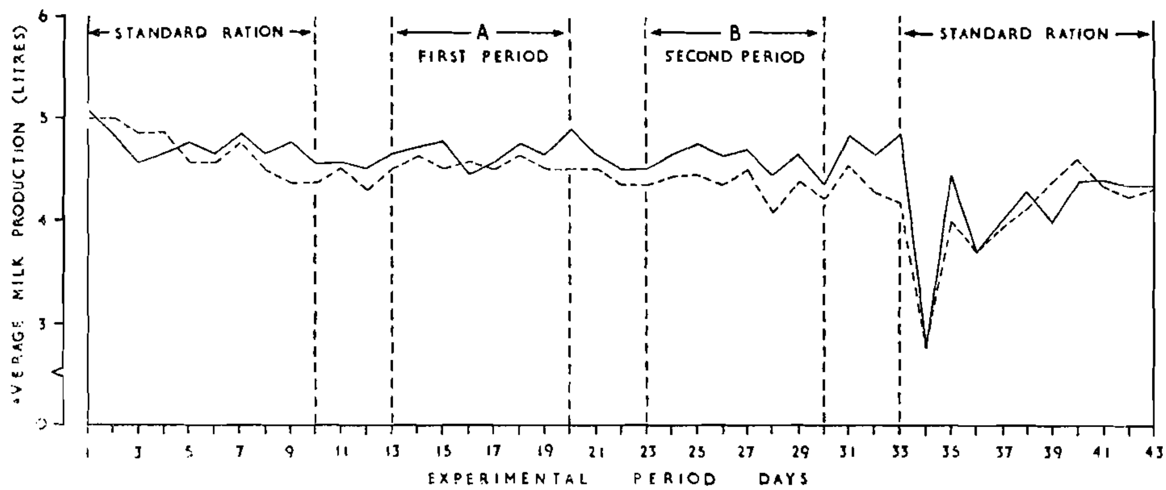

Fig. 32. Effect of "coagulate" and "control" rations on average milk production per cow, Curepipe Dairy.

Group A dotted line

Group B plain line

During first period, Group A received "coagulate" and group B "control" rations, and vice versa during the second period.

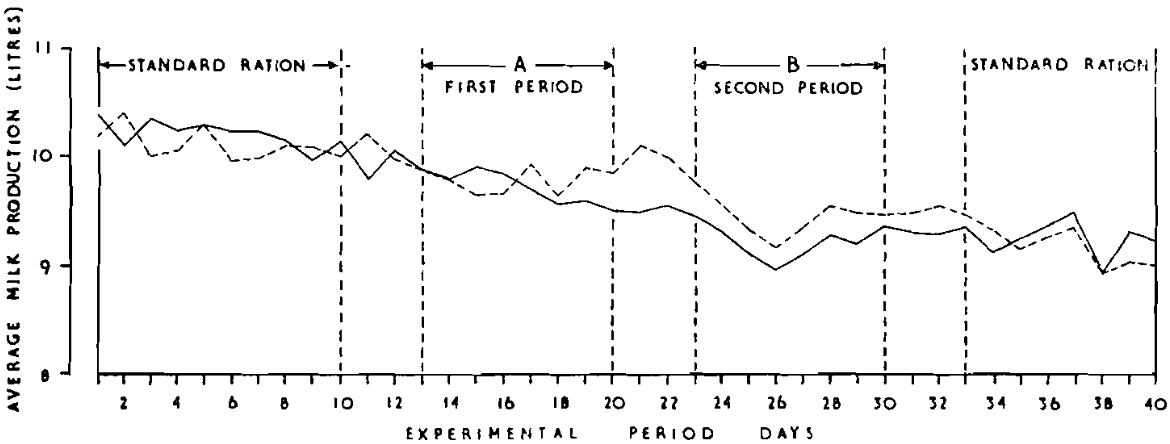

Fig. 33. Effect of "coagulate" and "control" rations on average milk production per cow, **Bénarès S. E.**

Group A dotted line

Group B plain line

During the first period, Group A received "coagulate" and group B "control" **rations, and** vice versa during the second period.

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APPENDIX*

I. Description of cane sectors.

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* *Grateful acknowledgment is made to the Secretary, Mauritius Chamber of Agriculture, for providing the necessary data to compile Tables II to VI.*

Table I. General description of sugar cane sectors of Mauritius.

SECTORS		WEST	NORTH	EAST	SOUTH	CENTRE
DISTRICT		Black River	Pamplemousses & Rivière du Rempart	Flacq	Grand Port & Savanne	Plaines Wilhems & Moka
ORIENTATION		Leeward	—	Windward	Windward	—
PHYSIOGRAPHY		Lowlands and Slopes	Lowlands	Slopes	Slopes	Plateau
GEOLOGY		Late lava — Pleistocene.				
PETROLOGY		Compact or vesicular doleritic basalts and subordinate tuffs.				
ALTITUDE		Sea level—900 ft.	Sea level—600 ft.	Sea level—1,200 ft.	Sea level—1,200 ft.	900—1,800 ft.
HUMIDITY PROVINCE		Sub-humid	Sub-humid to humid	Humid to super-humid		
ANNUAL RAINFALL, inches. Range and mean		(30—60) 44	(40—75) 55	(60—125) 94	(60—125) 90	(60—150) 90
MONTHS RECEIVING LESS THAN TWO INCHES RAIN		June to October	September to October	None		
AVERAGE TEMPERATURE °C	JAN.	27.0°	26.5°	25.5°	25.0°	23.5°
	JUL.	21.0°	20.5°	19.5°	19.0°	17.5°
CYCLONIC WINDS, greater than 30m p.h. during 1 hour		December to May				
PEDOLOGY Great Soil Groups		Soil Families				
Low Humic Latosol		« Richelieu »	« Richelieu » « Réduit »	« Réduit » « Bonne Mère »	« Reduit »	« Réduit » « Ebène »
Humic Latosol		—	« Rosalie »		« Riche Bois »	« Riche Bois »
Humic Ferruginous Latosol		—	—	« Sans Souci »	« Belle Rive » « Sans Souci » « Midlands » « Chamarel »	« Belle Rive » « Sans Souci » « Midlands »
Latosolic Reddish Prairie		« Médine »	« Labourdonnais » « Mont Choisy »	« Mont Choisy »	« Labourdonnais » « Mont Choisy »	« Médine »
Latosolic Brown forest		—	—	« Rose Belle »	« Rose Belle » « Bois Chéri »	« Rose Belle » « Bois Chéri »
Dark Magnesium Clay		« Lauzun » « Magenta »	« Lauzun »	—	—	—
Grey Hydromorphic		« Balaclava »	« Balaclava » « St. André »	« Balaclava »	—	—
Low Humic Gley		—	—	« Valetta »	—	« Valetta » « Petrin »
Lithosol		—	« Melleville »	« Pl. des Roches » « Melleville »	« Melleville »	—
IRRIGATION		Common	Some	Rare		
APPROXIMATE AREA 1000 arpents	**Sector**	56	91	72	160	63
	Cane	11	53	44	63	26
CANE PRODUCTION 1000 metric tons		275	1,100	970	1,640	672
SUGAR PRODUCTION 1000 metric tons		33	139	114	186	80
SUGAR FACTORIES Production in 1000 metric tons		Médine 33	Mon Loisir 27 St. Antoine 21 Solitude 21 The Mount 21 Beau Plan 20 Belle Vue 20	Union Flacq 65 Beau Champ 28 Constance 21	Savinia 29 Mon Trésor 23 Rose Belle 21 Riche en Eau 20 Union 20 Britannia 20 Bel Ombre 14 Benarès 13 Ferney 11 St. Félix 11	Mon Désert 36 Highlands 24 Réunion 20

Table II. Area under sugar cane in thousand arpents(1), 1956 - 1961.

Year	Area under cane Island	Area repead					
		Island	West	North	East	South	Centre
1956	181.21	167.90	8.74	48.16	35.95	53.17	21.88
1957	182.67	169.58	8.95	48.27	35.72	54.25	22.29
1958	189.22	176.69	9.20	49.14	38.78	56.62	22.95
1959	195.31	183.12	9.62	50.37	40.93	58.77	23.43
1960	201.61	188.36	10.22	51.50	42.15	60.34	24.14
1961(2)	200.00	186.41	9.72	51.00	40.89	60.65	24.15

NOTE : (*1*) *To convert into acres multiply by 1.043*

„ „ „ hectares „ „ 0.422

(*2*) *Provisional figures.*

Table III. Sugar production in thousand metric tons(1), 1956 - 1961.

Crop Year	No. of factories operating	Av. Pol.	Island	West	North	East	South	Centre
1956	26	98.6	572.5	31.06	167.14	110.22	187.60	76.47
1957	26	98.5	562.0	36.05	141.28	103.31	198.86	82.50
1958	25	98.5	525.8	31.80	137.17	106.07	178.80	72.01
1959	24	98.6	580.4	35.22	141.95	123.76	195.86	83.59
1960	23	98.0	235.8	18.06	75.22	50.02	72.24	20.24
1961(2)	23	98.7	552.7	32.63	139.48	111.82	183.25	84.87

NOTE : (*1*) *To convert into long tons multiply by 0.984*

„ „ „ short „ „ „ 1.102

(*2*) *Provisional figures*

Table IV. Yield of cane metric tons per arpent(1), 1956 - 1961.

	1956	1957	1958	1959	1960	1961(2)
ISLAND						
Millers	32.0	32.2	30.5	32.5	15.3	32.2
Planters	21.0	19.1	19.1	19.7	10.2	20.8
Average	26.3	25.6	24.5	25.9	12.7	26.5
WEST						
Millers	32.2	35.9	32.4	34.4	21.3	35.3
Planters	24.1	27.8	25.2	26.4	13.5	25.7
Average	27.0	30.8	28.0	29.3	16.2	29.5
NORTH						
Millers	32.2	29.0	29.5	30.0	19.2	29.1
Planters	22.2	16.9	17.5	17.1	11.4	20.3
Average	25.5	21.1	21.6	21.5	14.1	23.3
EAST						
Millers	31.6	31.5	31.5	33.0	16.3	32.5
Planters	19.2	17.2	16.8	19.2	9.3	18.7
Average	23.9	22.9	22.4	24.8	12.2	25.0
SOUTH						
Millers	31.7	32.8	30.3	32.3	14.6	31.7
Planters	20.9	22.0	22.5	21.4	9.4	21.1
Average	28.3	29.3	27.4	28.6	12.9	28.1
CENTRE						
Millers	32.7	34.1	30.6	34.9	9.7	36.5
Planters	19.0	20.4	19.9	22.0	7.6	23.5
Average	27.1	28.6	25.9	29.1	8.8	30.6

NOTE : (*1*) *To convert in metric tons/acre multiply by 0.959*
„ „ „ long tons/acre „ „ 0.945
„ „ „ short tons/acre „ „ 1.058
„ „ „ metric tons/hectare „ „ 2.370

(2) *Provisional figures.*

Table V. Average sugar manufactured % cane(1), 1956 - 1961

Crop Year	Island	West	North	East	South	Centre
1956	12.95	13.17	13.59	12.84	12.47	12.89
1957	12.94	13.07	13.86	12.64	12.49	12.88
1958	12.14	12.36	12.95	12.22	11.53	12.12
1959	12.24	12.48	13.08	12.22	11.64	12.27
1960	9.84	10.94	10.34	9.73	9.29	9.56
1961(2)	11.18	11.40	11.74	10.94	10.78	11.47

NOTE : (1) To convert into tons cane per ton sugar manufactured : divide 100 by above percentage.
(2) Provisional figures.

Table VI. Tons sugar manufactured per arpent reaped, 1956 — 1961.

	Island	West	North	East	South	Centre
1956	3.41	3.56	3.47	3.07	3.53	3.49
1957	3.31	4.02	2.92	2.89	3.66	3.68
1958	2.98	3.46	2.79	2.74	3.16	3.14
1959	3.17	3.66	2.81	3.03	3.33	3.57
1960	1.26	1.96	1.49	1.19	1.20	0.84
1961(1)	2.97	3.36	2.74	2.74	3.03	3.51

NOTE : (1) Provisional figures.

