THE ECONOMICS OF IRRIGATION DEVELOPMENT OF THE AMURI PLAINS IRRIGATION SCHEME

by

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

Irrigation has become an issue of major significance and considerable contention in Canterbury during recent years. At present, schemes which may have the capacity to irrigate 192,000 hectares in Canterbury are under consideration. There are, however, competing demands for both water and capital from other users.

It is important, therefore, that the benefits of existing schemes are recorded in order to facilitate the ex-ante evaluation of future schemes. The differences between schemes in both physical and social factors, and the effects of such differences on the expected costs and benefits of irrigation, must also be understood. Without such understanding, extrapolation from the results of existing schemes to estimate the expected benefits of future schemes may lead to serious inaccuracies.

In this study the author has used cost-benefit analysis to determine the net benefits, at both national and private levels, of the Waiau Section of the Amuri Plains Irrigation Scheme in North Canterbury. The effects on private returns of changes in the level of Government subsidization of irrigation development have also been analysed within this framework.

The A.E.R.U. has continuing interest in irrigation. Other papers concerned with this subject include A.E.R.U. Research Reports No. 99 (The Regional Impacts of Irrigation Development in the Lower Waitaki) and No. 135 (Water and Choice in Canterbury).

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Professor J.B. Dent
Acting Director

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SUMMARY

The results of a study of the costs and benefits of the Waiau Section of the Amuri Plains Irrigation Scheme in North Canterbury are presented in this report. Although this scheme has been developed under policies of lending and subsidization which have since been superseded, it was the first scheme to be subjected to strong opposition from environmentalists and consequently, the first to be developed with emphasis on water conservation. Thus it embodies issues which are relevant for future irrigation development in Canterbury.

Thirty nine properties within the scheme area were surveyed and details of physical and financial changes, sustained and proposed, which could be directly attributable to irrigation were obtained.

Cost-benefit analysis was then conducted at both national and private levels. The analysis was repeated several times to test the sensitivity of the results to changes in price assumptions and to changes in the level of Government subsidization of irrigation development.

Under the provisions of the 1975 Irrigation Policy, which applies to the Amuri Scheme, the national internal rate of return is estimated to be 9.77% while the weighted average private internal rate of return is estimated to be 32.68%. Even with the high rates of subsidization provided by this policy the cash-flow problems for many farmers are severe during the early years of development. The average discounted payback period is 12 years.

Relatively little difference was discovered between returns to the farmer under the 1975 policy and the returns under the 1983 policy, which does not include suspensory loans. However, further reduction of the subsidies, by increasing the interest rates on irrigation loans to market rates and disallowing the three year interest and principal deferrment introduced in the 1983 policy, reduced the mean private internal rate of return to 26.31%. Removal of the subsidies inherent in the water-charges paid by farmers resulted in a further reduction of the private IRR. Although the private returns were still markedly higher than the national returns, it is most important to note that in the absence of all specific irrigation subsidies the cash-flow deficits sustained in the development years are extremely large. The extension of the discounted payback period to 20 years, particularly at a time when confidence in the farming industry is low, may well discourage farmers from undertaking irrigation development in the future if all subsidies for irrigation development are removed.

CHAPTER 1

INTRODUCTION

1.1 The Amuri Plains Irrigation Scheme

The development of the Waiau Section of the Amuri Plains Irrigation Scheme was first discussed in 1950 when local farmers approached the Government to ask that such a scheme be considered. Preliminary surveys were carried out but no further action was taken until the early 1970s.

In 1975 a ballot was conducted amongst landowners in the scheme area and it was decided that the scheme should proceed. Official approval was given in July 1977 and work started in September of that year.

The area served by the scheme has, in early technical and economic evaluations, been estimated to be approximately 17,000 hectares. However, Ministry of Works and Development staff now estimate the area served by gravity-feed within the scheme boundaries to be 13,606 hectares. It is this area on which current estimates of water charges have been made. The analysis discussed in this report, therefore, used 13,606 hectares as a basis for apportioning off-farm costs between properties.

Within this section of the scheme are 89 properties of which 86 are in agricultural use. The remaining three properties belong to sports clubs. The area covered by the Waiau Section of the Amuri Plains Irrigation Scheme is shown in Figure 1.

It is now anticipated that off-farm development works will be completed during the 1985-86 financial year and that on-farm development will be finished during the early 1990s.

The first properties received water in November 1980, and by the time this study was conducted approximately 60 properties were able to irrigate.

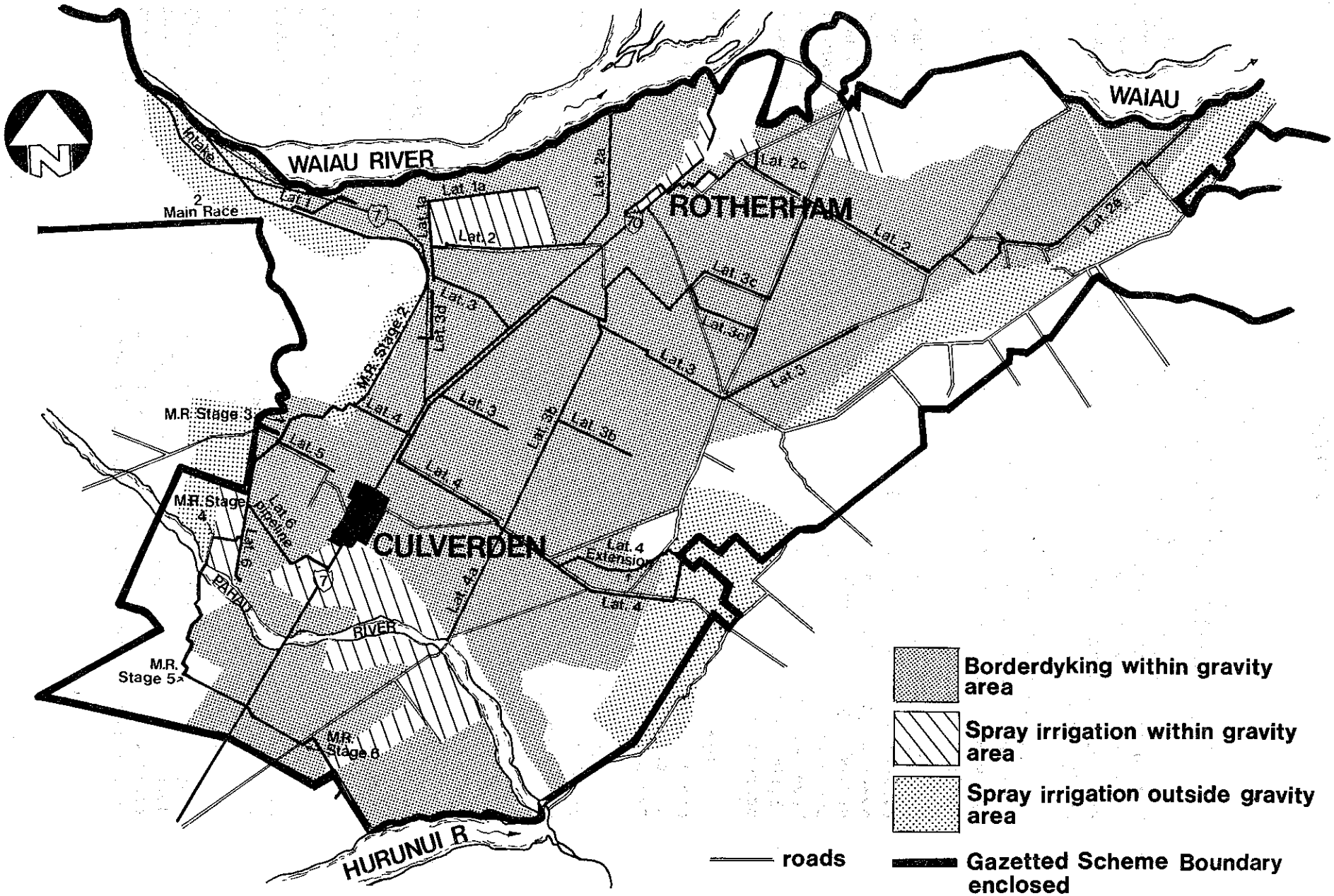
At the time development began the area was largely devoted to sheep farming with flocks breeding their own replacements. Some cattle were run and some cereal and small seed crops were grown.

Adjacent to the Waiau Section of the Scheme a further 5,000 hectares will be irrigated by water from the Balmoral section. This scheme received official approval in 1981 and farms will receive water for the first time during the 1985/86 season.

The Amuri Plains Scheme has been, and will continue to be, developed under the rates of on-farm and off-farm subsidization laid down in the Government irrigation policy introduced in 1973 and ratified in 1975. Under this policy 50% of the costs of earthworks and structures is covered by a subsidy in the form of a suspensory loan to

FIGURE 1

The Waiau Section of the Amuri Plains Irrigation Scheme



be written off over ten years. Spray irrigators also receive a suspensory loan for 50% of the costs of 'non-transferable' irrigation development. This includes the costs of installation and the purchase cost of items other than applicators, pumps and motors which could be removed from the property.

Spray irrigators benefit also from a provision of the current irrigation policy which was introduced in 1983. Under this policy irrigation plant has become eligible for Rural Bank development loans. This was not the case under previous policies.

1.2 The Purpose of the Study

It is recognised that dryland farming in Canterbury is nearing its potential under present farming systems and that irrigation represents a major avenue to increased farm production. Of an estimated 500,000 hectares of land considered suitable for inclusion in community irrigation schemes in Canterbury, approximately 117,000 hectares have been developed or have received approval for development. A further 192,000 hectares are included in the Central Plains, Lower Rakaia, Barrhill and other Schemes which are presently under consideration. The development of such schemes is extremely costly and there are competing demands for both capital and water from other users. It is, therefore, important that the benefits of existing irrigation schemes are accurately documented in order to provide a sound base of data for ex-ante evaluations of future schemes.

Although ex-ante evaluations have been made of all recent community irrigation schemes, there have been few published ex-post studies. Of those which have been published, most deal with aspects other than the changes in farm productivity.

In addition, the implication of government policies designed to subsidize private investment is that the investment is more attractive to the nation than to the individual investor. Consequently, differences may arise between national and private objectives. Policy decisions concerning changes to subsidies of this kind would be aided by an objective measure of the extent to which national and private returns differ.

For these reasons it was decided to conduct a detailed study of the costs and benefits of the Waiau Section of the Amuri Plains Irrigation Scheme. Although the full benefits of irrigating the Waiau Section of the Amuri Plains have not yet been realised, it was considered important that a preliminary study be conducted while farmers' recollections and records of development and changes in the levels of production were still available. Already a number of properties have changed ownership or undergone subdivision and it is expected that this trend will continue. It is anticipated that future monitoring of the scheme will be undertaken.

Such a study will be of use in the formulation of future irrigation policies and in future ex-ante evaluation of irrigation schemes.

1.3 The Scope of the Study

Thirty nine farmers in the scheme were selected randomly. Each farmer was interviewed to obtain details of irrigation development costs, changes in farm operating costs, changes in production parameters, and loans received as a consequence of irrigation development.

These data were used to estimate the net present values and internal rates of return of irrigation to individual farmers and to the nation as a whole.

1.4 The Organisation of the Report

The remainder of the report is organised into three chapters. Chapter 2 of the report details the methodologies used in assessment of the costs and benefits of irrigation at both national and private levels. In Chapter 3 the results of an exercise in land valuation carried out in conjunction with the cost-benefit study are reported and the question of capital gains considered. The results of the analysis are described in Chapter 4 and their implications discussed.

CHAPTER 2

THE METHODOLOGY

2.1 The Sample

Of the eighty nine properties within the boundaries of the Waiau Section of the Amuri Plains Irrigation Scheme, seventy three were considered eligible for inclusion within the survey sample. Of these, four were farmed in conjunction with other properties in the sample population and did not have a separate accounting identity. They were, therefore, included in the population only as parts of other farms. The reasons for excluding the sixteen properties are shown in Table 1.

TABLE 1

Reasons for Ineligibility for Inclusion in Sample

Reason for Exclusion	No. of Properties Excluded
No irrigation plan i.e. no projections of stocking rates or estimates of costs available yet	7
Farm area less than 5 hectares	5
Property of more than 5 hectares not a commercial farming enterprise	3
More than one separate property farmed by one owner	1
Total	16

The sixty nine eligible properties were then divided into two groups according to whether or not they had had water available for at least one season as at June 1983, and further subdivided according to the proportion of the farm area irrigable. The categories designated and the number of properties in each are shown in Table 2.

TABLE 2

Categorisation of Properties Eligible for Inclusion in Sample

Water Available for:	Proportion Irrigable <40%	40-80%	>80%
Less than one full season	5	9	10
At least one full season	9	15	21

Two-way proportional stratified random sampling was then used to draw a sample of forty farms, fourteen of which had been irrigating for less than one full season or had not yet started irrigation.

2.2 The Survey

The majority of farmers was interviewed by the author during late May and June of 1983 and the remainder during the following three months.

Of the farmers approached, five refused to be interviewed and in a further three cases farming operations were of such a complex nature that it was not possible to determine the expected effects of irrigation at such an early stage. The overall response rate was, therefore, 80%. In fact, only thirty nine valid responses were elicited since there were two refusals from farmers in the smallest group and only one replacement was available. The other seven properties which could not be surveyed were replaced by others randomly drawn from the same strata. Ten of the properties surveyed had been sold since the scheme was voted in. In six of these cases it was necessary to speak to previous owners to obtain information about the farm before development or the costs of early development. The remainder were family transactions or transactions which occurred some time before development was started.

The thirty nine properties surveyed included 8,529 of the 13,606 hectares in the scheme.

2.3 The Questionnaire

The questionnaire administered to farmers surveyed is shown in Appendix 1. An initial draft of the questionnaire was given to Ministry of Agriculture farm advisors and Lincoln College staff for comment before being pre-tested on two Amuri farmers.

As the pre-test showed the questionnaire to be satisfactory in its present form, the pre-tested farmers were not excluded from the sample population.

On average, each farmer took between two and a half and three hours to respond to the questionnaire which was completed by the interviewer. In general, farmers provided the considerable volume of financial information required very willingly. Many of them found the costs of irrigation development easier to recall in physical than in financial terms.

2.4 The Analysis

2.4.1 The dryland base.

Before the costs and benefits of irrigation could be assessed it was necessary first to determine the changes in farm production likely to have occurred in the absence of irrigation. The problem has two facets. The first is the assessment of the changes which would have occurred between the beginning of on-farm irrigation development and June 1983. The second facet is the estimation of changes in dryland productivity over the next ten years. It was not considered feasible to extend the estimates beyond that period and the assumption of static productivity after that time is therefore inherent in the analysis.

It was assumed that the balance of crop and sheep enterprises present in the area before development began would have continued to exist had irrigation development not been undertaken. Unless farmers specifically stated otherwise, it was assumed that the movement out of cattle into sheep which occurred during the late 1970s was a consequence of factors other than irrigation.

The possibility of irrigation of farms within the scheme from groundwater was not included in the estimation of the dryland base since the Amuri Plains area has only limited supplies of groundwater. In addition, groundwater transmissivities are believed to be low.

(a) The dryland base to 1984.

Between summer 1980 and late spring 1983 the Amuri Plains, like the rest of Canterbury, experienced severe drought. This drought has had considerable impact on the costs and benefits of irrigation development. For some, who developed rapidly and had water available early, the effects of drought have been mitigated by irrigation. For others, without significant areas irrigated but with stock numbers increased in anticipation of irrigation, the effects have probably been exaggerated. A method of quantifying these changes was required for the analysis.

At first it was hoped that a largely objective approach could be applied to this section of the analysis. Farmers in the neighbouring Balmoral Section of the Scheme have not yet received irrigation water, and in June 1983 had undertaken relatively little development. It was decided to survey them to determine the changes in farm productivity which had occurred during the years of drought and to attempt to correct the results obtained by the difference in average productivity between the two areas. The decision to survey the Balmoral farmers rather than farmers in a similar area not affected by irrigation at all was taken because it was anticipated that higher levels of co-operation

would be obtained from farmers with a personal commitment to irrigation.

However, although this survey was conducted, only eleven valid responses were obtained from farmers whose properties could be considered typical of those in the Waiau Section of the Scheme and had not been undergoing other major development during the period. It was felt, therefore, that while the data obtained would provide a useful input to a more subjective approach, they were not sufficient on their own to assess the effects of drought on the Waiau properties. These results are shown in Table 3. Farms were divided into upper and lower groups on the basis of stocking rate.

TABLE 3

Changes in Stock Productivity on Eleven Farms in the Balmoral Irrigation Scheme

Year	S.U./ha	% Change	% Lambing[a]	% Change	Wool/S.U.	% Change
(1) Average of All Farms Surveyed						
Status Quo	8.20		99.56		4.53	
1980	8.41	2.6	103.10	3.6	4.38	-3.3
1981	8.59	4.8	110.38	10.9	4.97	9.7
1982	8.59	4.8	104.08	4.5	4.15	-8.4
1983	8.01	-2.3	98.19	-1.4	3.98	-12.1
(2) Average of Top Half						
Status Quo	9.54		98.44		4.43	
1980	9.54	0	103.86	5.5	4.37	-1.4
1981	9.53	0	108.97	10.7	5.05	14.0
1982	9.87	-7.0	106.09	7.8	4.04	-8.8
1983	8.74	-8.4	94.90	-3.6	4.05	-8.6
(3) Average of Lower Half						
Status Quo	7.04		100.91		4.61	
1980	7.05	0	102.18	1.2	4.39	-4.8
1981	7.49	6.4	112.08	11.1	4.88	5.9
1982	7.31	3.8	101.58	0.7	4.25	-7.8
1983	7.14	1.4	102.14	1.2	3.90	-15.4

a Survival to sale or fat.

Changes in crop production were impossible to gauge using this approach since, although total yield could be extrapolated from farm accounts, many farmers were unsure of the areas relating to those yields.

Secondly, a dry-matter deficit approach was adopted. It was intended to use empirically established relationships between pasture dry-matter production and available soil moisture holding capacity to establish dry-matter deficits, and therefore changes in stock production or feed purchases. Such relationships had already been derived on similar soils in Central Canterbury and it was hoped to extrapolate from these to the soils of the Amuri Plains. The soils of the area were divided into five broad categories on the basis of depth and water-holding capacity (AWHC). These groups are defined in Table 4.

TABLE 4

The Soils of the Waiau Section of the Amuri Plains Scheme

Group	Soil Types	Depth	Average AWHC (mm)
1	Balmoral stony and very stony	Shallow	40
2	Balmoral Shallow/Eyre/ Waimakariri Shallow/Selwyn Shallow	Shallow/ mod deep	70
3	Chertsey/Waimakariri/ Selwyn/Pahau	Mod deep	90
4	Barrhill/Hatfield/Templeton/ Kaiapoi	Mod deep	120
5	Wakanui/Temuka	Deep	120

SOURCE: T. Webb, D.S.I.R., pers. comm.

NOTE: The Pahau soils, although much deeper than the Chertsey and other soils in Category 3 have impeded drainage, thus reducing the proportion of total soil moisture which is available to plants.

However, application of empirical relationships established on similar soils in the Central Plains region of Canterbury produced results which appeared unrealistic both to the agronomists and farm advisors consulted. Consequently soil types were useful only as input data to a subjective approach to the estimation of the past and future dryland bases.

Finally, it was decided to present the data described above and data available on individual farms to advisors familiar with the properties and the personal characteristics of the farmers, asking them to estimate the effects of the drought on each property in the absence of irrigation development.

The form of the on-farm data presented to advisors is shown in Appendix 2.

