FACTORS AFFECTING CANE FARM PRODUCTIVITY AND PROFITABILITY IN THE BUNDABERG DISTRICT

Undertaken by the
Queensland Department of Primary Industries
for the Bundaberg Cane Productivity Committee

1993

FOREWORD

The Bundaberg Cane Productivity Committee's motto, 'Profit through productivity' describes its main objective, that is to improve the profitability of Bundaberg cane growers. The demand for such effort has been increased by recent low prices, increasing costs and poor seasonal conditions.

Many factors influence the productivity of cane growing in the Bundaberg district. The complex of interrelationships among these factors makes the identification of ways to improve productivity and profitability very difficult.

The Committee approached DPI Economic and Financial Services for assistance in the identification process. In response they, through this survey report, have identified several reasons for the variation in the productivity and profitability of cane growing in our district. The Committee will now be in a better position to identify possible remedies for some of our district's problems.

On behalf of the local industry I would like to express our appreciation of the DPI's work, especially that of Ross Culpitt and Blair Bartholomew, and the efforts and cooperation of all local farmers and staff who were involved.

Barrie McLellan
Chairman
Bundaberg Cane Productivity Committee
February 1993

ACKNOWLEDGEMENTS

This report was prepared by officers of Economic and Financial Services, Division of Agribusiness Services, Department of Primary Industries (DPI), Brisbane. Blair Bartholomew and Ross Culpitt, Senior Agricultural Economists, were responsible for design of the survey, survey implementation, data analysis and preparation of the report.

They wish to acknowledge the assistance provided by the following:

- Susan McMeniman, Economic and Financial Services, Brisbane;
- Trevor Wilson, Economic and Financial Services, Brisbane;
- Michelle Stretton and Susan Towne, Economic and Financial Services, Brisbane;
- Mike Smith, Productivity Co-ordinator, Bundaberg;
- Jim Mackson, Farm Financial Counsellor, Bundaberg;
- Bundaberg Cane Productivity Committee;
- Bundaberg Sugar Company;
- Officers of the Bureau of Sugar Experimental Stations (BSES), Bundaberg;
- CANEGROWERS, Bundaberg District (and in particular John Poulsen); and
- Queensland Industry Development Corporation (QIDC).

Finally this report would not have been possible without the co-operation of those canegrowers who willingly provided their time and financial and technical information. Their support is gratefully acknowledged.

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SUMMARY

At the request of the Bundaberg Cane Productivity Committee, the Queensland Department of Primary Industries carried out a study to identify factors affecting the level of sugar yields and reasons for variation in the level of farm input use and to examine other on-farm influences affecting the profitability of cane growing in the Bundaberg district.

A purposive sample of 53 cane growers was selected and information obtained through personal interview. Other information, particularly crop details was obtained from the Bundaberg Sugar Company grower data base and information on water use during the period was supplied by Water Resources. This information was supplied on a confidential basis to only DPI members of the study team. Data were collected for the three financial years 1988-89, 1989-90 and 1990-91.

The study examined a wide range of farm characteristics which were expected to affect sugar yields in the district. The study found that 70% of the variation in sugar yields over the survey period could be explained by:

- the percentage of harvested cane consisting of Autumn plant cane;
- type of irrigation use (flood or non-flood);
- number of days to irrigate the crop (length of irrigation cycle);
- amount of nitrogen applied to ratoon crops;
- soil type; and
- water use.

Sugar yield and farm size were identified as important factors affecting the profitability of cane growing on specialist cane farms.

For specialist cane farmers in the sample, the overall economic performance during the survey period was disappointing. While the sample of growers in this study cannot be considered a 'representative' sample of Bundaberg cane growers, the figures suggest that during the survey period Bundaberg growers were under considerable financial pressure. A continuation of recent prices, yields and costs would lead to further downward pressure on land values and farm equity.

The estimated relationship between yield and water use derived from the study data, suggests that Bundaberg cane farmers, on average, do not apply unreasonably low levels of irrigation water. However, the analysis suggests that sugar yields could be increased by better irrigation techniques including better timing and frequency of application of irrigation water.

While the analysis suggests that economies of size do exist on Bundaberg cane farms, yield levels have a much more important bearing on the average costs of cane production. At prevailing farm sizes, sugar returns and yields, a significant percentage of Bundaberg cane growers are not meeting their total costs of production. Based on 1989 year data, for a farm producing 4000 tonnes of cane, yields would have to increase from 11 tonnes of sugar per hectare to 17 tonnes of sugar per hectare (an increase of 55 percent) for growers to breakeven at a sugar return of $200 per tonne of sugar. At a grower return of $200 per tonne of sugar, only farms with yields of 15 tonnes of sugar per hectare or more and an output level in excess of 8000 tonnes of cane would cover all costs including return to land.

1. PROJECT BACKGROUND AND OBJECTIVES

1.1 Introduction

The decline in average sugar yields (of both plant and ratoon crops) in the Bundaberg area over the past twenty years coupled with the fall in the (real) sugar price over the same period has placed considerable economic pressure on Bundaberg cane farmers. While average sugar yields have declined there still exists a significant percentage of Bundaberg cane growers who achieve satisfactory yields. For example, for the 1989 crop, over one quarter of Bundaberg cane growers achieved sugar yields (tonnes sugar per hectare harvested) in excess of 12 tonnes with ten percent achieving yields of over 13 tonnes of sugar per hectare. In contrast the average cane yield in 1989 was 10.5 tonnes of sugar per hectare with 25 percent of growers achieving yields of nine tonnes of sugar per hectare or less.

1.2 Initiation of the project

With this background of concern about lower than expected and declining sugar yields, and the economic pressure from declining sugar prices, the Bundaberg Cane Productivity Committee approached the DPI for advice and assistance in undertaking a study to examine a range of issues related to farm productivity and economic performance. The Bundaberg Cane Productivity Committee is a body representative of cane growers, the Bundaberg Sugar Company and the Bureau of Sugar Experiment Stations. The DPI, while not formally a member of the Committee, has close links with it through the farm financial counsellor for the region, Jim Mackson. The Committee agreed with suggestions presented by DPI as to the conduct of the study and Committee members further agreed to supply resources to the study. The Queensland Industry Development Corporation provided funding for the operational expenses of the study.

Meetings between the DPI study team, Committee members and invited representatives of industry and research organisations further clarified the objectives of the project and the responsibilities of the various groups concerned. While the DPI would be responsible for the overall design and undertaking of the study, it was agreed that Committee members and nominated experts would be fully consulted during the course of the study.

1.3 Project objectives

The Committee identified several possible reasons for the variability and level of sugar yields in the region, and why average sugar yields were not as high as could be expected, particularly in view of the good performance of a significant percentage of Bundaberg growers and the availability of irrigation water through the Bundaberg Irrigation Scheme.

The Committee identified the following possible factors which could account for the variability and level of sugar yields:

- Soil type.
- Lack of grower finance: not enough, high debt levels, finance available at the wrong time of the year, thus affecting growers' expenditure on farm inputs.
- Drought conditions: rainfall supplementing irrigation rather than irrigation supplementing rainfall over the past eight years.
- Farms too small to support further investment in irrigation.
- Lack of grower confidence in future of industry: growers will not seek out new technologies or seek technical advice to improve their financial position.
- Poor cane varieties.
- Entomological problems: while control methods are available, they are expensive and many growers have tended to gamble and not treat.
- Age of grower.
- Frost damage.
- Alternative enterprises: farmer may have other time and financial commitments which reduce the input into the sugarcane enterprise, for example, small crops, harvester contract, etc.
- Weed growth.
- Drainage constraints: poor surface drainage and/or high water tables reduce cane yields.
- Lack of adequate plant nutrition.
- Soil salinity.
- Topographical constraints e.g. hilliness, gullies, etc.
- Large number of ratoons.

While it was not considered possible to examine the importance of all the identified factors for low cane yields, the Committee's list provided the basis for the methodology used. It was decided to conduct a personal interview of (approximately) 60 Bundaberg cane farmers to identify and where possible quantify relationships between these factors and the level of and variability in sugar yields in the Bundaberg district. The factors examined in the main, corresponded to those formally or informally identified by members of the Productivity Committee. The overall aim of the study was to test their validity.

The objectives of the study were:

- to identify factors affecting sugar yields in the Bundaberg district;
- to identify reasons for variation in the levels of farm input use; and
- to examine on-farm factors affecting the profitability of cane growing in the Bundaberg district.

2. SAMPLE SELECTION AND DATA COLLECTION

2.1 Identification of study farms

As the main objective of the study was the identification of factors affecting yields, it was decided initially to collate existing data on all cane growers from various sources including grower productivity data collected by Bundaberg Sugar Company, data supplied by BSES on land types, WR on water use and then to examine the relationship (if any) between yield and the variables contained in these data.

The grower productivity data base contained, for each grower for the 1989 crop, details of:

- area of each block
- area fallow on farm
- area harvested according to
  - type of plant crop, eg. Autumn plant, Spring fallow plant
  - age of ratoon
  - standover cane or not
  - variety
- tonnes cane harvested
- tonnes of sugar (CCS) harvested

The BSES identified for each grower in the grower data base the predominant soil types on his farm. The soil classifications adopted were as follows:

Broad category	Class code	Soil type
GOOD	GR	Red volcanics
	GE	Red & yellow earths
	GA	Alluvials
AVERAGE	AP	Red & yellow podsolics
	AC	Clays
	AB	Black and brown sands
	AA	Flood plain alluvia
POOR	PS	Sands
	PG	Gleyed podsolics
	PR	Residual solodics, soloths

WR supplied water use for the financial year 1988-89, most of which would have been used on the 1989 crop. To be eligible for inclusion in the data base, a grower's water use in 1988-89 had to be recorded by WR. Water use data related to the whole farm operation as it was not possible to exclude water use on crops other than sugar cane.

Data obtained from the Bundaberg Sugar Company were on an assignment basis whereas data provided by WR and BSES were on a per farm basis. In a number of cases where a farm consisted of more than one assignment, it was necessary to combine mill data to arrive at comparable farm level data. A total of 514 farms were identified. Regression analysis was carried out to determine the relationship between yield (tonnes of sugar per hectare harvested) and the explanatory variables listed below.

Dependent variable: Yield (tonnes of sugar per hectare harvested)

Independent or explanatory variables	Expected sign of the relationship
Area of cane	positive or negative
Age of cane (Percent of cane area harvested) -	
• Plant cane (AUTSPRPLPC)*	positive
• First, second or third ratoon (RAT123PC)*	positive
• Fourth ratoon (RAT4PC)*	positive
• Fifth ratoon or older (RAT5PC)	Reference category
Megalitres of irrigation water per hectare harvested (MLPERHA)	positive
Megalitres of irrigation water per hectare harvested squared (MLPERHASQ)	negative
Variety of cane (Percent of cane area harvested) -	
• Variety CP44** (CP44PC)	positive or negative
• Variety H 56** (H56PC)	positive or negative
• Variety Q110** (Q110PC)	positive or negative
• Variety Q125** (Q125PC)	positive or negative
• Other varieties	Reference group
Soil type***	
GR	positive
GE	positive
GA	positive
AP	positive
AC	positive
ABAA	positive
PR	positive
PG	positive
PS	Reference soil type

* Yield and age of cane are expected to be negatively related. The yield relationships estimated for the age variables listed above are relative to sugar yields for the reference category (which comprises all cane older than 4th ratoon). For example, if 100 per cent of harvested cane was plant cane then multiplying the estimated relationship or coefficient for plant cane (AUTSPRPLPC) by 100 gives the additional yield above that which would have occurred if 100 per cent of cane belonged to the reference category.

** Yield could be expected to vary by cane variety. The yield relationships estimated for the varieties listed above are relative to sugar yields for the reference group of varieties (which comprises all cane varieties other than those specified). For example, if 100 per cent of harvested cane was CP44 then multiplying the estimated relationship or coefficient for CP44 by 100 gives the yield above or below that which would have been achieved if 100 per cent of cane belonged to the reference group of varieties.

*** Sugar yield could be expected to be lower on poorer soils. The yield relationships estimated for the soil types listed above are relative to sugar yields achieved on the reference soil type PS, the poorest soil type. That is, the estimated relationship or coefficient for any soil type represents the additional yield above that which would have been achieved had PS soils been the dominant soil type.

Table 2.1 shows the results of the regression analysis.

Table 2.1. Relationship between yield and selected variables: 1989 census data

Explanatory variable	Co-efficient	t-value*
Constant	5.035	5.48
GR	2.485	3.74
GE	2.410	3.50
GA	2.198	3.25
AP	2.066	3.15
AC	1.439	2.16
ABAA	1.407	2.03
PR	2.262	3.17
PG	1.486	2.04
AUTSPRPLPC	.039	4.18
RAT123PC	.021	2.74
RAT4PC	.023	2.08
CP44PC	.011	2.45
MLPERHA	.972	4.90
MLPERHASQ (megalitres per hectare squared)	-.094	2.91

*If the t-value exceeds 2, the coefficient is significant at the 95% level. This means that we can be at least 95% certain that a coefficient has a non-zero value i.e. a relationship does exist between yield and the explanatory variable.

Overall F	10.46
Adjusted R squared	.21

Approximately 20 percent of the variability in sugar yields is explained by the relationship specified above, leaving 80 percent to be explained by factors other than those specified in the original regression equation. The water variables (MLPERHA and MLPERHASQ) alone explained about 16 per cent of the variability in sugar yields or 80 per cent of the explained variability. Factors which were originally specified but not significant in explaining yield variability have been excluded from the final regression equation. Factors not specified in the original analysis which may affect yield include:

- level of fertiliser use;
- weed control measures;
- irrigation frequency;
- pesticide use; and
- expenditure on other materials.

As a result of the initial regression analysis of the population of 514 farms two groups were selected: the expected high and the expected low yielders. The characteristics used to select the two groups are presented in Table 2.2.

Table 2.2 Characteristics used to select farm groups

Characteristic	Expected high yield group	Expected low yield group
Predominant soil type	GR, GE, GA or AP	AC, ABAA, PS, PG or PR[@]
Plant cane percentage	Greater than 15% of area harvested	Less than 15% of area harvested
Variety of cane	Greater than 25% of area harvested was CP44	Less than 25% of area harvested was CP44
Ratoon cane percentage	Greater than 55% of area harvested was 1st, 2nd or 3rd ratoon	Less than 55 percent of area harvested was 1st, 2nd, 3rd ratoon

[@] Soil type PR was included in the list of poor soils even though the regression results presented in Table 2.1 indicate that it is superior to AP and GA soils. An analysis of soil type data showed that only a small number of farms had PR type soils, which could effect the validity of the regression results. Therefore, it was decided to adopt the BSES classification of this soil type.

To be eligible as either an expected high or expected low yielder a farm had to possess **all** of the identified characteristics for the specific group. Consequently a total of only 49 expected high yielders and 42 expected low yielders were identified from the population of 514. Note that even though water application had the major effect on yield, water use was not used as a screening variable. This was done for the following reasons:

- as the level of water use had the major effect on yield, the interest was in knowing why water use varied among farms which did not differ in soil types, percentage ratoons etc. Restricting the sample of (say) expected low yielders to include low water users and conversely the sample of expected high yielders to high water users would have resulted in little variation in water use within each sample, making analysis of likely reasons for variation in water use difficult;

- water use data were felt to be not as reliable as the other data in the regression analysis; and

- because water used on non sugar activities could not be identified separately.

Once the eligible farms were identified, farmers were notified by letter and by phone about the survey and a farm interview was arranged. All farm interviews were carried out by agricultural economists from the Division of Agribusiness Services, Queensland Department of Primary Industries using a prepared questionnaire. Publicity about the proposed study was given through the media and through grower representatives.