Table VII. Monthly rainfall in inches. Average over whole sugar cane area of Mauritius.

	GROWTH PERIOD (deficient months in italics)								NOV-JUNE (sum of monthly deficits)	MATURATION PERIOD (excess months in italics)				JULY-OCT. (sum of monthly excesses)
Crop year	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE		JULY	AUG.	SEPT.	OCT.	
Normals 1875-1949	3.77	7.09	11.04	11.06	12.09	9.50	6.91	4.96	15.00	4.59	4.15	2.90	2.81	2.50
Extremes	0.52 13.18	1.74 39.92	2.69 32.46	3.07 36.04	3.35 38.98	1.45 27.60	1.62 21.41	0.97 16.49	2.20 29.20	1.62 10.23	0.60 12.52	0.69 6.41	0.76 9.83	0.00 9.40
1947	10.36	*3.42*	*8.06*	*6.83*	*4.26*	9.69	*3.50*	5.66	22.57	2.76	3.91	2.20	1.24	0.00
1948	*2.52*	*6.83*	*8.23*	*5.10*	*8.04*	12.13	*2.61*	*1.80*	21.79	4.12	2.84	*3.34*	*2.98*	0.61
1949	4.01	*5.48*	*4.81*	16.71	*8.86*	*7.01*	*3.30*	10.09	17.17	4.11	1.91	1.39	1.39	0.00
1950	*3.34*	*3.42*	*10.20*	*5.21*	23.18	11.39	2.98	7.02	14.72	4.47	*5.02*	2.80	2.35	0.87
1951	*3.15*	*5.86*	11.65	*8.20*	*10.89*	*7.98*	7.00	7.26	7.43	*4.91*	*5.41*	*4.16*	*3.84*	3.87
1952	4.08	*2.22*	*5.26*	11.17	16.88	10.11	*5.69*	*4.86*	12.31	*8.22*	*5.20*	*3.47*	*3.13*	5.61
1953	6.06	18.05	11.65	*6.59*	*10.57*	*8.35*	11.95	12.75	7.14	*10.10*	*4.72*	*3.07*	2.68	6.25
1954	*3.76*	11.47	*5.00*	*7.96*	14.89	*6.20*	*6.49*	6.06	12.88	*6.44*	*5.04*	*4.11*	1.53	3.76
1955	4.81	*5.19*	*4.50*	23.28	19.60	10.97	8.83	7.73	8.44	*4.66*	3.85	*3.68*	1.12	0.85
1956	*3.03*	7.70	12.02	13.59	*10.60*	*4.14*	*5.93*	*4.90*	8.63	2.94	2.82	1.68	1.40	0.00
1957	*2.08*	8.11	*7.80*	*6.98*	*8.93*	10.66	*6.14*	*3.66*	14.24	3.55	2.54	*3.32*	0.96	0.42
1958	*2.09*	10.26	13.49	13.28	29.54	13.29	*4.95*	*2.20*	6.40	*8.22*	*4.51*	1.50	2.47	3.99
1959	*1.18*	*3.06*	13.64	*9.48*	13.93	4.81	*3.04*	*1.80*	19.91	3.07	*6.01*	2.67	*6.53*	5.59
1960	11.43	*6.58*	23.46	18.29	16.97	*1.73*	*3.23*	5.06	11.96	3.57	2.29	*8.06*	1.49	5.16
1961	*2.48*	*3.13*	*4.31*	*2.59*	*7.96*	*7.58*	*4.70*	7.13	28.71	*7.84*	*5.65*	2.05	2.26	4.75

NOTE: To convert into millimetres multiply by 25.4.

Table VIII. Highest wind speed during one hour in miles(1). Average over Mauritius.

Crop Year	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Nov.	—	21	17	24	18	18	14	16	12	13	13	19	16
Dec.	18	16	24	21	15	16	15	17	13	13	14	15	15
Jan.	27	26	21	22	18	28	13	20	20	14	17	*53*(2)	16
Feb.	20	24	20	25	15	15	*34*(2)	16	19	18	17	*74*(2)	13
March	20	17	18	25	15	15	29	19	18	*33*(2)	18	15	13
April	18	21	17	22	20	16	16	17	16	28	17	15	12
May	20	19	20	24	22	22	19	18	15	14	16	17	13
June	24	20	23	25	23	20	22	17	13	14	17	17	19
July	21	23	21	20	24	16	17	15	12	11	16	15	19
August	18	19	24	25	24	23	20	14	17	20	18	16	20
Sept.	20	21	21	21	20	19	19	17	17	17	17	20	21
October	18	19	20	20	19	20	14	18	15	17	18	18	19

NOTE : (1) To convert into : knots multiply by 0.87.
kilometres/hr. multiply by 1.61.
metres/sec. multiply by 0.45.
(2) Cyclonic wind above 30 miles per hour.

Table IX. Highest wind speed during one hour in miles in different sectors. Cyclone years.

	West	North	East	South	Centre
February 1955	—	30	—	37	35
March 1958	34	29	22	35	31
January 1960 *Alix*	60	48	43	60	—
February 1960 *Carol*	83	82	78	74	55

Table X. Variety trend in Mauritius, 1950 - 1961.

% Area cultivated (Estate lands).

	M. 134/32	M. 112/34	M. 147/44	M. 31/45	M.202/46	M. 93/48	M. 253/48	Other M. seedlings	Ebène 1/37	Ebène 50/47	B. 3337	B. 34104	B. 37161	B. 37172	Others
1950	91	2	—	—	—	—	—	5	1	—	—	—	—	—	1
1951	92	2	—	—	—	—	—	4	2	—	—	—	—	—	—
1952	90	2	—	—	—	—	—	3	4	—	—	—	—	—	1
1953	86	2	—	—	—	—	—	3	8	—	—	—	—	—	1
1954	83	2	—	—	—	—	—	3	9	—	1	—	1	—	1
1955	74	2	—	—	—	—	—	2	15	—	3	—	2	1	1
1956	66	2	1	1	—	—	—	3	17	—	4	—	3	2	1
1957	55	2	6	3	—	—	—	1	21	—	4	1	3	3	1
1958	43	2	10	4	—	—	—	2	24	—	5	1	3	5	1
1959	33	2	15	5	—	—	—	1	25	—	5	2	3	8	1
1960	25	2	19	5	—	—	—	1	26	—	6	2	3	10	1
1961(1)	19	1	22	5	2	1	1	—	24	1	7	2	2	12	1

(*1*) *Provisional figures.*

Table XI. Percentage annual plantations under different cane varieties on sugar estates, 1957 to 1961.

Years / Varieties	Island					West					North					East					South					Centre				
	1957	1958	1959	1960	1961	1957	1958	1959	1960	1961	1957	1958	1959	1960	1961	1957	1958	1959	1960	1961	1957	1958	1959	1960	1961	1957	1958	1959	1960	1961
M.134/32	7.5	3.0	1.2	2.8	1.0	23.8	6.2	—	—	—	17.8	8.1	2.7	11.3	5.0	1.7	0.5	0.2	0.4	—	7.9	3.0	1.5	1.2	0.4	—	0.4	0.4	0.3	0.1
M.147/44	35.6	28.9	32.7	30.0	30.1	46.4	25.2	20.5	17.8	17.8	47.3	35.3	50.4	49.4	55.4	32.1	34.8	39.0	27.8	34.4	39.6	25.1	31.2	27.9	27.9	13.5	22.0	8.0	16.4	8.9
M.31/45	9.1	8.0	3.8	2.6	0.8	6.9	13.1	4.8	7.4	—	5.8	4.8	4.9	6.7	3.3	10.1	15.7	5.7	3.8	1.0	12.6	7.3	2.4	0.3	0.2	1.0	2.8	3.3	—	—
M.202/46	—	—	—	7.7	12.6	—	—	—	9.2	18.3	—	—	—	6.2	11.2	—	—	—	4.9	15.3	—	—	—	10.4	11.5	—	—	—	5.0	10.8
M.93/48	—	—	—	2.9	11.6	—	—	—	1.5	—	—	—	—	0.9	2.9	—	—	—	1.8	12.8	—	—	—	5.3	18.7	—	—	—	0.4	5.5
M.253/48	—	—	—	2.1	3.6	—	—	—	20.2	12.8	—	—	—	0.2	3.1	—	—	—	3.6	4.0	—	—	—	0.6	2.2	—	—	—	0.7	3.4
Ebène 1/37	33.2	28.9	24.3	14.5	12.7	—	—	—	—	—	6.6	5.2	7.2	3.2	3.3	43.1	27.5	25.2	17.8	11.7	24.7	30.5	30.2	14.5	12.3	81.2	57.5	35.2	—	30.3
Ebène 50/47	—	—	—	—	7.3	—	—	—	—	3.1	—	—	—	—	0.5	—	—	—	—	6.4	—	—	—	—	3.9	—	—	—	—	26.3
B.3337	1.8	4.8	6.9	10.3	6.0	—	—	—	—	—	—	—	—	—	—	1.0	1.7	6.4	10.2	5.7	—	7.6	8.3	15.2	6.9	1.8	8.4	14.7	—	12.9
B.34104	2.2	2.9	2.8	2.5	4.0	7.8	32.0	29.6	15.9	26.7	1.6	5.6	2.9	2.1	0.6	0.5	0.1	—	0.3	1.5	3.3	3.2	2.1	2.9	4.3	0.3	2.7	1.2	—	0.6
B.37161	2.1	0.9	—	—	—	1.1	1.1	—	—	—	4.6	4.4	—	—	—	2.7	—	—	—	—	1.6	—	—	—	—	—	—	—	—	—
B.37172	5.7	20.6	21.0	16.5	8.7	3.9	13.3	30.9	26.4	18.7	11.6	32.3	25.7	19.6	14.0	7.3	18.8	15.9	17.4	6.1	4.8	22.3	19.8	18.6	9.2	0.1	3.0	23.0	0.5	0.6
Other varieties	0.7	1.2	6.8	8.1	1.6	0.7	6.3	14.2	—	2.6	1.2	1.9	5.1	0.4	0.7	0.7	0.7	7.0	12.0	1.2	0.5	0.7	4.2	3.1	2.5	1.0	2.6	14.1	—	0.6
Total area arpents	13948	13011	13203	14321	15451	536	403	512	729	1042	2105	2573	2579	2796	2559	3076	2964	2620	2834	3071	6224	5536	5565	6058	6318	2007	1939	1927	1905	2461

Table XII. Percentage weight of ratoons in total cane production on estates.

Year	Island	West	North	East	South	Centre
1949	82.0	75.9	78.9	81.7	83.3	82.3
1950	83.0	79.1	82.3	83.5	87.3	83.9
1951	87.6	80.0	82.5	85.6	91.5	86.3
1952	88.6	85.0	83.4	87.9	90.2	86.7
1953	87.8	85.9	87.7	88.1	88.5	85.4
1954	88.0	83.8	86.8	89.6	89.4	85.3
1955	87.1	86.7	88.6	87.7	86.4	86.1
1956	84.5	87.5	86.4	84.9	83.8	82.9
1957	85.0	79.0	86.9	83.6	85.7	83.7
1958	82.9	77.9	86.3	77.5	83.1	85.5
1959	86.1	87.8	85.9	82.1	87.2	87.8
1960	81.9	82.2	82.7	78.3	75.2	84.8
1961	85.4	78.5	84.4	85.1	86.3	86.7

NOTE: The weight of cane produced on estates in 1961 was: virgins 441,850 tons; ratoons 2,583,468.

Table XIII. Average yields of virgin and ratoon canes on estates.

Tons per arpent. A: 1955 - 1959 B: 1961.