Fortunately, the area has a very high advisory input from the Ministry of Agriculture and Fisheries and from private farm consultants. For most farms at least two of the advisors approached were able to estimate the changes in stocking rates, wool production, lambing percentage and feed purchases which would have arisen had development not occurred. Differences between estimates made by different advisors were extremely small and tended to be self-balancing. Where such differences occurred an average figure was used.

The impact of the drought will also have been observed on stock productivity in the 1984 financial year although the drought broke during that season. Estimates of that impact were also obtained.

(b) The dryland base in future.

A similar subjective method was used to estimate the dryland base for the next ten years. Advisors were asked to assess how far each farm was from its potential carrying capacity. Then, based on their knowledge of the individual farmers, they were asked to estimate the increases in productivity and carrying capacity likely to be realised.

There were only small differences between estimates provided by different advisors, and as before, an average figure was used.

2.4.2 The future with irrigation.

Actual changes in farm costs and production levels were obtained in detail from farmers for the years 1978-1983. Estimates of future changes in production levels were obtained from both farmers and farm advisors. It is hoped that continued monitoring of the scheme will be undertaken which will not only provide an accurate record of the changes which occur during irrigation development, but will also provide information on the accuracy with which such changes are estimated.

Farmers were asked for their estimates of future stocking rates and enterprise balances as well as future cropping areas. However, it was not considered that farmer estimates of changes in stock productivity or crop yields should be used. Consequently, advisors were also asked to estimate changes in wool production and lambing percentages given the total area to be irrigated and the stocking rate expected. Each of the advisors interviewed felt that some farmers had significantly underestimated their post-irrigation status-quo stocking rates in the light of their farming abilities and the potential of their properties. It was considered that when these farmers became fully aware of the

effects of the full water charges, they would increase stock numbers to levels higher than those which they presently anticipate.

As was the case with estimates of the dryland base, there were no major differences between estimates made by different advisors.

2.4.3 Costs of irrigation.

(a) On-farm costs.

The on-farm costs of irrigation have been divided into two major categories, capital costs associated with development and the changes in the farm running costs as a consequence of irrigation.

Calculation of individual cost items is fully described in Appendix 3.

All costs have been estimated in 1983 dollars and have been determined either by calculating the actual cost in 1983 of the resources employed or by inflating the monetary cost incurred in previous years by the appropriate indices. Where published indices have not been available, for example in the case of fencing costs, they have been calculated using the methods outlined in Appendix 3.

On-farm costs to be used in the private financial analyses have been calculated net of subsidies on irrigation development, Catchment Board approved shelter and fertiliser, although the value of these subsidies has been included in the national analysis.

Selected totals of on-farm capital costs are shown in Tables 28 and 30 and changes in operating costs are presented in Tables 29 and 31 (Appendix 6).

(b) Off-farm costs.

Off-farm costs of the irrigation scheme and of the associated Amuri Plains Rural Water Supply scheme are apportioned between the area included and that which is excluded from the analysis by multiplying total costs by 8,529/13,606[1] = .627. The total off-farm costs incurred are shown in Appendix 3.

2.4.4 Benefits of irrigation.

The benefits of irrigation have been calculated using the prices shown in Appendix 4.

For sheep enterprises the net return per ewe, irrigated and dry land, has been calculated for each year. A gross margin approach has been extended to include all sheep benefits including those from the purchase of store stock. The return per ewe has then been multiplied by the total number of ewes, and the total benefit of irrigation calculated by subtracting the dryland result from the irrigated result.

1 The proportion of total irrigable area included in the survey.

In the gross margin actual costs have been used where these have been expected to vary between farms but other costs have been standardized. Standard distances of 100 kilometres to Christchurch and 10 kilometres to Culverden have been used in calculating transport costs. The form of the gross margin used is shown in Appendix 5. The gross margin costs have been derived from the Lincoln College Budget Manual 1983.

Crop benefits also have been calculated using a gross-margin approach. The dryland base used has been calculated by multiplying pre-irrigation status-quo yields and areas by the prices current in each year of the analysis. The gross margin form is shown in Appendix 5. Crop yields were estimated using a model developed by Dr T. Heiler of the Agricultural Engineering Institute, Lincoln College, and are shown in Table 5.

Cattle, dairy and other benefits including horticulture, deer and sheep benefits for properties carrying only trading stock have been hand calculated on an individual property basis since there were few instances of each.

On three of the properties surveyed irrigable area was a very small proportion of total farm area. In addition, irrigation development was undertaken at a time when other major development projects were in progress or anticipated. On these properties changes in stock numbers or productivity could not be attributed entirely to irrigation and it was felt that a more appropriate approach would be to calculate the conversion of extra pasture dry-matter into stock production increases. The assumptions used in this calculation are shown in Table 6.

TABLE 5

Crop Yields under Irrigation by Soil Types for Soils on Which Cropping Will Occur under Irrigation

Soil Group	Crop Yield (tonnes/hectare)				
	Wheat	Barley	Peas	Grass seed	Clover
1	4.512	4.338	3.680	0.977	0.360
2	4.677	4.589	3.813	1.011	0.372
3	4.783	4.701	3.897	1.021	0.378
4,5	4.880	4.824	3.970	1.027	0.382

TABLE 6

Assumptions Used in Calculation of Stock Production Increases with Irrigation

Additional D.M. per hectare	
Soil Group 0	4,000kg
Soil Groups 3 and 4	6,200kg
Pasture Utilisation	85%
Flushing one ewe for 5 weeks to achieve .1 extra lambs and .2 kg extra wool	14.0kg
Increasing bodyweight of 1 ewe by 10kg throughout the year (from 40 to 50 kg L.W.) to achieve .2 extra lambs and 1 kg extra wool	36.5kg
Increasing carcase weight of 1 lamb by 1 kg (assuming a growth rate of 100 g LW/day and an average consumption of 1.2 kg DM/day)	17.5kg

2.4.5 Loans received for irrigation development.

Details of the loans incurred by each farmer were obtained during the interview or, with the farmers' permission, from the Rural Banking and Finance Corporation. Farmers were also asked to estimate the proportion of future development to be financed by borrowing. Interest and principal repayments were then calculated based on the amount borrowed during each financial year. This standardized method will have resulted in some inaccuracies in the estimation of annual principal repayments since the terms of irrigation development loans begin when the first advance is made on any loan, and loans may be uplifted over two or three years.

For the purposes of the analysis the interest rates on loans made before the 1984 financial year have been assumed to drop by 1.5% at the end of 1984. In reality, this decrease will not occur until the end of the current review period.

Future loans have been included with the same term and interest rate (adjusted for the decrease in 1984) as the most recent of the loans already received.

In the few cases where flat mortgages from sources other than the Rural Bank have been taken out for development it has been assumed that these loans will be refinanced at the end of the current term, and that interest payments will therefore continue.

As the analysis has been undertaken with all data in real ($1983) terms, the loans received have been inflated using the Ministry of Works and Development Construction Costs Index (Table 20). All other costs and benefits which will increase in nominal terms have been included in constant real terms. Therefore debt servicing costs, which are fixed in nominal terms, must decline in real terms. The Farm Input Price Index compiled by the New Zealand Meat and Wool Boards' Economic Service has been applied to past debt servicing costs and, as a future inflation rate of 8% has been assumed, future debt servicing has been deflated by 8% per year.

Payments under the Livestock Incentive Scheme are added to other loan advances.

2.4.6 Net present values and internal rates of return.

A FORTRAN program, written for the VAX 11/780 computer was used for financial analyses of irrigation development on both individual farm and national bases.

At the individual farm level the unit of analysis is the farm itself rather than the owner of that farm. Thus, where farms have been sold during development, the loans taken out for development by previous owners have been assumed to continue. In cases where present owners intend to diversify into dairying by entering into sharemilking agreements, dairy stock have been included as a capital cost to the farm and all running costs as additions to farm operating costs.

The program calculates for each farm the net present value (at specified discount rates) of costs, benefits and loans per farm, per irrigable hectare and per hectare irrigated. Where possible, private internal rates of return were calculated, although for a number of farms the internal rate of return function had multiple roots.

At the national level the program adds to the total of private costs the subsidies paid and the off-farm costs incurred. Water charges and stock water charges paid by individual farmers are subtracted since the off-farm costs of irrigation and water supply have been included in the years in which they were incurred. The program calculates the internal rate of return using the interval bisection method and also calculates net present values at specified discount rates.

Price sensitivity analysis was conducted at both national and individual farm levels by altering all the prices by specified proportions.

The analysis was conducted with and without the foreign exchange weighting coefficients presented in Table 27.

Sensitivity to different irrigation policies was also examined. While the Amuri Plains Irrigation Scheme was developed under the 1975 policy of suspensory and development loans, subsequent schemes will be implemented under the Irrigation Policy introduced in 1983. This latter policy does not provide for subsidisation of on-farm construction works but irrigation loans for the full value of such works will be provided by the Rural Bank. The conditions applying to these loans will include a three-year principal holiday with interest deferred during that period. After three years annual repayments will be based on the original loan plus the deferred interest. Deferred interest is calculated as simple interest. In general, interest rates of 7.5% or 9.5% and terms of ten or fifteen years will apply after the initial three years. In addition, off-farm subsidization changed from 100% of headworks and 50% of distribution costs to 70% of both headworks and distribution costs.

Using the details of existing loans and subsidies obtained from farmers and the Ministry of Works, the borrowing and debt-servicing of each farmer were recalculated as if the latter policy had prevailed. It was assumed that each farmer would borrow the full amount of the existing subsidy.

The analysis was then repeated for each loan policy without the constraint of a particular time-frame. Long-term-forecast product prices were substituted for the actual prices employed previously and actual rates of inflation were replaced by the long-term-forecast rate of 8%. Current interest rates were included and the effects of the Livestock Incentive Scheme excluded.

Finally the sensitivity of the results to a variety of subsidy, interest-rate and water charging policies was tested.

CHAPTER 3

LAND VALUES IN THE WAIAU SECTION OF THE AMURI PLAINS IRRIGATION SCHEME

3.1 Valuation Results

Ten properties, all of which have been sold since the Amuri Plains Irrigation Scheme was approved in July 1977, were valued on 29th of August 1983. Land value only was assessed during this exercise and the values discussed in this section exclude all structural improvements such as buildings, fences and irrigation structures. The valuations, therefore, include the value of the potential to irrigate and the added value of the earthworks and pasture sown after border-dyke development.

A major source of difficulty encountered during the valuation exercise was the market fluctuation which has occurred during the past three years. Valuations, both irrigated and the hypothetical dryland valuations made, have been based on comparable sales from 1980 to 1983. Unfortunately there have been few recent sales of properties, border-dyked or dry, in the area.

Market fluctuations have been a consequence of changes in the market's expectations of the potential for irrigated and non-irrigated properties. Market expectations during the period have been affected by changes in the predicted long-term returns for agricultural products, by climatic events, and most recently by changes in land use. Two of the latest sales in the area have been made for conversion to dairying.

In Table 7, land valuations are related to particular soil types and carrying capacities. Where possible, valuations are given for each soil type with border-dyke development, with potential to irrigate but no development, and dryland without irrigation potential. The valuations relate only to the ten properties valued and extrapolation to other properties with similar soil types may lead to major inaccuracies.

Land-value per hectare in every case was highest where border-dyke development had occurred and lowest in the absence of irrigation potential. Land values per stock unit on the other hand were highest with irrigation potential and lowest where development had been undertaken.

3.2 Regression Analysis

Regression analysis was used in an attempt to relate land/sale price to measurable factors expected to affect sale price. These factors were:

TABLE 7

Land Values per Stock Unit and per Hectare on Ten Properties Sold Between 1979 and 1983

SOIL TYPE	ESTIMATED CARRYING CAPACITY S.U./ha		LAND VALUE/STOCK UNIT $/S.U.			LAND VALUE/HECTARE $/ha		
	Borderdyked	Dryland	Borderdyked	With Potential	Dryland Without Potential	Borderdyked	With Potential	Dryland Without Potential
Balmoral Very Stony Silt Loam	14.5	6.5	165	261	200	2,400	1,650-1,700	1,300
Balmoral Stony Silt Loam	15.0	6.5	167	261	204	2,500	1,700	1,300-1,350
Chertsey Mod. Deep Silt Loam	17.5-18.0	9-11	167	218	216	2,950-3,000	2,400	2,250-2,300
Hatfield Mod. Deep Silt Loam	18.0	12.0	167	-	192	3,000	-	2,300
Hatfield Deep Silt Loam	-	14.0	-	214	171	-	3,000	2,400
Temuka Silt/Clay Loam (Imperfectly drained)	17.0	10.5	165	-	186	2,750		1,950
Wakanui Mod. Deep Silt Loam (Imperfectly Drained)	18.0	13.0	167	-	184	3,000	-	2,400
Waimakariri Shallow and Stony	-	8.0	-	225	200	-	1,800	1,600
Eyre Shallow and Stony Silt Loam	15.0	7-7.5	167	-	180-185	2,500	-	1,300-1,350
Templeton Mod. Deep Fine Sandy Loam	17.5	10.0	160	220	200	2,800	2,200	2,000
Kaiapoi Mod. Deep Silt Loam (Imperfectly Drained)	-	10.5	-	209	200	-	2,200	2,100
Pahau Silt Loam (Shallow and Imperfectly Drained)	-	8.0	-	221	200	-	2,100	1,900

(a) Total farm area (hectares) : (AREA)

(b) Sale date (on a monthly basis - August 1980 = 0, August 1983 = 36) : (DATE)

(c) The desirability of the soils on the property based on the groupings described in Section 3 : (SOILS)

(d) The potential area irrigable (ha) : (POTN)

(e) The contour of the property (CONTOUR) : 1 = Flat
2 = Undulating
3 = Hill Country (No potential for irrigation)

The most satisfactory explanation of the sale price per hectare was obtained using data from thirteen properties sold within the scheme area during the relevant period. The ratios of area border-dyked to potential area irrigated (BD : POT) and irrigable area to total area (IA : TOT) were included as independent variables. The equation derived is shown below:

$$\text{SALE PRICE} = 1753\ \text{AREA} + 6061\ \text{DATE} + 39614\ \text{SOILS} + 353\ \text{CONTOUR} - 15360\ \text{BD:POT} + 5164\ \text{IA:TOT} - 212147$$

Statistics
Adjusted R^2 = .91
F = 17.91

3.3 Capital Gains

Table 7 shows, that at 1983 land prices, capital gains to be made as a consequence of the introduction of the Amuri Plains Irrigation Scheme are probably made because of the potential to irrigate rather than because irrigation development has actually been undertaken.

Differences in valuation between developed land and potentially irrigable but undeveloped land range between $450 and $800 per hectare. An approximate average cost per hectare for earthworks is $800 of which, in this Scheme, the farmer pays 50%. Cultivation, fertiliser and lime, and seed cost on average approximately $140 hectare. Thus development costs farmers approximately $540 per hectare excluding labour to borderdyke and grass-down land. For most farmers significant capital gains cannot be made by developing and selling potentially irrigable land, and, in fact, capital losses may be incurred. Taxation savings may offset such losses to a greater or lesser extent.

Differences in market value between dryland with the potential to irrigate and dryland without that potential range from $100 to $400 per hectare with no costs incurred by the farmer in the transition. All regression equations estimated gave an increase in market value per hectare of approximately $200 per hectare. Part of that increase in net present value is the taxation saving to be made as a consequence of

development expenditure and the capital losses incurred by some farmers selling border-dyked land reflect the inability to make such savings on land already developed.

CHAPTER 4

THE RESULTS

4.1 Results of the National Analysis

At the national level, and under current price assumptions, the internal rate of return of the Waiau Section of the Amuri Plains Irrigation Scheme is estimated to be 9.77%. If the foreign exchange adjustments presented in Table 27 are included in the analysis the internal rate of return increases to 10.10%. At the Government's guideline discount rate of 10% the scheme has a net present value to the nation of -$413,369 or -$48.47 per irrigable hectare. The results of price sensitivity analysis conducted at the national level are shown in Table 8. Only future prices have been varied.

TABLE 8

Results of Price Sensitivity Analysis at the National Level

Price Level Assumed	Internal Rate of Return %	Net Present Value at 10%	
		$ Per Irrigable ha	$ Per irrigated ha
Actual	9.77	-48	-58
Actual +10%	10.73	156	186
Actual +25%	12.09	550	462
Actual +50%	14.16	972	1159
Actual -10%	8.76	-253	-301
Actual -25%	7.13	-559	-666
Actual -50%	4.05	-1069	-1274
[Actual prices -10% while Actual costs +10%]	8.29	-363	-433

4.2 Results of the Private Analysis

The results outlined in this section should be considered in conjunction with the discussion presented in Section 4.4 where a number of factors which influence their interpretation are discussed.

A number of measures of private economic returns are described in the tables and text of the remainder of this report. These are defined as follows:

Weighted mean NPV per irrigated (irrigable) hectare: The net present value per irrigated (irrigable) hectare on each property has been weighted by the ratio of irrigated (irrigable) hectares on that property to the total irrigated (irrigable) area. These values have been summed to derive the mean NPV.

Weighted mean IRR per irrigated (irrigable) hectare: Those private IRRs which it has been possible to calculate have been weighted in the same manner as the NPVs and the mean calculated.

Total NPV per irrigated (irrigable) hectare: The total private cash flow has been calculated by summing all individual private cash flows and deriving the total net present value per hectare.

Total IRR: Also calculated from the total private cash flows.

Differences which arise between the 'total' and 'weighted' measures are a consequence of the differences in the timing of development on different properties. The 'total' measures discount all costs and returns to 1978. The 'weighted mean' measures discount the costs and returns on each property to the year in which investment began on that farm.

4.2.1 The private analysis under the conditions imposed by the 1975 Irrigation Policy.

Under the policies of subsidization and Rural Bank lending which apply to this scheme the returns to the farmer are inevitably very much higher than to the nation.

The weighted mean internal rate of return is estimated to be 32.68% while the internal rate of return calculated from the total private cash-flow for the scheme at current prices was 27.08%. Only eighteen individual rates of return were calculable. The streams of net benefits accruing to irrigation on the other twenty one properties exhibited more than one change of sign and a unique solution to the internal rate of return function was not, therefore, possible. Consequently a more complete picture of the distribution of private returns can be derived from the private net present values calculated. Figures 2 and 3 depict the distribution of private NPVs, discounted at 10%, per irrigated hectare and per irrigable hectare respectively. Although the total irrigable area of the properties surveyed is 8529 hectares, farmers presently intend developing only 7282 hectares or 85% of the area possible. Most felt that the future prospects of the pastoral industry were too uncertain to justify incurring the capital costs of developing the remaining areas.