2.2 Response rate and final sample size

To be eligible for final inclusion in the study, growers had to have grown cane on the farm for the three years 1988-89, 1989-90 and 1990-91 and to have been prepared to provide financial details for the three years of the study period.

Using the selection criteria presented in Table 2.2, ninety one farms were identified, of which 49 were identified as expected high yielders and 42 as expected low yielders. Details of farm selection, final sample size and response rate are presented in Table 2.3.

Table 2.3 Response rate and final sample size

	Expected high yield group	Expected low yield group	Total
Initial selection (no.)	49	42	91
Final sample size (no.)	26	27	53
Response rate (%)	53.0	64.3	58.2

There were a number of reasons for the relatively low response rate achieved by the study, including: the unwillingness on the part of some growers to participate in the study (this was particularly relevant during the early stages of the field work when growers were generally uncertain of the objectives of the study); inability to contact the farm manager; unavailability of farm financial data for part or all of the study period; inability to arrange an interview at a time convenient to both grower and interviewer; and exclusion by the interviewer on a number of grounds (e.g. farm not owned by the selected grower for all the study period, change in farming enterprise during the study period, etc.).

2.3 Data collected and questionnaire design

As discussed in Section 1.3 the objectives of the study included the identification of factors, technical and non-technical, affecting the level of sugar yields in the Bundaberg district and the identification of reasons for variation in the level of input use by Bundaberg cane growers. A comprehensive questionnaire was prepared (and tested), covering both technical and non-technical aspects of sugar farming in the Bundaberg district.

Some information, particularly crop details was obtained from the Bundaberg Sugar Company's grower data base for the three years of the study period. Information on water use during the period was supplied by WR. These data were supplied on a confidential basis to DPI members of the study team. Information sought from growers through personal interview was grouped in the following categories:

1. Grower identification

Sample number, farm group (expected high yielder or expected low yielder), type of business organisation (sole proprietor, family partnership etc.).

2. Land use

Area of property, land use (area of cane, area of annual crops, tree crops etc.), area of leasehold property, cane production 1991 - own and leasehold.

3. Cane plantings in 1990-91 (for cane not harvested in 1991 crop year)

4. Water use

Annual water allocation, nominal and final announced, amount of water used. Nominal allocation is a base allocation whereas announced allocation can be varied each year. (While information was obtained from the WR on metered water use, growers occasionally pumped from unmetered streams. In this case, grower estimates were used).

5. Capital investment

Market values where possible (at 31/12/91) of motor vehicles, tractors, cultivation, planting, fertiliser and spray equipment, harvesting, handling and picking equipment, irrigation and water supply plant (mobile), workshop and office equipment, buildings, irrigation and water supply improvements (fixed), land, and other improvements. Where market values were not available current new values were estimated and depreciated using the actual age of the item and appropriate depreciation rate.

6. Value of property (estimated walk in walk out value)

7. Labour use

On-farm labour use according to type of labour, for example, operator and family labour, permanent and casual labour. Details of off-farm employment were also obtained. On-farm labour use was measured in weeks where a week consisted of 48 hours.

8. Farming practices

- Type of cultivation/harvesting system (conventional, green cane, burnt cane/trash incorporated etc.).

- Planting system (autumn plant, spring fallow plant, spring replant), previous crop, fallow period.
- Pre plant cultivation operations.
- Planting, post-plant cultivation and ratooning operations.
- Fertiliser and soil ameliorant use.
- Chemical weed control use.
- Crop protection practices.
- Harvesting costs for 1991 crop.
- Irrigation use (type of irrigation, application rate and area irrigated).
- Irrigation capacity (pumping capacity, time to irrigate entire sugar area).
- Irrigation rostering.
- Electricity tariff used for irrigation.
- Water use of farm in 1991 and reasons for level of water application in 1991.

9. Personal details

- Years of management experience.
- Years of farm ownership.
- Age of manager(s).
- Years experience of manager in sugar cane growing.
- Education level of manager.
- Years of irrigation experience of manager.
- Future of farm.
- Contact with technical and other farm advisers.
- Magazine subscription.

- Grower perceptions of their sugar yield and water use (how they ranked with other growers in their district).

- Major concerns about the future of farming in the Bundaberg area.

10. Cash receipts

Crop and livestock receipts, sundry farm receipts, receipts from non farm activities.

11. Cash payments

Cash outlays for hired labour, farm materials, repairs and maintenance, administration, contract services, insurance, rates and taxes, rentals, interest and livestock purchases.

Materials include such farm inputs as fertilisers, seeds sprays and pesticides, fuel, oil and grease.

Administration, while including accounting services, telephone, postage and stationery, also includes expenditure on electricity. No attempt was made to separate electricity used for irrigation from that used for general farm use.

Contract services include contract cane harvesting in addition to any other service performed by contractors e.g. contract planting.

Rates and taxes includes local authority rates and WR irrigation charges.

12. Farm business debt

Type of loan, lending institution, amount outstanding, original term and purpose of loan.

13. Farm business liquid assets

Amount and type of asset.

3. DEFINITION AND TREATMENT OF FINANCIAL DATA

3.1 Introduction

One objective of the study was to explain the variability in sugar yields. One underlying cause of variability could be the financial position of growers which may be influenced by their recent economic performance. Further, the level of confidence felt by growers regarding future industry profitability is likely to influence their choice of farming practices and their decisions regarding investment in yield-improving technologies. The level of confidence is strongly affected by recent economic performance.

Farm performance can be assessed in a number of different ways. Often it is a question of judgement whether a farm, which is performing well by one criterion and poorly by another, is in fact a good performer or not. Two broad criteria are usually adopted when discussing economic performance:

- capacity to invest/disinvest; and
- farmer welfare.

The first category encompasses a broad range of performance measures such as return on investment, farm business profit, or the adequacy of the cash flow to undertake a particular expenditure plan or program. The second category includes such measures as income earned by the farm household and the amount of cash available to meet family living expenses.

The measures of economic performance and financial position used in this study correspond, in the main, to those used by ABARE in their annual survey program. Indeed these measures and classifications were deliberately selected so that readers familiar with ABARE's classification and measures of performance would have less difficulty in interpreting the subsequent analysis. However, there are differences in the treatment of certain cost and revenue items, and in the calculation of some performance measures. These relate chiefly to the three year period of analysis used in this study compared with the annual review used by ABARE. Also, there are differences in the data collection methods used in the respective studies which may affect the values of certain items. These differences however are minor.

More importantly, the figures presented as part of ABARE's annual survey program are based on a random sample of farmers in the respective industries. The figures presented in this study are not based on a random sample of Bundaberg growers. As described earlier, the sample selected was the result of a decision to select farms with certain identified characteristics.

3.2 Definition of financial items

All receipts, payments, values of capital items, and imputed costs were expressed in 1991 (December) dollars. This was done to overcome the effect of inflation on monetary items and subsequent 'jumbling' of revenue and cost items. The ABARE prices paid indices were used to convert cash receipt and cash payment items from actual to 1991 dollar values.

Capital items (machinery, workshop equipment, tractors and motor vehicles, cultivation and harvesting equipment, livestock equipment, livestock) were valued using the owner's estimate of current market value. Where this was not possible (as in the case of fences, buildings and other fixed improvements) details of the type, dimensions and age of the item were obtained and an estimate was made of the new replacement value of the item. The new replacement value was depreciated using specified depreciation rates and the item's age to arrive at an estimate of the depreciated or current market value as at December 1991. To determine the closing capital values for previous years, the depreciation rate was applied to the current market value.

The annual diminishing value depreciation rates used to calculate annual depreciation and depreciated values were:

- cars, utilities and motor bikes - 15%
- tractors - 7.5%
- cultivation equipment, irrigation and water supply plant and improvements, and workshop equipment - 5.0%
- Farm buildings - 4.5%

The value of non-depreciable assets, such as land and livestock, were also based on the owner's estimate of current market value. The valuation of land proved to be particularly difficult. Even though estimates of land values were sought indirectly through grower's estimates of walk-in walk-out property values, for some respondents it was often necessary to apply standard values based on information obtained from informed sources.

The value of unpaid family (and operator) labour was calculated using the Adult Field Worker's award rate of $21,021 per annum. All family labour was charged at this rate irrespective of any personal drawings.

3.3 Definition of financial measures

Total cash receipts represents cash inflows to the farm business during the financial year from the sale of livestock, livestock products and crops produced on the farm and from agistment, royalties, rebates, refunds, plant hire, contracts, sharefarming, insurance claims and compensation, government assistance and other revenue from farm operations. Receipts from the sale of non-livestock capital were excluded from cash receipts.

Total cash payments represents payments made by the farm business for permanent and casual hired labour (excluding operator, partner and family labour), materials, services, produce purchased for resale, rent, payments for leased capital items, interest, and livestock purchases. Purchases of non-livestock capital, loan repayments, and household expenditures were excluded from total cash payments.

Depreciation of farm improvements, plant and equipment was estimated by the diminishing value method, based on the depreciated replacement value of the particular item (See above).

Measures of performance

Farm cash income is the difference between total cash receipts and total cash payments, and represents the surplus generated by the year's operations and available for consumption and investment. The measure is negative where cash payments exceed receipts.

Farm business profit is defined as farm cash income plus lease payments less depreciation and the imputed value of operator, partner and family labour at $21,000 per person full time. This is the residual return after allowing for interest on borrowed funds (not including the interest component of lease payments). Cash payments for *operator and family labour* may bear little relationship to their actual work input. Hence, the value of the labour input of the operator, partners and their families was imputed using the respective award wage.

Profit at full equity is defined as farm business profit, with the amounts paid for rent and interest added to the returns. It represents the return produced by the resources employed in the farm business irrespective of the level of farm business debt and type of land ownership.

Rate of return (%) is the profit at fully equity expressed as a percentage of average total capital.

Average capital is the mean or average value ([opening value + closing value] ÷ 2) of farm assets during the survey period.

Return to land. This equals profit at full equity less an imputed interest (6%) on depreciable assets.

Return to land per hectare. This equals return to land divided by the area of assignment plus leased assigned area. The measures 'return to land' and 'return to land per hectare' were calculated because of the difficulty in assigning a value to land given the present land market in the Bundaberg region. This measure was used to compare the financial performance of surveyed farms.

Debt is defined as external liabilities to the farm business as shown in the farm balance sheet. Amounts still owing on leased plant and equipment were included in the calculation of total property debt.

3.4 Period of analysis

The period of the analysis comprised the 'sugar' years 1989, 1990 and 1991, corresponding (approximately) to the financial years 1988-89, 1989-90 and 1990-91. However though the majority of costs incurred in growing (say) the 1991 crop occurred in the 1990-91 financial year, sugar returns from the 1991 crop would not have been received until the 1991-92 financial year. Accordingly sugar returns (and harvesting costs) were taken back one year to more evenly match costs and returns for a particular year. Crop returns and harvesting costs were estimated for the 1990-91 year and were based on grower production and return estimates.

4. METHOD OF ANALYSIS

4.1 Introduction

As discussed in Chapters 1 and 2, the sample of 53 growers was purposively selected to include growers who had certain characteristics which were associated with either high or low yields. Selecting farms which have similar combinations of known characteristics i.e. characteristics associated with high or low yields, improves the changes of identifying other yield related characteristics for a given sample size. Removing known sources of variability from the sample facilitates the identification of other possible sources of variability. If no data were available on the characteristics used to select farms then a much larger sample would have been required to achieve the results obtained below.

In addition to those characteristics previously identified, namely irrigation water per hectare, soil type, cane variety, number of ratoons, percentage of harvested area from plant cane, it was hypothesised that other characteristics (or variables) may significantly affect yield. These characteristics or (variables) included:

- percentage of income from cane production (non-specialist cane growers may concentrate their farming effort on non-cane crops such as vegetables to the detriment of their cane crops);
- irrigation capacity (Other things being equal, a farmer's capacity to apply a given amount of water in a shorter period may increase yield. The extent to which yield improvements can be achieved is dependent upon soil characteristics, particularly water holding capacity, and crop water requirements.);
- level of nitrogen application on ratoon crops;
- level of weed control (by mechanical and/or chemical means);
- type of irrigation used (it was suggested that use of flood irrigation may be more effective in wetting the soil than use of travelling irrigators due to problems of wind drift etc.); and
- debt levels (it was suggested that high debt levels may be associated with lower expenditure on farm inputs and hence lower yields).

A preliminary ordinary least square regression was carried out on the total sample of 52 growers (one cane grower was unable to provide three years of financial data and was excluded from the analysis) incorporating, in addition to the earlier identified explanatory variables, the explanatory variables mentioned above. Variables which did not significantly affect yield such as debt level and percentage of income from cane were then identified and excluded from further analysis. Further, it was subsequently decided to restrict any regression analysis to 'specialist' cane farms. A specialist cane farm was one which, over the three year survey period, showed cane receipts greater than 85 percent of total farm cash receipts. By restricting the analysis to specialist growers, estimates of water use on cane could be improved as it was difficult to estimate water use on cane crops on non-specialist farms.

4.2 Factors affecting yield on specialist cane farms

The final regression equation, the relationship between yield (tonnes of sugar per hectare harvested) and selected variables or characteristics explained almost 70 percent of yield variability in the sample of 43 specialist cane farms over the three year period 1988-89 to 1990-91. The explanatory variables or characteristics finally selected were:

AUTTOTAR: The percentage of harvested area consisting of Autumn plant cane. The analysis discussed in Chapter 2 included a composite variable (AUTSPRPLPC) which included both Spring and Autumn plant cane areas. In this analysis Spring and Autumn plant cane areas were treated separately.

FLOODYN: A variable representing whether the farmer used flood irrigation or not.

IRRIGDAYS: The number of days it took the farmer to irrigate his cane crop.

NITROGEN APPLICATION

- NITROCODE 1 A variable representing whether the farmer applied less than the BSES recommended rate of N on his ratoon crops.

- NITROCODE 2 A variable representing whether the farmer applied the BSES recommended rate of N on his ratoon crops (120-160 kg/hectare). (The value of the co-efficient in the regression equation is relative to the yield for those farmers who applied less than the recommended rate of N on their ratoon crop).

- NITROCODE 3 A variable representing whether the farmer applied more than the BSES recommended rate of N on his ratoon crop. (The value of the co-efficient in the regression equation is relative to the yield for those farmers who applied less than the recommended rate of N on their ratoon crop).

SOILTYPE: A variable representing the soil type on the farm (It was necessary to combine the previously identified soil types into two groups 'good' (soil types GR, GE, GA and AP) and 'bad' (PR, PS, PG, ABAA and AC). This was done because of the small sample size. A larger sample size would have allowed the use of the more detailed soil classification. The value of the co-efficient is relative to the yield for those farms possessing 'bad' soil.

WATERHA: Megalitres of water per hectare (irrigation water plus effective rainfall), applied to the crop during the period October to April inclusive. Effective rainfall was defined as that quantity of water that was the lesser of actual rainfall and pan evaporation, calculated on a daily basis.

WATERHASQ: The square of megalitres of water per hectare. This was selected as it was believed that yield increases would decline as the amount of water applied increased.

The co-efficients (the degree of influence of the variables on yield) and the overall strength of the relationship are shown in Table 4.1.

Table 4.1. Relationship between yield and selected variables: sample data

Explanatory variable	Coefficient	t-value*
CONSTANT	-3.80	0.99
AUTTOTAR	.05	2.89
FLOODYN	.93	2.83
IRRIGDAYS	-.13	3.37
NITROCODE 2	1.52	2.83
NITROCODE 3	2.52	4.59
SOIL TYPE	.87	2.64
WATERHA	2.43	3.17
WATERHASQ	-.09	2.39

*If the t-value exceeds 2, the coefficient is significant at the 95% level. This means that we can be at least 95% certain that a coefficient has a non-zero value.