	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
Virgin	35.6	34.4	41.8	48.2	34.4	30.7	38.8	36.0	34.2	32.5	35.7	38.9
1st Ratoon	34.0	33.6	36.4	36.8	32.6	29.2	35.1	34.1	33.4	33.9	35.3	37.0
2nd ,,	32.4	32.8	34.0	33.1	32.0	28.4	32.8	34.3	31.9	32.2	33.3	39.0
3rd ,,	31.1	32.9	32.8	31.6	29.9	29.5	31.3	34.6	30.8	32.3	32.7	36.9
4th ,,	30.2	31.4	31.6	29.6	28.8	28.3	30.2	32.5	30.2	30.8	31.9	36.1
5th ,,	29.5	30.8	31.7	29.7	28.9	28.0	28.6	31.8	29.6	29.4	30.3	36.8
6th ,,	29.2	30.0	30.3	29.3	28.4	28.5	28.6	30.0	29.8	29.1	29.4	35.5

Table XV. Evolution of cane quality during 1961 sugar crop.

Week Ending	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
22nd July	11.05	9.25	10.80	9.05	—	—	10.96	9.17	11.03	9.07	11.32	9.77
29th ,,	11.21	9.49	11.09	9.38	10.18	8.09	11.23	9.61	11.20	9.39	11.54	10.07
5th August	11.44	9.73	11.46	9.67	10.88	8.95	11.57	9.84	11.40	9.70	11.91	10.37
12th ,,	11.42	9.80	11.73	9.90	10.86	9.34	11.49	9.87	11.54	9.82	11.92	10.41
19th ,,	11.88	10.20	12.30	10.58	11.55	9.57	11.87	10.32	11.79	10.11	12.39	10.93
26th ,,	12.12	10.48	12.55	10.78	12.02	10.31	12.03	10.52	11.96	10.23	12.60	11.12
2nd September	12.39	10.79	13.17	11.50	12.32	10.66	12.30	10.79	12.20	10.61	12.74	11.31
9th ,,	12.68	11.19	13.32	11.88	12.62	11.09	12.50	11.21	12.50	10.95	12.99	10.48
16th ,,	13.01	11.46	13.60	12.22	13.03	11.43	12.93	11.51	12.74	11.13	13.35	11.91
23rd ,,	13.17	11.64	13.39	12.26	13.19	11.50	13.06	11.57	12.94	11.38	13.54	12.16
30th ,,	13.46	11.84	13.97	12.40	13.49	11.93	13.29	11.90	13.56	11.49	13.46	12.20
7th October	13.65	12.10	14.36	12.85	13.95	12.32	13.53	12.13	13.30	11.65	13.64	12.34
14th ,,	13.75	12.21	14.19	12.73	14.26	12.66	13.50	11.96	13.35	11.72	13.75	12.47
21st ,,	13.81	12.25	14.32	12.73	14.47	12.86	13.53	11.90	13.35	11.78	13.65	12.31
28th ,,	13.99	12.39	14.30	12.69	14.76	13.12	13.55	11.84	13.47	11.88	13.94	12.58
4th November	13.93	12.42	14.19	12.58	14.97	13.26	13.64	11.91	13.55	11.93	13.02	12.59
11th ,,	14.24	12.51	14.18	12.44	15.06	13.18	13.84	12.04	13.72	12.01	14.31	12.94
18th ,,	13.93	12.22	13.91	12.02	14.88	13.11	13.48	11.74	13.41	11.71	14.01	12.68
25th ,,	13.83	12.54	14.06	11.81	14.77	12.83	13.53	11.72	13.31	11.59	13.90	12.42
2nd December	13.36	11.48	—	—	—	—	12.81	11.10	13.47	10.79	—	—
9th ,,	12.64	10.72	—	—	—	—	—	—	12.21	10.27	—	—
16th ,,	12.41	10.60	—	—	—	—	—	—	—	—	—	—

NOTE: A = Sucrose % cane.

B = Sugar manufactured % cane.

Table XIV. Evolution of 1961 crop – Production data at weekly intervals

	Island	West	North	East	South	Centre
	8th July					
Cane crushed (1000m. tons)	76	—	—	3	58	15
Sugar manufactured % cane	8.69	—	—	10.51	8.55	9.19
Sugar manufactured (1000 m. tons)	6.6	—	—	0.2	5.0	1.4
	5th August					
Cane crushed (1000 m. tons)	768	59	49	182	319	159
Sugar manufactured % cane	9.31	9.20	8.73	9.36	9.18	9.73
Sugar manufactured (1000 m. tons)	71.5	5.5	4.2	17.0	29.3	15.5
	2nd September					
Cane crushed (1000 m. tons)	1,657	114	275	373	601	294
Sugar manufactured % cane	9.85	9.91	9.74	9.88	9.66	10.29
Sugar manufactured (1000 m. tons)	163.3	11.3	26.8	36.9	58.0	30.3
	30th September					
Cane crushed (1000 m. tons)	2,702	175	574	578	927	448
Sugar manufactured % cane	10.51	10.70	10.67	10.48	10.23	10.86
Sugar manufactured (1000 m. tons)	284.0	18.7	61.2	60.6	94.8	48.7
	28th October					
Cane crushed (1000 m. tons)	3,679	228	868	759	1,231	593
Sugar manufactured % cane	10.97	11.18	11.36	10.83	10.62	11.25
Sugar manufactured (1000 m. tons)	403.7	25.5	98.6	82.2	130.7	66.7
	25th November					
Cane crushed (1000 m. tons)	4,494	281	1,092	914	1,511	696
Sugar manufactured % cane	11.21	11.37	11.72	11.0	10.84	11.46
Sugar manufactured (1000 m. tons)	503.8	32.0	127.9	100.5	164.7	79.7

	Island	West	North	East	South	Centre
	15th July					
Cane crushed (1000m. tons)	216	15	—	40	110	51
Sugar manufactured % cane	8.77	8.72	—	8.60	8.72	9.01
Sugar manufactured (1000 m. tons)	18.9	1.3	—	3.4	9.6	4.6
	12th August					
Cane crushed (1000 m. tons)	975	74	100	229	380	192
Sugar manufactured % cane	9.39	9.34	8.89	9.47	9.27	9.85
Sugar manufactured (1000 m. tons)	91.6	7.0	8.9	21.7	35.1	18.9
	9th September					
Cane crushed (1000 m. tons)	1,918	130	348	426	680	334
Sugar manufactured % cane	10.03	10.15	10.04	10.04	9.80	10.44
Sugar manufactured (1000 m. tons)	192.4	13.2	34.9	42.8	66.6	34.9
	7th October					
Cane crushed (1000 m. tons)	2,958	189	650	627	1,007	485
Sugar manufactured % cane	10.64	10.87	10.86	10.60	10.33	10.97
Sugar manufactured (1000 m. tons)	314.9	20.6	70.5	66.4	104.0	53.2
	4th November					
Cane crushed (1000 m. tons)	3,893	240	928	798	1,303	623
Sugar manufactured % cane	11.08	11.25	11.47	10.89	10.76	11.31
Sugar manufactured (1000 m. tons)	431.3	27.1	106.5	87.0	140.2	70.5
	2nd December					
Cane crushed (1000 m. tons)	4,673	286	1,138	950	1,582	717
Sugar manufactured % cane	11.22	11.40	11.74	11.01	10.84	11.45
Sugar manufactured (1000 m. tons)	524.3	32.6	133.6	104.5	171.5	82.1

	Island	West	North	East	South	Centre
	22nd July					
Cane crushed (1000m. tons)	369	29	—	82	173	85
Sugar manufactured % cane	8.96	8.87	—	8.69	8.86	9.32
Sugar manufactured (1000 m. tons)	33.1	2.6	—	7.2	15.3	8.0
	19th August					
Cane crushed (1000 m. tons)	1,185	87	147	276	450	225
Sugar manufactured % cane	9.55	9.52	9.12	9.62	9.43	10.0
Sugar manufactured (1000 m. tons)	113.2	8.3	13.4	26.6	42.4	22.5
	16th September					
Cane crushed (1000 m. tons)	2,185	145	424	479	764	373
Sugar manufactured % cane	10.22	10.37	10.30	10.20	9.96	10.59
Sugar manufactured (1000 m. tons)	223.5	15.0	43.7	48.8	76.1	35.9
	14th October					
Cane crushed (1000 m. tons)	3,203	203	725	672	1,082	522
Sugar manufactured % cane	10.76	10.99	11.04	10.69	10.43	11.06
Sugar manufactured (1000 m. tons)	344.7	22.3	80.0	71.5	112.8	57.8
	11th November					
Cane crushed (1000 m. tons)	4,084	252	935	835	1,363	649
Sugar manufactured % cane	11.13	11.31	11.57	10.93	10.76	11.39
Sugar manufactured (1000 m. tons)	459.4	28.5	114.0	91.3	146.7	73.9
	9th December					
Cane crushed (1000 m. tons)	4,809	286	1,171	982	1,643	727
Sugar manufactured % cane	11.20	11.40	11.76	10.96	10.83	11.47
Sugar manufactured (1000 m. tons)	539.5	32.6	137.7	107.8	178.0	83.4

	Island	West	North	East	South	Centre
	29th July					
Cane crushed (1000m. tons)	549	44	13	125	246	121
Sugar manufactured % cane	9.15	9.04	8.09	9.14	9.05	9.54
Sugar manufactured (1000 m. tons)	50.2	4.0	1.1	11.4	22.2	11.5
	26th August					
Cane crushed (1000 m. tons)	1,412	100	210	324	520	258
Sugar manufactured % cane	9.71	9.68	9.50	9.74	9.55	10.16
Sugar manufactured (1000 m. tons)	137.0	9.7	20.0	31.5	49.6	26.2
	23rd September					
Cane crushed (1000 m. tons)	2,446	160	499	529	847	411
Sugar manufactured % cane	10.37	10.55	10.48	10.35	10.11	10.74
Sugar manufactured (1000 m. tons)	253.6	16.9	52.3	54.8	85.6	44.2
	21st October					
Cane crushed (1000 m. tons)	3,442	216	797	714	1,157	558
Sugar manufactured % cane	10.86	11.10	11.20	10.77	10.50	11.14
Sugar manufactured (1000 m. tons)	374.0	24.0	89.3	76.9	121.7	62.1
	18th November					
Cane crushed (1000 m. tons)	4,298	267	1,043	877	1,437	674
Sugar manufactured % cane	11.18	11.35	11.65	10.98	10.79	11.43
Sugar manufactured (1000 m. tons)	480.5	30.4	121.6	96.3	155.1	77.1
	Total crop production (preliminary figs.)					
Cane crushed (1000 m. tons)	4,943	286	1,191	1,022	1,704	740
Sugar manufactured % cane	11.18	11.40	11.74	10.94	10.78	11.47
Sugar manufactured (1000 m. tons)	552.7	32.6	139.8	111.8	183.6	84.9

Table XVI. Total duration of harvest in days (A) and weekly crushing rates of factories in 1000 metric tons (B) in different sectors of the island, 1948 - 1961.

YEARS	Island		West		North		East		South		Centre	
	A	B	A	B	A	B	A	B	A	B	A	B
1948	132	167.6	140	7.3	122	42.1	136	33.6	140	60.0	125	24.6
1949	133	176.5	142	7.7	128	44.0	129	37.0	140	62.4	127	25.4
1950	141	184.6	130	10.1	140	47.9	145	35.1	144	65.0	135	26.5
1951	154	197.8	150	10.3	169	52.0	159	40.3	140	65.8	132	29.4
1952	149	192.4	151	9.9	149	50.5	155	40.2	154	63.4	131	28.4
1953	158	205.7	162	11.8	167	57.7	161	42.5	153	66.0	145	27.7
1954	140	214.1	142	11.7	137	60.5	138	42.9	147	68.7	134	30.3
1955	133	222.6	134	12.8	122	64.2	140	41.5	140	71.6	127	32.5
1956	136	227.3	129	12.7	137	62.7	138	43.4	138	76.2	128	32.3
1957	128	237.5	144	13.3	104	68.2	133	42.9	141	78.6	129	34.5
1958	130	233.0	128	14.3	106	69.9	137	44.4	141	77.0	133	31.3
1959	135	238.0	133	14.4	102	73.3	149	47.8	147	81.2	133	35.7
1960	107	156.5	108	10.7	118	43.0	121	29.8	118	46.1	83	17.8
1961	151	229.1	145	13.8	126	66.2	160	44.7	164	72.7	153	33.9

Table XVII. Summary of chemical control data 1961.

