BUREAU OF SUGAR EXPERIMENT STATIONS

Queensland, Australia

RESEARCH SEMINAR

Bundaberg, 2nd March, 1988

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QUEENSLAND, AUSTRALIA

RESEARCH SEMINAR

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OPENING REMARKS

Owen W. Sturgess, Director of Sugar Experiment Stations

This is the fourth occasion that a research seminar focussing on the southern canegrowing district has been held in Bundaberg.

At the first of these seminars held in 1978, Fiji disease was of major concern. Yield losses in commercial blocks of NCo310 were being experienced and the adoption of resistant varieties for commercial production was in its infancy.

While BSES recognises that some of the replacement varieties do not have the attributes of NCo310, it must also be acknowledged that without the introduction of varieties that were resistant to Fiji disease, sugar production in the Bundaberg district would have been seriously curtailed for some years.

This is one instance where the value of research is easily identified. There was no other way that varieties could be screened for resistance to Fiji disease, propagated in a disease-free state, and released to commercial growers, without the basic knowledge, research skills, legislative backing, and organisational ability that BSES staff were able to contribute.

While the problems with Fiji disease have declined, other serious productivity problems still face growers in the Bundaberg district in particular, and in other southern canegrowing districts to a greater or lesser extent.

Productivity trends for the Bundaberg district, expressed as tonnes c.c.s. per assigned hectare, are illustrated in Figure 1. The two components that make up this figure are cane yield and c.c.s. Cane yields increased steadily from the early 1960's but there has been a decline in yield since 1980. C.C.S., on the other hand, has declined during the whole of this period, with a disturbing trend to increasingly lower c.c.s. levels since the mid-1970's.

There are a number of factors that have contributed to this situation, one of the important ones being weather during the past few years.

Staff of the CSIRO Division of Tropical Crops and Pastures are collaborating with BSES in an investigation of the factors that are preventing an improvement in cane yields. The next stage in this project, when supported by appropriate funding arrangements, will focus on the reasons why productivity has reached a plateau in two canegrowing districts, Innisfail-Tully, and Bundaberg.

Analysis of a long series of weather data for Bundaberg (1890 to the present time), shows that the past 10 or so years have seen a decline in annual rainfall from historically high levels to a point where they are now well below average. This is similar to the weather pattern experienced in Bundaberg in the early years of this century, from around 1905 until 1950.

This alone represents a serious constraint on productivity, but there are others, many of which are well known to industry representatives.

The topics being addressed by speakers at this seminar on ratooning, pest management strategies, sugarcane mosaic disease, and cane harvesting, are all extremely important when discussing productivity. Cane breeding can be singled out for separate mention as it is the objective of the cane breeder to breed and select varieties that combine all of the previously mentioned factors, along with others that affect cane and sugar quality, in an acceptable, commercial variety.

Some significant research topics, particularly salinity and herbicide research, are not included among the presentations for this seminar. These topics have had wide coverage at field days, shed meetings, and in the BSES Bulletin, and it was felt that the industry was well aware of research activities in these areas.

Although the main topic for discussion at the seminar is research, two other issues warrant mention.

One is the changes that are occurring in research funding since the industry agreed to seek Commonwealth Government support through the establishment of the Sugar Industry Research Council. It is envisaged that the availability of funding through the Council will benefit BSES as well as open up sugar industry research to a number of other research organisations. BSES will be collaborating with a number of these to ensure that SRC funds are used to benefit the industry to the greatest possible extent.

Secondly, there are significant changes occurring in extension. Late in 1987, BSES staff participated in the Australasian Agricultural Extension Conference where the major emphasis, expressed by both Australian and overseas representatives was that extension services are addressing the problems of managing farm enterprises to a much greater extent than was the case, 20 or even 10 years ago. This increased emphasis on economic and managerial advice is being matched by greater use of modern technology in preparing and presenting information to primary producers.

Some of the techniques being advocated, like data retrieval systems and use of video tapes to present research applications of a practical nature to larger audiences, are already in use by BSES and further developments are expected in this area in the future.

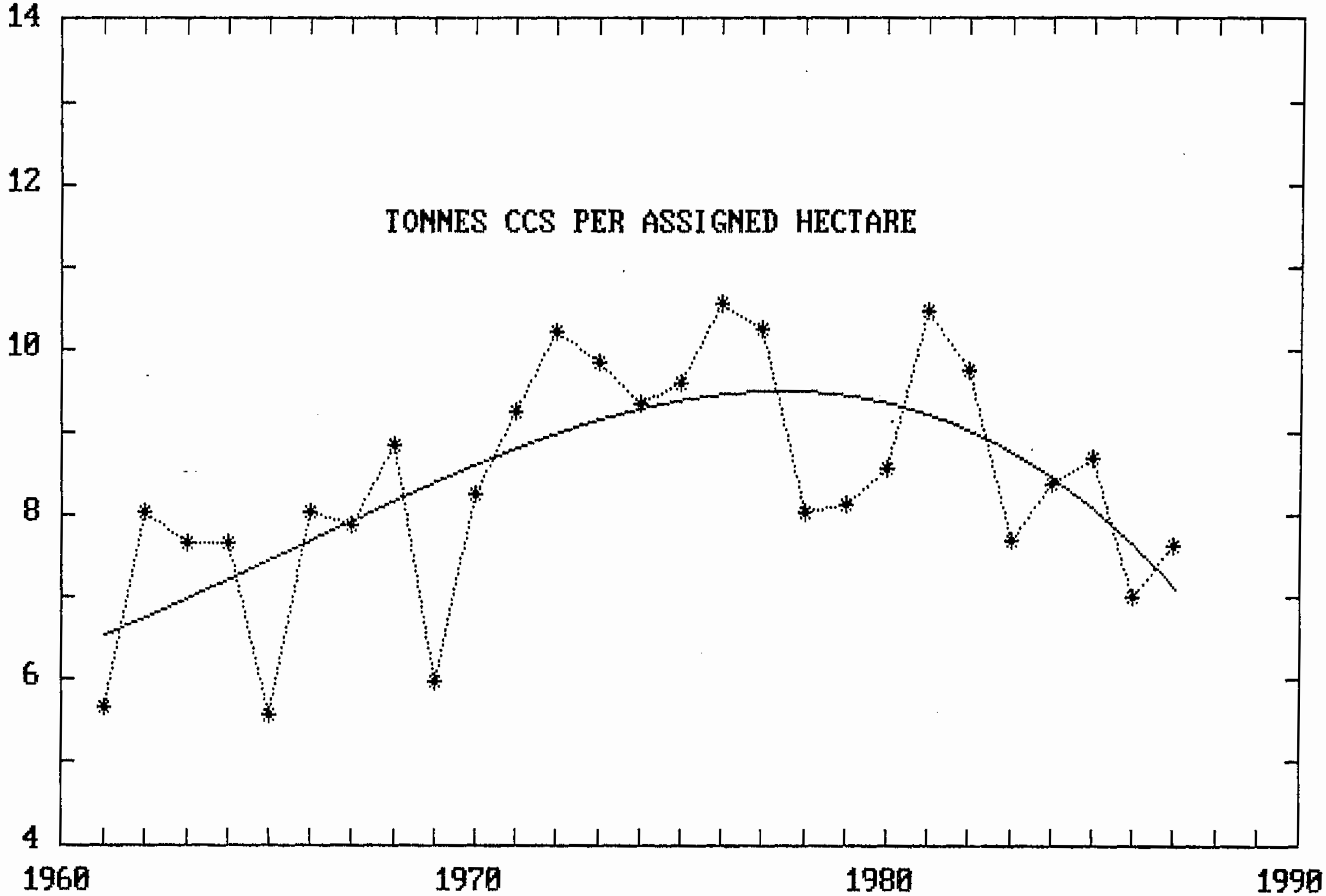

Figure 1: Sugarcane productivity in Bundaberg district, 1961-1987

CHANGES IN SOUTH QUEENSLAND CANE BREEDING PROGRAM

D.M. Hogarth, BSES Bundaberg

At the previous south Queensland research seminar held three years ago, the release of a number of new varieties in the region was foreshadowed. This has now happened, and these varieties are about to make an impact on productivity in the southern region.

The table shows the varieties that have been released in each of the south Queensland districts in the past three years.

Bundaberg	H56-752, Q140, Q141, Q144, CP51-21
Isis	H56-752, Q137, Q143, Q145
Maryborough	H56-752, Q137, Q143, Q145
Moreton	H56-752, Q137, Q140, Q143
Rocky Point	H56-752, Q125, Q137, Q143

In the Bundaberg district, Q145 will be released in 1989.

At Isis, varieties such as Q141, and CP51-21 are showing considerable promise. Unfortunately, the advent of mosaic disease has cast doubt on the future of the highly productive varieties, Q95 and Q137. There is an urgent need for alternative varieties for the elevated red soil areas in that mill area.

In the Moreton Mill area, Q116 and Q145 are showing promise in some difficult areas such as salt-affected country.

Fiji disease is still a major factor affecting varietal releases in the Rocky Point area.

Will there continue to be regular releases of new, more productive varieties? Since the previous seminar, there have been major changes in the cane improvement program. These will ensure continued progress for the foreseeable future.

BSES cane breeders have been decentralised, and there are now two professional cane breeders at both Meringa and Bundaberg. Duties of the cane breeding staff have been modified so that all districts will benefit equally from cane breeding research and improvements in selection techniques. The cane breeders will maintain a close liaison with the technicians who have the responsibility for conducting the selection programs.