Overall F	35.0
Adjusted R squared	0.68

The above regression equation shows that, other things being equal, farms on the 'good' soils had an average sugar yield of .87 tonnes of sugar per hectare higher than those farms on the 'bad' soils. Similarly the co-efficient for IRRIGDAYS of -.13 means that, other things being equal, for every day longer to irrigate the cane crop, sugar yields fall by .13 of a tonne. For example, if the number of days to irrigate the farm was reduced by five days then, on average, sugar yields would increase by .65 tonnes of sugar per hectare, subject to some minimum period between irrigations which is determined by the water holding capacity of the soil and crop water requirements. The co-efficient for AUTTOTAR shows that, other things being equal, a ten percent increase in the percentage of crop harvested as Autumn plant cane, would result in an increase in average harvested yield of .5 tonne of sugar per hectare. The co-efficient for NITROCODE 3, of 2.52 means that, other things being equal, the application of more nitrogen than that recommended by BSES, on average, gives a yield 2.52 tonnes of sugar higher than if the rate applied was below the recommended level and 1.0 tonne (2.52 — 1.52) higher if the recommended rate (NITROCODE 2) was applied.

It must be remembered that there could well be other factors including some of those excluded in earlier regression analyses, for example the percentage of cane harvested green, that affect yield. Because of the small number of observations and the lack of 'spread' of values for some variables, important characteristics may not be identified. Also the values of the co-efficients or degree of influence of the explanatory variables on yield are only estimates based on the number of observations. A larger number of observations may result in a 'better' estimate. Finally a significant relationship between yield and (say) the variable FLOODYN, may mask a more fundamental relationship between yield and an unidentified characteristic. It could be that it is not whether a farmer uses flood irrigation that is really important. There could be other characteristics possessed by flood irrigators (but not identified) which result in higher yields. Flood irrigators may be the 'better farmers' who, on average, have selected flood irrigation.

4.3 Delineation of strata

The regression analysis showed that water use (irrigation plus effective rain), was by far the most important factor affecting yield. Regressing yield against the two water variables WATERHA and WATERHASQ gave an adjusted R squared of 0.50 with an overall F of 63.67, compared with an adjusted R squared of 0.68, and an overall F of 35.0, for the complete regression as detailed in Section 4.2. Thus approximately 70 per cent of the relationship between yield and the listed explanatory variables can be explained by water use. Consequently, it was decided to re-allocate the total sample of 52 farms to four groups based on water use, cane receipts as a share of total receipts and expected yield. These groups were:

- specialist cane growers who were high water users;
- specialist cane growers who were low water users with below average expected yields;
- specialist cane growers who were low water users with above average expected yields; and
- non-specialist cane growers.

Specialist cane growers were cane growers whose sugar cane receipts accounted for more than 85% of total farm receipts. This group was separated into high and low water users according to their water use during the three year period with high water users being growers who applied water at or above the 'optimum' level for the period. The 'optimum' level was based on the coefficients presented in Table 4.1, a net grower return of around $175 per tonne of sugar and an irrigation cost of around $75 per megalitre. As a result, total water use of 10.5 megalitres per hectare or above was defined as 'high'.

The low water users were those farmers who applied less than a total of 10.5 megalitres of irrigation water and effective rainfall per hectare. These low water users were then separated into two groups according to whether, on the basis of the yield relationship shown in Table 4.1, their actual yields were either higher or lower than expected. This classification was adopted to help identify those characteristics of specialist cane growers that may explain variability in water use and to identify yield related factors not previously identified.

Table 4.2 shows the breakdown of the total sample into the four categories discussed above.

Table 4.2 Breakdown of total sample according to water-use, yields and sugar-cane receipts (no.)

	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Original grouping -				
• expected high yielders	10	7	8	-
• expected low yielders	9	8	1	-
TOTAL	19	15	9	9

5. RESOURCE USE, ECONOMIC PERFORMANCE AND FINANCIAL POSITION

5.1 Introduction

In this chapter, details of resource use on sample farms, the composition of farm costs, returns, and farm capital together with the economic performance of farms during the survey period are presented for the total sample of 52 farms. The financial position, debt and equity situation, of growers are shown. Also an analysis of factors affecting profitability on specialist cane farms is presented.

5.2 Land use

Table 5.1 shows details of land use including area under cane.

Table 5.1 Land use and sugar cane assignments — 1988-89 to 1990-91 (hectare/farm)

	Specialist cane farmers			
	Low water users		High water users	Non-specialist cane farmers
	Below expected yield	Above expected yield		
Sugar cane assignment	66.6	51.1	44.9	55.8
Leased assignment	1.4	1.1	7.3	2.6
Total	68.0	52.2	52.2	58.4
Cane area harvested	55.0	44.4	43.5	47.9
Small crops	0.4	0.2	0.0	6.5
Native & improved pasture	55.2	30.3	8.0	46.8
Other	4.6	3.0	2.6	2.0
Total farm area	128.0	75.2	58.6	110.9

Of the specialist cane growers the high water users had the lowest average farm area, with the area of cane harvested the smallest of the farm groups.

5.3 Yields and cane production

The high water users had the highest average cane and sugar production during the survey period, and the highest average sugar and cane yield per hectare harvested. For all groups cane and sugar yield declined during the survey period reflecting the climatic conditions (and irrigation use) during the period. Average cane production per farm ranged from 3673 tonnes (above expected yield group) to 4075 tonnes (high water users group).

Table 5.2 Cane and sugar yields — 1988-89 to 1990-91 (average per farm)

	Specialist cane farmers			
	Low water users		High water users	Non-specialist cane farmers
	Below expected yield	Above expected yield		
Cane production (t/farm)				
1988-89	4377	3944	4310	3831
1989-90	3758	3634	4340	3946
1990-91	3268	3441	3575	3383
Average	3801	3673	4075	3720
Cane yield (t cane/hectare)				
1988-89	78.0	91.1	100.4	82.4
1989-90	65.5	82.9	96.5	81.8
1990-91	59.2	74.3	82.8	65.9
Average	67.6	82.8	93.2	76.7
Sugar production (t/farm)				
1988-89	573	515	575	496
1989-90	516	501	614	531
1990-91	471	499	539	483
Average	520	505	576	504
Sugar yield (t/hectare)				
1988-89	10.1	11.9	13.4	10.7
1989-90	9.0	11.4	13.7	11.2
1990-91	8.5	10.8	12.5	9.5
Average	9.2	11.4	13.2	10.4

Cane and sugar yields for the Bundaberg district as a whole are presented in Table 5.3. As can be seen from this table, average Bundaberg yields were only slightly higher for each year of the study period than the yields for the below expected yield group. In Section 5.14 the relationship between yield and farm performance is established, so extrapolating from the yield figures presented in Table 5.3, it is suggested that the performance of Bundaberg cane growers, on average, was disappointing with important implications for future structural change in the region and the need for productivity improvement.

Table 5.3 Average Bundaberg district cane and sugar yields

	Year		
	1988-89	**1989-90**	**1990-91**
Cane yield (tonnes cane/ha harvested)	82.3	71.9	60.8
Sugar yield (tonnes sugar/ha harvested)	10.7	9.8	8.9

Source: CANEGROWERS, Bundaberg

5.4 Distribution of plant and ratoon cane

Table 5.4 shows the breakdown of average area harvested during the study period according to age of cane.

While all groups had approximately the same percentage of crop harvested from plant cane, for the high water users group, 15.2 per cent of cane harvested was Autumn plant cane compared with 9.3 and 6.5 per cent for the other two specialist groups.

Table 5.4. Area harvested of plant and ratoon cane — 1988-89 to 1990-91 (hectare/farm)

	Specialist cane farmers							
	Low water users				High water users		Non-specialist cane farmers	
	Below expected yield		Above expected yield					
	ha	%	ha	%	ha	%	ha	%
Autumn plant	5.1	9.3	2.9	6.5	6.6	15.2	2.9	6.1
Spring plant	7.3	13.3	5.9	13.3	2.8	6.4	7.2	15.0
1st ratoon	13.0	23.6	8.6	19.4	10.8	24.8	11.3	23.6
2nd ratoon	13.5	24.5	8.3	18.7	11.5	26.4	10.2	21.3
3rd ratoon	9.5	17.3	6.8	15.3	7.9	18.2	7.9	16.5
4th ratoon	3.9	7.1	5.9	13.3	2.6	6.0	4.6	9.6
5th ratoon	1.4	2.5	2.9	6.5	0.6	1.4	2.3	4.8
6th ratoon	0.6	1.1	2.3	5.2	0.5	1.1	1.4	2.9
Other	0.7	1.3	0.8	1.8	0.2	0.5	0.2	0.2
Total	55.0	100.0	44.4	100.0	43.5	100.0	47.9	100.0

5.5 Variety of cane harvested

Table 5.5 Area harvested by variety — 1988-89 to 1990-91 (hectare/farm)

	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
	ha	%	ha	%	ha	%	ha	%
CP44	12.1	22.0	12.9	29.1	14.1	32.4	5.0	10.4
CP51	1.8	3.3	2.5	5.6	2.8	6.4	3.3	6.9
H56	9.9	18.0	4.1	9.2	4.4	10.1	6.1	12.7
Q110	6.1	11.1	7.0	15.8	4.1	9.4	9.8	20.5
Q125	6.3	11.5	0.9	2.0	0.9	2.1	1.5	3.1
Q141	6.2	11.3	5.3	11.9	5.9	13.6	7.1	14.8
Other variety	12.6	22.9	11.7	26.4	11.3	26.0	15.1	31.5
Total area harvested	55.0	100.0	44.4	100.0	43.5	100.0	47.9	100.0

As can be seen from Table 5.5 the variety of CP44 was the most favoured variety (with the exception of the non-specialist cane growers where the variety Q110 was the most common variety).

5.6 Water allocation and water use

Table 5.6 presents details of water allocation and water use during the survey period.

Table 5.6. Nominal and announced water allocations and water use — 1988-89 to 1990-91 (average per farm)

	Specialist cane farmers							
	Low water users				High water users		Non-specialist cane farmers	
	Below expected yield		Above expected yield					
Nominal water allocation (Ml)	235		187		229		196	
Ml/ha of total area assigned	3.46		3.58		4.39		3.36	
Ml/ha harvested	4.27		4.21		5.26		4.09	
Announced water allocation (Ml)	321		264		310		255	
Water use (Ml)	Ml	% nom alloc	Ml	% nom alloc	Ml	% nom alloc	Ml	% nom alloc
1988-89	127	54.0	111	59.3	184	80.3	140	71.4
1989-90	210	89.4	184	98.4	301	131.4	235	120.0
1990-91	284	120.9	231	123.5	301	131.4	246	125.5
Average	207	88.1	175	93.6	262	114.4	207	105.6
Nominal water allocation/ha harvested (Ml/ha)	4.5		4.4		5.3		4.7	
Announced water allocation/ha harvested (Ml/ha)	6.2		6.2		6.9		6.0	
Water use (Ml/ha harvested)	harv		harv		harv		harv	
1988-89	2.2		2.3		4.4		3.9	
1989-90	3.7		3.9		6.8		5.5	
1990-91	5.2		4.9		7.1		5.4	
Average	3.7		3.8		6.2		4.9	

As expected the high water users group had the highest average per hectare water use for all three years of the survey period. Also this group had the highest per hectare water allocation expressed on both an assigned area and harvested area basis. During the 1989-90 growing year, a year of well below average rainfall (although not as dry as the 1990-91 year), both low water user groups did not, on average, exceed their nominal allocation. The high water users in 1988-89 (an 'average' rainfall year), used, on a per hectare basis, approximately twice as much water (4.4 Ml/hectare) as the low water users. As low water users applied more than 4.4 Ml/hectare in 1990-91 lack of capacity appears not to be the reason for the low water use in 1988-89. It may be that high water users see the economic value of 'high' water application even in an average year, given the cost of irrigation and other conditions peculiar to their farms.

5.7 Farm labour use

Details of labour use are presented in Tables 5.7 and 5.8.

Table 5.7. Average annual farm labour use - 1988-89 to 1990-91 (weeks/farm)

Capital item	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Farm operator(s)	50.3	51.2	45.1	51.7
Adult family labour	14.2	11.1	16.1	29.8
School-age family labour	0.8	0.0	0.0	0.0
Total family labour	65.3	62.3	61.2	81.5
Permanent labour	5.0	0.4	5.3	24.4
Casual labour	4.5	3.2	6.8	131.2
Total on-farm labour	74.8	65.9	73.3	237.1

Table 5.8. Average annual on-farm labour use per hectare of assigned area (weeks/hectare)

	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Farm operator(s)	0.92	1.12	1.11	1.05
Adult family	0.22	0.22	0.26	0.64
School-age family	0.02	0.0	0.0	0.0
Total family labour	1.16	1.34	1.37	1.69
Permanent labour	0.04	0.0	0.09	0.45
Casual labour	0.04	0.06	0.11	2.91
Total on-farm labour	1.25	1.40	1.57	5.04

Non-specialist cane farmers had the highest labour use, for both family and non family labour. While labour use is expressed in weeks of labour use, no allowance has been made for possible differences in the intensity of labour use (hours per week) during the survey period. High water users showed the greatest labour use on a per hectare basis for the specialist cane farmer group.

5.8 Farm cash receipts and payments

Table 5.9 shows details of farm cash receipts for the sample for the survey period 1988-89 to 1990-91, expressed on a per farm basis.

Table 5.9. Annual farm cash receipts — 1988-89 to 1990-91 (average/farm/year)

Cash receipt item	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
	$	%	$	%	$	%	$	%
Sugar cane receipts	117,954	95.6	108,864	96.8	143,020	98.8	112,229	34.8
Other crop receipts	1,760	1.4	1,546	1.4	524	0.4	189,721	58.8
Livestock receipts	1,697	1.4	0	0	550	0.4	2,720	0.8
Other enterprise receipts	39	0	1,277	1.1	153	0.1	2,499	0.8
Other cash receipts	1,881	1.5	766	0.7	568	0.4	15,229	4.7
Total	123,331	100.0	112,453	100.0	144,815	100.0	322,398	100.0
Number of farms	19		15		9		9	

While the high water users had the highest cash receipts of the specialist cane growers, non-specialist cane growers exhibited the highest cash receipts in the sample. This group also had high sugar receipts in addition to significant cash receipts from non-sugar enterprises.

Table 5.10. Cash receipts per hectare ($/hectare)

Cash receipt item	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Total farm area basis:				
Sugar cane receipts	1,277	1,773	2,520	1,202
Other crop receipts	38	22	14	3,172
Other cash receipts	25	35	9	140
Total cash receipts	1,341	1,830	2,544	4,514
Total assigned area basis:				
Sugar cane receipts	1,731	2,243	2,523	1,789
Other crop receipts	40	32	18	5,029
Other cash receipts	48	36	7	282
Total	1,819	2,312	2,548	7,100

The high water user group had the highest sugar cane receipts per hectare of total farm area and per hectare of total assigned area basis (including leasehold cane land), reflecting the higher yields of this group.

Table 5.11 presents details of farm cash payments, expressed on a per farm basis. Not surprisingly the non-specialist cane farmers had the highest figure for total cash payments. Table 5.12 and 5.13 express farm cash payments on a per hectare of total farm area and assigned area basis respectively.

