PERFORMANCE
OF NEW ZEALAND IRRIGATION SYSTEMS
AFTER TRANSFER

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ABSTRACT

This paper discusses the performance of irrigation schemes after they were transferred from Government control to irrigation companies in New Zealand. This study tested two hypotheses: a) privatisation of irrigation schemes in New Zealand has produced very large efficiency gains, and b) the privatisation of irrigation schemes in New Zealand has been very successful.

These hypotheses were proven.

Water costs for the same scheme would have been higher if it had not been privatised. The staff size was at minimum level. The companies seemed to be consistent with the O&M budget for water charge. Legal, financial and technical advice and services from professional groups were made available to the irrigation companies.

The water costs were controlled by irrigation companies. The schemes received strong physical, financial and spiritual support from farmers and shareholders. No evidence of documented environmental side-effects was found. The farmers indicated that they would stay with the current management instead of returning to the past system under which they received financial supports from the Government.

However, as the resource consents were thought to be a strategic threat and the irrigation companies seemed not to be prepared to enforce their capability in human resource management, technology development and company infrastructure, the irrigation companies could face difficulties in the future.

A number of recommendations were made as follows:

1. The water costs should be calculated on the basis of life cycle-costing.

2. The irrigation companies should consider contributing funds for training and research activities in order to achieve high efficiency for irrigation systems and irrigation techniques. Research would not only bring about improvement of efficiency in irrigation, but also gain glory for New Zealand science in the international arena.

3. The irrigation companies may need to consider re-establishing the New Zealand Irrigation Association to act as a focal point for the irrigation companies. This type of organisation would facilitate the networking of information, and the sharing of experience amongst its members.

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ABBREVIATIONS

FTE	Full-Time Equivalent
MAF	Ministry of Agriculture and Fisheries
MWD	Ministry of Works and Developments
PIM	Participatory Irrigation Management
PPI	Producer Price Index, compiled by Statistics New Zealand, is a series of quarterly economic indicators designed to measure the change in the prices received by producers in the New Zealand economy ("output") and the change in the prices of goods and services paid for by producers in the economy ("inputs") (New Zealand Official Yearbook, 1997)
RWC	Relative Water Costs
WUA	Water Users' Association
LCA	Life Cycle Analysis
LCC	Life Cycle Cost
PER	Personnel Employment Ratio
OMR	Operation and Maintenance Ratio
SOE	State Owned Enterprise

CHAPTER 1

INTRODUCTION

1.1 Overview of New Zealand

1.1.1 Physical Setting

New Zealand has an area of some 270,000 square kilometres. The country is long, narrow and very mountainous, with less than a quarter of the land below sea level. The country is divided across its centre into two more or less equally sized main islands: the North and South Islands. The country stretches for 1800 km between latitudes 34^0S and 47^0S. Mean daily maximum temperatures in Summer range from 25^0C in Northland to 18^0C in Southland. In Winter, the corresponding range is 14^0C to 8^0C, respectively (Choudhary and Baker, 1994). It has a population of 3.78 million people (on 31 December 1997, from New Zealand Official Yearbook 1998) and has traditionally been dependent on its agricultural industry. Agricultural products constitute nearly 60 percent of New Zealand's export earnings. Only 9% of New Zealand is considered arable.

The native Maori name for New Zealand is ***Aotearoa***, meaning "land of the long white cloud." This is how the first Polynesian Maori canoe travellers first perceived the country in their sightings from journeys across the Pacific Ocean. Such "long white clouds" are the basis of a benign temperate climate (Choudhary and Baker, 1994) which permits year-round plant growth and/or double-cropping in most farming areas.

The average annual rainfall ranges between 650 and 1500 mm in productive areas. This ensures that 40% of the land mass remains under permanent introduced pasture, with intensive animal grazing year-round (Choudhary and Baker, 1994). The pattern of rainfall determines the use in different areas;

pastures, gardens, and crops are raised in the dry east, while cattle raising and dairy-farming dominate in the wet west. Irrigation is required only in the semiarid areas such as the Otago district of South Island (Fukuda, 1976).

1.1.2 Water Resource Development in New Zealand

Water resource development in New Zealand began when the first European settlers arrived in 1840 (Viner, 1987). As a result, society has put increasing demands on New Zealand's water resources (see Appendix 1).

Population centres became established on the coasts of both islands and, in addition to that required for domestic needs, water was needed for agricultural industries. The introduction of refrigeration in 1882, which allowed the export of butter, cheese, and meat, in addition to wool, increased the demand for water. Rivers were used for access to the interior of the country, initially in search of grazing lands. Internal migration in the South Island was stimulated by the Central Otago gold rush in 1861. A new population pattern emerged at the beginning of the twentieth century in association with urbanisation and industrialisation. In the 1880s, almost two-thirds of the population lived in the South Island, but with increased industrialisation there was a general drift to the North Island.