SUBSTATIONS

The most important change with regard to the cane breeding program in the southern region has been the establishment of five substations - three in the Bundaberg district, and one each in the Maryborough and Nambour districts. The substations have resulted in an increase in the number of varieties being selected from Bundaberg Sugar Experiment Station from about 30 each year to at least 120.

Furthermore, the provision of mobile weighing equipment has enabled BSES to plant these varieties in replicated trials which are weighed and sampled for c.c.s. Previously, visual estimates of yield were made. The weighing trucks have improved the quality of the results being obtained and they also enable more trials to be harvested with fewer people than were previously involved.

The substations have been operating since 1985. First ratoon results from the first series of trials are now available. Results for five varieties, that were tentative selections after the plant crop, show the exciting potential of some of the varieties under test (see Table 1).

Table 1

Net merit grades for 1985 substation trials*

Variety	Crop	Substation					Mean
		Kalkie	Millaquin	Bingera	Maryborough	Moreton	
80S7349	P	12.8	14.5	9.3			12.2
	1R	13.2	16.3	10.4	11.2		12.8
80S7379	P	11.3	11.0	14.8			12.4
	1R	9.9	10.5	11.2	9.7		10.3
80S7499	P	13.4		17.7		12.7	14.6
	1R	13.4		11.4	14.7	12.5	13.0
81S797	P	12.8	13.2	21.0			15.7
	1R	13.8	15.5	16.3	12.5		14.5
82S501	P	10.9	13.0	19.7			14.5
	1R	11.5	13.5	14.2	10.8		12.5

* Net merit grades are based on tonnes sugar per hectare. Varieties were compared with the mean of three standard varieties CP44-101, Q110 and Q125. Standard varieties are allocated a mean net merit grade of 10.

RESEARCH ON SUBSTATIONS

Several research trials have also been planted on the substations. In 1985, two trials were planted to study the effects of location on results of a group of varieties, and to see if families of cane varieties perform differently in different environments.

Variety x location trial

Thirty selected varieties, and thirty varieties chosen at random from Bundaberg Experiment Station, were planted in replicated trials on the Experiment Station, at Bingera Plantation, at Granville Plantation (Maryborough), and on the Moreton substation. In the plant crop, despite the failure of the Granville site, some important results were obtained.

- Some randomly selected varieties performed well.
- The relative performance of varieties varied from site to site.

The results indicate the importance of the substation concept. The success of randomly chosen varieties, some of which performed very poorly in selection trials, shows that as many varieties as possible should be selected at the Experiment Station. Selection of varieties on the Experiment Station was based on the old system using visual estimates of yield, and consequently, it is possible that selection efficiency was poor. Selection is now based on actual yield, and should be much more effective. To confirm these findings, 30 randomly chosen varieties will be planted each year in substation trials for the next few years and compared with the varieties selected from weighed trials.

Since varieties performed differently relative to each other at the three sites, it is important to test varieties on a number of sites as early in the selection program as possible. This will minimise the chance of discarding superior varieties for, say, Bingera or Maryborough, just because they perform poorly on Bundaberg Experiment Station.

Cross x location experiment

Families of original seedlings (raised from true seed) are currently evaluated only on Bundaberg Experiment Station. There are sound economic and practical reasons for this approach but, if families have vastly different performance in different environments, it would be important to change current practices.

Initial results from the 1985 trials showed sufficiently different performance among families at the three sites for further experiments to be planted in 1986. It is hoped to employ a post-graduate student from the University of Queensland to work on this project. This would provide excellent contact between BSES and the University which would be mutually beneficial.

HIGH EARLY C.C.S. PROJECT

Increased sugar content of varieties during May, June and July would increase the yield of sugar per hectare for that portion of the crop currently harvested early in the season. Furthermore, it would enable an earlier start to the season than is present practice, enabling a larger crop to be handled by mills without the necessity to increase crushing rate. In the current economic climate, this would be an important factor where increased production, or mill rationalisation, requires a larger tonnage to be crushed. The alternative of extending the season is not favoured because of disruption through wet weather and poor, subsequent ratoon crops.

An experiment was planted in 1986 using 30 varieties that had shown high, early c.c.s. in selection trials. Varieties were sampled monthly from April to October. Results for a few varieties are shown in Table 2.

Table 2

C.C.S. values, April to October

Variety	C.C.S.						
	April	May	June	July	August	September	October
Q87	2.99	7.84	10.95	12.27	13.82	15.00	16.51
Q137	6.24	10.15	12.98	13.63	14.67	16.12	16.19
Q141	3.88	8.97	12.31	14.28	15.31	16.84	17.65
Q144	6.95	10.86	13.01	13.84	14.57	15.81	16.45
CP44-101	3.40	7.45	10.75	12.05	14.68	15.75	16.07
CP51-21	4.69	9.46	13.42	14.27	15.24	15.97	17.13
76S1299	6.71	10.84	12.86	13.49	15.08	15.99	17.15
79S7046	6.56	11.20	13.09	14.32	15.35	15.79	17.20
81S385	7.57	12.33	13.26	13.04	15.04	15.90	16.86
81S7239	8.40	10.84	12.42	12.19	13.74	14.60	15.04
81S7282	7.86	11.04	12.69	12.76	14.23	15.16	16.39
82S301	6.79	11.28	13.81	14.75	15.73	16.13	16.64
82S1147	7.95	12.96	13.40	14.08	15.14	16.19	16.70
82S1204	8.68	11.85	13.12	12.64	14.14	14.63	16.05
82S1235	6.98	11.76	13.48	13.48	15.38	15.93	17.08

The comparison between current commercial canes and some of the experimental varieties shows that there is considerable scope for improving c.c.s. levels in the April-June period.

With the appointment of an additional cane breeder to Bundaberg, this project is being expanded. Varieties showing promise in trials such as the one described will be used as parent canes at Meringa. In addition, varieties from crosses between parents with high sugar content will be tested at an early stage of selection. Those with exceptionally high c.c.s. will also be sent to Meringa to be used as parents. Progeny from the resulting crosses will be tested for sugar content, and varieties with high sugar content will be returned for a further round of crossing. This rapid turnover of parental material and emphasis on one particular character is expected to result in a concentration of genes for high early sugar. Varieties with higher early sugar than at present should result. This project is expected to have relatively little effect on sugar content of varieties later in the season.

REDUCTION OF GENERATION INTERVAL

Generation interval is the time between planting a variety from true seed until it is used as a parent variety. The generation interval for southern varieties is now about 15 years, whereas most sugarcane breeders would regard seven years as acceptable. This long genetation interval has resulted from the need for strict quarantine of southern varieties to avoid spreading Fiji disease to north Queensland. The other consequence of quarantine is that relatively few varieties have been sent to Meringa each year to be used as parent canes in the crossing program.

Starting in 1988, the number of varieties sent to Meringa from south Queensland will be increased from about 20 to 60 per year, and varieties will be used as parents ten years after they were first planted as original seedlings. Some varieties in the early c.c.s. project will have a generation interval of only five years. The best varieties from the plant crop of the substation trials, and special varieties from the early c.c.s. project, will be selected and sent to the quarantine house in Brisbane for one year. They will then be sent to Walkamin on the Atherton Tableland for a second year of isolation. At Walkamin, many varieties flower, and these flowers will be used immediately in cross pollination at Meringa. At the end of a year at Walkamin, the varieties will be planted in the breeding blocks at Meringa, and will be available for crossing in subsequent years.

Research on methods to detect diseases in sugarcane using biotechnological techniques is being undertaken by the Pathology Division. If this is successful, disease-free material could be taken directly from Bundaberg to Walkamin, and save an extra year.

Reduction in the generation interval will be a major advance for the southern breeding program. It will ensure that progress through breeding is maintained and, probably, increased.

FROSTING

Frost damage is a frequent problem for canegrowers in many parts of south Queensland. In recognition of this problem, BSES now plants all varieties selected for substation trials into small plots in a frost-prone area. These varieties are assessed for tolerance to frost, and this information will be used when assessing the future of varieties in the selection program. Some research on physiological aspects of frost tolerance may be commenced to obtain an appreciation of the problem and to understand how to select for it.

GENETIC ENGINEERING

There is considerable interest in the community about the prospects for genetic engineering of plants. Some progress has been made in some crops and prospects are most exciting, but it should be realised that the problems to be overcome with a crop such as sugarcane are considerable.

Most of the characteristics of the sugarcane plant are believed to be controlled by many genes but genetic engineering techniques, at present, are only suitable for characteristics controlled by one or two genes.

It is extremely difficult to identify the genes responsible for particular characters in sugarcane, so that it will be difficult to isolate and transfer favourable genes from one variety to another. It should, however, be possible to incorporate genes from other crops or from bacteria.

The most promising method for introducing new genetic material into sugarcane involves taking single cells through a tissue culture stage and regenerating plants from these cells. Unfortunately, with current technology some somaclonal variation, brought about by a random rearrangement of genetic material occurs in a high proportion of regenerated plants. This generally results in plants with inferior agronomic properties.

As a result, plants which have been regenerated after attempts have been made to insert particular genes have to be screened, not only for the presence of the gene, but also for the usual agronomic characteristics.

Because it is difficult to isolate genes for disease resistance in sugarcane, genetic engineers are working on attacking the pathogen, and some interesting strategies are being developed. Some of these will be discussed later by another speaker.