Table 5.11. Annual farm cash payments — 1988-89 to 1990-91 (average/farm/year)

Cash payment item	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
	$	%	$	%	$	%	$	%
Paid labour	4,503	4.5	1,094	1.5	4,649	4.7	57,476	22.7
Materials	32,411	32.4	23,184	31.1	26,704	26.8	85,915	34.0
Repairs & maintenance	14,372	14.4	10,313	13.8	13,755	13.8	28,412	11.2
Administration	13,337	13.3	7,807	10.5	12,451	12.5	15,648	6.2
Contractors	17,981	17.9	19,525	26.2	23,624	23.7	34,999	13.8
Insurance	1,342	1.3	1,402	1.9	1,249	1.3	3,141	1.2
Lease payments	575	0.6	425	0.6	1,346	1.4	3,593	1.4
Motor vehicle costs	1,867	1.9	1,051	1.4	1,177	1.2	2,497	1.0
Rates & taxes	7,276	7.3	5,810	7.8	10,203	10.3	5,290	2.1
Land rental	1,371	1.4	290	0.4	1,087	1.1	507	0.2
Interest paid	4,717	4.7	3,470	4.7	2,781	2.8	13,625	5.4
Other	334	0.3	293	0.4	526	0.5	1,793	0.7
Total cash payments	100,086	100.0	74,664	100.0	99,554	100.0	252,896	100.0

Table 5.12. Cash payments per hectare of total farm area ($/hectare)

Cash payment item	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Labour - paid	40	18	72	835
Materials	352	349	494	1,144
Repairs & maintenance	182	152	234	373
Administration	150	127	267	188
Contractors	206	317	423	511
Insurance	17	21	24	49
Lease payments on capital items	6	8	13	96
Motor vehicle costs	26	20	34	38
Rates & taxes	74	100	152	65
Land rental	20	4	37	11
Interest	38	52	40	153
Other	2	7	1	22
Total	1,113	1,176	1,790	3,485

Table 5.13. Cash payments per hectare of assigned area ($/hectare)

Cash payment item	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Paid labour	48	26	57	1,339
Materials	476	450	464	1,857
Repairs & maintenance	234	198	228	580
Administration	211	158	238	294
Contractors	278	402	419	768
Insurance	23	27	22	75
Lease payments on capital items	7	7	15	117
Motor vehicle costs	34	25	36	54
Rates & taxes	103	129	149	91
Land rental	20	4	15	17
Interest paid	65	70	33	235
Other	4	8	1	31
Total	1,503	1,504	1,677	5,458

The high water users had the highest per hectare costs reflecting their higher yields (contract payments per hectare), and higher water use (administration costs which include electricity costs, and rates and taxes which include water charges).

5.9 Depreciation

Table 5.14 shows details of average depreciation per farm. On average, depreciation per farm for the specialist groups was approximately half of the figure for the non-specialist producers. However, depreciation per farm showed little variability among the three specialist groups.

Table 5.14. Average depreciation ($/farm) — 1988-89 to 1990-91

Capital item	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Motor vehicles, trucks, etc.	2,407	2,616	1,932	5,499
Tractors	3,269	3,917	3,680	4,583
Cultivation equipment	1,041	975	1,122	1,518
Sugar specific equipment	532	319	536	2,312
Harvesting and handling equipment	12	0	22	17
Irrigation equipment (mobile)	1,499	1,337	1,522	2,066
Workshop equipment	264	248	297	410
Non-sugar specific equipment	11	0	0	1,803
Livestock equipment	73	0	3	11
Buildings	669	447	430	1,090
Irrigation improvements (fixed)	1,324	1,429	1,759	1,638
Other fixed improvements	286	168	199	258
Total	11,387	11,456	11,502	21,204

5.10 Average capital investment

Average per farm capital investment was highest for the high water user group and this was largely accounted for by the higher value of land for this group. However this group also showed the highest figure for capital investment in non land capital per hectare of assignment. This group showed the highest investment per hectare in irrigation equipment, irrigation improvements, tractors and cultivation equipment for the specialist group. Details are presented in Tables 5.15, 5.16 and 5.17.

Table 5.15. Average capital invested — 1988-89 to 1990-91 (average/farm)

Capital item	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
	$	%	$	%	$	%	$	%
Motor vehicles, trucks, etc.	15,886	3.7	16,708	5.3	12,908	2.5	25,606	5.0
Tractors	42,621	9.8	51,380	16.2	47,282	9.0	60,487	11.8
Cultivation equipment	20,446	4.7	19,026	6.0	21,924	4.2	29,745	5.8
Sugar specific equipment	10,540	2.4	6,239	2.0	9,117	1.7	30,832	6.0
Harvesting & handling equipment	228	0.1	0	0.0	432	0.1	333	0.0
Irrigation equipment (mobile)	33,468	7.7	26,165	8.2	29,700	5.6	40,356	7.9
Workshop equipment	5,184	1.2	4,840	1.5	5,806	1.1	8,012	1.6
Non-sugar specific equipment	221	0.1	0	0.0	0	0.0	35,178	6.9
Livestock & livestock equipment	6,915	1.6	800	0.2	1,759	0.3	7,973	1.6
Buildings	14,735	3.4	9,705	3.1	9,331	1.8	23,640	4.6
Irrigation improvements (fixed)	26,847	6.2	28,229	8.9	34,330	6.5	32,695	6.4
Other fixed improvements	5,920	1.4	3,449	1.1	3,910	0.7	5,788	1.1
Land	250,663	57.8	151,503	47.6	349,444	66.4	210,300	41.2
Total	433,673	100.0	318,044	100.0	525,945	100.0	510,945	100.0

Table 5.16. Average capital invested per hectare of total farm area — 1988-89 to 1990-91

Capital item	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
	$/ha	%+	$/ha	%+	$/ha	%+	$/ha	%+
Motor vehicles, trucks, etc.	199	10.1	302	11.3	278	8.8	355	10.0
Tractors	505	25.7	859	32.0	941	29.7	872	24.5
Cultivation equipment	227	11.5	331	12.3	348	11.0	360	10.1
Sugar specific equipment	94	4.8	80	3.0	119	3.8	206	5.8
Harvesting & handling equipment	5	0.3	0	0.0	4	0.1	2	0.1
Irrigation equipment (mobile)	354	18.0	411	15.3	616	19.4	455	12.8
Workshop equipment	57	2.9	83	3.1	85	2.7	86	2.4
Non-sugar specific equipment	6	0.3	0	0.0	0	0.0	461	13.0
Livestock & livestock equipment	29	1.5	4	0.2	18	0.6	41	1.2
Buildings	166	8.4	181	6.8	167	5.3	341	9.6
Irrigation improvements (fixed)	284	14.4	408	15.2	558	17.6	343	9.6
Other fixed improvements	41	2.1	23	0.9	39	1.2	37	1.0
Land	2655	n.a.	2271	n.a.	5229	n.a.	2196	n.a.
Non land capital	1968	100.00	2681	100.00	3173	100.00	3558	100.00
Total	4623		2681		8402		5754	

\+ Percentage figures relate to non-land capital
n.a. Not applicable

Table 5.17. Average capital invested per hectare of assigned area — 1988-89 to 1990-91

Capital item	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
	$/ha	%+	$/ha	%+	$/ha	%+	$/ha	%+
Motor vehicles, trucks, etc.	280	9.6	360	10.8	346	7.8	540	9.1
Tractors	692	23.7	1049	31.5	1349	30.5	1387	23.3
Cultivation equipment	333	11.4	413	12.4	445	10.1	583	9.8
Sugar specific equipment	146	5.0	116	3.5	162	3.7	448	7.5
Harvesting & handling equipment	7	0.2	0	0.0	5	0.1	3	0.1
Irrigation equipment (mobile)	519	17.8	517	15.5	855	19.3	742	12.5
Workshop equipment	84	2.9	98	2.9	106	2.4	148	2.5
Non-sugar specific equipment	7	0.2	0	0	0	0.0	718	12.1
Livestock & livestock equipment	94	3.2	7	0.2	27	0.6	116	1.9
Buildings	246	8.4	218	6.5	216	4.9	579	9.7
Irrigation improvements (fixed)	407	14.0	512	15.4	845	19.1	596	10.0
Other fixed improvements	100	3.4	43	1.3	65	1.5	92	1.5
Land	4158	n.a.	3050	n.a.	6639	n.a.	4347	n.a.
Non land capital	2914	100.00	3331	100.00	4421	100.00	5952	100.00
Total	7073		6381		11061		10299	

\+ Percentage figures relate to non-land capital
n.a. Not applicable

5.11 Farm financial performance

Table 5.18 shows measures of farm performance for the period 1988-89 to 1990-91.

Table 5.18. Measures of farm performance - 1988-89 to 1990-91 (Average/farm/year)

Capital item	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Farm cash income ($)	23245	39857	41768	73147
Farm business profit ($)	-16594	1139	3497	12927
Profit at full equity ($)	-9933	5286	8420	32514
Rate of return (%)	-4.42	1.27	1.31	5.3
Return to land ($)	-20913	-4707	-2170	13106
Return/hectare assigned ($)	-442	-118	-76	483

According to all six measures of farm performance defined in Section 3.3, the non-specialist cane farmers performed the best while the high water users performed better than the other specialist cane farmers. However for the specialist cane farmers, the overall economic performance during the survey period was disappointing, particularly the performance of low water users with below expected yields.

While the sample of growers in this study cannot be considered a 'representative' sample of Bundaberg cane growers, the figures suggest that during the survey period, growers in the Bundaberg district were under considerable financial pressure.

A continuation of sugar prices, sugar yields and costs at the levels existing during the survey period would lead to further downward pressure on land values and farm equity and would ultimately threaten the survival of a number of farms in the district. While off-farm employment and other forms of off-farm income, are possible solutions to low farm returns, such solutions are highly dependent on the availability of suitable employment, off-farm investment funds, and investment opportunities with acceptable levels of risk. During the survey period, off-farm employment for specialist cane growers averaged only eight weeks of operator and family labour per year, and average off-farm income, as recorded in farm business accounts, totalled $7,000 per annum. When averaged across all farms in the sample these figures are low, but in a number of cases they did represent a substantial contribution to cash income and farm viability during the period. It is expected that many small farms may become increasingly dependent on off-farm income in the near future. However, it is unlikely to be the only solution to their current financial difficulties. Farm amalgamation, another source of farm productivity improvement in the presence of economies of size, can only occur if land values fall to the point where farm amalgamation becomes profitable.

Tables 5.19 to 5.24 show the distribution of the various measures of farm performance. Table 5.20 shows that 85% of growers in the below expected yield group had negative farm business profits compared with only 33% and 45% for the other two specialist groups. Also, 80% of growers in that group showed a negative return to land per hectare of assignment (Table 5.24) which was only marginally greater than the percentage in the other low water users group.

Table 5.19. Distribution of farm cash income per farm — 1988-89 to 1990-91

Farm cash income	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
$	No.	%	No.	%	No.	%	No.	%
Less than zero	3	15.8	0	0.0	0	0.0	0	0.0
zero to 10,000	3	15.8	1	6.7	1	11.1	1	11.1
10,001 to 25,000	7	37.1	3	20.0	2	22.2	1	11.1
25,001 to 50,000	3	15.8	6	40.0	3	33.3	2	22.2
50,001 to 100,000	2	10.5	5	33.3	2	22.2	2	22.2
100,000 to 150,000	1	5.3	0	0.0	1	11.1	2	22.2
Greater than 150,000	0	0.0	0	0.0	0	0.0	1	11.2
Total	19	100.0	15	100.0	9	100.0	9	100.0

Table 5.20. Distribution of farm business profit per farm — 1988-89 to 1990-91

Farm business profit	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
$	No.	%	No.	%	No.	%	No.	%
Less than - 35,000	5	26.3	0	0.0	0	0.0	0	0.0
-35,000 to 0	11	57.9	5	33.3	4	44.4	3	33.3
1 to 25,000	2	10.5	8	53.3	4	44.4	4	44.4
25,001 to 50,000	1	5.3	2	13.3	1	11.1	1	11.1
Greater than 50,000	0	0.0	0	0.0	0	0.0	1	11.1
Total	19	100.0	15	100.0	9	100.0	9	100.0

Table 5.21. Distribution of farm business profit at full equity — 1988-89 to 1990-91

Farm business profit at full equity	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
$	No.	%	No.	%	No.	%	No.	%
Less than - 25,000	6	31.6	0	0.0	0	0.0	0	0.0
-25,000 to 0	9	47.4	5	33.3	4	44.4	3	33.3
1 to 10,000	0	0.0	6	40.0	1	11.1	0	0.0
10,001 to 20,000	1	5.3	1	6.7	2	22.2	1	11.1
20,001 to 40,000	2	10.5	3	20.0	1	11.1	0	0.0
40,001 to 80,000	1	5.3	0	0.0	1	11.1	4	44.4
Greater than 80,000	0	0.0	0	0.0	0	0.0	1	11.1
Total	19	100.0	15	100.0	9	100.0	9	100.0

Table 5.22. Distribution of rate of return to total capital — 1988-89 to 1990-91

Rate of return	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
%	No.	%	No.	%	No.	%	No.	%
Less than -15.0	2	10.5	0	0.0	0	0.0	0	0.0
-15.0 to 0.0	13	68.4	5	33.3	4	44.4	3	33.3
0.1 to 2.5	1	5.3	5	33.3	2	22.2	0	0.0
2.6 to 5.0	1	5.3	3	20.0	0	0.0	2	22.2
5.1 to 7.5	2	10.5	1	6.7	2	22.2	1	11.1
7.6 to 12.5	0	0.0	1	6.7	1	11.1	1	11.1
Greater than 12.5	0	0.0	0	0.0	0	0.0	2	22.2
Total	19	100.0	15	100.0	9	100.0	9	100.0

Table 5.23. Distribution of return to land per farm — 1988-89 to 1990-91

Return to land	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
$	No.	%	No.	%	No.	%	No.	%
Less than -25,000	8	42.1	2	13.3	1	11.1	2	22.2
-25,000 to 0	8	42.1	9	60.0	4	44.4	1	11.1
1 to 15,000	2	10.5	2	13.3	3	33.3	2	22.2
15,001 to 30,000	1	5.3	2	13.3	0	0.0	1	11.1
30,001 to 60,000	0	0.0	0	0.0	1	11.1	2	22.2
Greater than 60,000	0	0.0	0	0.0	0	0.0	1	11.1
Total	19	100.0	15	100.0	9	100.0	9	100.0

Table 5.24. Distribution of return to land per hectare of assigned area — 1988-89 to 1990-91

Return to land per hectare of assigned area	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
$/hectare	No.	%	No.	%	No.	%	No.	%
Less than -500	7	36.8	1	6.7	2	22.2	2	22.2
-500 to 0	9	47.4	10	66.6	3	33.3	1	11.1
1 to 100	0	0.0	2	13.3	0	0.0	2	22.2
101 to 200	3	15.8	0	0.0	1	11.1	1	11.1
201 to 400	0	0.0	1	6.7	2	22.2	0	0.0
401 to 800	0	0.0	1	6.7	1	11.1	1	11.1
Greater than 800	0	0.0	0	0.0	0	0.0	2	22.2
Total	19	100.0	15	100.0	9	100.0	9	100.0

5.12 Sensitivity analysis

The farm performance measures are averages for the three years, 1988-89, 1989-90 and 1990-91, the last two years of which were years of well below average rainfall. Despite a doubling of water use in the low water users group, yields still declined (from 78 tonnes of cane per hectare to 59 tonnes of cane per hectare for the below expected yield group and from 90 tonnes of cane per hectare to 74 tonnes of cane per hectare for the above expected yield group). A combination of a fall in receipts brought about by a decline in output and the fall in sugar prices, and an increase in farm costs due to the costs associated with increased watering resulted in a substantial reduction in farm cash income during the last two years of the survey period.

To illustrate the effect of the seasonal conditions and fall in grower returns during the survey period, the economic performance for the sample of growers was recalculated for two situations:

(i) if growers had obtained for each year of the survey period, the yields they had received in 1989, together with the 1989 costs and 1989 sugar returns; and

(ii) if growers had obtained for each year of the survey period, the 1989 yields together with 1989 costs but 1989-91 average sugar returns.

The results are presented in Tables 5.25 and 5.26.