The growth of industry has resulted in greater demands being made on water resources, and for treatment of industrial wastes. In the 1920s, hydro-electric power development began to harness the considerable river potential (Natusch, 1964). Agricultural intensification and diversification since World War II also have changed water use, particularly with the irrigation boom in the period 1965-1975. By 1978, agriculture used almost twice as much water as industrial and domestic uses put together.

1.1.3 Irrigation in New Zealand

Irrigation reduces the risk of drought, doubles the output of traditional farming products and provides the opportunity for diversification into more intensive types of land use (Mosley, 1992). Irrigation, which uses 1.1km^3 per year (in 1988), is the major consumptive use of water in New Zealand (Mosley, 1992).

In 1995, New Zealand had 285,000 hectares of irrigated land. New Zealand has achieved a high level of irrigation development, nearly similar to the United States, with about 0.080ha of irrigated area per head of population. This is high compared with 0.041ha per head of population for mainland China, 0.051ha per head of population for India, and 0.045ha per head of population for the World (FAO Production Yearbook, 1996).

There are three main types of irrigation in New Zealand: surface, sprinkler and trickle irrigation. The method used depends to a large extent on what the farmer intends to do with the land, i.e., cropping, horticulture or grazing. It depends also on the farmer's personal preference, labour requirements, the shape of the farm, its terrain, soil types and availability of water (Ministry of Works and Development, 1984; Farley, 1994).

Irrigation's arrival in New Zealand was closely linked with the Central Otago gold rush of the 1860s (Ministry of Works and Development, 1984), as shown in Appendix 1. It was the miners who first constructed contour races, sometimes kilometres long, to take water to their claims for sluicing gold. The settlers learnt to adapt their water races to irrigate the land. Where irrigated, the land showed great potential for both pastoral farming and orchard development. This attracted the Government of the time into financing some 12 community irrigation schemes in Central Otago between 1910 and 1935, beginning with the Ida Valley Scheme (Ministry of Works and Development, 1984; Farley, 1994).

Irrigation began with small diversions in the Canterbury Plains in 1878 (Fukuda, 1976). But it was not until the 1930s, that the Government turned its attention to the Canterbury Plains (Ministry of Works and Development, 1984). In 1959, the Department of Agriculture produced evidence from the Ashburton-Lyndhurst area to show that partial irrigation, on smaller holdings, could double stock-carrying capacity and income per hectare. Thus, irrigation was proving a worthwhile investment and received financial assistance from Government, which expected an acceptable return on capital costs.

In 1988, New Zealand had 234,000 hectares of irrigated land, of which some 45 percent was supplied by the Government constructed irrigation schemes. The remainder was largely private irrigation comprising of individuals or small groups of (up to six) irrigators using primarily groundwater (Farley, 1994).

It should be noted that great technological efforts have been made to improve water utilisation in irrigation. But the existence of obsolete administrations prevents the widespread use of these techniques in agriculture (Chambouleyron, 1996). If the irrigation management is decentralised, farmers and other stakeholders could play a more important role in the management of water resources (Keating, 1993).

The privatisation of the irrigation schemes was initiated in the early 1990s under the Irrigation Schemes Act, 1990. New Zealand is one of many countries which has adopted a programme transferring the management authority for irrigation systems from government to local irrigation companies.

1.2 Statement of the Problem

There was a strong interest in finding out about the potential benefits of privatisation of irrigation schemes in New Zealand. For these reasons, it is relevant to obtain and examine the evidence available on the privatisation of irrigation schemes with key indicators. Therefore, performance parameters are required in order to assess the dynamic changes before and after transfer of the irrigation systems. This was an important focus of this study.

1.3 Objectives of the Study

The main aim of this study was to evaluate the transfer of New Zealand irrigation systems through the findings of performance indicators, before and after their transfer from Governmental control to irrigation companies.

The study was divided into 5 interrelated objectives:

1. To review literature related to the performance of irrigation and water supply systems;
2. To establish potential performance indicators related to efficiency gains and success of the privatisation of irrigation and community water supply schemes at pre- and post-transfer times.
3. To identify irrigation and community water supply systems to study;
4. To design a questionnaire and to collect data; and
5. To analyse data and write up the report.

1.4 Importance of the Study

The change of irrigation management approach from that of the state-run system to that of the private entities has great significance in irrigation history. The transfer offered an opportunity to farmers who used water to manage and control the schemes by themselves. Subsequent performance of the irrigation and community water supply would indicate how the transfer programme was working.