While the problems facing the genetic engineers will undoubtedly be overcome in the future, progress may not be as rapid as many people expect and it is important that this is well understood by industry representatives.

With the present state of knowledge, it will be more efficient to use conventional breeding methods if desired characters are present in the gene pool. For characters not in the gene pool, such as herbicide resistance, or grub tolerance, genetic engineering offers the chance to add such characters. Once they are represented in the gene pool, conventional breeding methods can be used to incorporate the characters in new varieties of sugarcane.

RESEARCH INTO RATOONING

L.S. Chapman, BSES Mackay

INTRODUCTION

Growers generally agree that the cost of growing ratoon crops is less than the cost of growing plant cane crops. Profitability is therefore enhanced by growing more ratoons - as long as the yields of the older ratoons do not decline excessively. Although factors which lead to yield decline in ratoon crops have been researched extensively, complete understanding of all the constraints to ratoon cane production is not imminent. Infection with diseases such as ratoon stunting disease, and latterly poor root syndrome, damage by a range of insects, and damage by harvesting operations have been identified as contributing to yield decline.

This presentation demonstrates the importance of varieties with superior ratooning potential, lists the priorities for research into ratooning, and provides some detail on associated projects on ratooning being undertaken by BSES staff, either alone, or in cooperation with CSIRO staff.

BSES RESEARCH PRIORITIES ON RATOONING

BSES staff are currently involved in a number of projects on ratooning. Meetings between CSIRO, University of Queensland, and Queensland Department of Primary Industries staff have been held to discuss areas where cooperative projects can be arranged to achieve the following objectives:

- To determine the limitations to yield of ratoon cane crops, and the constraints imposed by current varieties, the environment, and current management practices.
- To devise improved management practices that minimise these constraints.
- To identify selection criteria for improved ratooning that could be used in BSES cane breeding and selection programs.

RATOONING PRACTICE

The number of ratoons normally grown in various districts differs as illustrated by Table 1. South Queensland growers grow fewer ratoons than growers at Mackay because of different practices, and because of the different cane varieties that are grown. There has been a trend in recent years for growers to grow more ratoon crops.

Table 1

Ratio of the area of ratoon to area of plant cane

	1984	1985	1986
Mossman-Cairns	3.0	3.0	3.8
Babinda-Tully	3.3	3.1	4.0
Ingham	3.6	3.5	3.9
Burdekin	2.7	2.6	3.3
Mackay	4.2	4.4	5.1
Bundaberg	3.6	3.4	4.6
Maryborough-Rocky Point	4.8	4.2	4.8
New South Wales	-	-	3.0

RATOONING CAPABILITY OF VARIETIES

For many years, it has been recognised by growers that some varieties ratoon better than others. An example of this was provided by the results of a ratooning trial conducted at the Sugar Experiment Station, Mackay. Unfortunately appropriate similar data for south Queensland varieties do not exist and the Mackay results are presented here to illustrate the effect that different ratooning capabilities of varieties can have on optimising management techniques.

In the Mackay trial, the yields of a plant and six ratoon crops were measured in the varieties NCo310, Q50, Q58 and Q68. The ratooning trial was designed so that a plant and six ratoon crops were harvested each year for several years.

The data presented in Figure 1 illustrate that NCo310, compared with the other three varieties, had an average yield in the plant crop but good yields in the older ratoons.

The yield data for three varieties NCo310, Q58 and Q50 (Q68 and Q50 had similar yields) were used to estimate the cane yield per assigned hectare for various crop rotations and these predictions are presented in Figure 2. Maximum production of cane per assigned hectare, that is the level of maximum production for a farm, was achieved by growing a plant and four ratoons of NCo310, a plant and three ratoons of Q58, and a plant and two ratoons of Q50.

There would have been little change in production if a plant and two ratoons or a plant and six ratoons of NCo310 had been grown but this was not the case for Q50, where production declined sharply if cane older than third ratoon was grown.

The returns from growing various crop cycles were also calculated, using 1987 costs. Fixed costs were not included and the variable costs included fertiliser, fuel, oil and repairs, and labour. The returns for various crop cycles are presented in Figure 3 for NCo310, Q50 and Q58. Again these data indicate that the highest returns would be achieved by growing a plant and four ratoons for NCo310, a plant and three ratoons for Q58 and a plant and two ratoons for Q50.

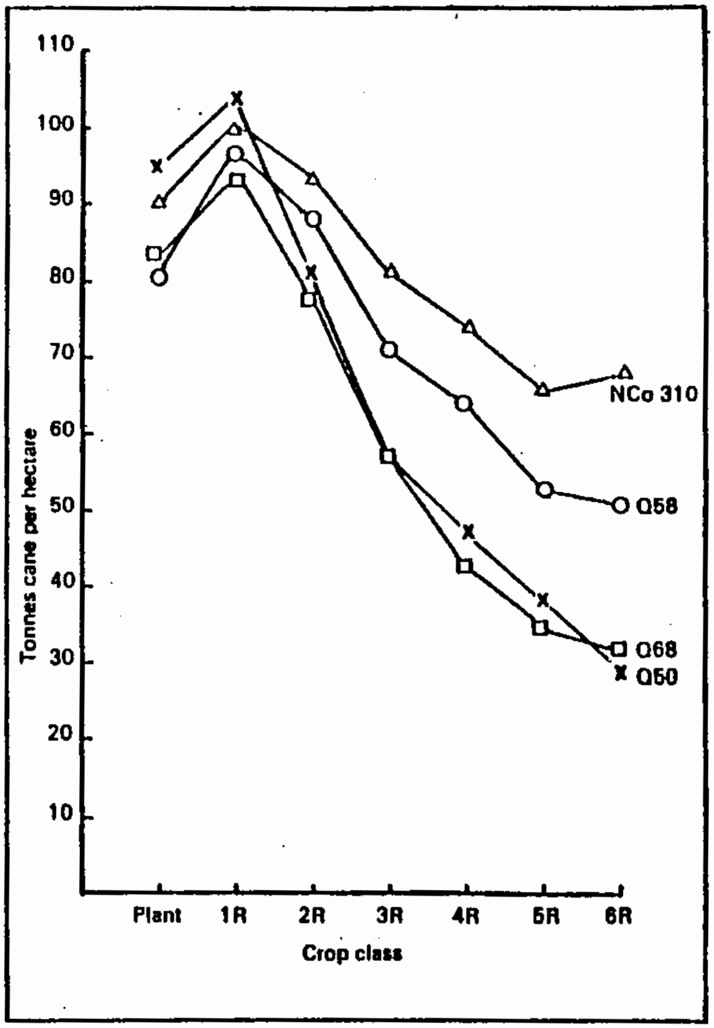

Figure 1: Cane yield from long term ratooning trial, Mackay

CONSTRAINTS TO YIELD OF RATOONS

A study of the components of yield which affect the performance of ratoon crops was undertaken using data from five replicated variety trials, four at Mackay and one at Bundaberg. The trials were harvested for plant and three ratoon crops by a sampling method where stalk population and stalk weight were measured. These data were used with appropriate c.c.s. analyses to estimate sugar yields. In order to reduce year to year variation, the data for the ratoon crops were expressed as a proportion of the plant crop data.