Table 5.25 Measures of farm performance - 1989 yields, costs and 1989 grower returns

Farm performance measure	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Farm cash income ($)	50,981	65,372	68,065	101,059
Farm business profit ($)	11,668	26,655	31,390	44,372
Profit @ full equity	18,181	30,426	35,058	60,345
Rate of return (%)	2.92	8.67	8.36	11.14
Return to land ($)	7,200	20,433	24,468	40,937
Return/hectare assigned ($)	19	334	385	1,118

Table 5.26 Measures of farm performance - 1989 yields, costs and average grower returns

Farm performance measure	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Farm cash income ($)	31,918	44,611	48,020	84,686
Farm business profit ($)	-7,395	5,893	11,345	28,000
Profit @ full equity	-882	9,664	15,013	43,973
Rate of return (%)	-2.03	2.41	2.72	8.36
Return to land ($)	-11,863	-328	4,422	24,564
Return/hectare assigned ($)	-277	-68	-3.8	880

Tables 5.18, 5.25 and 5.26 show that although the decline in yield and increase in costs resulting from seasonal conditions during the last two years of the study period were responsible for a decline in economic performance, the major factor responsible for the diminished performance was the fall in sugar returns. For example, actual farm cash income for the high water users group during the study period averaged $41,768 per year. For the '1989 yields and costs and average grower return' situation (Table 5.26) average farm cash income is $48,020, an increase of $6,250 or 15 percent. However, for the '1989 yields, costs and returns' situation (Table 5.25) average farm cash income is $68,065, an increase of $26,297 or 62%. The difference of $6250 per annum is the result of the seasonal conditions prevailing in the last two years of the survey period. The cost of the drought ranged from $14,000 to $35,000 over the three year period, depending on the group under consideration. The remaining difference of $20,047 ($26,297 - $6,250) can be attributed to the fall in grower returns during the study period.

The *combined* effect of lower grower returns and seasonal conditions resulted in an estimated decline in farm cash income of approximately $80,000 per farm over the three year survey period.

Nevertheless if 1989 yields and average grower returns over the survey period are considered a realistic estimate of future productivity and returns, then the future of Bundaberg cane farming is not as bleak as many would believe. While the hypothetical farm performance of the below expected yield group would still be disappointing, Table 5.26 shows that the other specialist grower groups would achieve reasonable returns with, on average, a positive though low return to capital being earned, and positive business profits. Further downward pressure on sugar returns, even if average yields were realised, however would place a substantial burden on Bundaberg cane growers, in the absence of other possible changes in cane growing.

5.13 Farm business equity and debt

One of the factors identified as possibly influencing yield was the level of debt though the regression analysis did not support this hypothesis. Indeed Table 5.27 shows that overall absolute debt levels for the specialist cane growers were low and that corresponding equity percentages were high.

Table 5.27. Farm business debt, equity and equity to total capital ratio — 30-6-89, 30-6-90 and 30-6-91

	Specialist cane farmers			Non-specialist cane farmers
	Low water users		High water users	
	Below expected yield	Above expected yield		
Farm business equity				
30 June 1989	399 063	314 923	510 543	352 679
30 June 1990	400 615	325 238	511 886	334 700
30 June 1991	396 561	299 819	504 807	334 869
Equity: asset ratio				
30 June 1989	88.0	90.7	96.5	66.3
30 June 1990	88.9	91.7	97.5	66.8
30 June 1991	88.7	89.4	98.2	68.6
Farm business debt				
30 June 1989	59 399	29 857	37 582	201 448
30 June 1990	51 509	26 400	29 331	192 630
30 June 1991	46 750	37 258	21 658	170 954

Table 5.28 shows that forty-two percent of growers in the below expected yield group, 27 percent in the above expected yield group and 56 percent of growers in the high water use group had no debt. In contrast, only ten percent of non-specialist growers had no debt and 40 percent of these growers' debts were between $100,000 and $500,000.

Table 5.28. Distribution of farm business debt per farm as at 30 June 1991

Farm Business Debt	Specialist cane farmers						Non-specialist cane farmers	
	Low water users				High water users			
	Below expected yield		Above expected yield					
$	No.	%	No.	%	No.	%	No.	%
Zero	8	42.1	4	26.7	5	55.6	1	10.0
Zero to 10,000	2	10.5	3	20.0	1	11.1	0	0.0
10,001 to 50,000	4	21.1	4	26.7	1	11.1	2	20.0
50,001 to 100,000	3	15.8	2	13.3	0	0	2	20.0
100,001 to 500,000	2	10.5	2	13.3	2	22.2	4	40.0
Greater than 500,000	0	0	0	0	0	0	1	10.0
Total	19	100.0	15	100.0	9	100.0	10	100.0

5.14 Factors affecting profitability on specialist cane farms

Although one objective of the study was the identification of factors affecting yield in the Bundaberg district, an additional objective was the identification of factors affecting profitability of cane growing. While yield may be the major influence affecting profitability, hence the concern to identify reasons for variability in yields, other factors may also be important. The study was therefore extended to examine factors likely to influence profitability of sugar growing in the Bundaberg region. One of these possible factors is the size of the farming operation. The measure of profitability used in this analysis was the return to land per hectare of assignment (including leasehold cane land). A simple regression examining the relationship between return per hectare and yield and farm size (expressed as tonnes of sugar harvested) was carried out. The results are presented in Table 4.29.

Table 5.29. Relationship between return per hectare and yield (tonnes of sugar per hectare harvested) and farm size (tonnes of sugar)

Explanatory variable	Co-efficient	t-value*
Constant	-1185.4	6.82
Yield	82.77	4.89
Tonnes of sugar	.45	2.97

*If the t-value exceeds 2, the coefficient is significant at the 95% level. This means that we can be at least 95% certain that a coefficient has a non-zero value.

Overall F	26.07
Adjusted R squared	0.28

The co-efficient of 82.77 for yield means that for every increase in yield of one tonne of sugar per hectare, return per hectare increased by $82.77. Similarly for every increase in farm size (measured by tonnes of sugar) of one tonne of sugar, return per hectare increased by $0.45. However, the relatively poor explanatory power of the relationship as indicated by the low R squared value shows that only 28 percent of the variability in return per hectare could be explained by the two variables, yield and tonnes of sugar. Other sources of variability were not able to be identified in this analysis principally due to the small sample size.

It was thought that a 'better' explanation of variability in return per hectare may be achieved using yield and labour use. It was hypothesised that labour use per hectare declined with increasing farm size (economies of size) and that this variable may better explain variability in return per hectare than farm size itself. Consequently return per hectare was regressed against yield and total labour per hectare (weeks per hectare harvested). The results are presented in Table 5.30.

Table 5.30. Relationship between return per hectare, yield and total labour use per hectare

Explanatory variable	Co-efficient	t-value*
Constant	-847.31	4.66
Yield	116.41	7.60
Total labour per hectare	-280.07	4.38

*If the t-value exceeds 2, the coefficient is significant at the 95% level. This means that we can be at least 95% certain that a coefficient has a non-zero value.

Overall F	32.95
Adjusted R squared	0.33

The above equation still explains only 33 percent of the variability in return per hectare with yield still the major determinant of variability. That is, other things being equal, higher yields are associated with higher returns per hectare.

6. RESPONSE TO IRRIGATION, OPTIMUM WATER USE AND ECONOMIES OF SIZE

6.1 Introduction

In the preceding Chapter details of the economic performance of the sample of cane growers during the survey period were presented and discussed. Growers experienced severe financial pressure during the study period, as a result of a combination of a fall in sugar returns and poor seasonal conditions. While a return to 'normal' seasons would alleviate some of this pressure, the analysis showed that the continuation of sugar returns experienced in recent years, would still exert considerable pressure on the financial situation of many growers. Improvements in cane yields and increases in farm size are possible remedies, albeit long term, to the current financial situation. In this chapter the economic response to irrigation use is discussed, along with an analysis of possible economies of size in cane growing.

6.2 Response to irrigation and optimum water use

The overriding importance of sugar yield as a factor affecting the profitability of cane farming was shown in the preceeding chapter. Irrigation use was, in turn, identified as the major influence on yields. The study has identified significant variation among the sample of growers in the level of irrigation use during the survey period, despite growers receiving similar rainfall during the study period. Table 6.1 shows estimates of total farm water use, based on estimates of effective rainfall (Fairymead), and deliveries of surface water through the channel systems in the Bundaberg Irrigation Area for the period 1983 to 1991 inclusive.

Table 6.1. Total water use: surface irrigators Bundaberg Irrigation Area (Ml/hectare@)

	Irrigation deliveries	Effective rain (Oct-April)	Total water use
1982-83	3.76	6.17	9.93
1983-84	2.43	6.12	8.55
1984-85	1.46	8.86	10.32
1985-86	2.73	6.33	9.06
1986-87	2.59	7.25	9.84
1987-88	3.45	5.79	9.23
1988-89	2.13	7.70	9.83
1989-90	4.86	4.57	9.43
1990-91	4.87	3.64	8.51

@ Water use per hectare was on a harvested area basis
Source: WR Annual Reports

Excluding the years 1983-84, 1984-85 and 1990-91, total water use per hectare did not vary greatly during the nine year period, averaging approximately 9.5 Ml/hectare. Only once in the past five years (1990-91) did total annual water use fall below 9Ml/hectare.

The regression analysis presented in Chapter 4, showed the relationship between yield and a number of factors, including total water use. That factor explained most of the variability in yield among the sample of growers in the study. The co-efficients for the two water variables, water per hectare and water per hectare squared were 2.4255 and -.091588 respectively.

These co-efficients can be used to calculate the expected response to irrigation for a range of total water use. The response to irrigation (as measured by the additional output of sugar per hectare achieved from an increase in water use of one megalitre per hectare) is the marginal physical product of water (MPP_w). The response or MPP_w for a range of water use levels is shown in Table 6.2.

Table 6.2. Response to water use

Water (Ml/hectare)	MPP_w (tonnes of sugar/ha)
1.0000	2.2423
2.0000	2.0591
3.0000	1.8760
4.0000	1.6928
5.0000	1.5096
6.0000	1.3264
7.0000	1.1433
8.0000	0.9601
9.0000	0.7769
10.0000	0.5937
11.0000	0.4106
11.5000	0.3190
12.0000	0.2274
13.0000	0.0442
14.0000	-0.1390
15.0000	-0.3221
16.0000	-0.5053
17.0000	-0.6885

The yield responses reported above assume that the MPP_w is independent of other influences including soil type, nutrient levels, irrigation type, etc. While it is generally agreed that this is not the case, e.g. the response to water will be greater for good soils, such interactions were not able to be isolated with the available data. The yield relationships presented below however, do include independent variables to take account of soil differences, fertiliser application levels and irrigation type.

The response to increases in water use, the marginal physical product (MPP), can be utilised to derive the optimal, or profit maximising level of irrigation application. The optimal level of water application is that level where the increase in total revenue from applying more water equals the additional cost of applying that water. In economic terms the optimal level of water use is achieved when the value of the marginal product (MVP) equals the cost of the next unit of the input. The MVP equals the MPP times the net return. The cost of the water is the total cost associated with applying an additional unit of water, including irrigation charges, pumping costs, repairs and maintenance costs and labour costs. Table 6.3 shows the optimal irrigation rate, based on an average effective rainfall of 7.5 Ml/hectare for a range of grower net returns and water costs.

Table 6.3. Optimum irrigation rates (Ml/hectare) for various combinations of returns and water costs

Net return (Grower return less harvesting costs and levies) ($/t)	Cost of water applied ($/Ml)					
	0	35	50	75	100	125
100	5.75	3.84	3.02	1.65	0.29	n.a.
150	5.75	4.47	3.93	3.03	2.11	1.20
175	5.75	4.65	4.19	3.41	2.63	1.85
200	5.75	4.79	4.38	3.70	3.02	2.33
225	5.75	4.90	4.53	3.93	3.32	2.71
250	5.75	4.98	4.65	44.11	3.56	3.02

n.a. not applicable

Thus for a net return of (say) $175 per tonne, and a cost of water of (say) $75 per Ml (irrigation charge plus application costs) in an average year, the optimal irrigation application rate is 3.4 Ml/hectare. If the cost was $125/Ml then the optimal irrigation rate would be 1.8 Ml/hectare. Thus in an average year (effective rainfall of 7.5 Ml/ha), the optimal total water application could vary between 9.3 and 10.9 Ml/hectare depending on water costs. Int he hypothetical situation where irrigation water was free, te would be 5.7 Ml/hectare. Figure 6.1 presents these results diagrammatically, and shows the optimal irrigation rate (in an average season) for a range of net returns and water costs.

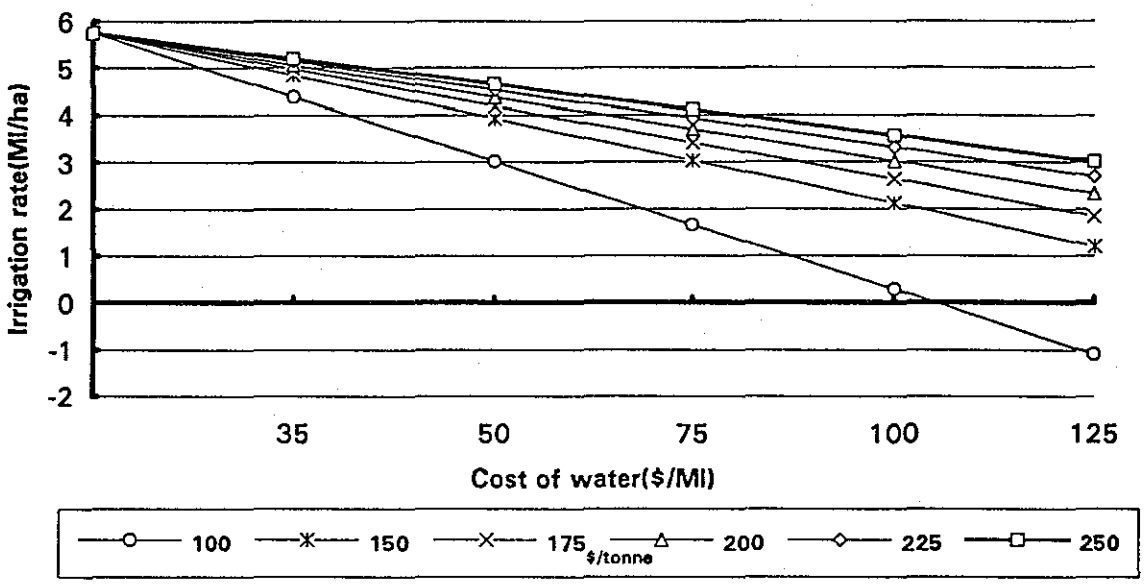

Figure 6.1. Net return, water costs and optimal irrigation rates

In an 'average' season of 7.5 Ml/hectare of effective rainfall and an irrigation cost of $100/Ml, the optimal irrigation rate would vary from 2 Ml/hectare for a net return of $150/tonne to over 3.5 Ml/hectare for a net return of $250/tonne. Other things being equal, it is profitable to increase water use when the grower return increases.

Figure 6.2 shows the optimal irrigation rates for a net return of $175/tonne and for three levels of effective rainfall.