(i) CANE CRUSHED AND SUGAR PRODUCED.

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
CRUSHING PERIOD	From	7/7	29/7	4/8	29/7	7/8	21/7	21/8	27/7	7/7	7/7	14/7	28/6	1/7	3/7	30/6	26/6	21/7	1/7	24/7	18/7	30/6	14/7	3/7	26.6
	To	28/11	12/12	16/12	6/12	16/12	14/11	28/11	1/12	20/12	15/12	29/12	14/12	7/12	30/11	16/12	16/12	19/12	14/12	27/12	23/12	11/11	20/12	7/12	29/12
	No. of crushing days	121	111	110	105	110	92	83	105	140	134	136	139	134	127	143	147	116	140	129	132	111	128	132	123
	No. of crushing hours per day	20.63	22.27	22.99	20.61	22.14	21.87	19.67	17.75	20.09	18.05	15.31	16.79	13.92	18.63	21.37	17.59	16.64	17.04	16.28	16.70	18.60	21.59	20.56	18.86
	Hours stoppage per day	1.20	0.69	0.50	0.88	1.47	0.57	1.24	0.42	1.36	0.26	0.48	0.26	0.64	0.11	0.82	1.09	0.57	0.79	0.67	1.66	0.80	1.13	0.73	0.80
	Overall time Efficiency	94.5	97.0	97.9	95.9	93.8	97.4	94.1	97.7	93.7	98.6	96.9	98.4	95.6	99.4	96.3	93.8	96.7	95.6	96.0	91.0	95.9	95.0	96.6	95.8
CANE CRUSHED (Metric Tons)	Factory	133,540	46,335	54,203	101,793	86,387	65,348	117,142	65,193	375,074	157,281	70,534	187,845	142,897	168,260	155,882	176,918	111,164	190,331	47,293	63,417	109,697	135,229	239,175	3,000,938
	Planters	152,705	171,684	149,755	63,067	123,694	127,853	83,378	92,356	247,822	84,636	44,107	32,969	35,668	57,564	66,708	26,685	1,876	200	61,579	61,863	73,770	76,473	105,623	1,942,035
	Total	286,245	218,019	203,958	164,860	210,081	193,201	200,520	157,549	622,896	241,917	114,641	220,814	178,565	225,824	222,590	203,603	113,040	190,531	108,872	125,280	183,467	211,702	344,798	4,942,973
	Factory % Total	46.7	21.3	26.6	61.7	41.1	33.7	58.4	41.4	60.2	65.0	61.5	85.0	80.0	74.5	70.0	86.9	98.3	99.9	43.4	50.6	59.8	63.9	69.4	60.7
	Per day	2,366	1,964	1,854	1,570	1,910	2,100	2,416	1,500	4,449	1,805	843	1,588	1,333	1,778	1,557	1,385	974	1,361	844	949	1,653	1,654	2,612	1,750
	Per hour actual crushing	114.6	88.2	80.7	76.2	86.3	96.0	122.8	84.4	222.4	100.0	55.1	94.6	95.7	95.4	72.8	78.7	58.5	79.9	51.8	56.8	89.0	76.6	127.1	92.8
VARIETIES CRUSHED (Factory)	M.134/32 per cent	31.2	35.1	44.1	27.4	60.1	22.1	38.0	22.9	13.8	15.6	9.9	6.5	17.4	35.8	3.9	11.0	11.8	28.8	4.5	26.9	6.1	0.3	3.5	18.1
	Ebène 1/37 per cent	2.0	0.4	3.2	12.2	0.5	—	3.4	6.6	39.9	22.4	16.2	23.5	30.9	15.7	49.3	27.5	11.0	20.1	14.6	6.3	44.4	61.9	64.7	27.0
	M.147/44 per cent	23.2	36.7	26.8	27.9	21.0	36.4	34.9	43.7	20.6	20.3	29.2	27.2	13.5	18.6	8.9	19.9	20.3	20.5	39.5	24.0	22.2	2.7	15.2	21.4
	M.31/45 per cent	4.4	1.7	1.6	8.8	1.3	4.6	1.8	6.8	6.6	7.4	9.1	6.5	2.6	4.4	5.0	8.6	6.6	5.8	7.8	6.1	2.6	—	0.2	4.9
	B.3337 per cent	–			0.3	1.7				6.3	3.4	5.8	11.1	1.7	2.8	28.8	25.5	2.2	5.2	6.0	3.0	15.8	17.1	8.3	7.7
	B.37172 per cent	11.5	19.4	5.6	15.3	7.3	32.0	14.8	18.0	4.7	20.1	13.2	18.0	15.2	14.2	1.4	1.2	31.4	8.4	16.8	15.8	3.5	—	0.1	10.5
	Other varieties	27.7	6.7	18.7	8.1	8.1	4.9	7.1	2.0	8.1	10.8	16.6	7.2	18.7	8.5	2.7	6.3	16.7	11.2	10.8	17.9	5.4	18.0	8.0	10.4
SUGAR PRODUCED (Metric tons)	Raw Sugar	32,632	24,198	23,985	19,375	25,549	15,225	25,084	17,078	69,130	25,670	2,441	22,968	20,500	25,405	25,020	22,205	6,089	19,951	11,383	12,986	19,650	25,207	40,000	531,731
	White Sugar	—	—	—	—		6,353	–	—			8,338	—		—	—	—	6,313	—		—		—		21,004
	Total	32,632	24,198	23,985	19,375	25,549	21,578	25,084	17,078	69,130	25,670	10,779	22,968	20,500	25,405	25,020	22,205	12,402	19,951	11,383	12,986	19,650	25,207	40,000	552,735
	Tons Sugar 96° Pol.	33,478	24,922	24,627	19,848	26,220	22,257	25,763	17,566	70,858	26,366	11,161	23,591	21,023	26,106	25,712	22,820	12,807	20,494	11,713	13,353	20,205	25,867	41,083	567,840
CANE/SUGAR RATIO	Tons cane per ton sugar made	8.8	9.0	8.5	8.5	8.2	9.0	8.0	9.2	9.0	9.4	10.7	9.6	8.7	8.9	8.9	9.2	9.1	9.6	9.6	9.7	9.3	8.4	8.6	8.9
	,, ,, ,, ,, ,, of 96° Pol.	8.6	8.7	8.3	8.3	8.0	8.7	7.8	9.0	8.8	9.0	10.3	9.4	8.5	8.6	8.7	8.9	8.8	9.3	9.3	9.4	9.1	8.2	8.4	8.7

Table XVII. Summary of chemical control data 1961.

(ii) CANE, BAGASSE AND JUICES.

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
CANE	Sucrose per cent	13.06	13.08	13.31	13.28	13.89	13.27	13.92	12.51	12.67	12.22	11.65	11.95	13.08	12.97	12.72	12.14	12.79	12.04	12.31	12.29	12.20	13.37	13.00	12.81
	Fibre per cent	12.43	12.58	11.99	12.44	13.47	14.41	12.66	13.68	11.76	13.05	14.30	13.60	12.84	13.56	12.21	12.98	14.28	11.96	14.19	14.52	11.85	10.67	10.80	12.61
BAGASSE	Sucrose per cent	2.07	2.26	2.15	1.73	2.58	1.84	1.84	2.29	2.29	1.58	2.09	1.46	2.34	2.28	2.39	1.78	2.18	1.59	2.13	2.23	2.10	2.32	2.14	2.09
	Moisture per cent	49.77	47.96	47.12	45.99	46.90	50.31	48.78	47.00	50.00	47.40	47.90	45.90	48.98	47.80	48.16	47.10	46.47	49.17	48.30	48.40	52.27	50.00	50.17	48.57
	Fibre per cent	47.05	48.89	49.62	51.50	49.73	47.14	48.83	49.78	46.80	50.16	49.03	52.13	47.96	49.10	48.76	50.20	50.57	48.63	48.81	48.70	44.86	46.91	46.99	48.52
	Weight per cent cane	26.4	25.7	24.2	24.1	27.1	30.6	25.9	27.5	25.1	26.0	29.2	26.1	26.8	27.6	25.0	25.8	28.3	24.6	29.1	29.8	26.4	22.8	23.0	26.0
1st EXPRESSED JUICE	Brix (B_1)	18.79	19.17	19.28	18.58	19.97	19.61	19.81	18.74	17.96	18.11	17.38	17.41	18.55	18.30	17.77	17.25	18.22	17.29	16.23	17.85	17.33	18.32	17.85	18.25
	Gravity Purity	85.6	86.5	85.8	89.5	87.9	88.0	88.3	85.9	87.2	86.8	85.0	87.1	87.7	87.9	88.5	88.7	87.6	86.2	87.5	87.6	87.6	89.3	89.0	87.4
	Reducing sugar/sucrose ratio	4.3	5.1	4.8	4.0	2.7	3.2	3.1	4.6	3.2	3.6	4.9	3.9	3.2	4.6	3.6	4.7	3.5	4.6	2.9	3.3	3.8	3.2	3.3	3.8
LAST EXPRESSED JUICE	Brix	2.87	4.22	2.69	2.04	4.30	3.82	2.90	3.87	3.62	2.68	3.32	3.94	3.72	3.29	4.28	2.65	2.88	2.00	2.27	3.61	2.92	2.18	3.34	3.19
	Apparent Purity	64.9	72.0	66.0	70.0	74.2	71.9	77.1	71.8	71.8	65.3	70.5	75.1	73.2	74.4	77.6	66.0	73.4	67.3	74.4	77.0	73.1	74.8	75.4	72.1
MIXED JUICE	Brix	14.53	15.31	14.68	14.85	14.97	15.92	14.53	13.46	14.62	13.21	12.95	13.88	13.93	13.52	14.56	12.96	13.73	13.33	13.26	12.64	13.52	14.33	13.68	14.11
	Gravity Purity	83.8	83.6	83.6	86.6	85.1	84.9	86.2	83.9	85.6	83.6	82.4	83.8	85.9	86.0	86.6	86.0	86.2	84.2	85.0	85.1	85.4	87.3	86.6	85.2
	Reducing sugar/sucrose ratio	4.6	5.5	5.6	4.8	4.1	3.5	3.9	5.1	3.6	4.1	5.6	4.9	3.8	6.0	4.2	5.1	3.3	5.7	3.6	3.7	4.2	3.6	3.5	4.4
	Gty. Pty. drop from 1st expressed juice	1.8	2.9	2.2	2.9	2.8	3.1	2.1	2.0	1.6	3.2	2.6	3.3	1.8	1.9	1.9	2.7	1.5	2.0	2.5	2.5	2.2	2.0	2.4	2.2
ABSOLUTE JUICE	Brix (B_A)	18.00	18.02	18.27	17.65	19.01	18.41	18.56	17.41	16.93	16.95	16.67	16.42	17.61	17.57	16.81	16.41	17.47	16.37	17.00	17.01	16.34	17.26	16.92	17.33
	B_A/B_1	0.958	0.940	0.948	0.950	0.952	0.939	0.937	0.930	0.943	0.936	0.960	0.940	0.949	0.960	0.950	0.950	0.959	0.947	—	0.953	0.943	0.942	0.948	0.950
	Gravity Purity	82.8	83.0	82.8	85.9	84.5	84.2	85.9	83.3	84.8	82.9	81.5	84.1	85.2	85.4	86.2	85.0	85.5	83.5	84.4	84.5	84.7	86.7	86.1	84.5
CLARIFIED JUICE	Brix	14.49	15.24	14.27	14.59	14.88	15.14	14.47	13.87	14.64	13.10	13.15	13.42	13.88	13.75	14.61	13.23	13.91	13.22	13.19	12.63	13.64	14.28	13.60	13.96
	Gravity Purity	84.3 †	83.4 †	83.5	86.6	84.5	85.2	85.7 †	83.8	85.9	83.9	81.9	84.5	85.9	86.2	86.9 †	86.5	85.6	84.7	85.2	86.3	86.2	87.7	87.0	85.3
	Reducing sugar/sucrose ratio	4.5	5.3	5.7	5.0	3.6	3.9	—	5.1	3.6	4.2	5.4	4.8	3.2	5.6	4.5	5.9	3.3	5.1	3.2	3.4	4.1	3.9	3.6	4.4

† Apparent purity

Table XVII. Summary of chemical control data 1961.