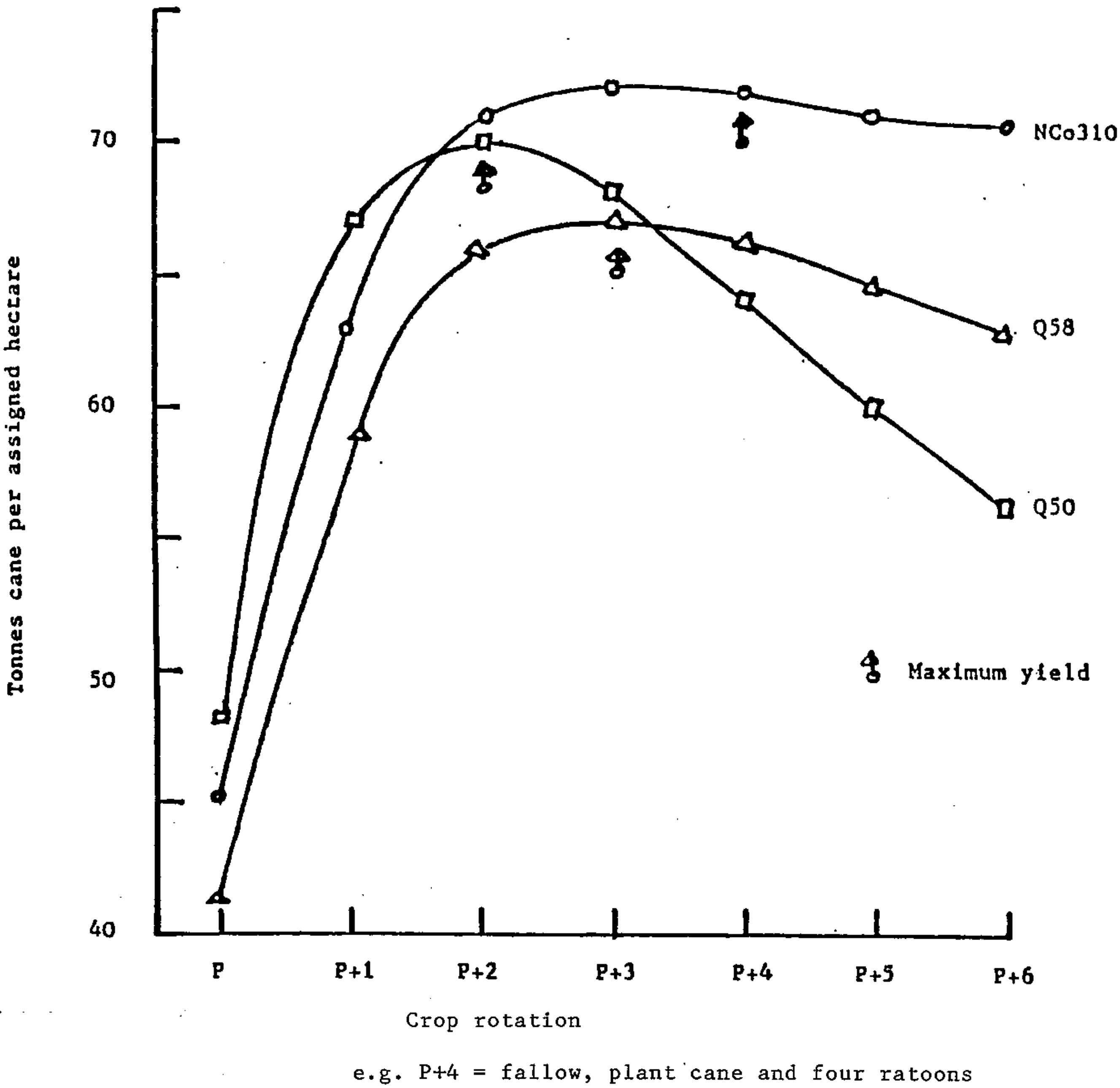

Figure 2: Cane yields for various crop rotations for three cane varieties

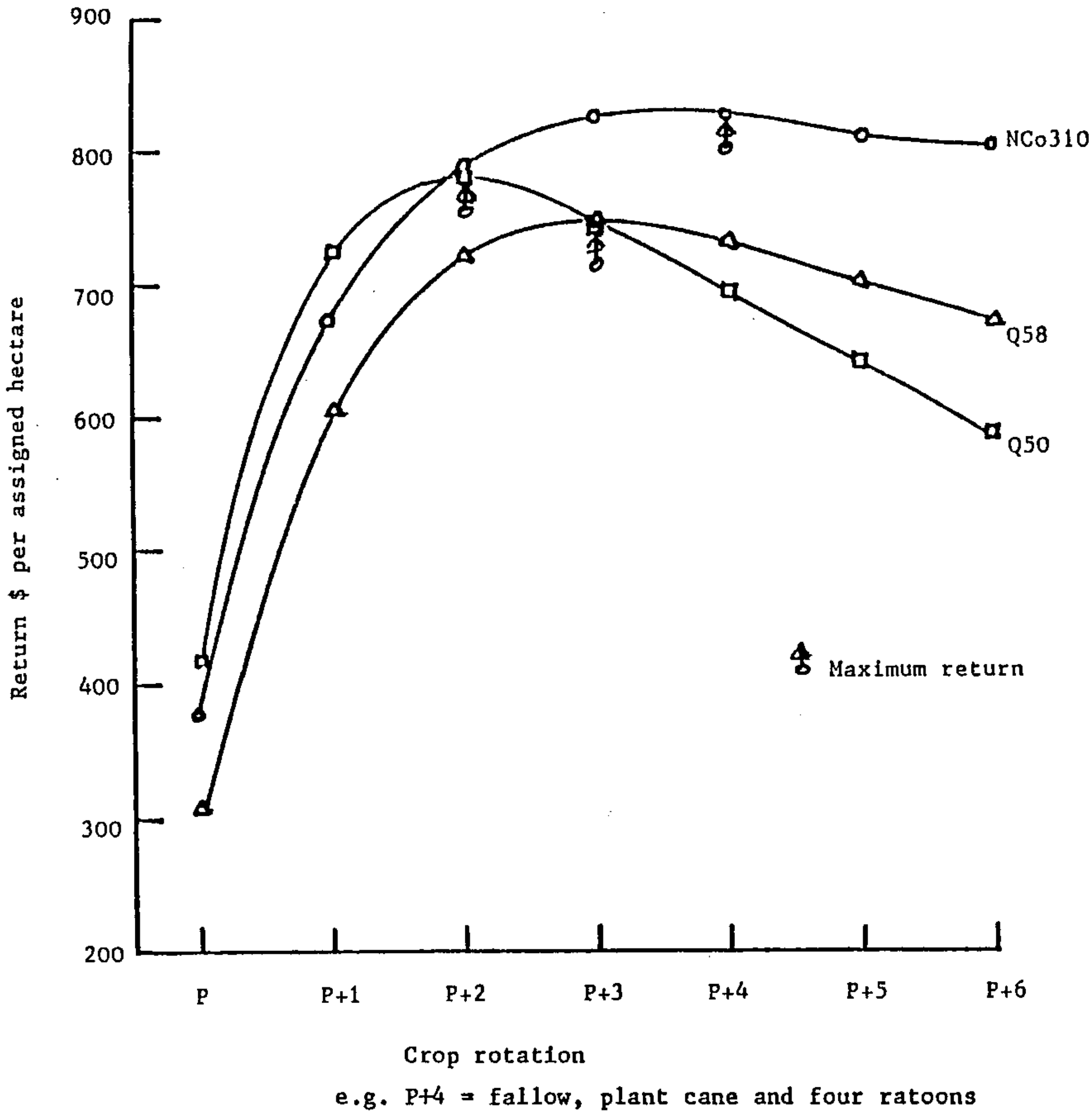

Figure 3: Financial returns from various crop rotations for three cane varieties

For three groupings, i.e. high, medium and low producing varieties, average data for third ratoon stalk weight and population, cane yield, c.c.s. and sugar yield are presented in Figure 4.

The results of this analysis showed:

- There was a decline in stalk weight for successive ratoon crops, indicating an obvious need for further experimental work to evaluate the reasons for this decline.

- In the group of poor ratooning varieties, there was a decline in the stalk population of older ratoons which contrasted with the group of good ratooning varieties where the stalk population increased.

- There was no trend throughout the whole crop cycle in the level of c.c.s. in any group of varieties.

- For each of the three groups of varieties, there was a segregation of cane and sugar yields early in the crop cycle, indicating that the yield of early ratoons was a useful index of yield in older ratoons.

These results suggest that the currently used techniques are adequately identifying the good ratooning varieties. There is considerable divergence of opinion on this latter point, for many growers point to the poor ratooning capability of some 'Q' varieties compared to some foreign varieties such as NCo310, CP44-101, and H56-752, which are generally strong ratooners. There are, of course, some good ratooning 'Q' varieties. The objective of this research is to have all strong ratooning, commercial varieties.

RAPID RATOONING TECHNIQUES

It is easy to identify high yielding varieties in old ratoon crops because, at that stage, poor ratooning varieties have either failed, or produce very low yields compared to the good ratooning varieties. Trials have been established in Mackay and at Bundaberg to evaluate the effect of repeatedly slashing cane to force it to ratoon four times each year. It is speculated that this accelerated ratooning program could be applied to large numbers of experimental varieties thus allowing an evaluation of ratooning potential before other agronomic factors are tested in replicated field trials. If this technique proves to be successful and is introduced into the cane breeding program, the ratooning potential of future commercial varieties may be improved. Reliable evidence is not yet available to make a judgement on the use of rapid ratooning techniques to determine ratooning potential but, conceptually, it appears promising.

MANAGEMENT PRACTICES

Trial work has started at Tully to evaluate the effects of management practices on ratoon performance. In this regard, exploratory plots were established to evaluate the effect of soil compaction on ratoon performance.