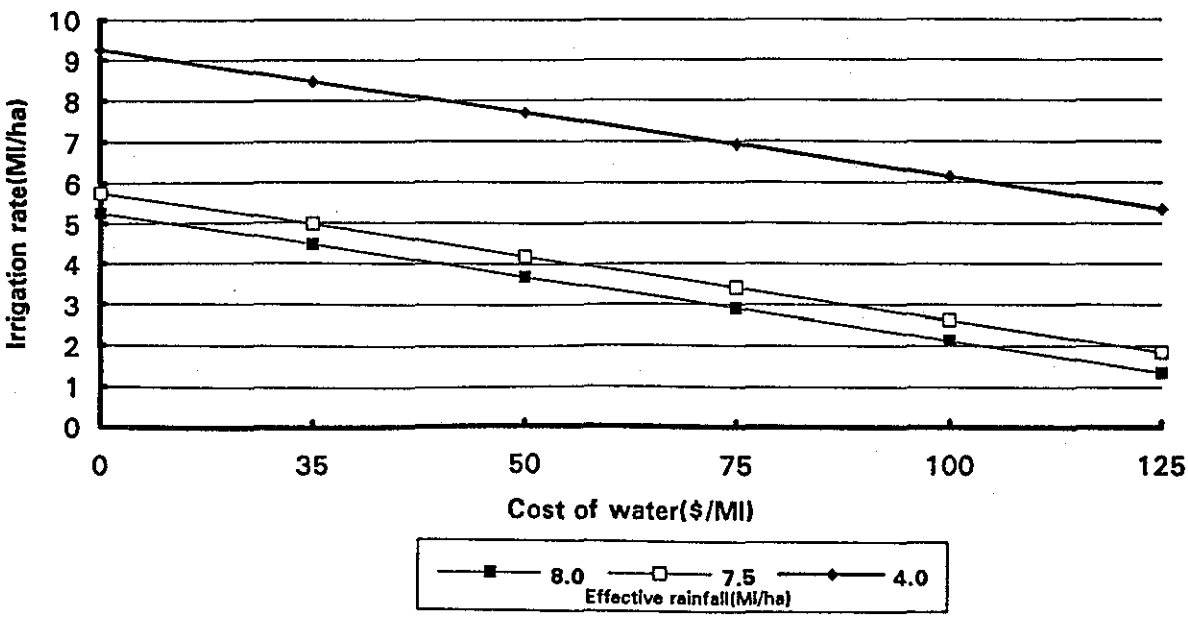

Figure 6.2. Water costs, effective rainfall and optimal irrigation rates

The economic response function derived from the initial regression analysis suggests that, even allowing for a wide range in water costs, Bundaberg cane farmers on average, applied less than optimal amounts of irrigation water during the years 1983 to 1991, where total water use was approximately 9.5 Ml/hectare in most years. However these figures suggest that on average, Bundaberg growers did not apply excessively low levels of irrigation water. This does not mean that, on average, growers could not increase their sugar yields (and returns/farm) for the same amount of irrigation water applied per hectare. This could be achieved by employing better irrigation techniques including better timing and frequency of the application of irrigation water, and by the selection of better cane varieties, weed control practices etc.

Indeed one factor identified from the grower survey as affecting yield was the number of days to irrigate the crop. For the same total use of irrigation water, a decrease in the period between applications was associated with an increase in yields. In other words, during a season, more frequent lighter applications resulted in a higher yield than less frequent heavier applications. There is however a maximum frequency which will be determined by agronomic factors including soil type and crop water requrements. While the preceding analysis focussed on the optimal level or amount of irrigation water, an underlying concern is the efficiency of irrigation, that is, the total product or yield for a particular level of irrigation or water use. Table 6.4a and Table 6.4b show the relationship between water application and sugar yield, based on the following regression.

Explanatory variable	Co-efficient	t-value*	Mean value
CONSTANT	-6.154	1.54	
AUTTOTAR	.05772	3.12	14.53
IRRIGDAYS	-.15094	4.11	13.53
NITROGEN	.02656	4.74	153.3
SOIL TYPE	.93611	2.86	
WATER HA	2.6628	3.48	
WATER HASQ	-.10218	2.67	
FLOODYN	.90388	2.79	

* If the t-value exceeds 2, the coefficient is significant at the 95% level. This means that we can be at least 95% certain that a coefficient has a non-zero value.

Descriptions of the variables were given in Chapter 4. The only 'new' variable used in this analysis is NITROGEN which is the estimated kilograms of N per hectare applied to the ratoon crop.

The sugar yields shown in Tables 6.4a and 6.4b were derived by holding the levels of AUTTOTAR, IRRIGDAYS and NITROGEN at their mean values, and adjusting for SOILTYPE and type of irrigation (FLOODYN).

Table 6.4a. Relationship between yield and water use, flood irrigation

Water use (Ml/hectare)	Yield (tonnes of sugar/hectare)	
	Good soils	Bad soils
1	0.1786	-0.7575
2	2.5349	1.5988
3	4.6868	3.7507
4	6.6343	5.6982
5	8.3775	7.4414
6	9.9163	8.9802
7	11.2508	10.3147
8	12.3809	11.4448
9	13.3066	12.3705
10	14.0280	13.0919
11	15.5450	13.6089
12	14.8577	13.9216
13	14.9660	14.0299
14	14.8699	13.9338
15	14.5695	13.6334
16	14.0647	13.1286
17	13.3556	12.4195

Table 6.4b. Relationship between yield and water use, flood irrigation

Water use (Ml/hectare)	Yield (tonnes of sugar/hectare)	
	Good soils	Bad soils
1	-0.7253	-1.6614
2	1.6310	0.6949
3	3.7829	2.8468
4	5.7304	4.7943
5	7.4736	6.5375
6	9.0124	8.0763
7	10.3469	9.4108
8	11.4770	10.5409
9	12.4027	11.4666
10	13.1241	12.1880
11	13.6411	12.7050
12	13.9538	13.0177
13	14.0624	13.1260
14	13.9660	13.0299
15	13.6656	12.7295
16	13.1608	12.2247
17	12.4517	11.5156

Maximum sugar yield (tonnes of sugar per hectare) occurs at approximately 13 Ml per hectare of total water use. Maximum yields varied between 15t/ha for flood irrigation on good soils and 13.13 ha for non-flood irrigation on poor soils.

The estimated yields presented in Tables 6.4a and 6.4b are higher than those shown in the BSES publication entitled "Calculating the Benefits of Irrigation" (BSES, 1991) for water use below 13 Ml/ha. While yields are higher over this range of water use the responses to each additional unit of water (the MPP_w as defined on pages 43 and 44) are below those suggested by the BSES. Tables 6.4 and 6.5 also show that at water application rates above 13Ml/ha overall yields decline (i.e. MPP_w becomes negative). By contrast, the BSES publication shows that yields continue to increase (positive MPP_w) well beyond a total water application of 13 Ml/ha. The difference between the response to irrigation or MPP_w presented in this report and that shown in the BSES publication has a major implication for the determination of optimal irrigation use in the district.

The survey data also show that Bundaberg district cane farmers did not, on average, significantly underutilise available irrigation water during the survey period. Further, the irrigation use data reported by WR for the period 1982-83 to 1990-91 are consistent with the optimal levels derived from the economic response data presented above. In contrast, the water use-yield relationship presented in the BSES publication suggests that, on average, Bundaberg canegrowers should have used more irrigation water during the past decade and even at current grower returns are underutilising the available irrigation resources.

6.3 Economies of size

Economies of size, that is a reduction in average cost per unit of output as the size or scale of the operation increases, are often postulated as a source of improvement in *aggregate* industry efficiency and profitability. These economies often result from a spreading of such 'lumpy' inputs as labour and investment in buildings and equipment over a larger farm operation. Another source of economies in sugar production, as mentioned previously, is yield improvement where the economies result not from an increase in the size of the farm, but from improvements in the efficiency of the farming activity.

In order to explore the relationship between cost per unit of output, size and yield, two sets of data were examined:

- average for the three study years; and
- data for 1989 only. (This was considered an 'average' year in contrast to the study period which included two 'drought' years.)

A simple relationship between cost, yield and farm size was hypothesised. The estimated relationship for the three study years was:

Cost per tonne sugar = 431.8 — 17.20 x Yield (tonnes sugar per ha harvested)+

($/tonne sugar) 1951.29 x $Area^{-1}$ (hectares harvested)

The relationship explained approximately 40 per cent of the variability in unit costs and the coefficients for yield and size were significant at the 95% level of significance ('t' values of 4.44 and 2.98 respectively).

The relationship for the 1989 year was also estimated:

Cost per tonne sugar = 389.06 - 15.58 x Yield + 1862.92 x $Area^{-1}$

The R^2 was 0.30 and the 't' values were 4.44 and 2.98 respectively.

Not surprisingly for a given area and yield, average cost per unit of output was lower for the 1989 year than for the average of the three years, reflecting the costs associated with drought. In deriving cost per unit of output, in the above relationships, no allowance was made for interest on land, largely as a result of difficulties in assigning a value for land. Interest was charged on all non-land cpaital inputs, irrespective of the debt situation of farmers. All other costs including allowance for unpaid labour were included.

Table 6.5 and Table 6.6 show the estimated average costs of production for a particuar sugar yield (tonnes of sugar per hectare harvested) and farm output level (tonnes of cane harvested) based on the relationships presented above. An average CCS of 13.5 was used in the derivation of these tables.

Table 6.5. Cost per tonne of sugar for a range of yield and output levels (based on 1989-91 data)

Yield (t/ha)	Tonnes cane per farm								
	1000	2000	3000	4000	5000	6000	7000	8000	10000
10.0	404	332	308	296	289	284	280	278	274
10.5	403	327	302	289	282	276	273	270	266
11.0	402	322	296	282	274	269	265	262	258
11.5	400	317	289	275	267	262	258	255	251
12.0	399	312	283	269	260	254	250	247	243
12.5	397	307	277	262	253	247	243	239	235
13.0	396	302	271	255	246	240	235	232	227
13.5	395	297	265	248	239	232	227	224	220
14.0	393	292	258	242	231	225	220	216	211
15.0	391	282	246	228	217	210	205	201	195
16.0	388	272	234	214	203	195	190	186	180
17.0	385	262	221	201	189	180	175	170	164

Table 6.6. Cost per tonne of sugar for a range of yield and output levels (1989 data)

Yield (t/ha)	Tonnes cane per farm								
	1000	2000	3000	4000	5000	6000	7000	8000	10000
10.0	371	302	279	268	261	256	253	251	247
10.5	370	298	274	262	254	250	246	244	240
11.0	369	294	268	256	248	243	239	235	233
11.5	369	289	263	250	242	236	233	230	226
12.0	368	285	257	243	235	230	226	223	219
12.5	367	281	251	237	229	223	219	216	212
13.0	366	276	246	231	222	216	212	209	204
13.5	365	272	241	225	216	210	205	202	197
14.0	364	268	235	219	210	203	199	195	190
15.0	362	259	224	207	197	190	185	181	176
16.0	361	250	213	195	184	177	171	167	162
17.0	359	241	202	183	171	163	158	154	148

Both tables demonstrate the effect of farm size (output level) and yield on average cost of production (excluding land). For example, for a farm output of 4000 tonnes of cane and a sugar yield of 11 tonnes of sugar per hectare harvested, average cost of production, based on three years data is $282/tonne of sugar. In contrast, average cost based on 14 tonnes of sugar per hectare harvested and an output level of 10 000 tonnes of cane is estimated at $211/tonne of sugar. At 14 tonnes of sugar per hectare harvested and an output of 4000 tonnes of cane, cost per tonne is $241 per tonne of sugar.

For the 1989 data set, cost per tonne at a yield of 11 tonnes of sugar per hectare harvested and an output of 4000 tonnes of cane is $256. At a yield of 14 tonnes of sugar per hectare harvested and an output of 10 000 tonnes of cane the cost is $190 per tonne of sugar, demonstrating economies resulting from both farm size and yield.

The analysis was extended to allow for the impact of cost of land on average cost of production. Two land values were selected, $1,000 and $2,000 per hectare, and then regression analysis carried out on the 1989 data to derive the relationship between cost of production, yield and farm size. The following equations were derived:

(a) Land valued at $1,000 per hectare

$$\text{Cost per tonne sugar} = 407.8 - 16.1 \times \text{Yield} + 1937\ \text{Area}^{-1}$$

(b) Land valued at $2,000 per hectare

$$\text{Cost per tonne sugar} = 422.9 - 16.8 \times \text{Yield} + 1925 \times \text{Area}^{-1}$$

The R^2 was 0.39 and 't' values were 4.61 and 2.5 for each question.

Both equations show significant relationships between cost per unit of output, yield and size. Tables 6.7 and 6.8 show cost of production for a range of sugar yields (tonnes of sugar per hectare) and output (tonnes of cane), for land prices of $1,000 per hectare and $2,000 per hectare respectively.

Table 6.7. Cost per tonne of sugar for a range of yield and output levels (1989 data and land valued at $1,000/ha)

Yield (t/ha)	Tonnes cane per farm								
	1000	2000	3000	4000	5000	6000	7000	8000	10000
10.0	391	319	295	283	276	271	268	265	262
10.5	390	315	289	277	269	264	261	258	254
11.0	389	310	284	271	263	257	254	250	247
11.5	388	306	278	264	256	250	247	244	240
12.0	387	301	272	258	250	244	240	237	232
12.5	386	297	267	252	243	237	233	229	225
13.0	386	292	261	246	236	230	226	222	218
13.5	385	288	256	239	230	223	219	215	210
14.0	384	283	250	233	223	216	212	208	203
15.0	382	275	239	221	210	203	198	194	188
16.0	380	266	227	208	197	189	184	180	174
17.0	379	257	216	196	184	175	170	165	159

Table 6.8. Cost per tonne of sugar for a range of yield and output levels (1989 data and land valued at $2,000/ha)

Yield t/ha	Tonnes cane per farm								
	1000	2000	3000	4000	5000	6000	7000	8000	10000
10.0	398	326	303	291	284	279	276	273	269
10.5	397	322	297	284	277	272	268	265	262
11.0	395	317	291	278	270	265	261	258	254
11.5	394	312	285	271	263	257	253	250	246
12.0	393	307	279	264	256	250	246	243	239
12.5	392	302	273	258	249	243	239	236	231
13.0	390	298	267	251	242	236	231	228	223
13.5	389	293	261	245	235	229	224	221	216
14.0	388	288	255	238	228	221	216	213	208
15.0	385	278	243	225	214	207	202	198	193
16.0	383	269	231	212	200	193	187	183	177
17.0	380	259	219	198	186	178	172	168	162

These tables again demonstrate the influence of yield and size on cost of production. For example, at a grower return of $200 per tonne of sugar, only farms with yields of 15 tonnes of sugar per hectare harvested and an output in excess of 8000 tonnes of cane would cover all costs including land. For an output level of 4000 tonnes of cane only farms with a yield of almost 17 tonnes of sugar per hectare would cover all costs. At grower returns received during the seventies (average grower return of $540/tonne in 1992 dollars), at an output level of (say) 4000 tonnes of cane, even growers with yields as low as ten tonnes of sugar per hectare would earn reasonable profits.

While the relationships between costs, yield and size are 'average' for the sample, the derived costs shown in the tables above again highlight the economic difficulties facing many Bundaberg growers. At an average production per farm of 4000 tonnes of cane yields would

have had to increase from an average of 11 tonnes of sugar per hectare to 17 tonnes of sugar per hectare harvested (an increase of 55 per cent) for growers to breakeven at a sugar return of $200 per tonne of sugar. At a grower return of $250/tonne, yields would have to increase by approximately 20 per cent. While the analysis suggests economies of size are present on Bundaberg cane farms, at current grower returns these economies are only important for sugar yields in excess of 15 tonnes per hectare.

Even if land was 'free', at an output of 10 000 tonnes of cane, yields would have to exceed 13.5 tonnes of sugar per hectare if all costs of production were to be covered. Similarly at an output level of 4000 tonnes of cane, yields would have to exceed 15 tonnes of sugar per hectare if all costs were to be covered.

In summary the above analysis suggests that at prevailing farm sizes, grower returns and yields, a significant percentage of Bundaberg growers are not meeting their total costs. While costs such as depreciation, imputed interest and owner/operator and family labour are non-cash costs (and represent approximately 40% of total costs) these costs must eventually be covered if the grower is to remain in the business of canegrowing.