(iii) FILTER CAKE, SYRUP, pH, FINAL MOLASSES, SUGAR.

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
FILTER CAKE	Sucrose per cent	3.00	1.23	2.51	1.51	1.93	184	1.15	1.21	2.14	0.91	6.70	1.39	3.34	2.20	5.67	1.73	0.95	1.26	7.00	6.00	6.90	6.46	2.40	2.46
	Weight per cent cane	4.0	2.6	3.6	3.0	2.3	3.7	3.3	3.8	2.8	3.0	2.3	5.0	2.5	2.1	1.6	2.9	2.2	2.3	1.9	1.9	1.5	1.7	3.6	2.8
SYRUP	Brix	57.4	49.4	54.8	60.4	64.5	67.7	58.9	63.9	59.1	56.5	58.4	58.4	66.6	56.3	68.4	67.6	57.9	60.1	57.5	57.9	57.4	63.5	63.5	60.3
	Gravity Purity	—	—	83.5	86.2	85.2	84.3	—	83.5	86.3	84.1	83.4	85.0	85.9	86.2	—	86.1	86.3	84.9	85.3	84.0	86.0	87.4	86.9	85.3
	Reducing sugar/sucrose ratio	5.3	5.3	5.5	4.8	3.1	3.4	—	4.4	3.4	4.4	5.2	4.6	3.7	3.5	4.2	1.8	2.4	4.7	3.0	2.8	4.2	4.0	3.8	4.0
pH VALUES	Limed juice	7.3	—	—	8.0	7.8	—	—	8.1	8.5	8.2	8.5	8.3	7.9	8.2	7.4	7.9	8.2	7.6	—	7.3	8.4	7.8	7.6	7.9
	Clarified juice	6.9	7.1	7.4	7.1	7.0	7.1	7.1	7.1	7.2	7.1	6.8	7.2	7.0	6.9	7.0	7.1	6.8	7.0	6.8	7.2	7.3	7.2	6.9	7.1
	Filter Press juice	—	—	7.5	—	—	—	—	6.9	6.3	—	—	8.4	6.7	6.8	6.5	—	6.6	6.5	—	—	7.5	8.3	6.7	7.2
	Syrup	—	6.8	7.1	6.4	6.7	—	—	6.7	6.8	6.7	5.9	6.9	6.6	6.7	—	—	5.8	6.7	—	7.0	7.0	7.1	6.8	6.7
FINAL MOLASSES	Brix	99.0	98.6	95.8	96.6	98.7	93.9	95.1	93.1	93.4	94.5	93 8	94.8	94.2	97.2	95.0	94.9	98.6	95.2	90.9	96.1	97.2	95.2	96.3	95.5
	Sucrose per cent	34.0	35.7	33.0	34.1	34.4	35.5	33.2	30.5	35.0	33.5	33.2	34 1	30.9	34.4	32.3	32.2	38.3	34.6	35.1	37.4	34.7	35.3	34.5	34.1
	Reducing sugar per cent	16.8	16.7	19.7	18.7	16.3	12.0	16.5	16.1	11.6	16.5	17.4	15.9	16.0	14.4	19.6	20.4	13.1	15.3	12.0	11.1	17.5	16.7	15.8	15.9
	Total sugars*	50.8	52.4	52.7	52.8	50.7	47.5	49.7	46.6	46.6	50.0	50.6	50.0	46.9	48.8	51.9	52.6	51.4	49.9	47.1	48.5	52.2	52.0	50.3	50.0
	Gravity Purity	34.3	36.2	34.5	35.3	34.8	37.9	34.9	32.8	37.5	35.4	35.3	35.9	32.9	35.4	34.0	34.0	38.8	36.4	38.6	38.9	35.7	37.1	35.8	35.7
	Reducing sugar/sucrose ratio	49.5	46.8	59.7	55.1	47.3	33.9	49.7	52.8	33.1	49.3	52.4	46.8	51.6	41.9	60.8	63.1	34.3	44.1	34.1	29.7	50.5	47.2	45.9	46.6
	Weight per cent cane at 95° Brix	3.02	3.50	3.13	2.70	2.66	3.68	2.93	3.16	2.61	3.12	3.35	3.01	2.49	2.65	2.25	2.33	3.02	2.56	2.83	2.93	2.68	2.55	2.49	2.81
SUGAR MADE†	White sugar recovered per cent cane	—	—	—	—	—	3.28	—	—	—	—	2.13	—	—	—	—	—	5.58	—	—	—	—	—	—	—
	Raw ,, ,, ,, ,,	11.40	11.10	11.76	11.75	12.16	7.89	12.51	10.84	11.10	10.61	7.27	10.40	11.48	11.25	11.24	10.91	5.39	10.47	10.45	10.37	10.71	11.91	11.60	—
	Total ,, ,, ,, ,,	11.40	11.10	11.76	11.75	12.16	11.17	12.51	10.84	11.10	10.61	9.40	10.40	11.48	11.25	11.24	10.91	10.97	10.47	10.45	10.37	10.71	11.91	11.60	11.18
	Average Pol. of sugars	98.49	98.87	98.57	98.74	98.52	99.02	98.60	98.73	98.40	98.60	99 41	98.60	98.45	98.65	98.65	98.66	99.14	98.61	98.78	98.71	98.71	98.51	98.60	98.62
	Total sucrose recovered per cent cane	11.23	10.97	11.59	11.56	11.98	11.06	12.33	10.70	10.92	10.46	9.35	10.26	11.30	11.10	11.09	10.76	10.87	10.32	10.32	10.23	10.57	11.73	11.44	11.03
	Moisture content of raw sugar per cent	0.23	0.29	0.42	0.34	0.37	—	0.32	0.36	0.37	0.34	0.33	0.43	0.45	0.26	0.35	0.36	0.51	0.31	0.43	0.32	0.39	0.45	0.40	0.33
	Dilution indicator.	18.0	34.5	41.6	37.0	37.6	—	29.5	39.6	30.1	32.1	42.5	43.7	40.8	24.6	34.3	36.7	60.9	27.8	54.6	33.5	44.1	42.7	40.0	31.4

* Sucrose % + Reducing sugar %.

† Provisional figures.

Table XVII. Summary of chemical control data 1961.

(iv) MASSECUITES.

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St. Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre †	Réunion	Highlands	Mon Désert	Totals & Averages
MAGMA	Apparent Purity	75.5	87.9	84.2	80.0	81.7	81.7	84.4	76.5	78.7	80.7	91.1	88.0	84.4	90.5	80.6	78.2	79.8	79.3	—	—	80.2	81.8	82.4	82.3
A—MASSECUITE	Brix	97.3	94.6	94.7	94.6	94.7	94.2	95.1	95.4	94.0	95.3	93.1	94.8	94.5	94.2	94.1	94.3	93.4	94.1	93.6	96.2	94.8	95.2	94.4	94.6
	Apparent Purity	78.7	82.7	81.0	85.0	83.6	81.5	81.8	77.3	82.3	80.5	83.2	82.9	84.9	81.2	85.4	83.0	84.7	84.1	82.1	76.1	80.5	81.8	82.7	82.0
	,, ,, of A—Molasses	60.1	60.9	58.7	62.2	65.1	60.8	56.9	53.4	64.3	54.0	64.5	60.4	61.2	60.2	61.7	55.1	70.4	63.2	61.2	58.8	58.0	60.6	63.9	60.7
	Drop in Purity	18.6	21.8	22.3	22.8	18.5	20.7	24.9	23.9	18.0	26.5	18.7	22.5	23.7	21.0	23.7	27.9	14.3	20.9	20.9	17.3	22.5	21.2	18.8	22.3
	Crystal per cent Brix in massecuite	46.6	55.8	54.0	60.3	53.0	52.8	57.8	51.3	50.4	57.6	52.7	56.8	61.1	52.8	61.9	62.1	48.2	56.7	54.9	41.9	53.6	42.9	52.1	56.7
	Cubic feet per ton Brix in Mixed Juice	27.1	22.6	25.3	20.2	22.3	34.8	33.5	24.0	27.7	25.1	32.8	26.7	25.2	29.4	27.6	24.1	30.9	26.6	19.9	38.0	27.0	21.9	29.5	27.0
	A—Massecuite per cent total massecuite	53.0	47.7	53.3	49.9	54.7	66.0	64.3	51.6	62.5	50.5	51.4	53.4	57.0	58.4	54.4	50.0	48.6	50.9	45.5	68.4	60.7	50.6	61.1	55.9
B—MASSECUITE	Brix	99.3	97.0	96.1	96.2	97.4	96.9	96.6	96.7	95.5	96.0	94.3	96.2	96.9	95.9	95.0	96.4	95.4	95.3	93.5	97.7	96.9	96.4	95.7	96.2
	Apparent Purity	66.8	68.4	69.2	74.8	70.8	70.8	70.8	69.7	70.5	67.9	74.6	71.7	68.6	71.9	73.4	67.1	76.8	73.4	71.4	70.7	69.5	70.3	73.4	71.0
	,, ,, of B—Molasses	46.5	48.7	46.2	48.2	46.8	51.6	47.1	46.1	51.1	43.6	59.6	46.9	42.3	49.1	45.2	40.4	60.1	52.8	51.9	55.4	46.3	46.5	50.2	48.8
	Drop in purity	20.3	19.7	23.0	26.6	24.0	19.2	23.7	23.6	19.4	24.3	15.0	24.8	26.3	22.8	28.2	26.7	16.7	20.6	19.5	15.3	23.2	23.8	23.2	22.2
	Crystal per cent Brix in massecuite	37.9	38.4	42.8	51.4	45.1	39.7	44.8	43.8	39.7	43.1	37.1	46.7	45.6	44.8	51.5	44.8	41.7	43.6	40.5	34.3	43.2	43.6	46.6	43.4
	Cubic feet per ton Brix in Mixed Juice	13.2	13.6	13.5	11.7	11.8	7.5	9.4	13.6	9.2	12.7	15.5	13.4	11.2	12.2	13.3	15.6	19.4	15.6	14.3	6.5	9.8	12.9	11.5	12.1
	B—Massecuite per cent total Massecuite	25.8	28.7	28.5	28.7	28.9	14.2	18.2	29.3	20.7	25.5	24.3	26.7	25.4	24.3	26.2	32.6	30.5	29.9	32.7	11.7	22.0	29.9	23.8	25.0
	Kgs. Sugar per cubic foot of A & B Massecuite	18.9	20.5	19.8	24.8	23.0	17.6	18.7	20.4	21.3	19.8	11.5	18.8	21.7	18.8	19.7	20.2	15.4	17.9	22.2	17.0	21.3	23.2	19.6	19.9
C—MASSECUITE	Brix	101.6	100.3	100.2	100.2	101.5	98.6	100.1	99.5	98.3	99.4	99.5	98.3	100.1	100.8	99.6	99.2	100.7	100.4	96.9	99.8	99.4	99.1	101.2	99.8
	Apparent Purity	54.6	57.8	54.7	56.8	56.3	57.9	55.5	53.9	56.1	55.7	59.1	55.4	54.9	56.2	55.1	50.1	60.6	55.3	59.8	58.8	54.3	58.4	56.0	56.3
	,, ,, of final molasses	34.3	33.7	28.5	31.6	33.0	35.0	31.4	28.4	33.8	29.3	29.1	35.9	26.7	31.0	27.4	27.1	35.2	31.7	35.8	35.9	31.5	31.1	31.7	31.7
	Drop in Purity	20.3	24.1	26.2	25.2	23.3	22.9	24.1	25.5	22.3	26.4	30.0	19.5	28.2	25.2	27.7	23.0	25.4	23.6	24.0	22.9	22.8	27.3	24.3	24.6
	Crystal per cent Brix in massecuite	30.9	36.3	36.6	36.8	34.8	35.2	35.1	35.6	33.7	37.3	42.3	30.4	38.5	36.5	38.2	36.6	39.2	34.6	37.3	34.5	33.3	39.6	35.6	36.0
	Cubic feet per ton Brix in Mixed Juice	10.9	11.2	8.6	8.7	6.6	10.4	8.9	8.7	7.4	11.9	15.5	9.9	7.7	8.7	9.9	8.4	13.2	10.0	9.5	11.1	7.7	8.5	7.3	9.2
	C—Massecuite per cent total massecuite	21.2	23.6	18.2	21.4	16.4	19.8	17.5	19.1	16.8	24.0	24.3	19.9	17.6	17.3	19.4	17.4	20.9	19.2	21.8	19.9	17.3	19.5	15.1	19.1
TOTAL MASSECUITE	Cubic feet per ton Brix in Mixed Juice	51.2	47.3	47.4	40.6	40.7	52.7	51.8	46.3	44.3	49.7	63.7	50.0	44.1	50.3	50.8	48.1	63.5	52.2	43.7	54.4	44.5	43.3	48.3	48.3
	,, ,, ,, sugar made	67.1	63.7	61.6	51.3	51.9	79.0	64.6	60.4	56.4	66.2	91.0	65.9	55.9	64.2	63.1	59.9	81.9	69.0	57.4	73.4	56.6	53.5	60.0	62.1

† 2 Massecuite system during part of the crop.