The weighted mean NPV per irrigable hectare for the scheme was $1140 and weighted mean NPV per irrigated hectare, $1293. However, as Figures 2 and 3 show, the benefits of irrigation vary markedly between farms. In Table 9 the means and standard deviations of private returns are shown. The properties for which IRRs could be calculated did not differ significantly at the 95% level with respect to NPV per hectare from those for which the calculation was not possible. It was, therefore, considered valid to include the weighted means and standard

FIGURE 2

Distribution of NPVs (.10) per Irrigated Hectare

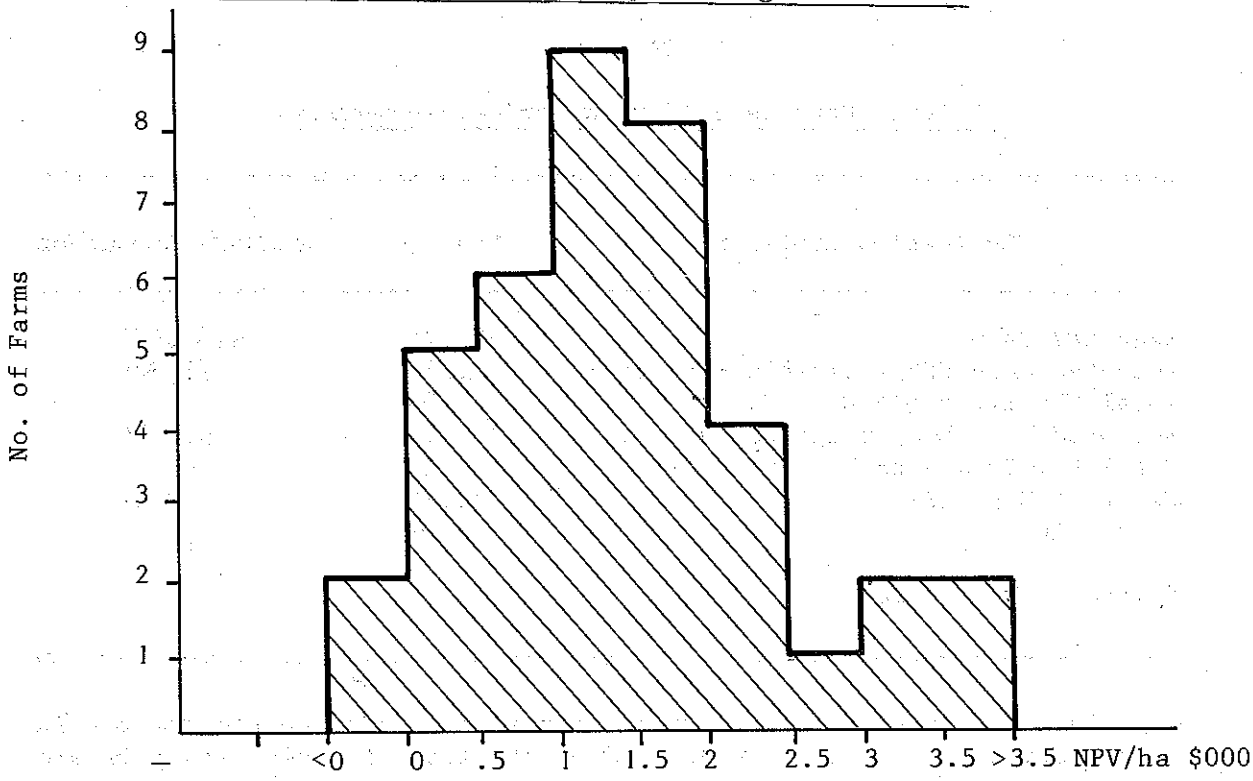
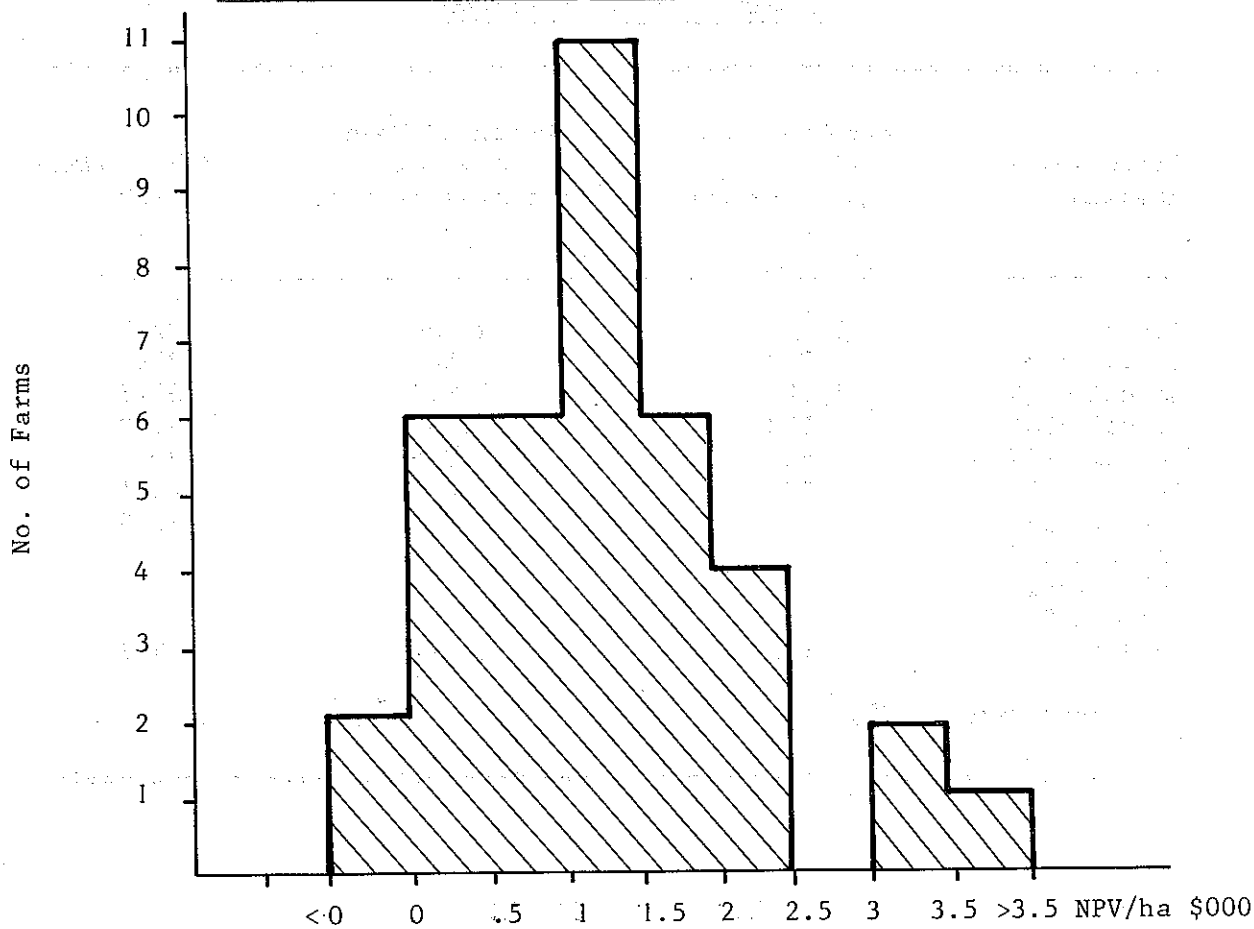


FIGURE 3

Distribution of NPVs (.10) per Irrigable Hectare



deviations of private IRRs in Table 9.

TABLE 9

Private Returns at Current Price Assumptions

Evaluation Criterion	Mean	Standard Deviation
Mean NPV/Farm	$241,546	$177,957
Weighted Mean NPV/Irrigable Hectare	$1,140	$1,046
Total NPV/Irrigable Hectare	$1,104	-
Weighted Mean NPV/Irrigated Hectare	$1,293	$1,370
Total NPV/Irrigated Hectare	$1,316	-
Weighted Mean IRR	32.7%	28.6%
Total IRR	27.1%	-

(Discount rate = 10%)

The sensitivity of the private return to irrigation to changes in future prices was also tested. The results of this analysis are presented in Table 10.

TABLE 10

The Sensitivity of Private Returns to Changes in Future Product Prices

Price level Assumed	Weighted Mean NPV per Irrigable Hectare $	Weighted Mean NPV per Irrigated Hectare $	Weighted Mean IRR %
Actual	1,140	1,294	32.7
Actual +10%	1,359	1,541	35.2
Actual +25%	1,686	1,913	38.5
Actual +50%	2,233	2,533	42.9
Actual -10%	922	1,046	30.2
Actual -25%	594	674	25.4
Actual -50%	48	55	17.5
[Actual prices -10% while Actual Costs +10%]	848	1,011	23.9

(Discount rate = 10%)

An important aspect of the effect of irrigation development on the financial position of the farm is the net effect on the farm cash-flow. Table 11 details the average net effect of irrigation for the years 1978-1994. These figures have been obtained by multiplying the weighted average cash-flow per irrigable hectare by the average number of irrigable hectares per farm (219). However, it should be noted that this average cash-flow understates the annual deficits which result for many farms in the early years, since it is derived by averaging the total development costs in each year over all farms surveyed. The average cash flow thus calculated includes some development cost in each year that development was undertaken on any property. The cash-flow also includes financial reward for extra production from the time when production increases were realized on the first farms. For most properties the bulk of expenditure will occur over a shorter period and annual deficits will be larger than for the calculated average.

TABLE 11

Net Effect of Irrigation on the Average Cash-Flow Position 1978-1994

Year	Net Effect on Cashflow $1983	Year	Net Effect on Cashflow $1983
1978	-1,996	1987	34,502
1979	-2,744	1988	40,168
1980	-11,800	1989	45,384
1981	-13,558	1990	50,225
1982	-8,227	1991	54,749
1983	-13,869	1992	55,064
1984	-15,008	1993	60,494
1985	1,033	1994	61,799
1986	17,768		

Discounted payback period = 12 years
(Discount rate = 10%)

The net effect of irrigation development on the average cash-flow is negative for the first seven years. In fact, the typical farmer has a reduced cash-flow position as a consequence of irrigation for only five years. During that time the net cash-flows on many properties will be $30,000 or more lower than they would have been without irrigation, for at least one year.

Table 12 shows the first ten years' annual cash-flow for a representative farm. The irrigable area of the property is slightly larger than the average at just over 300 hectares but it has an internal rate of return and net present value per hectare which are very close to the weighted averages. Selection of a representative

property is extremely difficult because of the wide variation in size, rate of development and production levels between farms.

TABLE 12

Change in Cash-flow on a Representative Farm as a Consequence of Irrigation 1980-1989

Year	Change in Cash-flow $1983	Year	Change in Cash-flow $1983
1980	-31,591	1985	-460
1981	-11,596	1986	15,923
1982	-29,839	1987	56,813
1983	-22,272	1988	96,461
1984	-24,171	1989	105,936

Using regression analysis an attempt was made to determine the effects of size, rate of development and the year in which development began, on the private returns to irrigation. The proportions of the irrigable area developed within the first three and five years were used as measures of the rate of development. No significant relationships were established.

4.2.2 The private analysis under the conditions imposed by the 1983 Irrigation Policy.

The analysis was repeated keeping all parameters constant except the Rural Bank lending policy. Suspensory loans for on-farm development were therefore removed and irrigation loans with a three year interest and principal deferrment included. These changes were introduced in the 1983 Irrigation Policy. Water charges were also recalculated incorporating the altered rates of subsidy on off-farm works.

The effect of this change on the private net present values and internal rates of return was not very marked. Since a loan of the same value as the subsidy withdrawn was offered in the year that earthworks and structures were completed, the financial position of the farmer in that year remained unchanged. The three-year deferrment of interest and principal on the whole cost of earthworks and structures meant that, for those farmers who had borrowed from the Rural Bank for part of the unsubsidized cost, the cash-flow position for three years following development improved. For the remainder of the term of the loan a reduction in net cash-flow occurred as a consequence of increased debt-servicing but the effects of inflation eroded the real value of that debt-servicing over time.

Table 13 shows the private returns to irrigation under the 1983 Irrigation Policy.

TABLE 13

Private Returns to Irrigation Under the 1983 Irrigation Policy

Evaluation Criterion	Mean	Standard Deviation
Mean NPV/Farm	$217,371	$171,000
Weighted Mean NPV/Irrigable Hectare	$1,026	$1,029
Total NPV/Irrigable Hectare	$994	-
Weighted Mean NPV/Irrigated Hectare	$1,164	$1,358
Total NPV/Irrigated Hectare	$1,184	-
Weighted Mean IRR	32.00%	29.24%
Total IRR	25.72%	-

(Discount rate = 10%)

All net present values calculated under the assumptions of the 1983 policy were a little over $100 per hectare lower than those calculated when the conditions of the 1975 policy prevailed. The weighted mean IRR declined by 0.7% while the total private IRR declined by 1.4%.

Both irrigation policies were also analysed under the assumption that the irrigation scheme was implemented in 1984. However the inclusion of constant prices and inflation and the removal of the Livestock Incentive Scheme payments had very little effect on the returns under either policy.

4.2.3 The effects of removing suspensory loans and interest subsidies on irrigation loans

If the 50% suspensory loan on irrigation development is removed and irrigation loans have an 11% rate of interest with no deferrment of interest and principal a marked reduction in the private return to irrigation occurs. Table 14 details the returns under these circumstances.

TABLE 14

Private Returns to Irrigation When Lending for On-farm Development is Not Subsidized

Evaluation Criterion	Mean	Standard Deviation
Mean NPV/Farm	$189,561	$172,839
Weighted Mean NPV/Irrigable Hectare	$895	$1,054
Total NPV/Irrigable Hectare	$867	-
Weighted Mean NPV/Irrigated Hectare	$1,015	$1,413
Total NPV/Irrigated Hectare	$1,032	
Weighted Mean IRR	26.39%	26.65%
Total IRR	21.48%	

(Discount Rate = 10%)

Table 15 shows the difference between the average farm cash-flow without irrigation and the cash-flow which exists where irrigation development occurs but suspensory loans and subsidized interest rates on loans uplifted for on-farm development are not available. Comparison of these figures with those presented in Table 11 shows that the deficits incurred in the early years are much larger when these subsidies are removed.

TABLE 15

The Effect of Irrigation on Average Cash-flow 1978-1994 When Lending for On-farm Development is Not Subsidized

Year	Net Effect on Cashflow $1983	Year	Net Effect on Cashflow $1983
1978	-1,996	1987	22,506
1979	-2,879	1988	28,335
1980	-11,969	1989	34,018
1981	-14,860	1990	39,424
1982	-11,256	1991	44,655
1983	-18,752	1992	45,755
1984	-20,203	1993	51,977
1985	-8,214	1994	54,524
1986	5,993		

4.2.4 The effects of removal of all irrigation subsidies.

The analysis was repeated with all specific irrigation subsidies removed. Fertilizer and fertilizer transport subsidies were not removed since these are available to all farmers. Subsidization by means of taxation concessions was not considered since this study was conducted on a pre-tax basis.

Subsidies removed include suspensory loans payable on on-farm development, low Rural Bank interest rates on irrigation loans and those inherent in the derivation of the water charges. In this analysis the costs of headworks, administration and investigation were added to the capital costs to be recovered by means of the water charges and the capital recovery formula incorporated market rates of interest. The market rates assumed for both Rural Bank loans and water charge calculations were the first and second mortgage rates of 11% and 14%. The results of this analysis are shown in Table 16.

TABLE 16

Private Returns in the Absence of All Specific Government Subsidies on Irrigation

Evaluation Criterion	Interest Rate 11%	14%
Mean NPV/Farm	$128,477	$79,384
Weighted Mean NPV/Irrigable Hectare	$607	$375
Total NPV/Irrigable Hectare	$587	$363
Weighted Mean NPV/Irrigated Hectare	$688	$425
Total NPV/Irrigated Hectare	$700	$433
Weighted Mean IRR	-	-
Total IRR	18.17%	14.74%

(Discount rate = 10%)

Removal of all specific irrigation subsidies reduces the private returns to irrigation very significantly, particularly where the present second mortgage interest rate is used as the interest/discount rate. Unfortunately, removal of all specific subsidies affected the cash-flows of a number of properties in such a way that their internal rate of return functions developed multiple roots and only ten private IRRs were calculable. The weighted mean private IRR could not, therefore be determined. However, the total private IRRs were reduced to 18.17% and 14.74% respectively in the absence of subsidies. The removal of subsidies reduced the weighted mean private NPV from $1140 per irrigable hectare under the 1975 policy to $607 where an interest/discount rate of 11% is used.

The effect of the removal of subsidies on the average farm cash-flow is also very marked as is shown by Table 17, and the discounted payback period is increased to twenty years. As previously discussed, the typical farmer, although facing a shorter period of deficit than is indicated by Table 17, will be forced to finance larger deficits in some years.

TABLE 17

Net Effect of Irrigation on the Average Cash-Flow Position 1978-1994 in the Absence of Subsidies
(Interest rate = 14%)

Year	Net Effect on Cash-flow $1983	Year	Net Effect on Cash-flow $1983
1978	-1,996	1987	17,717
1979	-2,985	1988	7,658
1980	-12,038	1989	8,036
1981	-15,124	1990	10,302
1982	-11,602	1991	15,228
1983	-19,746	1992	18,464
1984	-27,861	1993	26,731
1985	-13,931	1994	31,251
1986	2,471		

Discounted Payback Period = 20 years

Finally, the interest subsidies on loans for irrigation development costs not covered by irrigation loans as defined in the 1983 Irrigation Policy were removed from the analysis. These costs include fencing, fertilizer, buildings, etc. Increasing the interest rate on these loans to 14% further reduced the total private IRR to 13.94%.

4.3 Changes in Farm Production and Practices as a Consequence of Irrigation

In order to determine the economic consequences of irrigation of the Amuri Plains, estimates of changes in farm production were made for each of the farms surveyed. These estimates have been aggregated and the expected changes for the scheme as a whole calculated. These changes are summarised in Table 18. They are detailed in Appendix 7. Irrigation is expected to be responsible for an increase of 7.5 stock units per irrigated hectare devoted to livestock by 1994 over the level projected for the dryland situation at that time. This represents an increase of 6.2 stock units per irrigable hectare.

TABLE 18

Changes in Stock Numbers and Crop Areas in the Waiau Section of the Amuri Plains Irrigation Scheme 1977-1994

Year	Annual Change in Stock Units	Cumulative[a] Change in Stock Units	Annual Change[b] in Crop Areas (ha)	Cumulative Change in Crop Areas (ha)
1977/78	310	310	0	0
79	1,243	1,555	0	0
80	1,897	3,450	0	0
81	7,365	10,815	0	0
82	4,735	15,550	0	0
83	4,630	20,180	135	135[c]
84[c]	13,540	33,720	390	525
85	9,535	43,255	52	573
86	9,495	52,750	310	883
87	7,160	59,910	-18	865
88	5,510	65,420	34	899
89	5,320	70,740	-19	880
90	2,290	73,030	0	880
91	1,870	74,900	0	880
92	1,860	76,760	0	880
93	475	77,235	0	880
94	520	77,755	0	880

Notes: (a) Store lambs fattened = .1 stock units
(b) Crop area includes the change in dryland crop area, cash cereal crop areas and small seed areas
(c) Changes before 1984 are actual changes, changes after that are estimates.

In the ex-ante evaluation carried out in 1976 (MAF, 1976) it was estimated that there would be an increase of 7.7 stock units over the entire irrigated area which is equivalent to an increase of 10.9 stock units per irrigated hectare devoted to livestock.

4.3.1 Changes in existing enterprises.

Before irrigation development the area encompassed by the Waiau Section of the Amuri Plains Irrigation Scheme was essentially a sheep farming area with Corriedale ewes breeding their own replacements. A little cropping was undertaken although a significant proportion of the cereals grown was used for stock feed.

This pattern has not changed greatly. Of the farmers surveyed only one believed that irrigation was responsible for a change in the sheep replacement policy. However, within the same farming framework several major management changes were apparent. Almost all farmers had adopted, or intended to adopt, a later lambing date. In the past the high risk of drought necessitated early lambing and early drafting. With irrigation most flocks will lamb in early to mid-September and lambs will also be carried longer and drafted at heavier weights.

While the Corriedale remains the predominant sheep breed in the area, irrigation has resulted in a swing towards Coopworths, Romney and Border Leicester-Corriedale crosses. Thirteen of the farms visited were already undergoing breed changes and a further two farmers were considering making such a change.