7. SPECIALIST PRODUCERS : ATTITUDES AND ATTRIBUTES

7.1 Introduction

In this chapter the responses of specialist cane growers to a series of questions relating to additional water use, general concerns about farming in the Bundaberg district, and cane yields and irrigation use are presented. These responses together with details of management, ownership and education characteristics, can shed light on the variability in water use, cane yields and economic performance.

These insights can assist in the identification of appropriate government and industry responses, and in particular identify areas for future research and extension activity.

7.2 Attitude towards additional water use

Growers were asked to select which of the following statements best reflected the situation on their farm with respect to water use in 1991 and 1990.

A. On my farm my irrigation set-up had the capacity to efficiently apply more water than I did. I did not apply more water even though I know I could have made more money if I had.

B. Although my irrigation set-up had the capacity to efficiently apply more water, I did not think I would have made more money if I had.

C. My irrigation set-up (equipment) did not have the capacity to efficiently apply more water than I did.

The responses are presented in Table 7.1.

Table 7.1. Expressed attitude towards additional water use

	Specialist cane farmers						Total	
	Low water users				High water users			
	Below expected yield		Above expected yield					
	No.	%	No.	%	No.	%	No.	%
A. Available capacity and believed it would have been profitable to apply more water	5	26	7	47	2	22	14	33
B. Available capacity but believed it would not have been profitable to apply more water	8	42	8	53	5	56	21	49
C. Didn't have the capacity to apply more water in 1991 or 1990	6	32	0	0	2	22	8	19
Total	19	100.0	15	100.0	9	100.0	43	100.0

While it could be expected that a large percentage of the high water users' group would have considered it unprofitable to have applied more water in 1991, a high percentage of the low water users group, who applied on average 2 Ml/hectare less than the high water users group, also considered it unprofitable to apply more water.

The low water user groups had the highest percentage (32%) of growers who did not have the capacity to apply more water in 1990 and 1991. The high percentage of growers who did not consider it profitable to apply more water even in a drought year, may be a reflection of the generally tight economic condition facing growers in the survey period with growers not prepared to risk further expenditure on irrigation. On the other hand it may be an indication of the possible lack of awareness of the value of irrigation in the Bundaberg area. As mentioned in Chapter 6 more detailed economic analysis of the value of irrigation water, together with appropriate extension activity appears warranted.

As can be seen from Table 7.1, 47 percent of growers in the above expected yield group did not apply more water in 1991 even though they considered it profitable to do so. Of this group, 85 percent stated that one of the reasons for not applying water was concern about exceeding their water allocation, particularly groundwater users. Other reasons given were rostering difficulties (30%), unwillingness to go into debt (42%), and unwillingness to employ hired labour (42%). In a number of instances growers gave more than one reason for not applying more water, but were not asked to rank reasons in order of importance.

While 42 percent of this group were not willing to go into debt or increase debt to pay for the costs of more water use, only one grower (14%) said it was not possible for him to go into debt. Out of the 14 growers in the sample of 43 specialist growers who believed it profitable to apply more water, six growers cited unwillingness to go into debt as one of the reasons for not applying more water, but only two growers said it was not possible for them to increase their debt if they wished to. Half the growers (7 from 14) said that difficulties with rostering prevented them from applying more water, while eight growers out of the 14 said that fear of exceeding their water allocation was a factor in their not applying more water.

Of the 21 growers who did not apply more water because they did not consider it profitable, 12 growers said that an unwillingness to go into debt or increase their debt would have also been a factor affecting their decision not to increase water use. However all of the 12 growers considered that it would have been possible for them to increase their debt if they wished to. Nine growers from the 21 also stated concern about exceeding their water allocation as another possible influence in their decision not to increase water use. Thus from the total of 35 growers who had the capacity to increase water use, 17 growers cited unwillingness to increase or go into debt as a factor influencing their decision. Yet only two of the 17 growers said it would not have been possible for them to increase their debt or go into debt if they wished to. This unwillingness to go into debt as a consequence of applying more water is symptomatic of the uncertain economic outlook facing many Bundaberg cane growers.

Of the eight growers who did not have the capacity to apply more water in an 'average' year, insufficient response to irrigation and the low long term sugar price were cited as the main reasons for their unwillingness to increase their irrigation capacity.

7.3 Rostering

Rostering was cited as an important factor influencing water use (50% of growers who considered it profitable to apply more water stated that rostering affected their decision to do so). Table 7.2 presents details of rostering during the 1990-91 year.

While the below expected yield group had the highest percentage of growers on occasional roster the overall percentage of growers across all groups 'never on roster' was about the same, averaging 63 percent.

Table 7.2. Irrigation rostering

	Specialist cane farmers						Total	
	Low water users				High water users			
	Below expected yield		Above expected yield					
	No.	%	No.	%	No.	%	No.	%
Never on roster	13	68	8	53	6	67	27	63
On permanent roster	0	0	3	20	1	11	4	9
Occasionally on roster	6	32	4	27	2	22	12	28
Total	19		15		9		43	

7.4 Management, ownership and education characteristics

The average age of managers was just over 50, an age consistent with the age of managers in primary industries in Australia. Management experience was about 20 years with experience in cane growing averaging over thirty years. Average experience in irrigating cane was over twenty years for all three specialist groups, suggesting that lack of experience in irrigation is not a major factor in explaining variability in water use. With the exception of the high water use group, the majority of growers' formal education was completed at primary school. In contrast, for the high water users group, 56 percent of growers completed 1-4 years at high school. Details are shown in Table 7.3.

Table 7.3. Manager characteristics and farming intentions

	Specialist cane farmers					
	Low water users				High water users	
	Below expected yield		Above expected yield			
Years managed farm	23		24		19	
Years family ownership	37		57		35	
Years experience growing cane	36		36		32	
Age of manager	54		53		51	
Years experience irrigation	26		28		24	
Education level	No.	%	No.	%	No.	%
Attended/completed primary school	10	53	8	53	3	33
Completed 1-4 years high school	5	26	4	27	5	56
Completed 5-6 years high school	0	0	1	7	0	0
Completed trade/technical course	3	16	2	13	1	11
Completed tertiary course	1	5	0	0	0	0
Current intention	No.	%	No.	%	No.	%
Family partner other than spouse operate farm	4	21.1	1	6.7	1	11.1
Non-family partner operate farm	0	0.0	0	0	0	0
Adult son operate farm	6	31.6	3	20.0	2	22.2
Adult daughter operate farm	0	0	0	0	0	0
Spouse operate farm	0	0	0	0	0	0
Sell farm	8	42.1	7	46.7	4	44.4
Don't know	1	5.2	4	26.6	2	22.2

7.5 Future of farm

Growers were asked the hypothetical question - 'what would happen to your farm if you suddenly had to give up managing and operating the farm?' Their responses are shown above in Table 7.3. Across all specialist groups, over 40 percent said their farms would be sold. In the above expected yield group and the high water users group only 30 percent of growers thought members of their family would continue farming with another 20 percent unsure what

would happen to their farm if they could not continue farming. The high percentage of farmers who thought their farm would be sold is again a strong indication of the uncertainty growers perceive regarding the future of cane growing in the Bundaberg district, with only a majority of the below expected yield group believing that family members would continue to operate their farm.

7.6 Perceptions of water use and cane yields

Growers were asked how they considered their water use and cane yields compared with water use and cane yields of other growers in their district. Their responses are shown in Table 7.4.

Table 7.4. Water use and yield perceptions

	Specialist cane farmers					
	Low water users				High water users	
	Below expected yield		Above expected yield			
Perception of water use	No.	%	No.	%	No.	%
Above average	6	32	1	7	3	33
Average	10	53	6	40	4	44
Below average	2	11	6	40	2	22
Don't know	1	5	2	13	0	0
Perception of cane yields	No.	%	No.	%	No.	%
Above average	5	26	7	47	3	33
Average	9	47	5	33	5	56
Below average	5	26	1	7	1	11
Don't know	0	0	2	13	0	0

While 77 percent of the high water users group considered their water use to be average or above average for their district, 85 percent of the below expected yield group also considered their water use to be average or above average, with 32 percent considering their water use to be above average. Growers were more confident in their perception of their relative cane yields, many quoting or referring to their yields as shown in productivity reports supplied by mills.

The high percentage of the below expected yield group who considered their water use to be high (on average) reflects perhaps a lack of awareness by a section of Bundaberg water users of the economic response to irrigation application, with low water users believing that their application rates were already high in comparison with other low water users. (In 1988-

89 this groups' application rate was half of the high water users' application rate).

7.7 General concerns

Growers were asked to respond to a number of statements about their own farming situation and farming in general in the Bundaberg area, by stating whether they strongly agreed, agreed, didn't know, disagreed or strongly disagreed with each statement. The statements were:

1. My farm is not **large enough** to provide me and my family with an acceptable standard of living.

2. Off-farm employment and/or off-farm income is required to ensure an adequate level of income for my family.

3. Cane growing will not be as profitable in the future as it was in the 70's early 80's.

4. The average size of cane farms in the Bundaberg area will double in the next 20 years.

5. Bundaberg cane farmers will diversify further into other crops in the future.

6(a). The cane price will increase in the medium to long term

if 6(a) agree or strongly agree

6(b). While the cane price will increase in the medium to long term, costs will rise by as much or even more.

7. Total water use (for cane production), on Bundaberg cane farms will increase in the long term.

8. New technology (varieties, equipment) will maintain the viability of Bundaberg cane farms.

9. Most farms in Bundaberg have too much debt to survive in the long term.

10. Further deregulation is needed to promote profitability of cane growing in the Bundaberg district.

Their responses are shown in Table 7.5.

Table 7.5. General concerns

Statement	Low water users				High water users	
	Below expected yield		Above expected yield			
	No.	%	No.	%	No.	%
1. Farm not large enough						
Strongly agree	3	16	2	13	2	22
Agree	8	42	5	33	4	44
Don't know	0	0	2	13	0	0
Disagree	5	26	6	40	3	33
Strongly disagree	3	16	0	0	0	0
2. Off-farm employment and/or off farm income						
Strongly agree	2	11	3	20	1	11
Agree	10	53	6	40	4	44
Don't know	0	0	1	7	1	11
Disagree	5	26	5	33	3	33
Strongly disagree	2	10	0	0	0	0
3. Cane growing not as profitable in future						
Strongly agree	13	68	9	60	6	67
Agree	4	21	6	40	2	22
Don't know	1	5	0	0	1	11
Disagree	1	5	0	0	0	0
Strongly disagree	0	0	0	0	0	0
4. Cane farms will double in size						
Strongly agree	5	26	2	13	2	22
Agree	8	42	5	33	2	22
Don't know	1	5	0	0	0	0
Disagree	3	16	5	33	5	56
Strongly disagree	2	10	3	20	0	0

Table 7.5. General concerns (continued)

Statement		Low water users				High water users	
		Below expected yield		Above expected yield			
		No.	%	No.	%	No.	%
5.	Cane farmers will diversify further						
	Strongly agree	4	21	4	27	2	22
	Agree	6	32	9	60	4	44
	Don't know	0	0	0	0	1	11
	Disagree	8	42	1	7	2	22
	Strongly disagree	1	5	1	7	0	0
6(a)	Cane prices will increase in the medium to long term						
	Strongly agree	0	0	0	0	0	0
	Agree	12	63	7	47	5	56
	Don't know	3	16	1	7	1	11
	Disagree	4	21	6	40	3	33
	Strongly disagree	0	0	1	7	0	0
6(b)	Costs will rise by as much or even more						
	Strongly agree	3	25	0	0	2	40
	Agree	7	58	5	71	2	40
	Don't know	0	0	1	14	0	0
	Disagree	2	17	1	14	1	20
	Strongly disagree	0	0	0	0	0	0
7.	Water use will increase in the future						
	Strongly agree	0	0	0	0	1	11
	Agree	7	37	3	20	4	44
	Don't know	2	11	1	7	2	22
	Disagree	8	42	10	67	2	22
	Strongly disagree	2	10	1	7	0	0

Table 7.5. General concerns (continued)

Statement		Low water users				High water users	
		Below expected yield		Above expected yield			
		No.	%	No.	%	No.	%
8.	New technology will maintain the viability of farms						
	Strongly agree	2	11	0	0	0	0
	Agree	10	53	12	80	4	44
	Don't know	1	5	0	0	0	0
	Disagree	6	32	3	20	5	56
	Strongly disagree	0	0	0	0	0	0
9	Most farms have too much debt to survive						
	Strongly agree	0	0	2	13	1	11
	Agree	9	47	4	27	0	0
	Don't know	5	26	7	47	5	56
	Disagree	4	21	2	13	3	33
	Strongly disagree	1	5	0	0	0	0
10	Further deregulation is needed to promote profitability of cane growing						
	Strongly agree	0	0	1	7	0	0
	Agree	1	5	1	7	0	0
	Don't know	1	5	0	0	1	11
	Disagree	9	47	6	40	3	33
	Strongly disagree	8	42	7	47	5	56

1. Farm not large enough

While approximately 40 percent of growers in the three specialist groups said that their farms were large enough, 64 percent of the high water users agreed or strongly agreed that their farms were not large enough to provide their families with a satisfactory standard of living, despite this group averaging the highest level of cane production and having the highest level of farm performance during the study period. One would expect that the group with the best financial performance would also register the highest degree of satisfaction with their farm size. This however was not the case. Reasons why the 'high performance' group were generally dissatisfied with their current scale of operations are not clear but, given that there are no administrative impediments to farm purchase and expansion, it is suggested that these growers do not consider the economies of size sufficient to warrant an expansion of their existing operations at current land values. However, the finding outlined in Chapter 6 that economies of size exist in Bundaberg cane farms suggests that, given a period of adjustment, particularly in land values, cane farms could well increase in size in the future.

2. **Off farm employment and off farm income**

These findings are consistent with the results of the previous question, namely that current farm size is inadequate in the view of the sampled growers.

3. **Cane growing not as profitable**

Growers overwhelmingly believed that cane growing will not be as profitable in the future as it was in the seventies and early eighties. Sixty-five percent of growers strongly believed that cane growing will not be as profitable.

4. **Cane farms will double in size**

Though over 55 percent of specialist growers believed that farm size will double, 42 percent believed that they would not. Fifty-six percent of the high water users surprisingly did not agree even though 64% believe that their current farm size is too small. Reasons stated by growers why farm sizes would not double included the high cost of land, and the necessity to employ hired labour which they considered too expensive. Nevertheless a significant proportion believed that farm size would double over the next 20 years, supporting the view that economies of size do exist on Bundaberg cane farms.

5. **Cane farmers will diversify further**

Sixty-seven percent of specialist growers agreed that further diversification will occur, with only the below expected yield group showing a high proportion of growers (42%) disagreeing with the statement. The response to this statement, together with the response to the previous statement, suggest that Bundaberg cane farmers see major structural adjustment occurring on Bundaberg cane farms with a trend towards larger, more diversified farms.

6. **Cane price will increase**

While only 30 percent of cane farmers in the sample thought the cane price would not increase in the medium to long term, approximately 80 percent of cane growers who thought the price would increase also believed farm costs would increase by as much as or even more (Statement 6(a)). Growers tacitly believe that an increase in the real price of sugar is an unlikely remedy for the current economic position of cane growers.

7. **Water use will increase**

While thirty-three percent of the total sample believed water use on cane farms will increase in the future, a majority of growers in the low water users group did not. In contrast 55 percent of growers in the high water users believed water use will increase in the future. Again these results may reflect a belief that increased water application is not profitable, a general belief not shared by the high water users.

8. New technology will maintain viability

Even though the majority of high water users thought that water use would increase, (in contrast to the majority of growers in the low water use groups) the majority of growers in the low water users group believed that new technology (better varieties of cane, improved farm practices, etc.) would maintain the viability of Bundaberg cane farms, a view not shared by the majority of high water users. It may be that the high water users with their knowledge of the economic returns from higher water application place greater reliance on irrigation as a means of improving average farm profitability than the uncertainties of new technology.