Table XVII. Summary of chemical control data 1961.

(v) MILLING WORK, SUCROSE LOSSES & BALANCE RECOVERIES.

		Médine	Solitude	Beau Plan	The Mount	Belle Vue	St Antoine	Mon Loisir	Constance	Union Flacq	Beau Champ	Ferney	Riche en Eau	Mon Trésor	Savannah	Rose Belle	Britannia	Bénarès	Union St. Aubin	St. Félix	Bel Ombre	Réunion	Highlands	Mon Désert	Totals & Averages
MILLING WORK	Imbibition water % cane	29.2	23.3	28.4	24.1	30.7	24.7	33.2	32.6	21.8	32.8	33.1	24.7	31.1	33.7	21.1	30.7	31.2	28.4	32.7	37.9	27.3	25.4	28.5	28.0
	,, ,, % fibre	235	186	237	194	228	171	262	238	185	252	231	182	242	249	173	236	218	237	231	261	230	238	264	222
	Extraction ratio	33.8	35.2	32.6	25.7	37.4	29.3	27.1	36.5	38.3	25.8	36.6	23.9	35.7	36.1	38.7	29.3	33.4	27.1	35.5	37.2	38.4	37.0	35.0	33.3
	Mill extraction	95.8	95.5	96.1	96.8	95.0	95.8	96.6	95.0	95.5	96.6	94.8	96.7	95.4	95.1	95.3	96.2	95.2	96.8	95.0	94.6	95.4	96.1	96.2	95.8
	Reduced mill extraction	95.8	95.6	95.9	96.8	95.4	96.4	96.6	95.5	95.2	96.8	95.5	97.1	95.6	95.5	95.2	96.4	95.9	96.6	95.7	95.5	95.2	95.3	95.5	95.8
SUCROSE LOSSES	Sucrose lost in bagasse % cane	0.55	0.58	0.52	0.42	0.70	0.56	0.48	0.63	0.57	0.41	0.61	0.39	0.60	0.63	0.60	0.46	0.61	0.39	0.62	0.67	0.55	0.53	0.49	0.54
	,, ,, in filter cake % cane	0.12	0.03	0.09	0.05	0.04	0.07	0.04	0.05	0.06	0.03	0.15	0.07	0.08	0.05	0.09	0.05	0.02	0.03	0.13	0.11	0.11	0.11	0.08	0.07
	,, ,, in molasses % cane	0.97	1.20	1.03	0.90	0.88	1.32	0.97	0.97	0.93	1.05	1.12	1.10	0.78	0.89	0.73	0.75	1.11	0.89	1.04	1.14	0.91	0.91	0.85	0.96
	Undetermined losses % cane	0.19	0.29	0.08	0.35	0.29	0.26	0.10	0.16	0.19	0.27	0.42	0.14	0.32	0.30	0.21	0.12	0.18	0.40	0.20	0.14	0.06	0.09	0.13	0.21
	Industrial losses % cane	1.28	1.52	1.20	1.30	1.21	1.65	1.11	1.18	1.18	1.35	1.69	1.30	1.18	1.24	1.03	0.92	1.31	1.32	1.37	1.39	1.08	1.11	1.07	1.24
	Total losses % cane	1.83	2.10	1.72	1.72	1.91	2.21	1.59	1.81	1.75	1.76	2.30	1.69	1.78	1.87	1.63	1.38	1.92	1.71	1.99	2.06	1.63	1.64	1.56	1.78
SUCROSE BALANCE	Sucrose in bagasse % sucrose in cane	4.18	4.44	3.91	3.15	5.03	4.22	3.45	5.04	4.50	3.35	5.24	3.26	4.58	4.86	4.72	3.79	4.77	3.24	5.04	5.45	4.55	3.96	3.79	4.23
	,, ,, filter cake % sucrose in cane	0.91	0.23	0.70	0.34	0.32	0.53	0.29	0.40	0.47	0.25	1.29	0.59	0.63	0.39	0.70	0.41	0.16	0.24	1.05	0.90	0.87	0.82	0.66	0.55
	,, ,, molasses % sucrose in cane	7.45	9.18	7.70	6.81	6.32	9.94	6.97	7.75	7.34	8.59	9.61	9.18	5.96	6.86	5.74	6.18	8.70	7.17	8.45	9.28	7.43	6.81	6.52	7.47
	Undetermined losses % sucrose in cane	1.47	2.22	0.59	2.63	2.08	1.96	0.72	1.28	1.50	2.21	3.60	1.12	2.44	2.31	1.65	0.99	1.38	3.55	1.62	1.14	0.53	0.67	1.02	1.63
	Industrial losses % sucrose in cane	9.83	11.62	8.99	9.78	8.72	12.43	7.97	9.43	9.31	11.05	14.50	10.91	9.03	9.56	8.09	7.58	10.24	10.96	11.12	11.31	8.83	8.30	8.20	9.65
	Total losses % sucrose in cane	14.01	16.08	12.90	12.93	13.75	16.65	11.42	14.47	13.81	14.40	19.74	14.16	13.61	14.42	12.81	11.37	15.01	14.20	16.16	16.76	13.38	12.26	11.99	13.88
RECOVERIES	Boiling house recovery	89.7	87.8	90.6	89.9	90.8	87.0	91.7	90.1	90.2	88.6	84.6	88.7	90.6	89.9	91.5	92.1	89.2	88.6	88.2	88.0	90.7	91.4	91.5	89.9
	Reduced boiling house recovery (Pty.M.J.85°)	90.6	89.1	91.6	88.5	90.7	87.1	90.9	90.9	89.7	89.4	87.1	89.7	89.9	89.0	90.2	91.4	88.2	89.4	88.2	87.9	90.4	89.5	90.3	89.7
	Overall recovery	86.0	83.9	87.1	87.0	86.2	83.3	88.6	85.5	86.2	85.6	80.2	85.8	86.4	85.6	87.2	88.6	85.0	85.8	83.8	83.2	86.6	87.8	88.0	86.1
	Reduced overall recovery (Pty. M.J.85°, F% C12.5)	86.8	85.1	87.8	85.7	86.5	84.0	87.8	86.8	85.4	86.5	83.2	87.1	85.9	85.0	85.8	88.1	84.5	86.3	84.3	84.0	86.1	83.6	86.2	85.9
	Boiling house efficiency	99.2	98.4	100.5	97.6	99.6	97.0	99.7	98.9	99.8	98.3	95.3	98.8	97.9	98.2	98.9	100.0	98.7	98.7	98.5	98.4	99.8	99.3	99.5	98.9

Table XVIII. Production and utilisation of molasses.

Year	Production M. tons	Exports M. tons	Used for production of alcohol M. tons	Available as fertilizer M. tons	N.P.K. equivalent in molasses available as fertilizer M. tons		
					N	P_2O_5	K_2O
1948	85,308	—	42,640	42,768	222	107	2,198
1949	96,670	1,867	41,728	53,075	276	133	2,728
1950	98,496	79	25,754	72,643	378	182	3,734
1951	125,819	3,601	44,896	77,322	402	193	3,974
1952	113,756	40,537	29,878	43,339	225	108	2,228
1953	141,449	67,848	16,037	57,564	299	144	2,958
1954	120,495	89,912	8,300	22,383	116	56	1,145
1955	106,839	53,957	9,005	43,877	228	110	2,255
1956	181,716	52,694	8,661	57,361	298	143	2,948
1957	110,471	72,539	7,796	30,136	157	75	1,549
1958	113,811	59,158	8,435	46,218	240	116	2,376
1959	118,056	59,985	9,632	48,106	250	120	2,470
1960	72,991	45,180	8,871	18,940	98	47	970

Table XIX. Importation of inorganic fertilizers, in metric tons, 1950 - 1961.

	N	P_2O_5	K_2O
1950	3,990	870	1,930
1951	5,710	1,020	4,080
1952	5,800	1,140	2,960
1953	5,080	560	2,380
1954	4,170	1,110	3,340
1955	5,620	570	3,110
1956	8,870	2,170	3,940
1957	6,900	2,770	4,390
1958	6,210	3,020	4,690
1959	8,500	2,740	5,310
1960	8,170	4,382	5,765
1961	7,462	4,769	3,829

Table XX. Sales of Herbicides, 1960 - 1961.

HERBICIDES	1960			1961		
	Quantity		Sales in Rupees	Quantity		Sales in Rupees
	Imperial gallons	Kgs.		Imperial gallons	Kgs.	
MCPA — Metallic Salt	22,405	—	315,386	14,153	—	197,009
2, 4 - D — Amines	49,010	—	883,933	33,989	—	602,580
2, 4 - D Esters	5,214	—	246,936	11,132	—	420,857
Pentachlorophenol	2,641	—	44,749	1,403	—	23,335
Sodium Chlorate	—	304,851	372,215	—	214,301	263,638
Sodium Trichloroacetate (TCA)	—	377,063	1,231,815	—	363,716	1,125,550
Sodium 2, 2—Dichloro-propionate (Dalapon, Basfapon, Unipon)	—	400	4,200	—	9,553	27,695
Sodium Arsenite	—	6,000	12,000	—	8,000	11,208
Substituted Ureas (DCMU)	—	12,500	412,500	—	60,000	960,000
Triazine compounds (Simazine)	—	568	15,283	—	1,812	35,345
Unclassified	—	—	—	600	—	10,800
					117	1,501
TOTAL			3,539,017			3,679,518

Table XXI. List of crosses made in 1961.