Based on data obtained from farmers in the survey sample the total number of sheep stock units on the area encompassed by the scheme by 1994 was estimated to be approximately 217,000. Without irrigation it was estimated that the number of sheep stock units carried on the area by 1994 would have been 154,000. Details of the changes in sheep stock units between 1977 and 1994 with and without irrigation are presented in Tables 31 and 32 (Appendix 7).

The changes in the levels of per-head performance between the dryland and irrigated situations were also estimated for the scheme area. Tables 35, 36 and 37 (Appendix 7) show the annual changes in lambing percentage and wool production. By 1994 it is anticipated that under irrigation lambing percentage and wool production will be 9% and .5 kilograms per stock unit higher respectively than under the dryland conditions. In 1976 it was estimated that there would be a 7% increase in lambing percentage and an additional .3 kilograms of wool per stock unit.

The 1976 study also estimated that beef cattle numbers in the area would increase with irrigation. However, only four of the farmers visited anticipated a change in cattle numbers which could be directly attributed to irrigation. In three of the cases weaners were to be bought and carried to twenty months. Another farmer intended wintering eighteen month steers in years when extra silage could be made in summer. By 1988 it is estimated that an additional 2,235 beef cattle stock units will be carried on the scheme area as a consequence of irrigation. It is surprising that a greater swing to beef cattle is not intended by the Amuri farmers since the complementarity of sheep and beef enterprises on irrigated properties is generally recognised.

The marked increases in crop areas estimated in the 1976 evaluation have not yet occurred and farmers do not expect such a change to occur. In 1976 it was estimated that an additional 2,990 hectares of additional cereals and small seeds would be harvested if 17,131 hectares were irrigated. Only five of the farmers visited were intending to crop intensively under spray irrigation. In total, intensive cropping is expected to be carried out on 480 hectares. Several farmers intend sowing one or two paddocks of border-dyked crops and on some properties heavier land, once needed for lamb fattening, will be used for dryland cropping. It is anticipated that there will be 715 hectares of irrigated cash crop grown within the scheme

boundaries by 1990 while a decrease of 90 hectares in the area of dryland crop is expected. An additional 255 hectares will be harvested for small seeds. Thus the net change in cereal and small seeds will be 880 hectares. The increase in cereals grown, allowing for the smaller area irrigated, is only 42% of the increase predicted in 1976.

4.3.2 Diversification.

With the long-term prospects for traditional agricultural products looking rather bleak at the time of the survey the farmers in the Amuri, like many others, are considering the ways in which farm production might be diversified. As yet, however, few of them have definite plans to change from traditional farming enterprises.

Of those surveyed, three properties were to be developed as dairy farms. One, which will be used solely for dairying, is already in production. On the other two the present owners anticipate entering into 50:50 sharemilking agreements during the next two years.

A small-scale stonefruit orchard is under development on one of the farms surveyed and two other farmers suggested that they were seriously considering some orchard development.

Deer were also suggested as a possible diversification by several farmers but only one of those interviewed had definite intentions of taking up deer farming.

Most farmers are presently adopting a 'wait-and-see' attitude toward diversification. They are conscious of the fluctuations in the markets for non-traditional products and aware that irrigation development has imposed capital constraints which, at least in the short term, preclude entering into high risk activities.

4.3.3 Changes in management.

The benefits which have been estimated in the study will only be realised if farmers are able and prepared to develop the management skills necessary to successfully farm larger numbers of stock in a significantly altered environment. A ten-year development period is not long for farmers who are faced not only with the physical reality of development of large proportions of their properties, but also with the need to adopt a totally new system of management.

If it is considered to be in the national interest to develop community irrigation schemes and to facilitate rapid development by limiting the time during which subsidies and loans are available, then it may also be in the national interest to ensure that the advisory infrastructure is sufficiently strong to provide farmers with all the assistance necessary to ensure that appropriate management technology is also adopted rapidly.

4.3.4 Changes in the farm labour force.

Both the Ministry of Agriculture and Fisheries (1976) and Davison (1979) have anticipated that a number of jobs would be created on farms as a consequence of irrigation development. In fact, the economic climate in which farming has been conducted during the past five years has meant that relatively few of these jobs have eventuated. A number of farmers felt that, while additional labour was necessary to cope with increased stock, under present conditions the farm would be unable to sustain another labour unit.

Davison (1979) questioned thirty farmers who expected to employ an additional ten married couples, eight single workers and seven part-time employees. In the study described in this report it was anticipated that on the thirty-nine properties surveyed two additional married couples, three permanent full-time workers and 36 man-weeks per year of permanent part-time labour would be employed. In addition two permanent full-time single employees have been replaced by married couples and during the development period thirteen man-years of temporary labour will be employed.

4.4 Discussion

4.4.1 The national analysis.

One of the guidelines presently employed in the decision on whether or not the nation should proceed with investment projects is that the estimated internal rates of return on such projects should be at least 10%. In this study it has been estimated that the internal rate of return, calculated without the inclusion of foreign exchange adjustment is 9.8%. When foreign exchange weightings are applied to the costs and benefits in the analysis the internal rate of return is 10.1%. On the basis of returns to the nation, the Waiau Section of the Amuri Plains Scheme qualifies as an acceptable project. As so many of the production and price parameters used in this study are long-term estimates it would not be justifiable to suggest that an estimated 9.8% rate of return is significantly different from an estimate of 10%.

In 1976 the Ministry of Agriculture and Fisheries (MAF, 1976) estimated that the internal rate of return at mean estimates of product prices would be 10.6%. This estimate was, however, based on the assumption that off-farm development would be completed in four years. If off-farm development was extended to six years the internal rate of return was estimated to be 10.1%. Both of these estimates were based on costs and benefits adjusted for foreign exchange content. In fact, off-farm development is now expected to be completed in 9 years, although 88% of capital expenditure had been undertaken in the first six years.

Detailed comparisons have not been made between the 1976 report and the present study because of the difficulties of comparing real 1976 costs and prices with real 1983 costs and prices, where so many individual cost and price items are involved. It is, however, apparent that a number of farm working costs including labour, have not increased to the extent predicted in 1976 while the costs of

winterfeed, pasture renewal and lucerne renewal are all less under irrigation than in the dryland situation. The real capital costs of housing, feed storage and yards etc. have also been lower than anticipated.

The differences in production estimates between the two studies have been described in Section 4.3. Although the 1976 study predicted a greater increase in total stock numbers, this has been compensated for in part by the higher per-head productivity assumed in the present study. In addition, although the estimated off-farm capital costs have increased by a factor of 3 in real terms, the FOB sheep gross margin based on long-term projected prices has increased by a factor of almost 3.5 and the projected increase in farm operating costs exclusive of water charges has declined from $59 per hectare to $35 per hectare in nominal terms.

If, as is expected, areas which were not originally gazetted into the scheme are irrigated in future years, the national internal rate of return may be expected to exceed the estimates presented in this report. This will occur since there would be relatively little additional off-farm capital cost incurred and the per hectare average cost of development would, therefore, be reduced.

4.4.2 Comparison of national and private rates of return.

The estimated weighted mean private rate of return to irrigation development in the scheme is, at 32%, very much higher than the national rate of return at 10% over an infinite time horizon. Several factors contribute to this difference. Some are the result of deliberate policy decisions by Government, another is simply the consequence of economic conditions at the time when the greater part of off-farm construction was undertaken and others are caused by deficiencies in the cost-benefit framework used.

Government policy decisions which divorce national and private returns include the 50% suspensory loan on structures and earthworks, Rural Bank interest rates which are lower than market interest rates, and water charges which are not based on the total off-farm capital cost and which are discounted at the Rural Bank interest rate. The derivation of water charges is described in Appendix 3.

When the analysis was repeated, examining the effects of the removal of each of the subsidies, it was found that the greatest single change in private returns occurred when the deferred interest and principal payments and subsidized interest rates of the 1983 Irrigation Policy were excluded. Table 19 shows the effect on the weighted mean private IRR of successive reductions in the level of Government subsidization of irrigation.

TABLE 19

Private Returns to Irrigation Under Different Levels of Government Subsidization

Policy	Weighted Mean Private IRR	Total Private IRR
1975: 50% subsidy on on-farm development. Subsidized Rural Bank lending.	32.7	27.1%
1983: No subsidy on on-farm development. Three year interest and principle deferrment Subsidized interest rate.	32.0	25.7%
No subsidy on on-farm development. No deferrment 11% interest rate on irrigation loans.	26.3	21.5%
No subsidy on on-farm development. No deferrment 11% interest rate. Water charges based on full capital cost and 11% discount rate.	-	18.2%
No subsidy on on-farm development. No deferrment 14% interest rate on irrigation loans. Water charges based on full capital cost and 14% discount rate.	-	14.7%
No subsidy on on-farm development. No deferrment 14% interest rate on all RBFC irrigation and development loans.	-	13.9%

Even when the effects of all policies aimed at subsidizing irrigation development have been removed from the analysis there remains a significant divergence between national and private returns. This arises because of the way in which the off-farm capital costs are included in the analyses. In the national analysis the actual dollar value of off-farm capital costs has been inflated by the Construction Costs Index to a real (1983) dollar value. The real costs thus calculated have been added to the other real costs of irrigation in the year in which they were incurred. In the private analysis farmers do not meet the costs of off-farm development in the year in which they

have been incurred. Rather, they pay them back in water charges over forty years as if they had borrowed from the Ministry of Works to complete the scheme. The water charges are based on recovering the actual, not the real costs of off-farm development. The discounted flow of water charges will exceed the actual discounted flow of capital expenditure if a discount rate greater than the rate of inflation is used. It will never equal the discounted stream of real capital costs while the same discount rate is used in the national and private analyses.

However, all those members of society who borrowed funds during the highly inflationary period over which the greatest portion of off-farm capital expenditure occurred benefitted at the expense of the lenders. The high rates of inflation meant that the real after-tax rate of interest received by borrowers was negative and the purchasing power of capital lent was steadily eroded over that period. There seems to be little reason to differentiate between what were effectively loans offered by the State to the Waiau irrigators and other loans made at the same time. With the lower rates of inflation presently prevailing this effect will be less evident in any future irrigation schemes.

One omission from the costs of private analysis is the extra overdraft interest paid by farmers. For most farmers the deficits experienced in the early years of development will have been financed at least in part by overdraft, although for most it would be difficult to determine what proportion of any increase in overdraft requirement is due to irrigation rather than to reduction in the 'without irrigation' net farm income. For a farmer whose average overdraft increases by $20,000 the costs of irrigation would increase by $5,600 in each year that the deficit is incurred. If that deficit were carried throughout the first five years of development the NPV discounted at 10% would be reduced by almost 10% or $21,228.

Two other characteristics of the cost-benefit framework used also affect the relativity between national and private returns. Because of the difficulties involved in calculating the value added by the transport, freezing and processing industries the estimates of costs incurred between farmgate and FOB are made by subtracting farmgate prices from FOB prices (MAF, 1983). The difference between the revenue derived from agricultural exports and the post-farmgate costs of producing them is not included in the national benefits in agricultural cost-benefit analysis. More information on costs past the farm-gate would facilitate more accurate agricultural cost-benefit analysis.

In cost-benefit analysis labour which has not been employed on the project under evaluation is assumed to be surplus before the project's implementation and, therefore, to have an opportunity cost of zero. This is a reasonable assumption if a project is being evaluated purely from a national economic viewpoint. However for the individual farmer the personal non-financial costs of irrigation development have, in many cases, been very high. It became apparent during the conduct of the survey that for many farmers, particularly those who have undertaken the building of irrigation structures themselves, irrigation development had led to an enormous increase in workload and stress. Documentation of the effects of development on family life and farmers'

health is not within the scope of this study but it is not unreasonable for farmers to expect some return on this personal investment.

The results of this study suggest, that even where no specific irrigation subsidies exist, the returns to the average farmer from irrigation are higher than the returns to the nation. This appears to contradict the widely-held view that irrigation subsidies are required to encourage farmers to undertake investment which is in the 'national interest' but which they would not undertake without Government Assistance. Generally, this argument holds only where national returns from an investment exceed private returns. However, where the returns from an investment are realised over a period which is longer than the farmers' planning horizon, he may be reluctant to invest, although the longer time preference of the nation may mean that the investment is justified on a national basis (Chudleigh, Greer and Sheppard, 1983). It is true that farmers are often particularly concerned with leaving a soundly based enterprise for the next generation, but is unrealistic to assume that they will not expect to reap at least part of the reward for effort and investment during their working lives.

In future studies the problem of differing time horizons may be overcome in part by evaluating private returns over a particular time period and including the residual value for irrigation development in the cash-flow of the final year. Before this exercise could be attempted, research into the length and determinants of farmers' planning horizons would be required.

It is unlikely however, that an approach such as this would, on its own, enable the researcher to perceive the investment in irrigation in exactly the same manner as the farmer. Many farmers, although they may have a planning horizon of only ten years for example, may not consider selling at that time and may therefore have little interest in the residual benefits of irrigation development. Others, who anticipate handing over the property to children, may be concerned with receiving a reasonable income during their working lives but do not regard a high residual value as desirable.

Before new Government policies, formulated in the anticipation that returns from irrigation development are sufficiently high to motivate farmers to undertake development without subsidisation, are introduced, further research must be carried out on all aspects of the investment behaviour of farmers.

Even with the high level of subsidy prevailing under the 1975 Irrigation Policy, the net effect of irrigation development on farm cash-flows in the early years would for most be difficult to sustain. The discounted payback period under that policy has been calculated to be twelve years. Although farmers were not asked their ages during the interview an estimate of the average age of the farm decision-maker at the time when on-farm development was started lies between 40 and 45 years of age. The average farmer will therefore be close to the end of his or her working life before the capital costs of irrigation are recovered. If all specific irrigation subsidies are removed the discounted payback period increases to twenty years and on many farms the benefits of irrigation will be realised only by the next generation.

The effects of removing only the subsidies for on-farm development and instituting market-rates of interest on irrigation loans with interest and principal payments commencing in the period following the loan receipt is almost as severe. In this case the discounted payback period is 14 years.

The 1983 Irrigation Policy results in a slightly lower long-term private return to irrigation than the 1975 policy but the differences in cash-flow between the policies are relatively small. The discounted payback period is increased by less than one year.

These payback periods compare unfavourably from the farmer's point of view with the payback periods for horticultural developments which are generally regarded as fairly long-term investments. The average pay-back period for kiwifruit development is between eight and eleven years (Hadfield, S.M., pers. comm.). Certainly many forestry developments have a much longer payback period than this but substantial Forestry Encouragement grants for both operating and capital costs are available.

Another issue which appears likely to have a very significant effect on the extent of irrigation development in the absence of subsidisation is that of farm liquidity per se. The effects on cash-flow during the early years of development (see Table 17) may be so serious that many farmers will be unable to obtain the resources necessary to undertake development, or to sustain the debt-servicing costs if resources are provided from outside sources at overdraft interest rates.

While this does not provide justification for Government subsidisation of irrigation development it is an important aspect for consideration before policy changes are implemented. Farmers involved in community irrigation schemes, if subsidies were removed, would require access to considerable amounts of capital for the first years of the scheme. The provision of continuing capital supplies for several years would need to be assured. It is very probable, particularly in times of tight monetary control, that the capital market would fail to meet these requirements. Thus, if irrigation development is desired by Government because it is seen to benefit the nation, intervention may be required to correct that failure.

4.5 The Basis for Comparison Between the Amuri Plains and Other Canterbury Irrigation Schemes

The results of ex-post studies of this type will be of use in the ex-ante evaluation of other irrigation schemes although it is important that consideration be given to the degree of similarity between schemes. A number of factors should be considered when assessing the extent to which extrapolation from the results of one study is appropriate for another. These factors include:

(a) Physical factors which affect the productive capacity of an area, including soil type and climate;

(b) Farmers' experience with alternative farming systems;

(c) Capital and labour resources available on farms;

(d) Social and other considerations which affect the motivation of farmers to develop;

(e) Features of the scheme itself including ease of development, water availability and the methods of water application most appropriate; and

(f) The timing of the scheme in relation to levels of farmer confidence in the future of the industry, the drought cycle and the extent of local experience with irrigation.

Although the study described in this report was conceived purely as a cost-benefit exercise, a number of observations on the factors listed above are possible.

A classification of the soils of the Waiau section of the Amuri Plains Irrigation Scheme is presented in Table 2.4. The Ministry of Agriculture and Fisheries (1976) estimated that 11% of the soils of the area fall into the categories 4 and 5, 41% into category 3 and 45% into categories 1 and 2. Because of the relatively low water-holding capacity of a large proportion of soils within the scheme, the potential for intensive cropping is less than that of the Barrhill Scheme or the northern part of the Central Plains Scheme. There is a greater similarity between the soils of the Waiau Section and those of the Lower Rakaia Scheme and the southern part of the Central Plains.

Although the potential for horticultural development in the Amuri may be rather less than for the mid and central Canterbury schemes because of the frequency of late frosts, distance from overseas transport facilities is likely to be a more serious constraint. Climatic conditions do not differ greatly between the Amuri Plains and other parts of Canterbury for which irrigation schemes are proposed.

At the time when the development of the Scheme began, the area was predominantly a sheep-farming one with Corriedale flocks breeding their own replacements. The productivity of the majority of these flocks was low. Relatively little cropping was undertaken. Thus, the soils, the system of subsidization which at the time favoured border-dyke development, and the farmers' own preference and experience meant that the scheme was essentially pastoral from conception. In Central and Mid Canterbury and even in the Balmoral Section of the Amuri Plains Scheme cropping is a much more familiar farming system under a dryland regime.

Subsequent changes to the irrigation policy have motivated some farmers to spray irrigate at least part of their properties, thereby facilitating crop production. However a much greater emphasis on cropping under irrigation is expected in areas for which schemes are

presently under consideration. Where soils are better, Government policy does not discriminate between border-dyke and spray development and local experience of cropping is greater.

A distinctive feature of the Amuri before irrigation was the apparent long-term viability of dryland farming because of the relatively large farm size and strong capital position of many properties. This was a very different situation from that which prevailed in the Morven-Glenavy scheme where farmers were struggling with uneconomic units. The situation in the Central and Mid Canterbury schemes appears less clearcut. Farm size is generally smaller than in North Canterbury but the capital strength of properties reflects very strongly the ability of the individual farmer to cope with the droughts of the past seasons and is therefore extremely variable.

During the development of the Waiau Section a number of properties have acquired extra labour in the form of children leaving school and returning to the farm. While most of these have not returned specifically because irrigation development created a need for extra labour, it is very possible that development has taken up slack which may otherwise have existed.

An understanding of the social structure peculiar to an area is an important prerequisite for assessing the changes to be expected from implementation of major developments such as irrigation. It is therefore important that a sociological study be undertaken in the Amuri Area, the results of which could be useful in extrapolating from the present study to other community irrigation schemes.

Extrapolation from the results of this study to other community irrigation schemes without consideration of the social structure of the area would be unwise. Although this survey was not designed with the intention of relating financial and social aspects, it was quite apparent that farmers' attitudes to irrigation are strongly affected by factors such as age, family structure, background etc. The farming community of the Amuri Plains has been, and to some extent still is, affected by the social distinction between long established farming families and those who were settled on rehabilitation blocks after the war.

In addition, the social costs imposed on farmers and their families as a consequence of irrigation and the social benefits to be derived from freedom from drought are important elements of the social cost-benefit analysis. The social costs and benefits associated with changes in the structures of the communities of Culverden and Rotherham should also be documented.

In the Amuri Plains Scheme there is sufficient water available to adequately irrigate the scheme area throughout the season. Future schemes in Central and Mid Canterbury are likely to be unable to provide adequate water during January, February and March, which may significantly reduce the levels of production expected under irrigation.