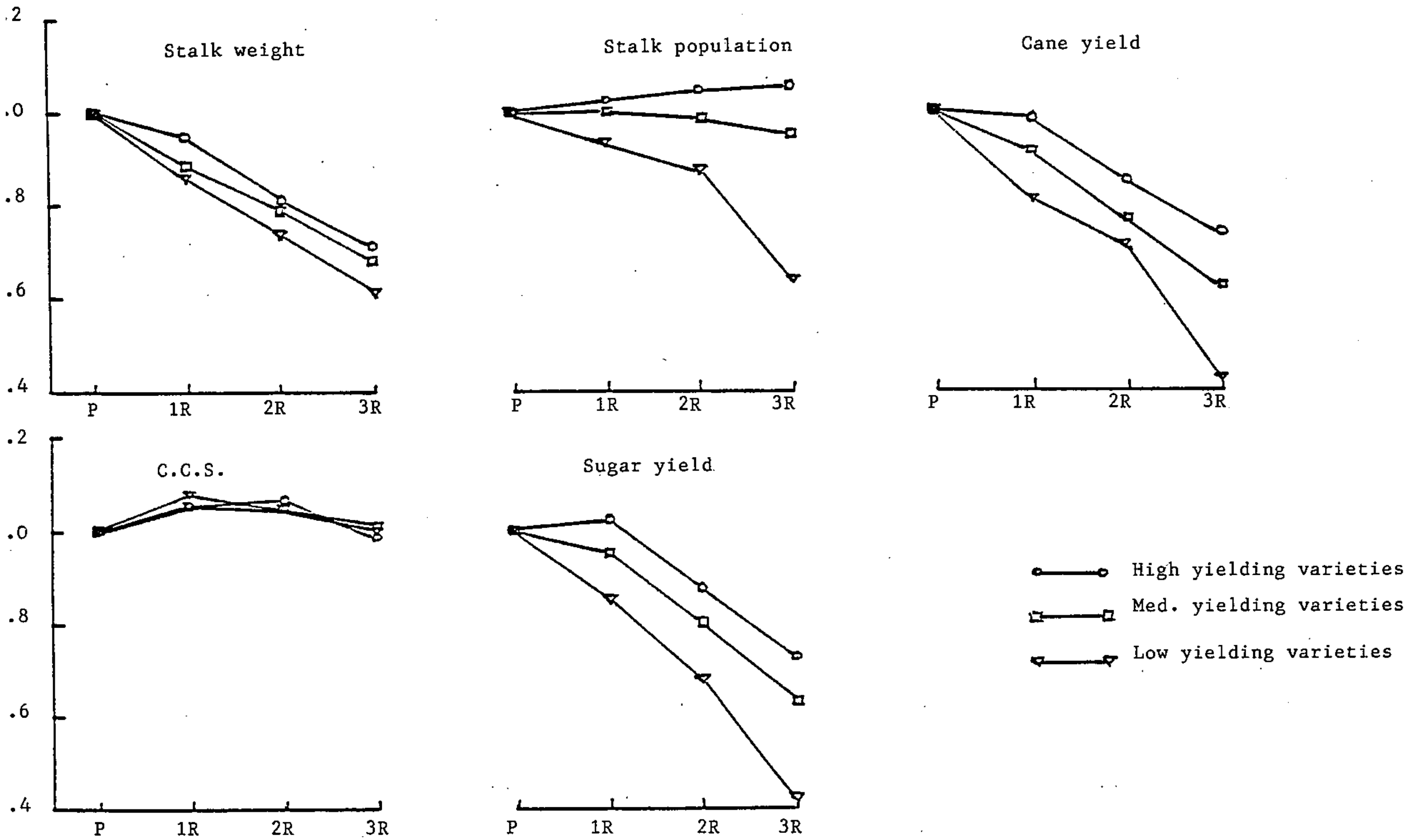

Figure 4: Comparison of plant and ratoon crop data for high, medium and low yielding crops

Initial trials have also been started at Tully to evaluate the effect of spraying ethepon on young ratoon shoots to increase the level of tillering, and possibly yield, in ratoon crops.

Strategies to increase yield by improved management practices are unlikely to be successful unless the mechanisms which control ratooning are fully understood. To this end, a comprehensive program of research is being considered for funding to evaluate the limitations to production.

MORPHOLOGICAL DIFFERENCES

Research may identify certain morphological characteristics that are common to varieties with good yielding ratoons. If these characteristics can be identified, they could be used to advantage by cane breeders in selecting superior varieties.

As illustrated previously, good ratooning varieties appear to have more stalks per hectare than poor ratooning varieties. Some evidence suggests that good ratooning varieties may also have better developed root systems and be able to utilise soil moisture better than poor ratooning varieties.

The manner in which varieties present leaves to intercept sunlight could be another factor worth evaluating.

GENOTYPICAL DIFFERENCES

In addition to morphological differences, varieties probably have specific differences in resistance to relatively minor diseases and/or tolerance to insects which could affect their ratooning capability.

Questions which have been asked, and so far not answered, include the differences that varieties may exhibit in their resistance to rots which invade stalks shattered by harvesters; their resistance to root rots affecting ratooning; and resistance to a whole range of soil microflora and microfauna.

CONCLUSIONS

The major conclusions to be drawn from these studies are:

- Ratoon crops can be more profitable than plant cane crops.
- Growers have observed the benefits of growing ratoons and are extending crop cycles.
- There is a need to have strong ratooning varieties to extend the crop cycle as long as this is profitable.
- There is an obvious need for cooperative research projects, involving many disciplines, to study the limitations to production in ratoon cane.
- Projects to study the constraints on ratoon cane growth are now in progress.

DEVELOPMENTS IN PEST MANAGEMENT STRATEGIES

P.G. Allsopp, BSES Bundaberg

The organochlorine insecticides BHC, dieldrin, aldrin and heptachlor provided the first cheap and effective method for control of canegrubs, soldier fly and wireworms. Their use from the late 1940s meant, in the words of Sir Robert Menzies, 'the difference between bankruptcy for the industry and prosperity'.

Unfortunately the great advantage of this group of chemicals, their long residual life, has been their downfall. On environmental grounds, and because of the possible development of resistance, use of these chemicals is now banned, or severely restricted. Such developments were foreseen by BSES entomologists and work on alternative controls has advanced, in one case, to the production and marketing of a commercial product, suSCon®.

The need for insect control methods for the sugar industry that are environmentally acceptable as well as cheap and effective is still present. The industry needs to broaden its pest control options, not only in terms of efficient use of chemicals but by using cultural and biological controls as well. In short, an integrated system of pest management is needed.

CONTROL STRATEGIES

With increasing costs of chemicals and reduced margins of profitability in canegrowing, there is a pressing need to develop alternative strategies for cane pest control. Reliance on one method of control invites development of resistance and does not allow costs to be reduced.

Depending on the potential for insect damage in each field, growers should be able to vary their treatment strategies accordingly, and to many this will result in substantial cost reductions. The economics of insect control can vary widely and are influenced by many factors including -

* Proximity to harborage and other damage areas;

* Species of insects present;

* Soil type, moixture levels, availability of irrigation, etc.;

* Finance available and alternative returns.

Growers need to remember that small numbers of insects will cause very little or no damage to a vigorously growing crop of sugarcane. In order to justify the expense of any routine treatment, the benefit, derived over a substantial period, must be several times greater than the value of that

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treatment. Possible control options for canegrub control include application of suSCon at planting, application of lower rates of suSCon at planting, protection of older ratoons with Mocap, or use of Mocap when an infestation develops. Each of these involves a risk and will not suit all situations.

The following ideas are avenues of research that BSES entomologists are considering. Some of these have been started. Some will probably lead to dead ends, but all need to be explored.

CONTROLLED RELEASE INSECTICIDES

SuSCon granules continuously release minute amounts of insecticide which only become active on reaching the surface of the granule. A canegrub must contact a granule before it is poisoned because there is little significant movement of the insecticide (chlorpyrifos) away from the granule.

The size of suSCon granules determines the number of granules in a given weight of material and influences the release rate of insecticide. In any given weight, there are nearly four times as many 1.3 mm diameter granules as 2.0 mm diameter granules and the surface area is increased by more than 50%. Consequently, significant cost savings may be possible through using an 'optimum' sized granule. The present 2.0 mm diameter granule appears to have been a result of what a factory could make rather than what is most efficient.

BSES entomologist at Meringa, Keith Chandler, is currently investigating the relative effectiveness of suSCon granules ranging from the current size (2.0 mm diameter) down to 1.0 mm. The slightly lower 'killing power' of the smaller granules should be more than compensated by the greatly increased numbers of granules available (and hence more chance of grubs encountering them). Small granules appear to remain effective for almost as long as the larger granules.

KNOCKDOWN INSECTICIDES

Insecticides such as Mocap can be applied to ratoon crops to control existing grub infestations. Two problems arise. The grower must be aware that an infestation exists and to minimise damage, the infestation must be treated at an early stage. Obviously a grower cannot take a long summer vacation and still hope to use these chemicals. He must be aware of what is happening in his crop. To help in monitoring this, we are considering research on cane beetle pheromones. These are chemicals which female beetles emit and use to attract males. If these chemicals can be identified and manufactured, they can be used to indicate when the different species of beetles are flying. A treatment with Mocap within four to six weeks of flights should then be effective.

The second problem with Mocap relates to its reduced efficiency under low soil moisture conditions and in different soil types. Research has shown that irrigation after Mocap application increases its efficiency. We are currently looking at factors such as soil type and soil organic matter so that better recommendations can be made regarding the conditions under which this chemical can be used.

PLACEMENT OF CHEMICALS

The ability to treat ratoon crops with controlled release insecticides would increase the range of pest control options available to growers. Placing granules in a band centrally along the row provides far superior control to that from other methods. The problem of achieving this objective is currently being addressed by BSES staff and also by a number of farmers.

In one experiment, the removal of a 100 mm wide slot from within the central portion of stools of a young second ratoon crop has not proven as damaging as may have been expected. In other experiments, suSCon placed into narrow (20 mm wide) bands created behind rolling coulters slicing through the stools gave poor grub control. This method of application may be improved by the addition of tine foot attachments which allow broader bands of granules to be placed under the stool.

This technology could also be applicable to knockdown insecticides. Better application techniques should reduce some of the problems associated with applying these chemicals under low soil moisture conditions.

BIOLOGICAL AND CULTURAL CONTROL OF SOLDIER FLY

The restrictions on using dieldrin and the studies by Robertson in the early 1980s have renewed interest in non-chemical control of soldier fly. Robertson found in both southern Queensland and in New Zealand that a complex of beetle predators exerted good control over soldier fly larvae and pupae. These predators, however, are more susceptible to dieldrin than are the soldier fly larvae. We are currently determining the levels of dieldrin at which these predators can re-enter the system.

The effects of cultural controls on soldier fly numbers are being investigated. Some of the questions being asked are:

- Does green trash blanketing affect soldier fly?
- How does the length of a fallow affect the survival of larvae?

Once we have answers to those questions we can design better management systems for this pest.

The appointment of an additional cane breeder to Bundaberg has meant that we have started to investigate the extent and effectiveness of resistance in sugarcane plants to soldier fly. Data from the 1960s show that differences in susceptibility of different varieties are probable. We intend to screen a range of varieties to determine their susceptibility. Incorporation of these varieties into the breeding program is a logical continuation of this work.