9. Most farms have too much debt

Not surprisingly a high percentage of growers (40 percent) did not know whether **most** farms had too much debt to survive. However, while 37 percent of the sample agreed that most farms had too much debt to survive, only 11 percent of growers in the high water users group supported this view. While debt levels are, in absolute terms, low (See Section 5.13), the poor financial returns experienced in recent years, if maintained, could place financial pressure on growers.

10. Further deregulation is needed

Eighty-nine percent of growers disagreed (or strongly disagreed) with this statement with this view shared equally across all groups.

8.0 MAJOR FINDINGS AND IMPLICATIONS

8.1 Major findings

While the primary objectives of the study were to identify factors affecting the level of sugar yields in the Bundaberg district and to identify reasons for variability in the level of farm input use, it became clear in the early stages of the project that information on farm profitability and financial position were necessary to construct profiles of farms in the district and to examine the relationship between sugar yields and farm profitability and financial performance. Hence, the major findings presented below cover not only the factors affecting sugar yields but also such issues as economies of farm size, level of farm business debt and equity, farmer's attitudes towards a number of important issues and the financial performance of surveyed farms.

Factors affecting cane yields

The study examined a range of farm characteristics which were expected to affect sugar yields in the region. It was found that 70% of the variation in sugar yields over the survey period could be explained by:

- the percentage of harvested cane consisting of Autumn plant cane;
- type of irrigation use (flood or non-flood);
- number of days to irrigate the crop; (length of irrigation cycle)
- amount of nitrogen applied to ratoon crops;
- soil type; and
- water use.

The nature and magnitude of the influence of each of these variables on yields is presented below. In each case it is assumed that the values of all other influences on yield are held constant.

- *The percentage of harvested cane consisting of Autumn plant cane.*

  For every 1% increase (decrease) in the percentage of harvested cane coming from Autumn plant cane, sugar yield would increase (decrease) by 0.53 t/ha.

- *Type of irrigation used (flood or non-flood).*

  The use of flood irrigation on ratoon cane results in an additional .925 tonnes of sugar per hectare over and above the yield achieved using other types of irrigation.

- *Number of days to irrigate the crop.*

  An increase (decrease) in the length of the irrigation cycle of one day reduces (increases) yield by .128 t/ha.

- *Amount of nitrogen applied to the crop.*

  The application of the recommended quantity of nitrogen on ratoon cane increases yield by an average of 1.5 t/ha compared with below recommended applications. Above recommended applications of nitrogen result in an additional 2.5 t/ha compared with below recommended applications.

- *Soil type.*

  Sugar yields on good soils, on average, are .87 t/ha higher than on poor soils.

- *Water use.*

  The relationship between sugar yield and water use is non-linear i.e. as the amount of water applied increases, the yield improvement declines until, at some point, a maximum yield is achieved. Further increases in water use cause overall yields to decline. The results of this analysis are discussed later in this section.

Factors affecting farm profitability

The study found that 33% of the variation in farm profitability (as measured by return per hectare of total farm assignment) could be explained by sugar yield (tonnes of sugar per hectare harvested) and total labour use per hectare (weeks per hectare of cane harvested). The extent of the influence of each of these variables on sugar yields is presented below. Once again it is stressed that in each case the value of the other variable is held constant.

- *Yield*

  For every increase (decrease) in yield of one tonne of sugar per hectare, return per hectare of total farm assignment increased (decreased) by $116.

- *Total labour per hectare*

  An increase (decrease) of one week of labour per hectare of cane harvested would reduce (increase) the return per hectare by $280. The decrease in labour use per hectare would normally be achieved by spreading fixed labour (owner/operator, fulltime permanent, etc.) over a larger output. The findings pertaining to economies of farm size are presented later in this section.

Resource use

- *Land use*

  High water users had smaller farms than the other specialist cane growers with a total farm area of 58.6 ha compared with 128.0 ha and 75.2 ha for below and above expected yielders respectively.

- *Yields*

  High water users achieved an average yield over the study period of 13.2 tonnes of sugar per hectare harvested. The two low water use groups recorded significantly lower yields of 9.2 and 11.4 tonnes of sugar per hectare harvested.

- *Water allocation and water use*

  In addition to having the highest per hectare water use for all three years of the survey period, high water users had the highest per hectare water allocation expressed on both a total assigned area and harvested area basis. In 1988-89 (an 'average' rainfall year), high water users used twice as much irrigation water (4.4 Ml/ha) as low water users (2.2 Ml/ha and 2.3 Ml/ha). However, in 1990-91 low water users had the capacity to significantly increase irrigation use and applied 5.2 Ml/ha and 4.9 Ml/ha for below and above expected yield groups respectively.

Economic performance and financial position

- *Capital invested*

  Total capital invested (including land) on specialist cane farms varied from $318,000 for low water users with above expected yields to $526,000 for high water users. Land accounted for 47.6% and 66.4% of total and capital respectively. Investment in tractors was the largest non-land component accounting for between 16.2% (Low water use, above expected yielders) and 9.0% (high water users).

- *Cash receipts*

  Total cash receipts was highest for non-specialist cane farmers ($322,398) with low water users receiving between $112,453 and $123,331 for above expected yielder and below expected yielders respectively. High water users received $144,815 of which 98.8% was sugar cane receipts.

- *Cash payments*

  Total cash payments, both on a per farm and per hectare basis, varied considerably among farm groups. Non-specialist cane farmers incurred $252,896 in cash payments compared with $74,664 for above expected yielders. In all groups payments for materials was the major cost category ranging from 26.8% to 34.0% of total payments. The major difference between specialist and non-specialists was the payments for paid labour which accounted for 22.7% of total payments for non-specialists compared with between 1.5% and 4.7% for specialists.

- *Economic performance*

  For specialist cane farmers in the sample, the overall economic performance during the survey period was disappointing, with all groups earning negative returns to land both on a per farm and per hectare of assigned area basis. Low water users who also

achieved below expected yields earned the lowest return to land of -$20,913 compared with high water users who earned -$2,170. By comparison, non-specialist cane farms performed extremely well with an average return to land of $13,106 per farm.

While the sample of growers in this study cannot be considered, a 'representative' sample of Bundaberg cane growers, these figures do indicate that during the survey period specialist cane farmers in Bundaberg experienced considerable financial pressure. While, on average, specialist producers performed poorly, as indicated by the figure presented above, over 44% of growers in the high water use group achieved positive returns to land compared with only 16% and 26.8% for the low water use groups.

The study examined the relative impact on financial performance of farms in the sample of falling grower returns from sugar and poor seasonal conditions. The study found that while low yields due to poor seasonal conditions in 1990 and 1991 reduced cash income per farm by between $5,000 and $8,000 for specialist cane growers, the fall in grower returns during the study period further reduced cash income per farm by approximately $20,000 per year for specialist cane growers.

- *Farm business equity and debt*

  Absolute debt levels for specialist cane growers were low during the study period and fell in real terms for all groups except above expected yielders. As at 30 June 1991 debt levels ranged from $21,658 for high water users to $46,750 for below expected yielders. Non-specialists were relatively heavily indebted with farm business debts totalling $170,954 as at 30 June 1991. Corresponding equity levels and equity percentages were high for all specialist groups.

Economic response to irrigation

As mentioned previously in this section, the relationship between sugar yield and total water use is non linear such that equal increments in total water use are associated with a declining response in term of sugar yield per hectare. This additional yield in economic terms is called the Marginal Physical Product of water (MPP_W). The study found that (on average) the MPP_W decreased from 2.24 tonnes of sugar per hectare for the first megalitre of water per hectare applied, to 0.44 tonnes for the thirteenth megalitre. The application of the fourteenth megalitre actually results in a yield decline of .139 tonnes. Subsequent applications cause further reductions in yield.

The relationship between water use and sugar yield was used to estimated the optimum, or profit maximising level of irrigation application. The optimum level of irrigation application is that level where the increase in total revenue from applying more water equals the total additional cost of applying that water. It was found that, based on an average effective rainfall of 7.5Ml/hectare and a net return (grower returns less harvesting costs and levies) per tonne of sugar of $175, the optimum irrigation rate varied between 4.7 Ml/ha (additional cost of $35/Ml) and 1.85 Ml/ha (additional cost of $125/Ml). At a total additional cost of $75/Ml the optimum irrigation rate would be 3.4 Ml/ha.

The results of this study suggest that while on average, Bundaberg growers did not apply excessively low levels of irrigation water over recent years (especially when allowance is made for water application costs in excess of $75/Ml), sugar yields could be increased by better irrigation techniques including better timing and frequency of application of irrigation water. It is recommended that the BSES further examine the range of economic issues pertaining to irrigation use in the Bundaberg district including the efficiency of water use, irrigation response, and irrigation costs.

Economies of size

Using survey data for 1989 the following relationship between cost per tonne of sugar, yield (tonnes of sugar per hectare) and area harvested was established -

$$\text{Cost per tonne of sugar} = 389 - 15.6 \times \text{Yield} + 1863 \times \text{Area}^{-1}$$

The relationship explained approximately 40% of the variability in unit costs and both coefficients were statistically significant.

- *Yield*

  An increase (decrease) in yield of 1 tonne of sugar reduces (increases) unit costs by $15.60 per tonne.

- *Area*

  Because the variable used in the relationship was the inverse of the figure for area harvested, a positive coefficient was estimated. This inverse relationship means that an increase (decrease) in area harvested of 1 ha reduces (increased) unit costs by approximately $17 per tonne. For example, the cost per tonne at a yield of 11 tonnes of sugar per hectare harvested and an output of 4000 tonnes of cane is $256. At a yield of 14 tonnes of sugar and an output of 4000 tonnes of cane, the cost is $219. However, at an output of 8000 tonnes of cane, the cost further declines to $195 per tonne of sugar.

While the analysis suggests that economies of size do exist in Bundaberg cane farming, yield levels have a more important bearing on the average costs of cane production.

Further analysis of economies of size was carried out which incorporated a return on investment in land (which was excluded from the above analysis). This analysis showed that for an output level of 4000 tonnes of cane only farms with a yield of 17 tonnes of sugar per hectare would cover <u>all</u> costs. It further showed that at an average production per farm of 4000 tonnes of cane, yields will have to increase from 11 tonnes to 17 tonnes of sugar per hectare harvested (an increase of 55 per cent) for growers to breakeven at a grower return of $200 per tonne of sugar.

At prevailing farm sizes, sugar returns and yields, a significant percentage of Bundaberg cane growers are not meeting their total costs of production.

Specialist producers : attitudes and attributes

- *Attitude toward additional water use*

  Thirty-seven per cent of growers who on average applied low levels of water, did not consider it profitable to apply more water even in a drought year, reflecting the tight economic conditions facing growers in the survey period. Growers who thought it profitable to apply more water but did not, cited reasons as concerns about exceeding their water allocation, rostering difficulties and unwillingness to go into debt. The unwillingness to either increase or go into debt as a consequence of applying more water is again symptomatic of the uncertain economic outlook facing many Bundaberg cane growers.

  A surprisingly high percentage of low water users with below expected sugar yields (85%) considered their water use to be average or above average for the district. This may reflect a lack of awareness by a section of Bundaberg water users of the economic response to irrigation.

- *Management, ownership and education characteristics*

  The average age of cane growers (managers) was just over 50, with average management experience 20 years, cane growing experience 30 years and irrigation experience over 20 years. With the exception of that group of growers who on average were high water users, the majority of growers' formal education was completed at primary school.

  When asked the hypothetical question 'what would happen to your farm if you suddenly had to give up managing and operating the farm', over 40 per cent of specialist growers said their farms would be sold. This high percentage is again a strong indication of the uncertainty growers perceive regarding the future of cane growing in the Bundaberg district.

- *General concerns*

  Approximately 60 per cent of specialist cane growers believed their farms were not large enough to provide them with an acceptable standard of living, and 55 per cent of specialist growers believed that farm size will double over the next twenty years. Over 60 per cent of specialist growers agreed that further diversification on cane farms will occur. Cane farmers see major structural adjustment occurring on Bundaberg cane farms with a trend towards larger, more diversified farms.

  Only 33 per cent of growers believe water use (for cane production) will increase in the future, but a majority of low water users did not. These results may reflect a belief that higher levels of water application are not profitable, a general belief not shared by high water users.

  Eighty-nine per cent of growers did not believe that further deregulation was needed to promote profitability of cane growing in the Bundaberg district.

8.2 Implications

The scope of the major findings presented above is indicative of the wide range of issues currently confronting Bundaberg District cane growers. While the study has touched on a number of these issues, it has chiefly addressed the following -

- The relationship between sugar yield and farm profitability;
- Farm financial performance, economies of farm size and future industry structure; and
- Water use and irrigation response.

The following implications are discussed under these three headings. While the data from which they are drawn are based on a sample of growers which is not 'representative' of all Bundaberg cane growers, we believe the relationships derived are valid for specialist Bundaberg cane farmers as a whole.

Farm profitability and yield

Yield, as measured by tonnes of sugar per harvested hectare, has been shown to be the most important determinant of farm profitability. While falling grower returns during the study period had a greater impact on farm profitability than the below average yields achieved in the last two years of the period, industry participants can exert little or no influence on sugar prices. Hence, yield improvement, generally speaking, holds the key to the future of cane growing in the District. It has been estimated that with current farm sizes in the district, a yield improvement of around 55% would be required to achieve farm viability. Even at a farm size twice the current average a yield improvement of around 35% would be required. This raises the question of whether yield improvements of this magnitude are likely to occur in the near future on Bundaberg cane farms. If they are not achievable, then the future of specialist cane farming in the district is, at least, very uncertain.

Farm financial performance and future industry structure

At prevailing farm sizes, grower returns and sugar yields, a significant percentage of specialist Bundaberg growers are not covering total costs. Farm financial performance, during the study period, of specialist cane growers was very unsatisfactory. Even when district average yields were superimposed on the financial data for the study period, with appropriate adjustments in costs, specialist cane growers still registered negative returns per hectare of assigned land. Clearly, a continuation of the sugar prices, sugar yields and farm costs which existed during the survey period will lead to further downward pressure on land values in the Bundaberg district.

The study also showed that for the average farm in the district with an output of approximately 4000 tonnes of cane, only farms with a yield of almost 17 tonnes of sugar per hectare would cover all costs (including a return to land). While not all these costs are cash costs (e.g. depreciation, imputed interest, etc.) they nevertheless must be covered over the medium to long term if the farm is to maintain viability. One method of improving productivity, which is strongly supported by the findings of this study, is to significantly increase the average farm size in order to achieve the 'economies of size' demonstrated in this report. However, farm amalgamation, the leasing of additional cane land, or some other

form of cooperative farming structure, will only occur if land values fall to the point where such activity becomes profitable. In the presence of limited numbers of profitable alternatives to cane production in the district, it is suggested that unless substantial yield improvements are achieved, land values will fall substantially and enterprise size will increase.

Water use and irrigation response

The major implications which can be drawn from the analysis of optimal irrigation use in the Bundaberg district is that because growers were found in general, to be applying near optimal levels of irrigation water in recent years, a significant increase in irrigation use on cane farms is considered extremely unlikely. A more likely trend is an improvement in irrigation efficiency as defined by an increase in sugar yield from a given level of water use. This could entail increased use of flood irrigation, irrigation scheduling, adoption of trickle irrigation systems and the like.

The study also identified a significant difference between the water use-sugar yield relationship established by this study and that used by the BSES. This difference has obvious and important implications for determining the economic response and optimal water use in the Bundaberg district and prediction of irrigation use on Bundaberg cane farms. It is therefore recommended that further research be undertaken into irrigation response and irrigation efficiency on Bundaberg cane farms in order to more precisely define the relationship between water use and commercial sugar yield. This would allow growers to more accurately assess optimal irrigation usage.