The Waiau Section of the Scheme was, in engineering terms, a comparatively straight-forward exercise. The Central Plains and

Barrhill schemes will require more complex intake structures and some water will be pumped upward over the terraces of the Rakaia River. Additional capital costs will therefore be incurred and the operating costs of the schemes will be increased as electricity is required for pumping.

Because the 1975 Irrigation Policy provided subsidies for earthworks and structures the Ministry of Works and Development was able to exercise quality control over development and there was, therefore, considerable concern for water efficiency in design. Development was sometimes more costly as a consequence. This may not be the case in future since the removal of subsidies has deprived the Ministry of the right to approve on-farm development. Water restrictions in future schemes may, however, encourage voluntary concern for the efficiency of water use.

In 1977 when work on the Amuri Plains Scheme began, there was a relatively high level of confidence in the future of farming. In addition, Canterbury had suffered severe drought in the early and mid 1970s. Consequently there was widespread belief in the farming community that irrigation was vital, and considerable enthusiasm for irrigation development. In the 1980s confidence in farming is much lower and the experiences of farmers in Otago schemes with escalating costs may have dampened the enthusiasm of many farmers in areas where schemes are presently proposed.

One disadvantage suffered by those in the Amuri Plains Scheme was lack of experience in both on and off-farm irrigation development in Canterbury. In addition, the absence of local contractors and therefore of competition at the beginning of the scheme development may have made early development relatively more expensive.

It is essential that all of these factors, and their effects on the costs and benefits of irrigation be considered before the results of this or any other ex-post study are used in the assessment of future irrigation development in Canterbury.

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APPENDIX I

The Questionnaire

AMURI PLAINS IRRIGATION SCHEME
QUESTIONNAIRE

FARM OWNER ..... DATE .....

INTERVIEWEE ..... POSITION .....

FARM NUMBER .....

TOTAL AREA ..... HA

EFFECTIVE AREA ..... HA

MOST RECENT DRYLAND VALUATION (1975/1980) $.....

OR

VALUATION NO. .....

OR

TITLES .....
.....
.....
.....
.....
.....
.....
.....

PART 1

BASELINE PRODUCTION AND FINANCIAL DATA

PRODUCTION

A. SHEEP

1) Sheep numbers

Year			Opening	Closing	Closing	Closing .....
Breeding Ewes						
Ewe hoggets (mated)						
Ewe hoggets (not mated)						
Wethers						
Rams						
Ram hoggets						
SALES	Ewes	2T				
		MA				
		CFA				
	Rams					
	Wethers					
	Lambs Store					
	Fat					
PURCHASES	Ewes	2T				
		MA				
		CFA				
	Rams					
	Store Lambs					
DEATHS	Ewes					
	Rams					
	Lambs					
	Wethers					

2) What was your average lambweight before irrigation? [kg]

3) What was your tailing percentage in each of these years?

Year	%	Year	%	Year	%

4) What was your total wool weight in each of these years?

Year	kg	Year	kg	Year	kg

5) What were your approximate wool weights per head for

Ewes [kg] Hoggets [kg] and lambs [kg]

6) What are your sheep standard values?

Class	$
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

B. CATTLE

7) Cattle numbers

Breeding Cows	.....	.....	.....	.....
Rising 1yr cattle	.....	.....	.....	.....
Rising 2yr cattle	.....	.....	.....	.....
Rising 3yr cattle	.....	.....	.....	.....
M.A. Bulls	.....	.....	.....	.....
SALES Breeding Cows	.....	.....	.....	.....
Calves	.....	.....	.....	.....
Rising 1yr cattle	.....	.....	.....	.....
Rising 2yr cattle	.....	.....	.....	.....
Rising 3yr cattle	.....	.....	.....	.....
M.A. Bulls	.....	.....	.....	.....
PURCHASES Breeding Cows	.....	.....	.....	.....
Calves	.....	.....	.....	.....
Rising 1yr cattle	.....	.....	.....	.....
Rising 2yr cattle	.....	.....	.....	.....
Rising 3yr cattle	.....	.....	.....	.....
Bulls	.....	.....	.....	.....
DEATHS Breeding Cows	.....	.....	.....	.....
Calves	.....	.....	.....	.....
Rising 1yr cattle	.....	.....	.....	.....
Rising 2yr cattle	.....	.....	.....	.....
Rising 3yr cattle	.....	.....	.....	.....
M.A. Bulls	.....	.....	.....	.....

8) What was your calving percentage in each of these years?

Year	%	Year	%	Year	%

9) Cattle Standard Values

Class	S.V.
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

C. CASH CROP

10) Crop Yields

	Ha	Yield	Ha	Yield	Ha	Yield
Wheat						
Barley						
Oats						
Peas						
Clover						
Grass Seed						
Other						

FINANCIAL

YEAR			
	$	$	$
11) INCOME			
Sheep and lambs			
Cattle			
SUB TOTAL			
Less stock purchases - sheep			
cattle			
SUB TOTAL			
Stock sales net			
Wool			
Crop			
Other			
TOTAL FARM INCOME			
Off-farm income			
TOTAL INCOME			
12) EXPENDITURE			
Fertiliser and lime			
Wages			
Animal Health			
Repairs and Maintenance			
Other			
SUB TOTAL WORKING EXPENDITURE			
Interest			
Other Standing Charges			
SUB TOTAL CASH EXPENDITURE			
Depreciation			
Income Equalisation Account			
Wool Retention Account			
TOTAL EXPENDITURE			
TOTAL TAXABLE INCOME			
13) LIABILITIES			
Fixed			
Current			
Principal Repayments			

PART 2

ACTUAL PRODUCTION LEVELS SINCE DEVELOPMENT BEGAN

Now that I have enough information to establish your position without irrigation I'd like to know what has actually happened to your production levels since irrigation development began.

SHEEP

1) Sheep numbers

			Year ..... Closing	..... Closing	..... Closing	..... Closing	..... Closing
Breeding Ewes							
Ewe hoggets (mated)							
Ewe hoggets (not mated)							
Wethers							
Rams							
Ram hoggets							
SALES	Ewes	2T					
		MA					
		CFA					
	Rams						
	Wethers						
	Lambs	Store					
		Fat					
PURCHASES	Ewes	2T					
		MA					
		CFA					
	Rams						
	Store lambs						
DEATHS	Ewes						
	Rams						
	Lambs						
	Wethers						

2) What was your tailing percentage in each of these years?

Year [ ] % Year [ ] % Year [ ] % Year [ ] % Year [ ] %

3) What were your average lamb weights in each of these years?

Year [ ] kg Year [ ] kg Year [ ] kg Year [ ] kg Year [ ] kg

4) What was your total wool weight in each of these years?

Year [ ] kg Year [ ] kg Year [ ] kg Year [ ] kg

Year [ ] kg

CATTLE

5) Cattle numbers

Year	..... Closing	..... Closing	..... Closing	..... Closing	..... Closing
Breeding Cows					
Rising 1yr cattle					
Rising 2yr cattle					
Rising 3yr cattle					
M.A. Bulls					
SALES					
Breeding Cows					
Calves					
Rising 1yr cattle					
Rising 2yr cattle					
Rising 3yr cattle					
M.A. Bulls					
PURCHASES					
Breeding Cows					
Calves					
Rising 1yr cattle					
Rising 2yr cattle					
Rising 3yr cattle					
M.A. Bulls					
DEATHS					
Breeding Cows					
Calves					
Rising 1yr cattle					
Rising 2yr cattle					
Rising 3yr cattle					
M.A. Bulls					

6) What was your calving percentage in each of these years?

Year	%	Year	%	Year	%	Year	%	Year	%

CASH CROP

7) Crop Areas

Year	.....		.....		.....		.....		.....	
	Ha	Yield	Ha	Yield	Ha	Yield	Ha	Yield	Ha	Yield
Wheat										
Barley										
Oats										
Peas										
Clover										
Grass Seed										
Other										
.....										

8) Have you had any contract cultivation associated with your cropping program during the development years?

Yes No → Go to Q.8

Year					
Wheat					
Barley					
Oats					
Peas					
Clover					
Grass Seed					
Other					

9) Have you had any contract harvesting done during the development years?

Yes No → Go to Part 3

Year					
Wheat					
Barley					
Oats					
Peas					
Clover					
Grass Seed					
Other					

PART 3

FUTURE FARM PRODUCTION

STOCK PRODUCTION

To complete this section on farm production levels I would like to know the changes in stock numbers and crop areas which have been projected for your farm in the future.

1) What are the projected stock numbers at closing date for each year until numbers stabilise?

YEAR										
Ewes										
Ewe hoggets										
Breeding Cows										
Rising 1yr Cattle										
Rising 2yr Cattle										
Rising 3yr Cattle										
M.A. Bulls										

2) Have you any plans to buy in store lambs as part of your farming activities in these years?

YEAR										
Store lambs										

3) Do you think your lamb carcase weights will change in the future?

Yes No → Go to Q.4

When do you expect the change to occur? [ ] Year

What will the change be? ..... kg heavier/lighter

4) Do you expect to shear a larger proportion of your lambs in future?

Yes No Go to Q.5.

When do you expect the change to occur? [ ] year

What do you expect the new proportion to be? [ ] %

CROP PRODUCTION

5) What is the main soil type of the area on which your future cropping activities will be carried out?

.....

6) What areas of crop do you intend growing in future years?

YEAR															
Wheat (ha)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Barley (ha)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Oats (ha)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Peas (ha)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
White Clover (ha)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Grass Seed (ha)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Other	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

PART 4

UNSUBSIDIZED CAPITAL COSTS

The Ministry of Works has given me the details of the subsidized expenditure which has already taken place on your farm, and the estimated expenditure which will occur in future. Could you just check through this and tell me whether you expect that there will be any major changes in the planned expenditure.

Now I would like to know what the unsubsidized capital expenditure has been, and is expected to be for each year until development is completed.

1) Gates, Clocks etc

Either $/year

Year	$	Year	$	Year	$

Or

Year	Description
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

2) Pump and Motor

Either $/year

Year	$	Year	$	Year	$

Or

Year	Description
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

3) Applicators

Either $/year

Year	$	Year	$	Year	$

Or

Year	Description
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

4) Water Supply

I have obtained details of your expenditure on the new stock water supply from the Council. Could you check these to make sure the record is complete.

5) Fencing

Either $/year

Year	$	Year	$	Year	$	Year	$
Year	$	Year	$	Year	$	Year	$

Or metres/year

Year	m	Type	Year	m	Type	Year	m	Type
Year	m	Type	Year	m	Type	Year	m	Type
Year	m	Type	Year	m	Type	Year	m	Type

6) Buildings and Stockhandling Facilities

Either $/year

Year	$	Year	$	Year	$	Year	$

Or

Year	Description
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

7) Employee Housing

Either

Year	$	Year	$

Or

Year	Description
.....	.....
.....	.....

8) Tractor

Did you or do you intend to make any change in your normal pattern of tractor replacement to allow for the increased cultivation during the development period?

Yes ☐ No ☐ → Go to Q. 9

A. If you bought a larger tractor on a temporary basis what was the cost (net-of-trade-in) in the year of purchase?

Year	$

B. If you intend to trade up to a larger tractor on a temporary basis, when will you do so?

Year ☐

What sort of tractor will you buy? .....

What sort of tractor will you trade in? .....

C. If you have already traded down again, what was the net cost/gain?

Year	$

D. If not, when do you propose to trade down?

Year ☐

What type of tractor will you buy? .....

How many hours do you expect the tractor you trade in to have run?
.....

9) Cultivation Equipment

Did you or do you intend to purchase additional cultivation equipment, or trade-up to larger cultivation equipment to allow for increased cultivation during the period of irrigation development?

Yes ☐ No ☐ → Go to Q. 10

A. If you bought additional cultivation equipment, or traded up to larger equipment what was the cost (net-of-trade-in) in the year of purchase of each item purchased?

	Item	Year	$
1.			
2.			
3.			

B. If you intend to buy additional equipment or trade up to larger equipment, when will you do so, what sort of machinery will you purchase and what sort of machinery will you trade in?

	Year	Purchase	Trade in
1.	.....	.....	.....
2.	.....	.....	.....
3.	.....	.....	.....

C. If you have already sold this machinery, or traded down what was the net cost/gain?

	Year	$
1.		
2.		
3.		

D. If you have not yet sold or traded down when will you do so, what type of machinery will you buy as its replacement and will you trade in the machinery purchased for irrigation development?

	Year	Purchase	Trade in	
1.	.....	.....	Yes	No
2.	.....	.....	Yes	No
3.	.....	.....	Yes	No

10) Contract Cultivation during Development

Did you or do you expect to employ contractors to do any of the unsubsidized cultivation work during development?

Yes No → Go to Q. 11

Either

Year	$	Year	$
Year	$	Year	$

Or

Year	ha	Operations
		.....
		.....
		.....
		.....
		.....
		.....
		.....
		.....
		.....
		.....

11) Own Cultivation Work During Development

How much additional cultivation work has or will be undertaken by you or your employees during irrigation development?

Either

Year	Machine	Hrs
......	......	......
......	......	......
......	......	......
......	......	......
......	......	......
......	......	......
......	......	......
......	......	......
......	......	......
......	......	......

Or

Year	Ha	Machine	Operations
......	......	......	......
......	......	......	......
......	......	......	......
......	......	......	......
......	......	......	......
......	......	......	......
......	......	......	......
......	......	......	......
......	......	......	......
......	......	......	......

12) Development Fertiliser

Either

What quantities and types of development fertiliser were or will be applied during development?

Year	Sowing		Topdressing		Total	
	Type	kg/ha	Type	kg/ha	Type	kg
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	......	......

Or

Year	$	Year	$	Year	$

Year	$	Year	$	Year	$

Year	$

13) What varieties and seeding rates have you used for the new pasture sown during development?

Variety	kg/ha
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

PART 5

ASSOCIATED COSTS

In addition to these capital costs, a number of farm working expenses will change with irrigation, and new costs will occur. I would like your estimates of when these costs will occur and the amounts involved.

1) Additional Labour

Year												
Permanent Married												
Permanent Single												
Part-time (part year)												
Casual (man weeks)												

2) Additional Fertiliser

Will your irrigated area receive a different level of fertiliser than it did under a dryland farming system?

	Type	Kg
Pre-irrigation		

	Year	Type	Kg	Ha
Post-irrigation				

3) Winter feed

Have you changed the area of greenfeed grown since irrigation development started, or do you intend doing so in the future?

	Type	Ha
Pre-irrigation		

	Year	Type	Ha
Post-irrigation			

4) Feed Conservation and Purchase

A. On average, how many bales of hay in total, or per stock unit, did you make before irrigation development?

bales	OR	bales/SU

B. During development how many bales, or bales per stock unit have you/ will you make?

(Size of bales.....)

Year	Total Bales	Bales per S.U.
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

C. Once development is complete how many bales, or bales per stock unit do you intend making?

bales	OR	bales/SU

D. Is haybaling carried out by contract or by farm labour?

C	F

E. Is haycarting carried out by contract or by farm labour?

C	F

F. Before development how much feed, on average did you purchase before development?

bales hay	kg barley	

G. During development how much feed have you purchased each year?

Year	Hay	Barley	Other
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

H. How much feed do you expect to buy in future years?

bales hay	kg barley	

5. Pasture Renewal

A. On average, how many hectares of new pasture would you have drilled in each year before irrigation development?

ha

B. How often do you expect to renew pasture once development is complete?

.....
.....
.....
.....

6) Lucerne Renewal

A. On average, what area of lucerne was grown on the farm before irrigation development?

[ha]

B. How long did a stand of lucerne last?

[yrs]

C. During irrigation development, what areas of lucerne were sown down / will be sown down in each year?

Year	Hectares	Year	Hectares
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

D. Will there be any lucerne grown on the farm after irrigation development is complete?

Irrigated lucerne [ha]

Dryland lucerne [ha]

7) Headrace Maintenance

How many metres of headrace will there be on the farm?
(M.O.W.D.) .....

8) Sprayrunning Costs

A. What is the estimated electricity cost for running your spray irrigation plant?

[$] [19]

B. What is the estimated cost of repairs and maintenance on your spray irrigation plant?

[$] [19]

9) Animal Health Costs

I would like to know how the following animal health routines have changed.

	Before Irrigation	After Irrigation
Lamb Drench	.....	.....
Ewe Drench	.....	.....
Lamb Vaccination	.....	.....
Ewe Vaccination	.....	.....
Footrot	.....	.....

10) Shearing

How is your shearing done?

Full contract ☐ Half contract ☐ Labour only ☐

11) Cropping

Do you expect to employ contractors for any of the cultivation or harvesting activities associated with your cropping programme?

Yes ☐ No ☐ → Go to Q.12

A. Cultivation

Wheat	☐
Barley	☐
Oats	☐
Peas	☐
White Clover	☐
Grass Seed	☐
Other	☐

B. Harvesting

Wheat	☐
Barley	☐
Oats	☐
Peas	☐
White Clover	☐
Grass Seed	☐
Other	☐

12) Vehicle Running

Do you think you are doing a much larger mileage in your Landrover/utility etc. as a consequence of irrigation?

Yes ☐ No ☐ Go to Part 6

Type of Vehicle .....

Extra miles/kilometres per year .....

PART 6

BORROWING

1) I should like to know something about Rural Bank loans you have or hope to take out for irrigation development.

Year	Amount	Term	Interest Rate
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

.....
.....
.....
.....
.....

2) If you have, or hope to receive development loans from sources other than the Rural Bank, I would also like details of these.

Year	Amount	Term	Interest Rate	Type	Principal Repayment
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....

.....
.....
.....

PART 7

MANAGEMENT CHANGES AND GENERAL INFORMATION

1) Have you, or do you plan to change your lambing date because of irrigation?

.....
.....
.....

2) Have you, or do you plan to change your pattern of lamb drafting because of irrigation?

.....
.....
.....

3) Have you, or do you intend to change the breed of stock run on the property?

.....
.....

4) Are you considering any type of diversification on your property in the future?

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

5) If you have done less development work in the last season than you had planned originally, what have been the main reasons for the change of plan?

Cash flow ☐

Consolidation ☐

Other ☐ .....

6) Are you considering the possibility of extending your irrigation beyond the gazetted area by means of spraylines? Do you have any idea of the area involved, and the likely timing of the extension?

.....
.....
.....

APPENDIX 2

On—farm Data Used in Estimation of the Dryland Base and the Future with Irrigation

1. NAME: _____

2. FARM NUMBER: [ ]

3. SOIL TYPE: [ ]

4. STATUS QUO S.U. [ ] STATUS QUO S.U./HA [ ]

5. S.U. AND S.U./HA SINCE DEVELOPMENT STARTED

Year						
S.U.						
S.U./ha						

Year						
S.U.						
S.U./ha						

Year						
S.U.						
S.U./ha						

6. AREA IRRIGATED EACH YEAR

Year										
Hectares										

7. FINAL PROPORTION IRRIGATED: [ ]

8. LAMBING PERCENTAGE:

Year							
% SSF							

THE DROUGHT YEARS

On the basis of the information given, your knowledge of the individual farms, and the changes observed in the Balmoral Scheme, could you assess the likely changes in production and feed purchases during the 1981/82 and 1982/83 financial years had they not been involved in irrigation development.

1. LAMBING %

82	83	84

2. WOOL WT

	82	83	84
With irrigation	X	X	
Without			

3. FEED PURCHASES

82	83

4. CHANGE IN STOCKING RATE

82	83

THE FUTURE WITH IRRIGATION

What changes in production level do you envisage on this farm given soil type and stock unit predictions?