BIOCONTROL USING METARHIZIUM

'Fungi undoubtedly play a most important part in grub control, especially when climatic conditions are suitable for their propagation'. So concluded Illingworth in 1921. In joint projects with CSIRO and the University of Adelaide, the use of the fungus Metarhizium anisopliae for grub and soldier fly control is being re-examined.

In principle, the use of Metarhizium is simple. The fungus, which grows easily on simple media, is inoculated into nutrient baits, and these are placed in the furrows during, or just after, planting. Insects become contaminated with spores which infect them directly through the cuticle. The fungus multiplies in the insect's blood and kills it in about two weeks. A new crop of spores then forms on the surface of the dead insects. The spores will survive at least one year in the soil in the absence of the host insects. The fungus has no side effects - it is specific to the hosts and is not phytotoxic.

Experience suggests that a number of important problems may be encountered in using this technology and these need to be researched. For example -

* Each strain of Metarhizium is likely to be specific to one or two species of grubs, or to soldier fly;
* Economical methods for mass production of the fungus need to be developed;
* The importance of soil conditions (pH, moisture and soil type) in determining effectiveness must be understood;
* The conditions for storing the living fungus need to be defined;
* The fungus may be inhibited by other micro-organisms in the soil.

This research project involves five stages:

* Isolation of effective strains of the fungus;
* Investigation of the factors affecting the effectiveness of Metarhizium under controlled conditions, and development of methods for mass production of the fungus;
* Selection and modification of native strains of the fungus to improve their virulence and longevity;
* Field trials to assess effectiveness and to check the dosage needed;
* Development of application techniques as well as understanding the factors affecting efficacy of the treatments.

To date, all stages have been addressed with respect to grub control. With soldier fly, the work is less advanced with sufficient quantities of suitable fungus yet to be produced for field trials.

GENETIC ENGINEERING

The rapidly developing part of science called genetic engineering may make a contribution to pest control in cane. For example, the transfer of genes from toxin-producing bacteria and fungi into sugarcane, or into bacteria which can colonise the roots of sugarcane, has great potential for improved pest control. Strains of Bacillus thuringiensis which are active against flies and beetles are becoming available. This bacterium produces toxins which are potent gut poisons. To control insects, the toxins must be ingested and they have no contact or direct effects on stages other than larvae. The difficult aspect of this approach is in the selection of host bacteria which can colonise sugarcane roots with sufficient reliability to control susceptible insects.

NEW CHEMICALS

Chemicals are and will continue to be an important part of any integrated pest management system. New chemicals may be incorporated into controlled release formulations or used as knockdowns. We will continue to evaluate new chemicals for grub, soldier fly and nematode control. Chemicals from groups such as the synthetic pyrethroids and chitin inhibitors or moulting disruptors have recently been tested.

CONCLUSIONS

The sugar industry has had to reappraise canegrub control measures in response to the loss of the cheap organochlorine insecticides and the availability of relatively high cost, controlled release products as an alternative. As a consequence, growers will be forced into adopting a more flexible pest management approach which will involve them in making decisions on the most cost-effective strategy for their situation. The era of 'treat with insecticide and forget the pest' is fast coming to an end. It needs to be remembered that there is no treatment so expensive as the cheap one which does not work.

SUGARCANE MOSAIC DISEASE AT ISIS

C.D. Jones, BSES Childers

DESCRIPTION

Sugarcane mosaic is a virus disease which is identified by its leaf symptoms. The general symptoms are islands of normal green on a background of pale green or yellowish chlorotic areas. The proportion of the leaf that is chlorotic varies greatly. At times there are only scattered, elongated, yellowish stripes but more usually the pale areas predominate over the normal green and are scattered evenly over the entire leaf area. The intensity of symptoms varies from variety to variety. Q95 produces a generally pale, diffuse pattern while Q103 and Q137 show a more distinct and sharply defined pattern of striping. On some varieties such as Q95, a mosaic pattern may also be present on the stalk.

METHODS OF SPREAD

There are two methods of transmission which take place in the field, diseased planting material and insect vectors.

Diseased planting material

Low levels of mosaic infection are difficult to find in mature cane and for this reason planting material containing some mosaic disease may inadvertently be used as planting material even after a thorough plant source inspection. There is little doubt that this method was responsible for a lot of the spread that took place in the Isis district in 1984 and 1985.

Insect vectors

There are a number of insect vectors which may spread mosaic disease. The most important of these is the corn leaf aphid. The main period of transmission appears to be spring and early summer and the large increase in the number of mosaic infected stools which took place in the Isis Mill area has shown that insect vectors may be more numerous and more mobile than was previously thought.

ALTERNATIVE HOST PLANTS

A number of grass species, including wild sorghum and maize have been shown to carry the sugarcane mosaic virus. Wild sorghum is a common weed in many south Queensland canegrowing districts and is present on wasteland areas adjacent to existing outbreaks of mosaic disease. Equally importantly, sorghum and maize are preferred host plants for the corn leaf aphid and may be responsible for the build-up in the population of these insects.

HISTORY IN QUEENSLAND

Sugarcane mosaic disease was first identified in Queensland in the Herbert River district in 1913. It had almost certainly been present before this in many districts. Although it has been variously reported in far north Queensland, in varieties such as Q78 and Q66, it has never assumed serious proportions.

Major outbreaks of mosaic occurred from time to time in the Burdekin and the central districts. The last of these were recorded from the mid 1950's until the early 1960's. Q50 was a significant factor in these outbreaks. In south Queensland, the Moreton Mill area has reported mosaic disease on a annual basis up to the present time, although a plant inspection and roguing campaign has kept it at a relatively low level. Large outbreaks occurred in the Isis, Maryborough, Wallaville and Bundaberg Mill areas in the 1950's and early 1960's. The susceptible variety Q50 was a major variety in these areas at the time. A plant inspection and roguing campaign combined with the replacement of Q50 by more resistant varieties, saw the last known outbreaks in these mill areas controlled by the mid 1960's.

THE CURRENT OUTBREAK

Mosaic was identified in the susceptible variety Q95, in the Logging Creek part of the Isis district in November, 1985. Before the end of 1985, it was subsequently found in Q95 in many separate sections of the district. Some early spread occurred through diseased planting material, however most of the disease spread since that time has been attributed to insect vectors. The susceptible varieties Q103, and Q137, also became widely infected. Monitoring has indicated that by the summer of 1986-87, mosaic disease was present on all Isis assignments. In some sections of the district the worst affected blocks of Q95 reached infection levels of 70-80%.

So far, monitoring in the Bingera Mill area has revealed the presence of mosaic disease on 16 assignments. In each instance, the disease has been located in the susceptible variety, Q103.

VARIETY TESTING PROGRAM

1986 Standard calibration trials

Trials were planted on two farms in the Isis Mill area in September 1986 to test the susceptibility ratings of a range of standard varieties. Three replicates were included in each trial and the plot size was 3 rows x 3 m. The trials were planted adjacent to heavily infected blocks of Q95. Mosaic disease was located in the susceptible varieties prior to the four leaf growth stage. The following results were obtained:

Variety	Final inspection date	% Mosaic disease
Q95	27/5/87	56.4
Q137	27/5/87	46.3
Q78	27/5/87	44.4
Q103	27/5/87	41.0
Q68	27/5/87	18.3
NCo310	27/5/87	18.1
Pindar	27/5/87	10.7
Q63	27/5/87	2.8
Trojan	27/5/87	2.8
Q82	27/5/87	2.1

These trials, clearly showed that three major varieties in the Isis Mill area, Q95, Q103, and Q137, were highly susceptible to mosaic disease.

1987 Mosaic susceptibility trials

Advanced varieties (autumn plant)

A replicated trial containing advanced seedlings, recently approved varieties, and standards was planted in autumn 1987 in a block adjacent to heavily infected Q95.

The plot size was 3 rows x 5 m and the varieties planted in the trial were:

Q145	Q110	66C760
Q144	Q103	73S1121
Q142	Q99	73S2255
Q141	Q95	74S982
Q140	Q87	74S1109
Q137	Q68	75S2497
Q136	CP44-101	76S1038
Q135	CP51-21	76S1299
Q125	H56-752	76S1584
Q124	H60-3802	77S1227
		77S1540
		78S1181

Insect vector populations have apparently been low during spring 1987 and consequently transmission rates of mosaic have been extremely low. To date mosaic disease has been located only in the susceptible standard variety, Q95, Q137, Q144, and the seedling 74S982.

Advanced varieties (spring plant)

A replicated trial containing the same varieties as the autumn plant trial just described was planted in August, 1987. Natural infection pressure was light and the centre row of each plot were mechanically inoculated using the needle prick method on 3rd December, 1987.