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. Crosses	No. pots		No. Crosses	No. pots	
			Bunches *	Singles		Bunches *	Singles		Bunches *	Singles
B.3337	x Ebène 1/37	1	—	—	—	—	—	1	—	—
,,	x unknown	9	—	32	—	—	—	9	—	32
B.34104	x M.147/44	3	—	22	—	—	—	3	—	22
,,	x M.202/46	3	32	42	—	—	—	3	32	42
,,	x R.397	3	—	17	—	—	—	3	—	17
B.37172	x M.63/39	1	—	—	—	—	—	1	—	—
C.B.38-22	x Ebène 1/37	3	—	—	1	—	—	4	—	—
,,	x M.147/44	2	48	—	6	124	885	8	172	885
,,	x M.462/54	1	—	—	2	—	14	3	—	14
,,	x M.3/57	—	—	—	1	—	1	1	—	1
,,	x R.397	—	—	—	3	29	112	3	29	112
,,	x 47R2777	—	—	—	10	335	710	10	335	710
,,	x *Saccharum spontaneum* self No. 1	—	—	—	1	—	55	1	—	55
,,	x unknown	1	—	—	4	—	3	5	—	3
Co. 281	x M.99/34	1	—	64	—	—	—	1	—	55
,,	x M.147/44	2	97	54	4	8	—	6	105	54
,,	x M.202/46	—	—	—	1	—	16	1	—	16
,,	x M.462/54	1	—	—	—	—	—	1	—	—
,,	x P.O.J.2940	1	—	—	—	—	—	1	—	—
,,	x R.397	2	14	32	—	—	—	2	14	32
,,	x 47R2777	1	101	—	1	—	48	2	101	48
Co.290	x M.63/39	1	—	—	—	—	—	1	—	—
,,	x M.147/44	1	—	—	—	—	—	1	—	—

* *A bunch contains 7 — 10 seedlings.*

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. crosses	No. pots		No. crosses	No. pots	
			Bunches	Singles		Bunches	Singles		Bunches	Singles
Co.290	x 39MQ832	1	—	4	—	—	—	1	—	4
,,	x 47R2777	1	44	—	—	—	—	1	44	—
,,	x unknown	6	—	28	—	—	—	6	—	28
Co.419	x C.P. 36-13	1	—	—	—	—	—	1	—	—
,,	x M.202/46	2	227	86	—	—	—	2	227	86
,,	x M.209/56	1	—	19	—	—	—	1	—	19
,,	x selfed	—	—	—	2	—	5	2	—	5
,,	x unknown	6	5	42	—	—	—	6	5	42
Co.421	x M.202/46	5	41	28	—	—	—	5	41	28
,,	x unknown	—	—	—	1	—	26	1	—	26
C.P.36-13	x B.3337	1	—	—	—	—	—	1	—	—
,,	x selfed	1	—	1	—	—	—	1	—	1
,,	x unknown	3	—	6	—	—	—	3	—	6
Ebène 1/37	x B.3337	2	—	13	—	—	—	2	—	13
,,	x Co.290	—	—	—	2	—	3	2	—	3
,,	x Co.419	2	—	5	—	—	—	2	—	5
,,	x M.99/34	2	29	48	—	—	—	2	29	48
,,	x M.63/39	1	—	4	3	541	—	4	541	4
,,	x M.213/40	—	—	—	2	15	30	2	15	30
,,	x M.147/44	3	—	1	7	218	748	10	218	749
,,	x M.202/46	1	—	—	2	—	33	3	—	33
,,	x M.716/51	—	—	—	1	—	—	1	—	—
,,	x M.81/52	—	—	—	3	85	—	3	85	—
,,	x M.462/54	2	—	77	—	—	—	2	—	77
,,	x M.158/55	—	—	—	2	7	—	2	7	—

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. crosses	No. pots		No. crosses	No. pots	
			Bunches	Singles		Bunches	Singles		Bunches	Singles
Ebène 1/37	x M.209/56	1	31	—	—	—	—	1	31	—
,,	x M.245/56	1	—	—	—	—	—	1	—	—
,,	x M.1/57	3	65	—	—	—	—	3	65	—
,,	x M.7/57	2	—	1	—	—	—	2	—	1
,,	x M.436/57	1	—	—	—	—	—	1	—	—
,,	x P.O.J.2940	1	—	—	—	—	—	1	—	—
,,	x R.397	1	—	—	—	—	—	1	—	—
,,	x 47R2777	3	—	11	8	569	532	11	569	543
,,	x 47R4066	2	—	60	—	—	—	2	—	60
,,	x unknown	7	—	8	—	—	—	7	—	8
Ebène 1/44	x Ebène 1/37	—	—	—	1	—	2	1	—	2
,,	x M.63/39	—	—	—	1	—	24	1	—	24
,,	x M.209/56	1	52	64	—	—	—	1	52	64
,,	x M.347/57	1	—	—	—	—	—	1	—	—
,,	x N:Co.310	—	—	—	2	—	119	2	—	119
Ebène 50/47	x B.3337	5	9	99	—	—	—	5	9	99
,,	x Co.419	5	—	36	—	—	—	5	—	36
,,	x Ebène 1/37	8	—	31	1	—	3	9	—	31
,,	x M.99/34	—	—	—	1	—	21	1	—	21
,,	x M.63/39	2	71	8	—	—	—	2	71	8
,,	x M.147/44	4	—	40	14	9	425	18	9	465
,,	x M.202/46	—	—	—	2	32	—	2	32	—
,,	x M.403/54	2	—	4	—	—	—	2	—	4
,,	x M.462/54	—	—	—	1	—	—	1	—	—
,,	x M.490/54	—	—	—	2	6	—	2	6	—

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. Crosses	No. pots		No. Crosses	No. pots	
			Bunches	Singles		Bunches	Singles		Bunches	Singles
Ebène 50/47	x M.158/55	—	—	—	1	—	22	1	—	22
,,	x M.80/57	1	—	23	—	—	—	1	—	23
,,	x 36MQ2717	1	48	—	—	—	—	1	48	—
,,	x P.O.J.2940	1	—	8	—	—	—	1	—	8
,,	x R.397	7	—	85	—	—	—	7	—	85
,,	x 47R2777	5	—	179	—	—	—	5	—	179
,,	x Uba Marot	1	—	75	—	—	—	1	—	75
,,	x Vesta	—	—	—	1	—	24	1	—	24
Ebène 3/48	x B.3337	2	60	49	—	—	—	2	60	49
,,	x M.99/34	1	72	—	—	—	—	1	72	—
,,	x M.147/44	1	169	—	7	—	—	8	169	—
,,	x M.202/46	2	22	—	—	—	—	2	22	—
,,	x 39MQ841	1	—	—	—	—	—	1	—	—
M.109/26	x M.147/44	—	—	—	1	50	—	1	50	—
M.134/32	x C.P. 36-13	1	—	3	—	—	—	1	—	3
,,	x Ebène 1/37	—	—	—	4	9	6	4	9	6
,,	x M.147/44	1	—	55	6	102	132	7	102	187
,,	x M.202/46	—	—	—	3	160	3	3	160	3
M.99/34	x unknown	9	16	35	—	—	—	9	16	35
M.112/34	x Ebène 1/37	2	—	13	—	—	—	2	—	13
,,	x M.63/39	2	—	69	—	—	—	2	—	69
,,	x M.147/44	7	22	18	1	5	—	8	27	18
,,	x M.202/46	2	42	—	—	—	—	2	42	—
,,	x M.55/55	1	—	9	—	—	—	1	—	9
,,	x M.439/57	2	—	—	—	—	—	2	—	—

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. Crosses	No. pots		No. Crosses	No. pots	
			Bunches *	Singles		Bunches *	Singles		Bunches *	Singles
M.112/34	x 39MQ841	2	—	—	—	—	—	2	—	—
,,	x 47R2777	5	329	56	—	—	—	5	329	56
M.84/35	x M.147/44	—	—	—	1	16	—	1	16	—
M.241/40	x Co.290	1	—	—	—	—	—	1	—	—
,,	x Co.419	1	—	18	—	—	—	1	—	18
,,	x Ebène 50/47	—	—	—	3	—	15	3	—	15
,,	x M.99/34	2	18	56	—	—	—	2	18	56
,,	x M.63/39	—	—	—	5	99	543	5	99	543
,,	x M.147/44	1	—	—	—	—	—	1	—	—
,,	x M.642/54	2	36	1	—	—	—	2	36	1
,,	x M.158/55	—	—	—	2	—	17	2	—	17
,,	x M.3/57	—	—	—	1	—	—	1	—	—
,,	x M.7/57	1	—	—	—	—	—	1	—	—
,,	x M.57/80	—	—	—	1	9	—	1	9	—
,,	x 36MQ2717	1	—	21	—	—	—	1	—	21
,,	x R.397	—	—	—	1	—	40	1	—	40
,,	x 47R2777	—	—	—	8	735	52	8	735	52
,,	x unknown	1	—	2	—	—	—	1	—	2
M.377/41	x M.63/39	—	—	—	1	—	17	1	—	17
M.11/43	x 47R2777	1	—	16	—	—	—	1	—	16
M.147/44	x M.202/46	—	—	—	4	42	18	4	42	18
,,	x 47R2777	2	—	20	—	—	—	2	—	20
,,	x unknown	5	15	62	—	—	—	5	15	62
M.31/45	x M.147/44	—	—	—	1	—	62	1	—	62
M.202/46	x B.3337	4	126	14	—	—	—	4	126	14

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. crosses	No. pots		No. crosses	No. pots	
			Bunches	Singles		Bunches	Singles		Bunches	Singles
M.202/46	x Co.419	1	—	—	—	—	—	1	—	—
,,	x M.99/34	3	—	11	—	—	—	3	—	11
,,	x M.147/44	1	—	—	1	—	10	2	—	10
,,	x M.462/54	—	—	—	1	—	72	1	—	72
,,	x M.447/57	—	—	—	1	—	80	1	—	80
,,	x 47R2777	4	179	—	1	22	—	5	201	—
,,	x unknown	6	—	39	—	—	—	6	—	39
M.93/48	x Ebène 1/37	—	—	—	2	—	17	2	—	17
,,	x M.63/39	—	—	—	2	86	107	2	86	107
,,	x M.147/44	—	—	—	1	66	—	1	66	—
,,	x 47R2777	1	—	—	—	—	—	1	—	—
M.99/48	x M.99/34	—	—	—	1	10	—	1	10	—
,,	x M.147/44	—	—	—	1	155	—	1	155	—
M.322/51	x M.63/39	1	—	—	—	—	—	1	—	—
M.381/51	x M.99/34	—	—	—	2	—	7	2	—	7
,,	x M.63/39	1	—	—	—	—	—	1	—	—
,,	x M.147/44	1	—	—	3	—	18	4	—	18
,,	x M.202/46	2	—	—	—	—	—	2	—	—
,,	x R.397	—	—	—	3	19	1	3	19	1
M.716/51	x Ebène 1/37	—	—	—	3	21	48	3	21	48
,,	x M.63/39	—	—	—	1	—	14	1	—	14
,,	x M.147/44	—	—	—	3	427	—	3	427	—
M.179/52	x M.202/46	1	—	—	—	—	—	1	—	—
M.272/52	x Co.419	1	—	—	—	—	—	1	—	—
,,	x Ebène 1/37	—	—	—	2	16	—	2	16	—

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. crosses	No. pots		No. crosses	No. pots	
			Bunches	Singles		Bunches	Singles		Bunches	Singles
M.272/52	x M.147/44	—	—	—	2	18	7	2	18	7
M.85/53	x M.147/44	1	54	—	—	—	—	1	54	—
,,	x M.202/46	2	202	—	—	—	—	2	202	—
,,	x M.462/54	1	—	—	—	—	—	1	—	—
,,	x 47R2777	1	297	—	—	—	—	1	297	—
,,	x unknown	3	—	4	—	—	—	3	—	4
M.98/53	x unknown	1	—	29	—	—	—	1	—	29
M.99/53	x M.147/44	1	9	—	—	—	—	1	9	—
M.63/54	x M.147/44	1	—	—	—	—	—	1	—	—
M.98/54	x Co.419	2	—	—	—	—	—	2	—	—
,,	x M.63/39	1	—	—	—	—	—	1	—	—
,,	x M.147/44	1	—	—	—	—	—	1	—	—
,,	x M.392/54	1	—	—	—	—	—	1	—	—
,,	x M.55/55	1	—	—	—	—	—	1	—	—
,,	x M.209/56	1	32	—	—	—	—	1	32	—
,,	x M.347/57	1	—	3	—	—	—	1	—	3
,,	x R.397	1	—	—	1	—	—	2	—	—
,,	x 47R2777	1	—	25	1	—	—	2	—	25
,,	x 47R4066	1	—	—	—	—	—	1	—	—
M.194/54	x M.147/44	—	—	—	2	—	161	2	—	161
M.376/54	x M.147/44	—	—	—	1	128	—	1	128	—
,,	x R.397	—	—	—	1	75	—	1	75	—
,,	x 47R2777	—	—	—	1	—	68	1	—	68
M.392/54	x unknown	1	—	—	—	—	—	1	—	—
M.403/54	x R.397	1	—	—	—	—	—	1	—	—