Lambing % _____

_____

Wool Wt _____

_____

APPENDIX 3

THE COST CALCULATIONS

A3.1 On-farm Costs

For the purpose of this study, all costs have been calculated, as nearly as possible, in June 1983 dollars. Many farmers had not documented individual item costs or even the total costs of irrigation development and these could not always be separated from farm operating costs in the annual accounts. As a consequence the development expenditure was often calculated by obtaining details of the physical resources employed and costing these at 1983 prices.

Individual cost items and their derivation will be briefly described in this section.

A3.1.1 Capital Costs

Gates.

Details of irrigation gates and release mechanisms were generally given in physical terms, either as the number purchased per year or as the number of hectares per dam on a representative block. The types of gate and release mechanism were recorded and the cost calculated. Where actual expenditure on gates was recorded the cost was inflated using the ratio of current prices to the prices prevailing at the time of purchase.

Spray irrigation costs.

Those farmers involved in spray irrigation were able to provide detailed costings from spray plans drawn up by private irrigation consultants or by Ministry of Agriculture and Fisheries farm advisors.

Stock water supply.

The Amuri Plains Rural Water Scheme was implemented as a direct consequence of the irrigation scheme and both the off-farm and on-farm costs of the water supply have been included in the analysis. Details of the contract costs of on-farm work were obtained from files held by the Amuri County Council. Although a number of farmers had done part of the installation themselves, they were not, in general, able to determine the actual costs involved. They did however feel that as a major part of the contract price was for materials and pipe-pulling the difference between contract and actual prices would not be great. The costs of water supply development undertaken in past years have been inflated using the Ministry of Works and Development Construction Cost Index (See Table 20).

TABLE 20

Construction Costs Index: 1977–82

Year	Period Ending	Labour	Plant	Materials	MWD Construction Cost Index	Structures	Earthworks	On–farm
1977	Sep	1029	700	590	916	733	815	820
	Dec	1099	704	610		766	842	
1978	Mar	1102	718	634		783	852	
	Jun	1131	731	657		807	871	
	Sep	1195	742	670	1019	835	901	909
	Dec	1197	763	692		851	915	
1979	Mar	1235	770	715		878	933	
	Jun	1298	794	734		909	970	
	Sep	1321	878	761	1257	941	1033	1131
	Dec	1415	979	808		1007	1132	
1980	Mar	1507	1118	855		1077	1254	
	Jun	1520	1180	901		1115	1299	
	Sep	1590	1280	946	1558	1173	1389	1410
	Dec	1700	1310	985		1232	1447	
1981	Mar	1810	1350	1030		1296	1511	
	Jun	1830	1470	1070		1338	1596	
	Sep	1920	1550	1120	1843	1403	1680	1669
	Dec	2000	1590	1160		1455	1734	
1982	Mar	2110	1620	1210		1521	1792	
	Jun	2110	1690	1270		1564	1837	
	Sep	2120	1810	1300	2013	1597	1919	1817
	Dec	2120	1810	1320		1609	1919	
1983	Mar	2120	1810	1320		1609	1919	
	Jun	2120	1830	1320		1609	1932	

Source: Ministry of Works and Development

Structures = 30%L, 10%P, 60%M

Earthworks = 35%L, 65%P

On-farm works = 67%, Earthworks and Structures 33%

Water Supply Subsidy.

The costs associated with the County Water Supply Scheme, or the equivalent contract costs have been subsidized to 50% by the Ministry of Works and Development.

Fencing.

Some farmers were able to give the exact costs of fencing for each year. A per hectare cost was derived from the total cost and area for the 1983 year, except in cases where the type of fencing was to change, and this was used to estimate future fencing costs. Because the Farm Capital Costs Index does not include fencing as a separate category actual costs of specific fence types in each year were obtained from the Ministry of Agriculture and Fisheries and annual costs were updated using the ratios derived from these.

Buildings.

The costs of buildings erected specifically for irrigation were without exception provided by the farmers. They were inflated using the Farm Capital Costs Index (F.C.C.).

Houses.

Very few houses were built or purchased specifically because of irrigation but in each case the costs of doing so were known. The Consumer Price Index (Housing) was used to inflate house prices.

Tractor.

In a number of cases farmers had purchased larger tractors specifically because of the irrigation development. While it is difficult to determine the exact effect of this on the tractor replacement policy it has been assumed that a new tractor would have been purchased at the time and the difference in cost has been included in the year of purchase. Where farmers do not intend to trade down again the difference in the sinking fund required for the two sizes has been included as a cost. Where a trade-down is anticipated the estimated difference in trade in value has been included as a positive or negative cost. Tractor prices prevailing in 1983 have been used.

Cultivation equipment.

Where cultivation equipment was purchased as a consequence of irrigation development the current costs were used where possible. In some cases the F.C.C. Index - Machinery was used to inflate costs. If farmers intended selling this machinery on completion of development, which was seldom the case, estimates of resale value were obtained from local firms.

Contract cultivation.

Where farmers have employed contractors for development cultivation the 1983 charges of the contractor involved have been used. Most of the contracting was for direct drilling rather than conventional cultivation.

Own cultivation.

The costs of cultivation carried out by farm staff have been calculated using the farmers' description of the sequence of operations conducted and the following estimates of time per operation.

Ploughing	1.07 hrs/ha
Grubbing	.45 hrs/ha
Harrowing	.38 hrs/ha
Drilling	.65 hrs/ha
Heavy rolling	0.8 hrs/ha

Where soils are particularly heavy or where tractors outside the range 44.7 - 59.6 kW (60 - 80 HP) have been used the cultivation time has been adjusted accordingly. The hourly cost of tractor running presented in the 1983 Lincoln College Budget Manual has been used to calculate the cultivation costs per hectare.

Development fertiliser.

Farmers were asked the level and types of fertiliser applied at sowing and in the following spring and the costs of fertiliser prevailing at June 1983 were used to calculate the value of fertiliser applied during development.

Many farmers apply lime when renewing pasture, not strictly as a consequence of pasture renewal, but because that is a convenient time to apply maintenance lime. Most farmers applied lime to land sown down after border-dyking but after discussion with farm advisors and soil scientists it was decided to treat the first tonne per hectare of lime applied as a cost of development and the remainder as a maintenance activity which would have been carried out irrespective of irrigation. Although the figure of one tonne is largely arbitrary, it was felt that since the subsoil pHs for most soils in the area were not markedly lower than those of the topsoil it would not take large quantities of lime to compensate for the deep cultivation involved in earthwork activities.

Seed.

Details of seed mixtures having been obtained from farmers, seed costs were calculated using average prices for the 1982/83 season obtained from a North Canterbury seed merchant. The prices used were as follows:

	$/kg
Nui ryegrass	2.35
Perennial ryegrass	1.40
Manawa ryegrass	1.50
Huia white clover	3.00
Turoa red clover	3.20
Turnips	3.75
Rape	1.35

Trees.

Tree costs were obtained directly from the 1983 Budget Manual.

Drainage.

Most of the drainage undertaken on irrigated farms has been subsidized and the costs are incorporated into the costs of structures and earthworks and the subsidies paid on these. In one case additional drainage was to be undertaken at the farmer's expense, and in the case of the three properties to be used for dairying drainage costs included the costs of effluent disposal.

Structures, earthworks and subsidized drainage.

Farmers receive a subsidy equal to 50% of the contract cost of structures, earthworks and approved drainage. A number of farmers have undertaken part, or in one case all, of this work using farm labour, under contract to the Ministry of Works and Development. They receive the subsidy on the equivalent contract price. However since farm labour, unless specifically employed, is not included in cost-benefit analysis the proportion of resource cost incurred by the farmer is lower than that incurred by the Ministry.

The Ministry provided details of the costs incurred during each financial year since development began and these were inflated using the Construction Costs Index. It was calculated on the following basis that $242 per hectare was saved by those farmers who built irrigation structures using farm labour.

ITEM	No/ha	Unit Price $	Total $
Contract Prices			
Sills (concrete and timber)	4	31.20	124.80
Dams	.66	140.00	92.40
Crossing	.125	1,190.00	149.00
Weir	.1	187.00	18.70
			$384.90

ITEM	No/ha	Unit Price $	Total $
Farmer completes all own structures except excavation for crossings			
Sills	4	9.79	39.16
Dams	.66	52.80	34.85
Crossing	.125	502.80	63.28
Weir	.1	69.20	6.92
			$144.19

Note: Contract prices were estimated from farmers' invoices for the 1982/83 year. Contract price for sills includes pulling and tidying. Costs incurred by farmers completing their own structure were estimated using Ministry of Works and Development specifications and farmers' own costings.

Expenditure on structures comprised 60% materials, 10% plant and 30% labour and earthworks comprised 65% plant and 35% labour. Thus an index was calculated on the basis of 33% labour, 47% plant and 20% materials. This index and its components are shown in Table 20.

Future costs have been calculated on the basis of the 1983 per hectare costs for each farm.

Irrigation subsidies.

The subsidy on border-dyke irrigation equals 50% of the total contract charge. Spray irrigation costs are only partially subsidized. In general permanently installed plant such as pipes, hydrants switch gear, pump houses and power supply is eligible for the 50% subsidy both on materials and installation. Moveable plant including applicators, pumps, and motors are unsubsidized.

Catchment Board subsidies.

Where North-West shelter eligible for Catchment Board Subsidy has been planted and fenced as a direct consequence of irrigation the subsidy has been calculated on the basis of the length of shelter belt and the type of fence. The subsidy has been deducted from the farmer's costs and included separately for use in the national cost-benefit calculation.

A3.1.2 Changes in farm working expenses.

Labour.

Additional labour employed as a direct consequence of irrigation has been costed at the actual wages paid if details of these were provided by the farmer or at $140 per week for single employees and $190 for married men. None of the farmers interviewed indicated that

irrigation allowed them to continue employing existing labour units which must otherwise have been dispensed with.

Fertiliser.

Additional fertiliser applied to irrigated land was costed at 1983 fertiliser prices and fertiliser maintenance foregone in development years was subtracted from additional maintenance costs.

Greenfeed.

For most farmers the area of greenfeed decreased or was expected to decrease as a consequence of irrigation. This decrease was valued using standardised costs of $64.85 per hectare for brassica crops and $89.21 per hectare for cereal crops derived as follows:

	Brassica	Cereal
Cultivation	32.95	21.65
Seed	3.75	32.40
Fertiliser	28.15	35.16
	$64.85	$89.21

In each case the costs of normal dryland maintenance fertilizer were subtracted from the greenfeed costs since these were built into the analysis elsewhere.

Feed conservation.

Changes in feed conservation costs were costed as follows:

(1) Standard square bales of hay made and carted on farm.

	$/1000 bales
Bailing 5 hrs @ $8.66 + $1.60	51.30
Mowing and conditioning 7 hrs @ $8.66	60.62
Raking 7 hrs @ $8.66	60.62
Twine	140.00
Repairs and maintenance	17.00
Cartage on farm 3km @ 50c per km	140.00
	$469.54

(2) Standard square bales, baled by contractors and carted by farm labour = $798.24 per 1,000

(3) Large round bales, baled by contractors and carted by farm labour = $643 per 1,000 bale equivalent

(4) Wilted silage = $10.60 per tonne.

It was assumed that changes in the quantity of feed conserved between the start of development and 1983 were due to climatic conditions, rather than to irrigation development, except in a few cases where large areas of development were undertaken in one year. In these cases the farmers' estimates of the change due to irrigation were used.

Feed purchase.

The rationale used for estimating the quantities of feed which would have been purchased under a dryland regime is discussed in Section 2 with other aspects of the dryland-base calculation. The differences between this and the actual feed purchases made were costed at $200 per tonne of barley purchased (which was the average price for purchases in the area during 1983) and $305.25 per tonne for sheep nuts.

Where the quantity of farm-grown cereals used for stock feed was estimated to vary between the actual situation and the hypothetical dryland situation the sale price foregone was used to cost consumption.

Pasture renewal.

Pasture renewal cost reductions as a consequence of irrigation were calculated using the farmers' estimates of the proportion of the irrigated area regrassed per year before development. Fertiliser, seed and cultivation costs used were very similar to those estimated for pastures sown after border-dyking. In most cases cultivation costs were reduced since fewer operations would be required during routine pasture renewal than would be necessary during border-dyking. Fertiliser maintenance costs for the year of renewal were deducted from renewal costs.

Lucerne renewal.

For many farmers the change to irrigation has meant that large areas of lucerne, previously grown to provide feed during the dry summer months, will no longer be necessary. While it is arguable that the problems of pests and diseases encountered by lucerne growers during the past few years would have resulted in reduced areas of lucerne even in the absence of irrigation development it would be very difficult to separate these effects. For the purposes of this analysis it has been assumed that the reduction in area has been a direct consequence of irrigation.

After discussion with farm advisors familiar with the area, the following costs for lucerne establishment and maintenance in the Amuri area have been used.

	IRRIGATED	DRY
Establishment Costs per Hectare		
Cultivation: 13 hrs @ $10.15	131.95	131.95
Seed: 5 kg @ $6.50 per kg	32.50	32.50
Fertiliser: 250 kg lime reverted superphosphate @ $153.64 per tonne including cartage and spreading	38.41	38.41
Seed Innoculation: 5 kg @ 90c/kg	4.50	4.50
	$207.36	$207.36
	(less dryland maintenance fertiliser)	
Maintenance Costs per Hectare		
Fertiliser: 375kg superphosphate (irrig)	65.08	Dryland Maintenance only
Heavy roll: 0.6 hr @ $10.15	6.09	6.09
Weedspray: 2,4-DB @ 4 litres/ha 5.60/litre + .33 hr/ha @ $10.15/hr application	25.45	25.45
Aphid spray Metasystox @ .345 kg/ha $11.80/litre + .33 hr/ha @ $10.15/hr application	7.43	-
	$104.05	$31.54
	(less irrigated fertiliser maintenance)	

Headrace maintenance.

Ministry of Works and Development estimates of headrace maintenance costs = $1/hectare irrigated.

Spray running costs.

Estimates of spray running costs, electricity and repairs and maintenance have been made for individual farms by Farm Advisory Officers of the Ministry of Agriculture and Fisheries and were incorporated in the analysis.

Vehicle running.

For some farmers, particularly those with large or divided properties and non-automated irrigation systems significant increases in vehicle mileage have occurred. These have been costed using fuel and maintenance costs appropriate for the vehicle driven.

Water charges.

Farmers within the scheme pay annual water charges based on the irrigable area of their properties. These charges are based on the capital cost of off-farm works less the value of subsidies amortized over forty years with the average Rural Bank interest rate used as a discount rate. This represents the annual basic charge and is payable on a per-irrigable hectare basis by all farmers whose properties lie within the scheme boundaries. In addition, those farmers who actually irrigate pay additional charges which cover the operating costs of the scheme, the accumulated loss on scheme operation over the first seven years amortized at the Rural Bank interest rate, and a sinking fund for renewal of off-farm works.

During the first seven years of water availability water charges increase gradually from $0 per weekly roster day to $1,000 per weekly roster day. In the eighth year the full charge which is currently estimated to be $65 per irrigable hectare will be introduced.

The scale of charges is as follows:

Season after water is made available	Availability Charge	
	Border Dyke ($/weekly roster day)	Spray ($/litre/second)
1st	0	0
2nd	0	0
3rd	200	4
4th	400	8
5th	600	12
6th	800	16
7th	1000	20

For border-dyke irrigation one roster day per week will be sufficient for approximately 75 hectares of irrigable land while 50 litres/second will irrigate 90 hectares.

Water charges were paid by the first farmers in 1983. From that time the portion of the charges which covers capital costs and accumulated operating loss which remains constant in actual dollar terms has been deflated at an annual rate of 8% while the operating and renewal costs have remained fixed in real $1983 terms.

Properties gazetted within the scheme boundaries but not developed for irrigation incur a basic charge which during the first seven years equals 75% of the availability charge. The basic charge from year 8 onwards is estimated to be $43 per hectare. Non-irrigated properties were not included in the survey.

Water supply costs.

Properties served by the Amuri Plains Rural Water Supply Scheme are rated at $50 per unit per year in 1983 dollars. Where properties were previously supplied by the Amuri County water race system the

rates which would previously have been charged to pay for that service have been deducted from the current charges.

Additional repairs and maintenance.

Additional repairs and maintenance have been included as follows:

Buildings and Yards	2.5% of capital
Fences	5% of capital
Plant (other than irrigation)	7.5% of capital

Tractor replacement.

It has been assumed that the average tractor in the area is kept for 7 years or 5,000 hours. Changes in the tractor hours worked as a consequence of development and changes in farming practices such as pasture renewal have been estimated and the change in sinking fund for tractor replacement included as a positive or negative cost. Resale values of tractors have been based on a machinery replacement program developed by the Department of Farm Management and Rural Valuation, Lincoln College (Nuthall, Woodford and Beck).

Sinking funds.

Sinking funds for on-farm irrigation development, plant and buildings have been estimated. Capital items have been assumed to last for the following periods:

Buildings	40 years
Plant (not irrigation)	15 years
Spray Irrigation	
Mainlines, hydrants etc.	30 years
Applicator	50 years
Hose	10 years
Border Dyke Irrigation	
Gates, automation	15 years
Sill, Weir	20 years
Dam	40 years
Access crossing	75 years

Fertiliser subsidy.

Price and transport subsidies on fertiliser and lime used for development and for additional maintenance have been included in the national analysis.

Fertiliser price is subsidised at the rate of $15.00/tonne, transport of fertiliser over 100 km is subsidised at $6.60/tonne, and lime transport over 72 km is subsidised at $4.64/tonne. Changes in the quantities of lime and fertiliser used as a consequence of development

and of changed farming practices are costed at these rates to estimate the total change in subsidy.

Animal health and breeding (dairy).

Costs of animal health and breeding for prospective dairy farms are based on estimates published in the 1983 Lincoln College Budget Manual. These are $22.12/cow for animal health, $11.06/cow for breeding and $10.00/cow for herd testing.

Shed expenses and electricity (dairy).

Estimates of shed expenses and electricity costs have also been derived from the 'Budget Manual'. These include $9.48/cow for shed expenses and $17.38/cow for electricity although $800 has been deducted from total electricity costs since it has been assumed that the properties would have used this had they remained sheep farms.

Rebordering and levelling.

It has been assumed that rebordering and levelling will be required only when cultivation is undertaken on border-dyked land. In this analysis rebordering and levelling have been assessed at the rate of $75.00 every second cultivation and included as $37.50/ha each time land is regrassed.

A3.2 Off-Farm Costs

A3.2.1 Capital costs of the irrigation scheme.

The Ministry of Works and Development have provided details of the off-farm costs of constructing the Amuri Plains Irrigation Scheme from 1977/78 to 1982/83 as well as estimates of future costs. These are shown in Table 21. Costs have been inflated using the construction costs index. The Ministry records these costs on a March year basis and extraction of June year totals would be difficult. However as the expenditure from March 31 to June 31 appears to be approximately one quarter of the previous March year's expenditure, March year totals have been included in the analysis.

A3.2.2 Running costs of the irrigation scheme.