Inspections carried out on 28th January, 1988 revealed the following percentage diseased stools in the inoculated centre row and the non-inoculated outside rows:

Mosaic - percentage diseased stools

Variety	% disease inoculated row	% disease non-inoculated row
Q95	87.0	3.5
Q137	71.5	2.5
Q144	53.0	3.0
Q103	50.0	5.0
76S1299	50.0	2.5
Q136	37.5	0
66C760	33.5	0
H60-3802	20.0	3.5
Q124	20.0	3.0
Q141	7.0	0
75S2497	6.5	0
73S1121	6.5	0
Q87	6.0	0
74S982	5.5	5.5
73S2255	0	5.5
78S1181	0	2.5
CP44-101	0	0
Q110	0	0
Q68	0	0
Q125	0	0
Q140	0	0
Q145	0	0
Q99	0	0
Q135	0	0
Q142	0	0
H56-752	0	0
CP51-21	0	0
77S1227	0	0
77S1540	0	0
76S1584	0	0
74S1109	0	0
76S1038	0	0

Varieties from substation yield trial

An unreplicated trial, containing varieties planted into the substation yield trials, was also planted at Isis Central in August, 1987. The trial included 59 varieties from the 1985 SYTs, 134 varieties from the 1986 SYTs and 55 varieties from the 1987 SYTs. The plot size is 1 row x 5 m. Natural infection pressure has been light and as a result, one half of each plot was mechanically inoculated using the Scotch-Brite method on 3rd December, 1987. Inspections carried out on 28th January, 1988, revealed mosaic disease in 48 seedlings.

Yield loss assessment trials

During the 1987 crushing season, trials were conducted under commercial growing conditions to quantify yield losses caused by mosaic disease. The varieties involved were the highly susceptible Q95, Q137, and Q103. Selection of suitable blocks for the trial proved difficult as totally infected stools were required for comparison with healthy, adjacent stools. Where possible, stools derived from planting diseased stalk lengths were used.

The following average results were obtained from the two trials carried out:

Variety	**Average loss in yield**	
Q137 - spring plant	5 replicates	41%
Q103 - spring plant	3 replicates	51%
Q95 - spring plant	6 replicates	25%

A further series of trials conducted by Isis Cane Pest and Disease Control Board staff, compared the weights of diseased and healthy cane stalks and showed the following average losses due to mosaic disease:

Q137	32%
Q103	36%
Q95	19%

It is likely that the weighing techniques used in this trial may in fact exaggerate losses to some extent as a result of competition factors which were not possible to measure.

Field observations and analysis of trial results have indicated that for each 10% increase in infection level, the following losses may occur:

Q95	2.5 t cane/ha
Q137	5.0 t cane/ha
Q103	5.0 t cane/ha

INSECT VECTORS

An insect trapping program to identify vector species, and to monitor population numbers and movements, has been initiated.

CONCLUSION

In the short term, a compromise between mosaic disease control and the maintenance of productivity is being sought. In the longer term, the effective control of mosaic disease, as with other major diseases of cane, will be achieved through the release of resistant varieties.

RESEARCH INTO SUGARCANE MOSAIC VIRUS IN SOUTH QUEENSLAND

P.W.J. Taylor, BSES Eight Mile Plains

As a result of the outbreak of sugarcane mosaic in the Isis district the research effort into this disease has been increased. Prior to the outbreak some cooperative studies with the University of Queensland on development of artificial inoculation techniques for use in assessing varietal resistance were underway; this work was expanded and investigations into the possible causes of the severity of the outbreak, development of diagnostic techniques for detection of the virus and use of genetic engineering techniques for incorporating disease resistance in susceptible varieties were also commenced.

STUDIES INTO THE SEVERITY AND SPREAD

The rate of spread of mosaic at Isis has been far more rapid than previously experienced in Queensland. This could be due to a number of factors including a different strain of the virus or different vector. Experiments were undertaken at the University of Queensland to determine whether a new strain was involved. This study involved comparing isolates of the sugarcane mosaic virus (SMV) obtained from Isis and Brisbane. Preliminary results, based on the reaction of a set of differential hosts have shown that the virus isolates in Isis and Brisbane are similar. However, with the Isis isolate symptoms were produced more rapidly on one of the sugarcane varieties used in tests suggesting there were differences in virulence. Serological and genetical tests will be conducted on these isolates to determine differences in the structure of the virus, which may provide information on the basis of virulence in SMV.

As noted in the previous paper studies were commenced into the nature of the mosaic vector and the seasonal pattern of spread. Aphid traps were erected at several sites in the Isis and Bingera districts. However due to the dry conditions being experienced relatively few aphids have been trapped. Most aphids have been trapped in the Isis Central area with the dominant species being the corn leaf aphid.

IMPROVEMENT IN THE INOCULATION TECHNIQUE FOR SMV RESISTANCE TRIALS

Prior to the outbreak at Isis very limited testing of varieties for resistance to mosaic was carried out because the disease was not important. In these trials natural transmission was low and artificial inoculation methods were needed to test varieties. The method previously used involved pricking through an infected leaf wrapped around the shoot of each plant in the trial. However, infection levels obtained by this method are often low and hence the results are unreliable.

It is our intention to test varieties for resistance at several stages in the southern plant improvement program. Where possible this will be done using natural infection in the field at Isis. However, when infection levels are low we will need to resort to an artificial inoculation method.

Experiments in cooperation with researchers from the University of Queensland have been undertaken to improve the inoculation technique and obtain better symptom expression in SMV resistance trials. Preliminary glasshouse experiments indicated that inoculating sugarcane plants by using a scourer pad (Scotchbrite®) with carborundum abrasive was more effective in mechanical transmission of SMV than an air brush, pricking, rubbing with a scourer and abrasive, or a scourer pad without abrasive. Results also indicated that the susceptibility of plants to SMV decreased as the age of plants at inoculation increased (from one to three months) for each treatment. A field trial to compare methods of inoculation (pricking and scourer pad) and age of the plant at inoculation on infection rate was carried out. Initial results have shown no difference in the level of infection between pricking and scourer pad methods, and both susceptible and resistant varieties inoculated at the two-leaf and tillering stages have shown extremely high infection levels.

DEVELOPMENT OF A GENE PROBE FOR DIAGNOSIS OF MOSAIC

To prevent the spread of important diseases from southern areas to north Queensland, varieties are quarantined for two years. During this period varieties are checked for presence of diseases by visual methods. The quarantine period is an impediment in the cane improvement program as it delays the use of superior varieties in the breeding program.

With the outbreak of mosaic in the Isis district, varieties will have to be carefully screened to prevent the accidental spread of mosaic to north Queensland. In some moderately susceptible varieties symptom expression is poor or slow to develop. Consequently there is a need to have available a diagnostic technique which can detect SMV and this may reduce the time that varieties need to be held in quarantine.

Currently BSES is developing a diagnostic procedure for SMV known as a 'gene probe'. The gene probe is based on the structure of SMV and its mode of multiplication in plants. Sugarcane mosaic virus particles are composed of single-stranded ribose nucleic acid (RNA) surrounded by a protein coat. After the virus particle penetrates the plant cell, the RNA (nucleic acid) separates from the protein coat. The nucleic acid in the virus uses the metabolic processes of the host plant cell to produce mature virus particles. A 'gene probe' is usually composed of a radioactively labelled segment of nucleic acid that specifically recognises viral nucleic acid and binds strongly to it. If an extract from infected sugarcane is incubated with the gene probe, the viral nucleic acid will bind to the probe and be detected by assaying for radioactibity. This procedure can take several days to complete. Using this technique it should be possible to reduce the quarantine period.

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DEVELOPMENT OF RESISTANCE IN SUSCEPTIBLE VARIETIES

As described earlier, it is estimated that mosaic is capable of causing yield losses of the order of 20-30% in highly susceptible varieties. At present agronomically suitable replacement varieties are not yet available.

Recent overseas research has shown that resistance to certain plant viruses can be induced in susceptible varieties by the incorporation and expression of the infecting virus' coat protein gene, introduced into the plant by genetic engineering. Expression of the viral coat protein in the plant cell prior to virus infection disrupts replication of the infecting virus' thus conferring resistance to the plant cell.

Proposed BSES research aims to isolate the SMV coat protein gene and transfer it into single cells of the susceptible varieties Q95 and Q137 using direct gene transfer techniques. These single cells will then be cultured until normal cell division occurs and ultimately intact transformed plants that contain the genes for SMV resistance will be produced.

HARVESTER RESEARCH - CANE VARIETY AND DIRT STUDIES

D.R. Ridge, BSES Bundaberg

INTRODUCTION

With the expansion of green cane harvesting in all districts, the suitability of cane varieties for green cane harvesting has become more important. This affects harvester throughput, extraneous matter levels, and cane losses during cleaning. All three factors can have an adverse effect on growers' and millers' costs and returns and this needs to be weighed against varietal yield characteristics and benefits from green cane trash blanketing.

A recent SRI report highlighted the detrimental effects in mills from high levels of dirt in the cane supply. A figure for maintenance costs of $0.62 to $0.95 per tonne of cane has been attributed to dirt. Dirt intake is also an important contributor to maintenance costs for harvesters.

The development, initially, of a test facility for harvesters at Bundaberg Sugar Experiment Station, and this year, the assembly of a portable set of testing equipment, has enabled detailed study of varietal characteristics that affect harvestibility. Discussion with harvester operators has provided supporting data on varietal factors that influence harvester throughput.

These test facilities have also been valuable in studying the effectiveness of different harvester components in rejecting dirt taken in with the cane from the basecutter. Cultural techniques contributing to dirt intake during basecutting are also under investigation.

VARIETAL CHARACTERISTICS

The first tests of the effect of varietal characteristics on harvesting were carried out at the Bundaberg test facility. These showed marked differences in extraneous matter levels and in cane losses between varieties and between erect and lodged cane.