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. Crosses	No. pots		No. Crosses	No. pots	
			Bunches *	Singles		Bunches *	Singles		Bunches *	Singles
M.403/54	x unknown	2	—	16	—	—	—	2	—	16
M.462/54	x Co.290	1	—	—	—	—	—	1	—	—
,,	x 47R2777	1	—	—	—	—	—	1	—	—
,,	x unknown	3	7	15	—	—	—	3	7	15
M.490/54	x 36MQ2717	1	17	—	—	—	—	1	17	—
,,	x unknown	1	—	10	—	—	—	1	—	10
M.506/54	x M.147/44	—	—	—	1	7	—	1	7	—
M.55/55	x B.3337	1	—	—	—	—	—	1	—	—
,,	x Co.290	1	—	8	—	—	—	1	—	8
M.158/55	x M.147/44	—	—	—	2	—	—	2	—	—
,,	x M.202/46	1	15	—	—	—	—	1	15	—
M.292/55	x B.3337	1	—	9	—	—	—	1	—	9
,,	x M.202/46	1	36	—	—	—	—	1	36	—
,,	x M.99/53	1	—	1	—	—	—	1	—	1
,,	x M.436/57	1	—	18	—	—	—	1	—	18
,,	x P.O.J.2940	1	—	12	—	—	—	1	—	12
,,	x 47R2777	1	37	—	—	—	—	1	37	—
,,	x Vesta	1	—	114	—	—	—	1	—	114
M.340/55	x M.436/57	1	11	—	—	—	—	1	11	—
M.415/55	x M.147/44	1	11	—	—	—	—	1	11	—
M.9/56	x M.147/44	1	—	—	—	—	—	1	—	—
M.146/56	x C.P.36-13	2	—	32	—	—	—	2	—	32
,,	x M.202/46	2	—	32	—	—	—	2	—	32
,,	x unknown	3	23	—	3	—	2	6	23	2
M.209/56	x 47R2777	1	—	—	—	—	—	1	—	—

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. Crosses	No. pots		No. Crosses	No. pots	
			Bunches	Singles		Bunches	Singles		Bunches	Singles
M.209/56	x unknown	7	216	42	—	—	—	7	216	42
M.212/56	x Co.290	1	18	—	—	—	—	1	18	—
,,	x Ebène 1/37	1	—	—	—	—	—	1	—	—
,,	x M.99/34	1	4	—	—	—	—	1	4	—
,,	x M.147/44	3	107	500	—	—	—	3	107	500
,,	x M.202/46	1	71	—	—	—	—	1	71	—
,,	x 39MQ832	1	18	—	—	—	—	1	18	—
,,	x R.397	1	—	3	—	—	—	1	—	3
,,	x 47R2777	1	—	500	—	—	—	1	—	500
,,	x 47R4066	1	31	—	—	—	—	1	31	—
,,	x 40SN5819	1	21	—	—	—	—	1	21	—
M.219/56	x Co.419	2	—	—	—	—	—	2	—	—
,,	x M.147/44	1	—	—	—	—	—	1	—	—
,,	x M.347/57	2	—	—	—	—	—	2	—	—
,,	x unknown	1	—	—	—	—	—	1	—	—
M.3/57	x M.147/44	2	—	—	3	—	1	5	—	1
,,	x M.462/54	1	69	—	—	—	—	1	69	—
,,	x M.209/56	1	126	—	—	—	—	1	126	—
M.6/57	x M.147/44	—	—	—	2	—	—	2	—	—
,,	x R.397	—	—	—	1	—	21	1	—	21
M.23/57	x Co.419	2	—	15	—	—	—	2	—	15
,,	x M.147/44	2	32	—	—	—	—	2	32	—
,,	x unknown	1	—	—	—	—	—	1	—	—
M.27/57	x M.147/44	—	—	—	2	—	—	2	—	—
M.28/57	x 39MQ832	—	—	—	1	—	20	1	—	20

CROSS		Greenhouse No. crosses	Greenhouse No. pots Bunches	Greenhouse No. pots Singles	Field No. Crosses	Field No. pots Bunches	Field No. pots Singles	TOTAL No. Crosses	TOTAL No. pots Bunches	TOTAL No. pots Singles
M.72/57	x Co.419	1	—	—	—	—	—	1	—	—
,,	x M.202/46	1	—	16	—	—	—	1	—	16
,,	x M.462/54	2	9	26	—	—	—	2	9	26
,,	x 47R2777	1	39	—	—	—	—	1	39	—
M.102/57	x R397	—	—	—	2	24	—	2	24	—
M.103/57	x 39MQ832	—	—	—	1	—	3	1	—	3
M.111/57	x M.147/44	2	—	42	—	—	—	2	—	42
,,	x M.347/57	1	25	—	—	—	—	1	25	—
,,	x 36MQ2717	1	17	—	—	—	—	1	17	—
M.115/57	x C.P.36-13	1	—	—	—	—	—	1	—	—
,,	x M.307/57	2	33	—	—	—	—	2	33	—
,,	x unknown	1	—	3	—	—	—	1	—	3
M.155/57	x M.191/57	—	—	—	1	—	—	1	—	—
M.172/57	x B.3337	1	—	—	—	—	—	1	—	—
M.173/57	x B.3337	—	—	—	1	—	—	1	—	—
M.181/57	x 47R2777	—	—	—	1	130	—	1	130	—
M.308/57	x Co.419	3	—	2	—	—	—	3	—	2
,,	x M.307/57	3	57	16	—	—	—	3	57	16
,,	x unknown	3	—	9	—	—	—	3	—	9
M.347/57	x Co.419	1	—	—	—	—	—	1	—	—
,,	x M.146/56	1	86	—	—	—	—	1	86	—
,,	x unknown	2	—	7	—	—	—	2	—	7
M.394/57	x M.76/39	—	—	—	1	—	—	1	—	—
,,	x M.147/44	—	—	—	1	—	—	1	—	—
,,	x 39MQ832	—	—	—	1	—	—	1	—	—

CROSS		Greenhouse			Field			TOTAL		
			No. pots			No. pots			No. pots	
		No. crosses	Bunches *	Singles	No. Crosses	Bunches *	Singles	No. Crosses	Bunches *	Singles
M.436/57	x M.147/44	—	—	—	2	14	—	2	14	—
,,	x M.462/54	1	22	—	—	—	—	1	22	—
,,	x R.366	1	—	26	—	—	—	1	—	26
,,	x unknown	6	—	42	—	—	—	6	—	42
M.439/57	x Co.290	1	—	—	—	—	—	1	—	—
,,	x Co.419	2	—	9	—	—	—	2	—	9
,	x M.147/44	2	12	3	—	—	—	2	12	3
,,	x M.202/46	1	12	—	—	—	—	1	12	—
,,	x M.436/57	1	—	—	—	—	—	1	—	—
,,	x R.397	1	—	—	—	—	—	1	—	—
,,	x 47R2777	1	—	2	—	—	—	1	—	2
M.440/57	x M.147/44	1	—	13	—	—	—	1	—	13
,,	x 47R2777	1	6	—	—	—	—	1	6	—
M.447/57	x B.3337	2	28	3	—	—	—	2	28	3
,,	x Co.290	1	—	—	—	—	—	1	—	—
,,	x M.147/44	—	—	—	2	—	—	2	—	—
,,	x M.403/54	1	—	27	—	—	—	1	—	27
,,	x M.436/57	1	—	—	—	—	—	1	—	—
,,	x 40SN5819	1	—	—	—	—	—	1	—	—
M.204/58	x P.O.J.2940	1	—	—	—	—	—	1	—	—
M.336	x Ebène 1/37	1	—	—	—	—	—	1	—	—
,,	x M.147/44	1	—	4	—	—	—	1	—	4
,,	x M.462/54	—	—	—	1	53	—	1	53	—
,,	x 47R2777	—	—	—	1	38	—	1	38	—
,,	x 47R4066	1	—	—	—	—	—	1	—	—

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. crosses	No. pots		No. crosses	No. pots	
			Bunches	Singles		Bunches	Singles		Bunches	Singles
36MQ2717	x B.3337	1	—	4	—	—	—	1	—	4
,,	x Co.419	1	—	77	—	—	—	1	—	77
,,	x Ebène 1/37	1	—	—	—	—	—	1	—	—
,,	x M.147/44	7	—	45	1	—	—	8	—	45
,,	x M.55/55	1	—	—	—	—	—	1	—	—
39MQ841	x M.147/44	3	121	—	—	—	—	3	121	—
N:Co.310	x Co.419	1	—	—	—	—	—	1	—	—
,,	x M.147/44	—	—	—	2	51	—	2	51	—
,,	x M.462/54	—	—	—	1	—	2	1	—	2
,,	x M.209/56	1	57	—	—	—	—	1	57	—
,,	x M.347/57	—	—	—	1	—	27	1	—	27
,,	x 39MQ832	2	31	32	—	—	—	2	31	32
,,	x 47R2777	2	453	34	—	—	—	2	453	34
,,	x *Saccharum robustum* seedling	1	—	—	—	—	—	1	—	—
,,	x unknown	2	—	1	—	—	—	2	—	1
P.O.J.2364	x M.147/44	—	—	—	1	55	—	1	55	—
P.O.J.2940	x unknown	3	—	—	—	—	—	3	—	—
P.O.J.3016	x R.397	1	—	88	—	—	—	1	—	88
P.R.1000	x Ebène 1/37	2	9	—	1	17	—	3	26	—
,,	x M.147/44	—	—	—	10	363	524	10	363	524
,,	x M.202/46	1	162	—	—	—	—	1	162	—
,,	x M.85/53	1	—	15	—	—	—	1	—	15
,,	x M.462/54	—	—	—	1	—	—	1	—	—
,,	x M.209/56	1	11	—	—	—	—	1	11	—

CROSS		Greenhouse			Field			TOTAL		
		No. crosses	No. pots		No. crosses	No. pots		No. crosses	No. pots	
			Bunches	Singles		Bunches	Singles		Bunches	Singles
P.R.1000	x M.80/57	—	—	—	1	—	13	1	—	13
,,	x 47R2777	—	—	—	8	1790	500	8	1790	500
,,	x 40SN5819	1	74	—	—	—	—	1	74	—
,,	x unknown	1	—	10	—	—	—	1	—	10
Q.47	x M.147/44	—	—	—	1	—	—	1	—	—
Q.50	x M.147/44	—	—	—	1	—	164	1	—	164
,,	x M.436/57	1	—	—	—	—	—	1	—	—
,,	x 47R2777	1	—	—	—	—	—	1	—	—
,,	x unknown	1	—	2	—	—	—	1	—	2
R.366	x unknown	1	—	15	—	—	—	1	—	15
R.397	x M.147/44	9	443	20	—	—	—	9	443	20
,,	x 39MQ328	1	—	—	—	—	—	1	—	—
,,	x unknown	1	—	—	—	—	—	1	—	—
47R2777	x M.147/44	1	—	—	—	—	—	1	—	—
,,	x 36MQ2717	1	—	2	—	—	—	1	—	2
,,	x 39MQ832	1	—	103	—	—	—	1	—	103
,,	x P.O.J.2940	1	—	16	—	—	—	1	—	16
,,	x R.397	1	—	31	—	—	—	1	—	31
,,	x unknown	3	—	64	—	—	—	3	—	64
47R4066	x B.3337	1	—	23	—	—	—	1	—	23
,,	x M.147/44	2	15	—	—	—	—	2	15	—
,,	x unknown	2	22	48	—	—	—	2	22	48
40SN5819	x unknown	3	46	25	—	—	—	3	46	25
Uba Marot	x unknown	1	—	6	—	—	—	1	—	6
(Ebène1/37	x M.147/44) x M.147/44	—	—	—	1	—	300	1	—	300
TOTALS		449	5677	4741	252	6821	7542	701	12498	12283