The costs of running the irrigation scheme (in $1983) have been estimated by the Ministry of Works and Development to be:

TABLE 21

Amuri Plains (Waiau Section) Irrigation Scheme Expenditure

Year	Headworks	Culverden Office	Investigations and Survey Off-Farm	Off-Farm Construction	Off-Farm 7½% Admin. (on 4 & 5)	Total Off-Farm	On-Farm	Total
	$	$	$	$	$	$	$	$
1977–78	256,361	136,799	1,681	29,441		32,282	11,276	435,558
$1983	*563,353*	*300,616*	*3,694*	*64,697*		*932,360*	*28,294*	*960,654*
1978–79	281,600	250,543	3,077	837,892	2,334	1,375,446	162,363	1,537,809
$1983	*565,554*	*495,173*	*6,081*	*1,656,010*	*4,613*	*2,727,431*	*348,431*	*3,075,862*
1979–80	214,712	397,344	8,479	924,283	63,073	1,607,891	373,242	1,981,133
$1983	*343,840*	*636,307*	*13,578*	*1,480,147*	*101,005*	*2,574,877*	*618,798*	*3,193,675*
1980–81	151,378	250,321	23,492	2,368,259	69,957	2,863,407	912,268	3,775,675
$1983	*195,580*	*323,415*	*30,352*	*3,059,791*	*90,384*	*3,699,522*	*1,192,243*	*4,891,765*
1981–82	40,601	176,504	24,154	2,346,850	179,381	2,767,490	1,154,359	3,921,849
$1983	*44,344*	*192,778*	*26,381*	*2,563,230*	*195,920*	*3,022,653*	*1,274,296*	*4,296,949*
1982–83	36,038	178,964	50,873	1,401,856	177,826	1,845,557	1,865,158	3,710,715
$1983	*36,038*	*178,964*	*50,873*	*1,401,856*	*177,826*	*1,845,557*	*1,865,158*	*3,710,715*
1983–84	*333,000*	*220,000*	*15,000*	*356,000*	*108,000*	*1,032,000*	*1,412,000*	*2,444,000*
1984–85	–	*100,000*	*5,000*	*600,000*	*27,000*	*723,000*	*1,500,000*	*2,223,000*
1985–86	–	*50,000*	–	*150,000*	*45,000*	*245,000*	*1,500,000*	*1,745,000*
Total	*($83)2,081,709*	*2,497,253*	*150,959*	*11,331,731*	*749,748*	*16,802,400*	*9,739,220*	*26,541,620*

Note: All costs except on-farm costs inflated by CCI
On-farm costs inflated by On-farm Costs Index
(see Table 20)

1980/81	$62,000
1981/82	$62,000
1982/83	$62,000
1983/84	$81,860
1984/85	$92,590
1985/86	$139,250
1986/87	$139,275

These include labour, vehicle and race maintenance.

A3.2.3 Off-farm costs of the Amuri Plains Rural Water Supply Scheme.

The total costs of the off-farm construction of the Amuri Plains Rural Water Supply Scheme, inflated by the Construction Costs Index, are as follows:

Year	$Nominal	$1983
1979/80	307,189	491,942
1980/81	40,834	52,759
1981/82	0	0
1982/83	3,928	3,928
		548,629

APPENDIX 4

PRICE ASSUMPTIONS AND SOURCES

Sheep Product Prices

Actual prices, inflated using the NZMWBES Farm Input Price Index in the case of farm prices and the Import Price Index in the case of F.O.B. prices, have been used for the years 1977/78 to 1982/83. Future prices have been derived by extrapolating from the Ministry of Agriculture and Fisheries' Product Price Assumptions 1983. Derivation of actual prices is described in the notes below (Tables 22-25).

	Farm Prices Received Index (1982/83 = 1000)	Import Price Index (1982/83 = 1000)
1977/78	472	504
1978/79	515	529
1979/80	631	672
1980/81	776	802
1981/82	908	914
1982/83	1000	1000

TABLE 22

Lamb prices

Year		Lamb c/kg			Woolly Pelt c/pelt		Shorn Pelt c/pelt	
		Farm[1]	Farm-SMP[2]	F.O.B.[3]	Farm[4]	F.O.B.[5]	Farm[6]	F.O.B.[7]
1977/78	a	65	65	109	343	497	229	370
	b	138	138	216	726	986	485	734
1978/79	a	72	72	131	434	552	312	425
	b	140	140	248	842	1043	605	803
1979/80	a	86	86	153	348	678	233	506
	b	136	136	228	552	1009	369	753
1980/81	a	108	108	188	120	459	0	296
	b	139	139	234	157	572	0	369
1981/82	a	136	126	175	252	555	85	382
	b	149	139	191	277	607	93	418
1982/83	b	138	106	223	268	600	145	441
1983/84	b	138	130	199	433	969	268	712
1984/85 and future	b	130	130	199	433	969	268	712

a. nominal c/kg
b. real (1983) c/kg

NOTES:

1. Actual farm prices for lamb in cents per kilogram obtained from the NZMWBES Annual Review of the Sheep and Beef Industry (A.R.S.B.I.).

2. In years when SMPs have been paid on lamb the average SMP/kg has been obtained from the A.R.S.B.I. (S.M.P./head ÷ av. carcase weight) and subtracted from returns.

3. F.O.B. values for lamb were obtained from the A.R.S.B.I. (1982/83) except for the year 1982/83 for which F.O.B. price was obtained by dividing total export value of lamb by total export quantity. Both of these statistics were obtained from the New Zealand Department of Statistics Export Statistics (1982/83).

4. Farm prices for lamb pelts with 1 kg wool-pull obtained from A.R.S.B.I.

5. F.O.B. values for woolly lamb pelts obtained by adding the F.O.B. price of 1 kg of slipe wool (N.Z. Wool Board's Statistical Handbooks) to the price of lamb skin (F.O.B. value - number exported) calculated from the Export Statistics.

6. The ratios of the schedule value of a shorn lamb with .4 kg wool-pull to that of a woolly lamb with 1 kg wool-pull for each year were calculated from Waitaki N.Z.R. South Island mid-January lamb schedules. Woolly pelt values were multiplied by these ratios to estimate shorn pelt values.

7. As for 5 above using the value of .4 kg slipe wool:

TABLE 23

Cull Ewe Prices

Year		Farm $/hd-	Farm - SMP $/hd-	FOB $/hd-
1977/78	a	8.51	8.51	19.37
	b	18.02	18.02	38.35
1978/79	a	9.40	9.40	21.08
	b	18.24	18.24	39.85
1979/80	a	11.86	11.86	30.50
	b	18.80	18.80	45.39
1980/81	a	10.27	10.27	28.41
	b	13.24	13.24	35.42
1981/82	a	9.94	6.96	24.02
	b	10.94	7.67	26.28
1982/83	b	10.50	9.91	24.91
1983/84	b	14.30	14.30	33.90
1984/85	b	14.30	14.30	33.90

a. Nominal $/head
b. Real (1983) $/head

NOTES:
1. Actual prices obtained from A.R.S.B.I. (1982/83)
2. As for Table 22, Note 2.
3. As for Table 22, Note 3.

TABLE 24

Wool Prices

Year		Farm $/kg [1]	Farm - SMP $/kg [2]	FOB $/kg [3]
1977/78	a	1.90	1.90	2.04
	b	4.02	4.02	4.05
1978/79	a	2.19	2.19	2.28
	b	4.25	4.25	4.31
1979/80	a	2.65	2.65	2.87
	b	4.20	4.20	4.27
1980/81	a	2.48	2.48	2.72
	b	3.20	3.20	3.39
1981/82	a	3.20	2.56	2.89
	b	3.53	2.82	3.16
1982/83	b	3.20	2.56	2.79
1983/84	b	3.38	3.38	3.58
1984/85	b	3.38	3.38	3.58

a. Nominal $/kg
b. Real (1983) $/kg

NOTES:
1. Average price for greasy wool at New Zealand Auctions obtained from New Zealand Wool Board's Statistical Handbooks 1977/78 - 1982/83.

2. S.M.P. level less average greasy price at auction.

3. Total F.O.B. value of New Zealand's Wool Exports divided by total weight of wool exported. Both statistics derived from the New Zealand Wool Board's Statistical Handbooks.

TABLE 25

Livestock Sale and Purchase Prices ($/hd)

Year		Hgts [1]	2TH [2]	CFA [2]	Store [2] Lamb	Rams [3]	Ewe [4] Purchase
1977/78	a	16.98	13.00	12.30	9.75	50.0	12.85
	b	35.97	27.53	26.04	20.65	106.00	27.23
1978/79	a	16.05	19.00	14.00	11.00	55.0	17.98
	b	31.55	36.87	27.16	21.35	107.00	34.92
1979/80	a	21.18	22.00	16.00	12.00	50.00	20.81
	b	33.57	34.88	25.37	19.03	95.00	32.98
1980/81	a	26.59	16.00	10.00	10.00	80.00	14.80
	b	34.26	20.62	12.89	12.89	103.00	19.07
1981/82	a	24.17	19.00	11.00	8.00	100.00	17.40
	b	26.62	20.92	12.11	8.81	110.00	19.16
1982/83	b	26.64	20.00	14.00	12.00	116.00	18.80
1983/84	b	29.91	31.80	22.40	17.20	116.00	29.92
1984/85	b	29.91	31.80	22.40	17.20	116.00	29.92

a. Nominal $/head
b. Real (1983) $/head

NOTES:
1. In the few cases where cull hoggets have been sold it has been assumed that they are sold to local butchers at the same price as a 16 kg lamb with two kilograms wool-pull.

2. All prices derived from A.R.S.B.I. 1982/83

3. Derived from Lincoln College Budget Manuals 1977/78 - 1982/83.

4. Ewe purchase price has been estimated as (.80 x 2TH price + .20 * C.F.A. price).

Crop Product Prices

TABLE 26

Crop Prices

Year		CROP $/TONNE Wheat [1]	Barley [2]	Oats [2]	Peas [3]	Grass Seed [4]	Clover [4]
1977-78	a	117	85	90			
	b	293	213	226			
1978-79	a	126	89	110			
	b	266	188	232			
1979-80	a	136	88	90			
	b	236	153	156			
1980-81	a	180	150	140			
	b	236	196	183			
1981-82	a	201	165	160			
	b	213	175	170			
1982-83	b	198	150	180	250		
1983-84	b	215	180	190	367	1,729	2,930

a. Nominal $/tonne
b. Real (1983) $/tonne

(1) Actual average wheat prices paid to farmers (net of varietal premiums and discounts) are published in the Annual Survey of Wheatgrowers.

(2) Actual average barley and oats prices paid to farmers were obtained from a major stock and station company.

(3) Peas were not grown on any of the properties surveyed until 1982-83 and previous years' prices were not, therefore, obtained.

(4) Changes in the areas of grass seed and clover grown had not occurred before the survey was conducted and only future prices were obtained. As Nui ryegrass will be most commonly grown the product price assumption for Ruanui was multiplied by 1.68 which was the relationship prevailing locally in 1983.

In the absence of an official index of cropping farm costs the following index has been derived from the tables of selected costs

published annually in 'An Economic Survey of New Zealand Wheatgrowers: Enterprise Analysis' by the A.E.R.U.

	Cost Index
1977-78	399
1978-79	473
1979-80	574
1980-81	764
1981-82	943
1982-83	1,000

All cropping prices have been inflated by this index.

Future crop prices were taker directly from the Ministry of Agriculture and Fisheries' Product Price Assumptions. No allowance is made in these assumptions for export prices which differ from domestic prices. The greatest effect of this omission is probably on the benefits from clover and grass seed crops.

Cattle, Milkfat, Deer and Horticultural Prices.

Changes in beef production, to deer farming and to dairying as a consequence of irrigation had not occurred by 1983 although several farmers intended changing within two years. Prices for store cattle, prime cattle, milkfat, venison, velvet and store deer, and stonefruit were therefore derived directly from the Product Price Assumptions.

Foreign Exchange Weighting.

In one section of the national analysis, FOB costs and benefits were weighted using the composite coefficients presented in the Ministry of Agriculture and Fisheries Technical Paper 3/77 'Overseas Exchange Weighting Procedure' (see Table 27).

TABLE 27

Composite Coefficient and Point of Application.

Cash Flow	Composite Coefficient	Point of Application
Beef	1.0884	F.O.B.
Lamb	1.0873	F.O.B.
Mutton	1.0909	F.O.B.
Wool	1.0890	F.O.B.
Dairy Products (Milkfat)	1.0844	F.O.B.
Livestock Salvage	1.0883	Farm Gate
Cash Crop	1.0874	Store
On-Farm Capital Costs (excluding livestock)	1.0358	Farm Gate
Livestock Capital Costs	1.0883	Farm Gate
Off-Farm Capital Costs	1.0481	On Site

SOURCE: Ministry of Agriculture and Fisheries.

APPENDIX 5

GROSS MARGIN FORMULAE

A5.1 Sheep Gross Margin (Standardized costs in italics)

Total costs per ewe ($1983)

Stock Purchase = [((Ewes purchased * Ewe purchase price) + (Store lambs purchased * Store lamb price))/ Ewe numbers]

Shearing = [((Ewe numbers + Ewe hogget numbers + ram hogget numbers) * Ewe shearing price) + (Lambs shorn * Lamb shearing price))/Ewe numbers]

Crutching = *.32*

Animal Health = [((Ewe animal health cost * Ewe numbers) + (Hogget animal health cost * Hogget numbers) + (Fat lamb animal costs * Fat lambs) + (Store lambs purchased * *.213*))/Ewe numbers]

Eartags and Docking = Lambing % * *.142*

Dipping = [(Ewe numbers + Hogget numbers * *.27*)/Ewe numbers]

Woolshed Expenses = [((Ewe numbers + Hogget numbers + Lambs shorn) * *.30*)/Ewe numbers]

Ram Purchase = [(Rams purchased * Ram price)/Ewe numbers]

Wool Cartage = [Total wool (kg) + *.0446*/ewe numbers]

Selling Charges = [((% sold CFA + % sold 2TH) * Ewes sold * *.26*)/Ewe numbers]

Commission = [((% sold 2TH * Ewes sold * 2TH price) + (% sold CFA * Ewes sold * CFA price)/Ewe numbers) * *.0475*]

Total revenue/ewe ($1983)

Lamb Revenue = [((Lamb weight * Lamb price * Fat lambs sold) + (Proportion fat lambs shorn * Shorn pelt price) + ((1 — Proportion fat lambs shorn) * Woolly pelt price))/Ewe numbers]

Domestic Mutton Revenue	= [(Hoggets sold * Hogget sale price)/Ewe numbers]
Breeding Stock Sale Revenue	= [((% sold CFA * Ewes sold * CFA price) + (% sold 2TH * Ewes sold * 2TH price) + (Rams sold * Ram price) + (Store lambs sold * Store price))/Ewe numbers]
Export Mutton Revenue	= [(% sold works * Ewes sold * Ewe price)/Ewe numbers]
Wool Revenue	= [Wool (kg) * Wool price/Ewe numbers]

A5.2 Crop Gross Margin

The following is the general form of the crop gross margin. Cultivation and Heading costs for each crop were calculated according to whether the operation was undertaken using farm machinery or by contract.

Crop costs (Standardized costs in italics)

Seed,Weed and Pest Control	= *Control* * Crop area
On—farm Cartage	= *O.F.C.* * Crop area
Cultivation	= Crop cultivation * Crop area
Fertilizer	= (*Crop fertilizer* — Maintenance fertilizer) * Crop area
Heading	= Crop heading * Crop area
Box hire	= *Crop B.H.* * Crop area
Cartage	= *Crop cartage* * ((Crop area * Crop yield) — Crop fed)
Levies	= *Crop Levy* * ((Crop area * Crop yield) — Crop fed)
Crop Revenue	= Crop area * (Crop yield — Crop fed) * Crop price

Note: Standardized crop costs derived from the Lincoln College Budget Manual for each crop.

A5.3 Example Sheep Gross Margin

[Note: This example was randomly chosen but does not necessarily represent the average for the scheme.]

Production parameters

The production parameters for the post-irrigation status quo year and for the same year under dryland conditions have been used to derive these gross margins. Long-term projected prices have been used.

	Lambing %	Wool Wt kg/ewe	Hgt:Ewe Ratio	% Lambs shorn	Lamb CW (kg)
With irrigation	1.30	6.43	.22	.76	14.0
Without irrigation	1.25	5.79	.29	.29	12.5

Total costs/ewe ($)

	Dryland	Irrigated
Stock purchase	0	0
Shearing	1.13	1.91
Crutching	.32	.32
Animal health	.36	1.05
Eartags and docking	.18	.19
Dipping	.35	.33
Woolshed expenses	.50	.66
Ram purchase	.23	.23
Stock cartage	1.39	1.48
Wool cartage	.26	.31
Selling charges	0	0
Commission	0	0
Total Direct Costs	$4.79	$6.48

Total revenue/ewe ($)

Lamb revenue	19.43	22.69
Domestic mutton revenue	0	0
Breeding stock sale revenue	0	0
Export mutton revenue	2.65	3.00
Wool revenue	19.57	21.73
Total Revenue/Ewe	$41.65	$47.42
GROSS MARGIN/EWE	$36.86	$40.94

APPENDIX 6

CHANGES IN ON-FARM COSTS

1978-1994

TABLE 28

Private Capital Costs for Scheme Area ($1983)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
GATES & AUTOMATION	0.	2792.	10797.	124351.	186855.	153938.	109861.	88869.	65115.	55368.
SPRAY SUBSIDISED	0.	0.	0.	0.	8670.	115403.	127318.	39258.	121905.	0.
SPRAY UNSUBSIDISED	0.	0.	0.	0.	0.	101805.	383969.	67542.	67001.	0.
WATER SUPPLY	0.	5335.	669942.	128060.	68603.	137359.	17648.	-14131.	6373.	6762.
FENCING	19910.	48453.	182265.	235766.	256624.	407923.	328090.	158349.	112315.	89992.
BUILDINGS	0.	72784.	67159.	210379.	33545.	0.	409185.	185196.	5347.	37253.
HOUSING	164821.	-3155.	48882.	-3155.	-3155.	132442.	-3155.	163.	163.	163.
TRACTOR	0.	40277.	0.	92173.	5280.	0.	-17578.	0.	0.	0.
CULTIVATION EQUIPMENT	0.	9417.	25467.	42555.	164559.	0.	4253.	0.	7443.	0.
CONTRACT CULTIVATION	0.	0.	0.	11097.	23624.	27882.	25243.	6864.	3189.	3382.
OWN CULTIVATION	3213.	9556.	38483.	50228.	41665.	69447.	43921.	24624.	20461.	16018.
DEVT FERTILISER	5146.	17942.	61558.	100363.	102612.	142404.	134176.	98750.	69606.	52511.
SEED	3628.	14696.	60121.	89965.	82603.	142628.	89107.	50019.	41373.	32039.
EARTHWORKS & STRUCTURES	0.	14322.	224959.	405234.	651163.	1379904.	819578.	377988.	273680.	226566.
OTHER CAP. COSTS	0.	0.	65.	518.	616.	10293.	32215.	16913.	2079.	1662.
TOTALS	196718.	232417.	1389698.	1487532.	1623263.	2821427.	2503830.	1100405.	796051.	521717.

	1988	1989	1990	1991	1992	1993	1994
GATES & AUTOMATION	28943.	15559.	5851.	8179.	0.	0.	0.
SPRAY SUBSIDISED	0.	0.	0.	0.	24964.	0.	0.
SPRAY UNSUBSIDISED	0.	0.	0.	0.	114514.	0.	0.
WATER SUPPLY	4411.	5647.	4907.	6858.	0.	0.	0.
FENCING	48451.	18875.	15536.	0.	0.	0.	0.
BUILDINGS	0.	0.	0.	0.	0.	0.	0.
HOUSING	163.	163.	3318.	3318.	3318.	3318.	0.
TRACTOR	0.	0.	0.	0.	0.	0.	0.
CULTIVATION EQUIPMENT	0.	0.	-30310.	0.	0.	0.	0.
CONTRACT CULTIVATION	2206.	2825.	2455.	0.	0.	0.	0.
OWN CULTIVATION	8133.	2774.	0.	0.	0.	0.	0.
DEVT FERTILISER	36568.	17932.	15326.	12004.	10010.	0.	0.
SEED	15830.	8220.	4649.	6496.	0.	0.	0.
EARTHWORKS & STRUCTURES	121816.	88127.	27450.	38361.	0.	0.	0.
OTHER CAP. COSTS	3098.	3098.	3098.	3098.	24666.	3098.	3098.
TOTALS	269619.	163221.	52280.	78315.	177473.	6416.	3098.