Table 1

Effect of cane variety and lodging on cane losses and extraneous matter levels - modified VT6000 harvester

Variety	Cane loss %	E.M. %	
		Initial	Final
Q110			
lodged	10.0	20.2	8.3
erect (topped)	5.2	12.2	3.9
CP44-101			

In these tests, cane losses were thought to be related to initial extraneous matter levels and either diameter, or density, of cane stalks. It was obvious that erect varieties, which could be topped effectively, for example CP44-101, would result in lower cane losses and lower extraneous matter levels than varieties, such as Q110, with a propensity for lodging.

The portable test facility constructed during the 1987 season was used to test a wider range of varieties in other districts. Two series of trials were conducted at Tully and Cairns with a suite of six varieties in each case. All tests were carried out with untopped green cane to represent the extreme case of lodged cane. The harvesters used were a VT6000 fitted with an Austoft 7000 chopper and extractor, and a standard Austoft 7000. The test results are summarised in Table 2.

Table 2

Effect of cane variety on cane losses and extraneous matter levels

Variety	Cane loss %	E.M. % Initial	E.M. % Final
Tully 6000 (September)			
Q113	9.6	20.8	6.7
Q117*	9.6	15.3	3.4
Q115*	7.3	18.2	3.6
Triton	6.4	21.3	5.9
Q124	5.3	16.3	3.5
Q138	4.6	19.3	5.3
Cairns 7000 (November)			
Q122	18.1	26.3	11.0
Q113	11.5	29.1	13.3
Q120	10.8	27.0	10.5
Q138	8.4	19.9	7.5
Q124	6.0	19.0	7.7
Q117	4.9	24.5	8.4

* Varieties with sideshooting

Mid-season tests at Tully with well grown cane showed relatively low initial, and low final, extraneous matter levels. Late-season tests with older ratoons of each variety produced higher extraneous matter levels in accordance with north Queensland experience. These tests in ratoon crops were taken with slightly smaller cane. The problem of high extraneous matter levels late in the season is accentuated by severe suckering in more open varieties. In varieties which are normally erect, and can be topped effectively, the test values may overestimate extraneous matter problems but they should be typical for varieties such as Q113, Q115, Q124, and Q138 which are often sprawled. Initial extraneous matter levels in a variety were found to be a good index of the final extraneous matter level (see Figure 1).

Cane losses for individual varieties were found to be strongly correlated with stalk thickness and initial extraneous matter levels (see Figure 2). Losses were highest in thin stalked trashy varieties. Within a particular variety, losses tended to be higher if sideshooting had occurred. Losses were also high in small crops having thin stalks and high initial extraneous matter levels, such as occur in older ratoons.

The local variety, Q110, behaves similarly to the two worst north Queensland varieties, Q113 and Q122. Like Q113, Q110 is frequently lodged and this accentuates harvesting problems in green cane.

The experience of harvesting contractors with different varieties generally reflects the test results. Varieties which lodge readily and have high trash and sucker levels, and thin stalks, are considered the most difficult to handle. Cutting rates are reduced, problems with trash wrapping around shafts are more serious, extraneous matter penalties are more likely, and modifications to improve cleaning result in visible cane losses.

What are the options for handling varieties that are less suitable for green cane harvesting?

These varieties should be topped as efficiently as possible to reduce leaf and trash intake into the harvester.

Burning is another option as cane losses in burnt cane are significantly lower for two of the worst varieties, Q110 and Q113. The reduction in losses ranges from 3 to 10% depending on crop conditions. Although it is recognised that cane losses are reduced by burning these varieties before harvest, there is a reluctance among green cane operators to burn any blocks due to fire risk in trash blankets, and the potential loss of advantages from trash blanketing.

If cane losses and harvesting difficulties are considered to outweigh the benefits, it may be better to change to varieties with better characteristics for green cane harvesting.

DIRT STUDIES

The construction of a portable set of harvester testing equipment has also enabled the study of dirt rejection by different harvesters. Two types of tests have been conducted. Either loose dirt, or whole stools of cane with attached dirt, were fed into the harvester. Test results for an Austoft 7000 harvester are given in Table 3.

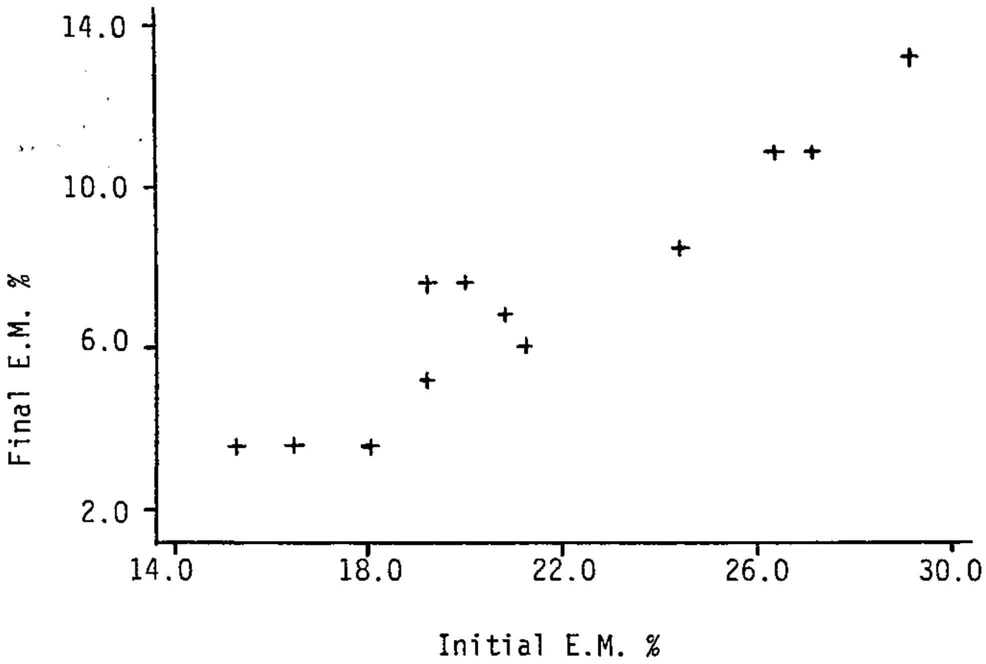

Figure 1: Relationship between initial and final extraneous matter levels of test varieties

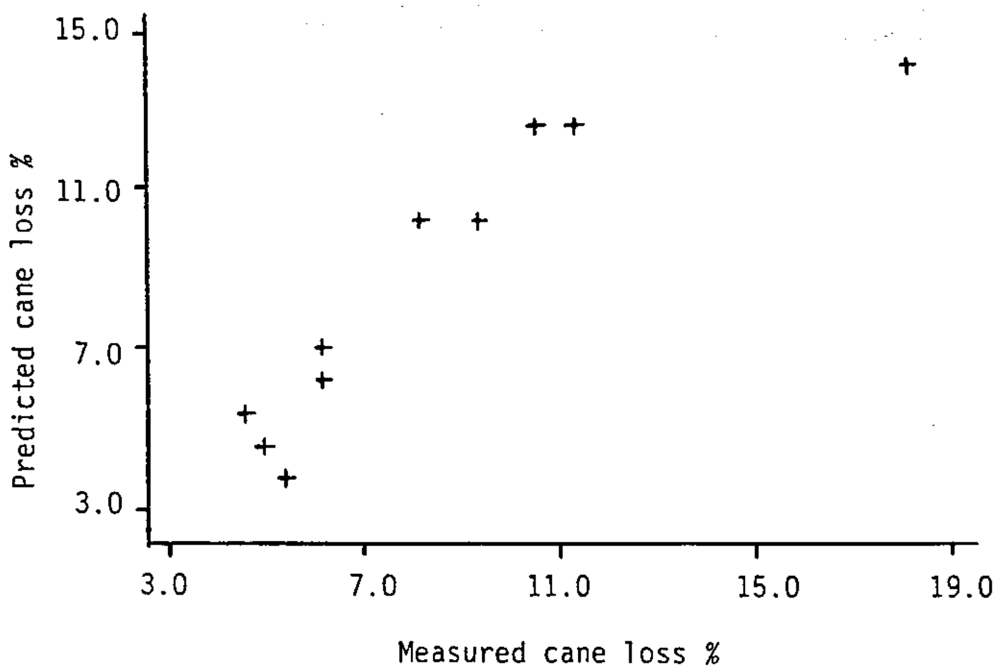

Figure 2: Comparison of measured cane loss with cane loss with cane loss predicted from stalk diameter, and initial extraneous matter levels

(Two observations where varieties were sideshoot not included in Figure)

Table 3

Removal of loose dirt or dirt attached to cane stools by the cleaning system of an Austoft 7000 harvester

Harvester component	% dirt removed		
	Loose dirt		Stool dirt
	Level 1*	Level 2*	
Basecutter	15	18	2
Buttlifter	73	68	18
Rollers 1 and 2	7	11	11
Other rollers	1	1	20
Machine dirt			2
Elevator			2
Extractors			8
Total removal	96	98	63

* Level 1 equivalent to cutting 2.5 cm below ground
Level 2 equivalent to cutting 5.0 cm below ground

These results show that most of the loose dirt is rejected by the buttlifter where it is mounted behind the basecutter as in the Austoft 7000.

All components of the cleaning system play a part in removing dirt attached to cane stools although a significant amount goes into the cane bin. Intake of loose dirt may be reduced in older model machines by changing the basecutter/buttlifter configuration but removal of dirt from tipped cane stools is a difficult problem. The most likely means of reducing dirt intake from the latter source is through field operations that reduce lodging and improve root anchorage.