TABLE 29

Private Operating Costs for Scheme Area ($1983)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
ADDITIONAL LABOUR	4148.	4148.	4148.	48837.	87910.	118889.	129052.	123845.	135463.	135463.
FERTILISER	-5909.	-9075.	-42050.	-23103.	26196.	35582.	132578.	182256.	215257.	234650.
GREENFEED	0.	2371.	-11725.	-9538.	-12655.	-9267.	-11588.	-31063.	-31818.	-34509.
FEED	0.	0.	0.	39009.	3331.	-1342.	-14501.	-8311.	1742.	879.
PASTURE RENEWAL	-2650.	-24666.	-95740.	-109719.	-116786.	-127466.	-132377.	-132377.	-133102.	-130571.
LUCERNE RENEWAL	-14589.	-28616.	-83887.	-117727.	-173099.	-178923.	-161859.	-144247.	-159292.	-158202.
HEADRACE MAINTENANCE	0.	0.	214.	1300.	2948.	4738.	6451.	7469.	8294.	8946.
SPRAY RUNNING	0.	0.	0.	0.	552.	3875.	45546.	58265.	58265.	71303.
VEHICLE RUNNING	0.	0.	798.	6780.	10569.	11897.	16205.	16205.	16205.	16205.
WATER CHARGES	0.	0.	0.	0.	6222.	91105.	142199.	189743.	224184.	257400.
STOCK WATER	214.	214.	2640.	20230.	20429.	21426.	25818.	25818.	25818.	25818.
ADDITIONAL R & M	0.	5601.	9412.	21077.	37868.	49707.	73114.	104740.	113417.	118801.
TRACTOR REPL	-493.	-1225.	-3833.	-7056.	-8152.	-7928.	-8206.	-9731.	-10163.	-11562.
OTHER OP. COSTS	0.	0.	0.	0.	0.	798.	33135.	36059.	46738.	56700.
TOTALS	-19279.	-51127.	-219609.	-128897.	-105112.	35833.	319907.	482422.	580892.	664131.

	1988	1989	1990	1991	1992	1993	1994
ADDITIONAL LABOUR	118873.	118873.	118873.	107254.	107254.	107254.	107254.
FERTILISER	258758.	272339.	277777.	251688.	256576.	257787.	257787.
GREENFEED	-36764.	-31983.	-34713.	-31696.	-33252.	-33252.	-33252.
FEED	3470.	6060.	8651.	11242.	13833.	16423.	19022.
PASTURE RENEWAL	-122074.	-119056.	-115807.	-107234.	-107234.	-107234.	-107234.
LUCERNE RENEWAL	-158202.	-158202.	-158202.	-158202.	-158202.	-158202.	-158202.
HEADRACE MAINTENANCE	12414.	11339.	11432.	10754.	10843.	10843.	10843.
SPRAY RUNNING	71303.	71303.	71303.	71303.	76089.	76089.	76089.
VEHICLE RUNNING	16205.	16205.	16205.	16205.	16205.	16205.	16205.
WATER CHARGES	434913.	489353.	534341.	499948.	472993.	448035.	424926.
STOCK WATER	25818.	25818.	25818.	25419.	25419.	25419.	25419.
ADDITIONAL R & M	124011.	126062.	127002.	121652.	121652.	121652.	121652.
TRACTOR REPL	-14136.	-15969.	-15969.	-15131.	-15131.	-15131.	-15131.
OTHER OP. COSTS	64375.	67979.	69986.	71993.	73999.	76006.	77437.
TOTALS	871847.	953003.	1008994.	944080.	929931.	910781.	891702.

TABLE 30

Private Capital Costs per Irrigable Hectare ($1983)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
GATES & AUTOMATION	0.	0.	1.	9.	14.	11.	8.	7.	5.	4.
SPRAY SUBSIDISED	0.	0.	0.	0.	1.	8.	9.	3.	9.	0.
SPRAY UNSUBSIDISED	0.	0.	0.	0.	0.	7.	28.	5.	5.	0.
WATER SUPPLY	0.	0.	49.	9.	5.	10.	1.	-1.	0.	0.
FENCING	1.	4.	13.	17.	19.	30.	24.	12.	8.	7.
BUILDINGS	0.	5.	5.	15.	2.	0.	30.	14.	0.	3.
HOUSING	12.	0.	4.	0.	0.	10.	0.	0.	0.	0.
TRACTOR	0.	3.	0.	7.	0.	0.	-1.	0.	0.	0.
CULTIVATION EQUIPMENT	0.	1.	2.	3.	12.	0.	0.	0.	1.	0.
CONTRACT CULTIVATION	0.	0.	0.	1.	2.	2.	2.	1.	0.	0.
OWN CULTIVATION	0.	1.	3.	4.	3.	5.	3.	2.	2.	1.
DEVT FERTILISER	0.	1.	5.	7.	8.	10.	10.	7.	5.	4.
SEED	0.	1.	4.	7.	6.	10.	7.	4.	3.	2.
EARTHWORKS & STRUCTURES	0.	1.	17.	30.	48.	101.	60.	28.	20.	17.
OTHER CAP. COSTS	0.	0.	0.	0.	0.	1.	2.	1.	0.	0.
TOTALS	14.	17.	102.	109.	119.	207.	184.	81.	59.	38.

	1988	1989	1990	1991	1992	1993	1994
GATES & AUTOMATION	2.	1.	0.	1.	0.	0.	0.
SPRAY SUBSIDISED	0.	0.	0.	0.	2.	0.	0.
SPRAY UNSUBSIDISED	0.	0.	0.	0.	8.	0.	0.
WATER SUPPLY	0.	0.	0.	1.	0.	0.	0.
FENCING	4.	1.	1.	0.	0.	0.	0.
BUILDINGS	0.	0.	0.	0.	0.	0.	0.
HOUSING	0.	0.	0.	0.	0.	0.	0.
TRACTOR	0.	0.	0.	0.	0.	0.	0.
CULTIVATION EQUIPMENT	0.	0.	-2.	0.	0.	0.	0.
CONTRACT CULTIVATION	0.	0.	0.	0.	0.	0.	0.
OWN CULTIVATION	1.	0.	0.	0.	0.	0.	0.
DEVT FERTILISER	3.	1.	1.	1.	1.	0.	0.
SEED	1.	1.	0.	0.	0.	0.	0.
EARTHWORKS & STRUCTURES	9.	6.	2.	3.	0.	0.	0.
OTHER CAP. COSTS	0.	0.	0.	0.	2.	0.	0.
TOTALS	20.	12.	4.	6.	13.	0	0

TABLE 31

Private Operating Costs per Irrigable Hectare ($1983)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
ADDITIONAL LABOUR	0.	0.	0.	4.	6.	9.	9.	9.	10.	10.
FERTILISER	0.	-1.	-3.	-2.	2.	3.	10.	13.	16.	17.
GREENFEED	0.	0.	-1.	-1.	-1.	-1.	-1.	-2.	-2.	-3.
FEED	0.	0.	0.	3.	0.	0.	-1.	-1.	0.	0.
PASTURE RENEWAL	0.	-2.	-7.	-8.	-9.	-9.	-10.	-10.	-10.	-10.
LUCERNE RENEWAL	-1.	-2.	-6.	-9.	-13.	-13.	-12.	-11.	-12.	-12.
HEADRACE MAINTENANCE	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.
SPRAY RUNNING	0.	0.	0.	0.	0.	0.	3.	4.	4.	5.
VEHICLE RUNNING	0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
WATER CHARGES	0.	0.	0.	0.	0.	7.	10.	14.	16.	19.
STOCK WATER	0.	0.	0.	1.	2.	2.	2.	2.	2.	2.
ADDITIONAL R & M	0.	0.	1.	2.	3.	4.	5.	8.	8.	9.
TRACTOR REPL	0.	0.	0.	-1.	-1.	-1.	-1.	-1.	-1.	-1.
OTHER OP. COSTS	0.	0.	0.	0.	0.	0.	2.	3.	3.	4.
TOTALS	-1.	-4.	-16.	-9.	-8.	3.	24.	35.	43.	49.

	1988	1989	1990	1991	1992	1993	1994
ADDITIONAL LABOUR	9.	9.	9.	8.	8.	8.	8.
FERTILISER	19.	20.	20.	18.	19.	19.	19.
GREENFEED	-3.	-2.	-3.	-2.	-2.	-2.	-2.
FEED	0.	0.	1.	1.	1.	1.	1.
PASTURE RENEWAL	-9.	-9.	-9.	-8.	-8.	-8.	-8.
LUCERNE RENEWAL	-12.	-12.	-12.	-12.	-12.	-12.	-12.
HEADRACE MAINTENANCE	1.	1.	1.	1.	1.	1.	1.
SPRAY RUNNING	5.	5.	5.	5.	6.	6.	6.
VEHICLE RUNNING	1.	1.	1.	1.	1.	1.	1.
WATER CHARGES	32.	36.	39.	37.	35.	33.	31.
STOCK WATER	2.	2.	2.	2.	2.	2.	2.
ADDITIONAL R & M	9.	9.	9.	9.	9.	9.	9.
TRACTOR REPL	-1.	-1.	-1.	-1.	-1.	-1.	-1.
OTHER OP. COSTS	5.	5.	5.	5.	5.	6.	6.
TOTALS	64.	70.	74.	69.	68.	67.	66.

TABLE 32

Average Capital Cost (to the Farmer) per Irrigated Hectare ($1983)

Note: These costs are averaged over the whole area irrigated; borderdyked and spray irrigated. The average cost of spray irrigation plant, installation etc. to the farmer was $954 per hectare sprayed and the average cost to the farmer of structures and earthworks per hectare borderdyked $454. The latter figure does not include the cost of farm labour except where additional labour was employed specifically for irrigation development.

Cost item	$1983
Gates and automation	75
Water supply	89
Fencing	169
Buildings	89
Housing	31
Tractor	11
Cultivation equipment	20
Contract cultivation	10
Own cultivation	30
Development fertilizer	77
Seed	55
Other	7
Structures and earthworks	410
Spray plant and installation	102
	1,175

TABLE 33

Average Change in Operating Costs (to the Farmer by 1994) per Irrigated Hectare ($1983)

Note: The capital recovery component of water charges remains fixed in actual dollar terms and therefore must be deflated annually in real dollar terms.

Cost item	$1983
Additional labour	10
Fertilizer	23
Greenfeed	—3
Feed	2
Pasture renewal	—10
Lucerne renewal	—11
Headrace maintenance	1
Spray running	7
Vehicle running	2
Water charges	38
Stock water	2
Additional R & M	11
Tractor replacement	—1
Other operating costs	7
	78

Note: This table excludes those additional costs included in sheep and cropping gross margins (See Appendix 5).

APPENDIX 7

CHANGES IN FARM PRODUCTION AND ENTERPRISE MIX

1978—1994

TABLE 34

CHANGE IN SHEEP STOCK UNITS ON SURVEYED AREA AS A CONSEQUENCE OF IRRIGATION, 1977-1994

YEAR	SHEEP S.U.s WITHOUT IRRIGATION	SHEEP S.U.s WITH IRRIGATION	CHANGE IN SHEEP S.U.s
1977	91800.	91800.	0.
1978	91886.	92093.	208.
1979	92061.	93104.	1043.
1980	92854.	95169.	2316.
1981	93992.	101249.	7257.
1982	96863.	107256.	10393.
1983	98524.	111990.	13466.
1984	100055.	118955.	18900.
1985	101667.	126026.	24359.
1986	102729.	131613.	28884.
1987	103421.	135064.	31644.
1988	103896.	138453.	34557.
1989	104150.	141162.	37012.
1990	104153.	142601.	38448.
1991	104153.	143978.	39825.
1992	104153.	145104.	40951.
1993	104153.	145421.	41268.
1994	104153.	145771.	41618.

TABLE 35

CHANGE IN SHEEP STOCK UNITS AS A CONSEQUENCE OF IRRIGATION ON IRRIGABLE AREA,1977-1994

YEAR	SHEEP S.U.s WITHOUT IRRIGATION	SHEEP S.U.s WITH IRRIGATION	CHANGE IN SHEEP S.U.s
1977	136820.	136820.	0.
1978	136948.	137257.	309.
1979	137210.	138764.	1554.
1980	138390.	141842.	3451.
1981	140087.	150902.	10816.
1982	144366.	159856.	15490.
1983	146842.	166911.	20070.
1984	149123.	177292.	28169.
1985	151526.	187832.	36306.
1986	153109.	196158.	43049.
1987	154140.	201302.	47162.
1988	154848.	206353.	51505.
1989	155227.	210390.	55163.
1990	155231.	212535.	57304.
1991	155231.	214587.	59356.
1992	155231.	216266.	61034.
1993	155231.	216738.	61507.
1994	155231.	217260.	62028.

TABLE 36

Changes in Enterprise Balances on Area Surveyed : 1977–1994

	Sheep S.U.s	Beef Cattle S.U.s	Dairy Cattle S.U.s	Store Lambs Nos	Deer (Ha)	Irrigated Cash Crop (Ha)	Dryland Cash Crop (Ha)	Irrigated Small Seeds (Ha)	Horticulture (Ha)
1977/78	210	0	0	0	0	0	0	0	0
1978/79	1,045	0	0	0	0	0	0	0	0
1979/80	2,315	0	0	0	0	0	0	0	0
1980/81	7,260	0	0	0	0	0	0	0	0
1981/82	10,390	0	0	400	0	0	0	0	0
1982/83	13,470	0	0	700	0	0	50	40	0
1983/84	18,915	640	2,335	7,350	32	230	50	70	1
1984/85	24,375	1,230	2,650	7,350		260	12	110	3
1985/86	28,885	1,320	4,410	7,750		410	12	170	5
1986/87	31,645	1,410	6,360	7,850		410	12		
1987/88	34,560	1,500	7,050			410	0		
1988/80	37,010		8,165			435	–4		
1989/90	38,450		8,265			480	–60		
1990/91	39,825					505			
1991/92	40,950								
1992/93	41,270								
1993/94	41,620								

TABLE 37

Changes in Enterprise Balances on Irrigable Area : 1977–1994

	Sheep S.U.s	Beef Cattle S.U.s	Dairy Cattle S.U.s	Store Lambs Nos	Deer (Ha)	Irrigated Cash Crop (Ha)	Dryland Cash Crop (Ha)	Irrigated Small Seeds (Ha)	Horticulture (Ha)
1977/78	310	0	0	0	0	0	0	0	0
1978/79	1,555	0	0	0	0	0	0	0	0
1979/80	3,450	0	0	0	0	0	0	0	0
1980/81	10,815	0	0	0	0	0	0	0	0
1981/82	15,490	0	0	600	0	0	0	0	0
1982/83	20,075	0	0	1,045	0	0	75	60	0
1983/84	28,190	955	3,480	10,955	50	345	75	105	2
1984/85	36,370	1,835	3,950	10,955		390	18	165	5
1985/86	43,050	1,970	6,575	11,550		610	18	255	7
1986/87	47,160	2,100	9,480	11,700		610	18		
1987/88	51,505	2,235	10,510			610	0		
1988/89	55,165		12,170			650	–6		
1989/90	57,305		12,320			715	–90		
1990/91	59,355								
1991/92	61,035								
1992/93	61,510								
1993/94	62,030								

TABLE 38

CHANGE IN WOOL PRODUCTION ON SURVEYED AREA AS A CONSEQUENCE OF IRRIGATION

YEAR	WOOL(000 KG) WITHOUT IRRIGATION	WOOL(000 KG) WITH IRRIGATION	CHANGE IN TOTAL WOOL PRODUCTION	WOOL/S.U. WITHOUT IRRIGATION	WOOL/S.U. WITH IRRIGATION	CHANGE IN WOOL/S.U. PRODUCTION
1977	463243.	463243.	0.	5.0	5.0	0.0
1978	464002.	460296.	-3706.	5.0	5.0	-.1
1979	458965.	461893.	2928.	5.0	5.0	0.0
1980	470911.	478860.	7949.	5.1	5.0	0.0
1981	503419.	522175.	18756.	5.4	5.2	-.2
1982	440887.	484038.	43152.	4.6	4.5	0.0
1983	448082.	531947.	83865.	4.5	4.7	0.2
1984	466658.	606806.	140148.	4.7	5.1	0.4
1985	514040.	676623.	162583.	5.1	5.4	0.3
1986	522212.	715211.	192999.	5.1	5.4	0.4
1987	526738.	743899.	217162.	5.1	5.5	0.4
1988	529813.	769155.	239342.	5.1	5.6	0.5
1989	531385.	789074.	257688.	5.1	5.6	0.5
1990	531826.	800463.	268638.	5.1	5.6	0.5
1991	531933.	807469.	275536.	5.1	5.6	0.5
1992	531966.	816694.	284727.	5.1	5.6	0.5
1993	531966.	817896.	285930.	5.1	5.6	0.5
1994	531966.	819874.	287908.	5.1	5.6	0.5

TABLE 39

CHANGE IN WOOL PRODUCTION AS A CONSEQUENCE OF IRRIGATION ON IRRIGABLE AREA

YEAR	WOOL(000 KG) WITHOUT IRRIGATION	WOOL(000 KG) WITH IRRIGATION	CHANGE IN TOTAL WOOL PRODUCTION	WOOL/S.U. WITHOUT IRRIGATION	WOOL/S.U. WITH IRRIGATION	CHANGE IN WOOL/S.U. PRODUCTION
1977	690425.	690425.	0.	5.0	5.0	0.0
1978	691556.	686032.	-5524.	5.0	5.0	-.1
1979	684048.	688413.	4365.	5.0	5.0	0.0
1980	701853.	713700.	11848.	5.1	5.0	0.0
1981	750303.	778257.	27954.	5.4	5.2	-.2
1982	657104.	721418.	64314.	4.6	4.5	0.0
1983	667828.	792822.	124993.	4.5	4.7	0.2
1984	695514.	904392.	208879.	4.7	5.1	0.4
1985	766133.	1008450.	242317.	5.1	5.4	0.3
1986	778313.	1065962.	287649.	5.1	5.4	0.4
1987	785058.	1108719.	323661.	5.1	5.5	0.4
1988	789641.	1146360.	356720.	5.1	5.6	0.5
1989	791985.	1176047.	384062.	5.1	5.6	0.5
1990	792641.	1193022.	400381.	5.1	5.6	0.5
1991	792802.	1203465.	410663.	5.1	5.6	0.5
1992	792851.	1217212.	424362.	5.1	5.6	0.5
1993	792851.	1219005.	426154.	5.1	5.6	0.5
1994	792851.	1221953.	429102.	5.1	5.6	0.5

TABLE 40

CHANGE IN LAMBING PERCENTAGE AS A CONSEQUENCE OF IRRIGATION

YEAR	LAMBING % WITHOUT IRRIGATION	LAMBING % WITH IRRIGATION	CHANGE IN LAMBING %
1977	102.	102.	0.
1978	102.	102.	0.
1979	99.	98.	-1.
1980	101.	101.	0.
1981	103.	104.	1.
1982	96.	98.	2.
1983	93.	97.	4.
1984	94.	102.	8.
1985	100.	105.	5.
1986	101.	107.	6.
1987	102.	109.	7.
1988	103.	110.	8.
1989	103.	112.	8.
1990	104.	113.	9.
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