The finding would provide guidance to policy makers, water resource managers, researchers, irrigation companies and individual farmers, and identify ways to develop better management systems. Finally, this study takes its place in the extensive body of literature on irrigation management and will enable further research activities in irrigation management to be carried out.

1.5 Thesis Outline

Chapter One - Introduction - provided a brief overview of New Zealand and agricultural development trends in New Zealand and their connection to irrigation policy. The problem was then stated, and the objectives were defined. Moreover, the importance of the study and the outline of the thesis were presented.

A review of literature followed in the next chapter. This discussed relevant studies and publications on such aspects as: irrigation, participatory irrigation management approach, privatisation of irrigation schemes in New Zealand and performance indicators of the transfer.

The methodology used in the study was outlined in Chapter 3. This included a description of the conceptual framework and the research design used. The location of the study area was presented and the types of data collected were discussed.

The results of the study were presented and discussed in Chapter 4. Tables and graphs were illustrated to provide or give a clearer understanding of the various discussions.

Chapter 5 presented the case studies of irrigation schemes visited. Finally, the closing Chapter summarised the results from the study and conclusions were drawn. A set of recommendations and related areas for further research was also provided.

CHAPTER 2

REVIEW OF LITERATURE

This chapter provides background information based on the existing literature on irrigation management. While there are numerous studies on irrigation management, this review focuses on those which deal with areas of concern namely, statutory frameworks, participatory irrigation management, privatisation of irrigation schemes and the performance of irrigation management.

2.1 Statutory Frameworks

Water management is most needed where demands exceed availability, in terms of both water quantity and water quality (Fenemor, 1992). As demand needs to be defined in its widest sense, New Zealand has attempted to aggregate certain types of legislation into larger, more consistent policy instruments with varying degrees of success. There were, previously, the Soil Conservation and Rivers Control Act 1941 and the Water and Soil Conservation Act 1967 (Mosley, 1992). Finally, the Resource Management Act of 1991 replaced several pieces of environmental legislation with a single unified act governing the management and use of all natural resources in the country (Alexander and Bhat, 1998), with the single purpose: "*to promote the sustainable management of natural and physical resources*" (Resource Management Act 1991). As a requirement of the Resource Management Act 1991, Regional and District Councils have their primary resource management functions, which are shown in the resource management framework in Appendix 2. The Regional Council must prepare a Regional Policy Statement, which looks at the issues relating to resources such as land, water, air and the coast, which are of importance to the Region.

Social and cultural recognition for Maori have been stressed in the Resource Management Act 1991. To Maori, water is the essential ingredient of life, a priceless treasure left by ancestors for the life-sustaining use of their descendants. The practice of discharging effluent into rivers, estuaries and the sea is not acceptable to Maori communities, particularly where the waters are used for traditional food-gathering (Waugh, 1992).

2.2 Participatory Irrigation Management (PIM)

2.2.1 Background

Participatory Irrigation Management (PIM) is defined as the process of involving irrigation beneficiaries (groups of irrigators) in irrigation project identification, formulation and design, construction, maintenance, rehabilitation, operation, and management (Adhikari and Jha, 1997).

Early efforts to transfer irrigation management from the Government to farmer organisations occurred in the USA, France, Colombia, and Taiwan from the 1950s through the 1970s (Vermillion, 1997). In the 1980s and early 1990s, some countries in the world accepted the idea of "participation", as in the Philippine model (Groenfeldt, 1997), in the sense that farmers would contribute labour and pay their dues while the official agency would continue to own and operate the system (Maloney and Clyma, 1997). In New Zealand, the Government sold irrigation schemes to the irrigation companies in the early 1990s (Farley, 1994). In the mid-90s the focus has been on "turnover" or to use a softer term as "participatory irrigation management". And near the turn of the twentieth century, the latest trend goes beyond these institutional issues, to comprehensive water resources management, including sustainability and environmental protection (Maloney and Clyma, 1997).

2.2.2 Transfer Approach in Participatory Irrigation Management (PIM)

Policy makers have rationalised participation in irrigation management both because government bureaucracies frequently are not very effective in managing irrigation systems and because recurring costs for operation and management of irrigation systems are more difficult to mobilise by government (Adhikari and Jha, 1997).

Participatory Irrigation Management (PIM) aims at the involvement of farmers in improving irrigation efficiency and effectiveness.

In 1989, the Mexican Government embarked on a programme of transfer of management of irrigation districts to Water User Organisations (WUOs). The process consists of transferring the operation and maintenance of irrigation districts from National Water Commission (CNA) to WUOs, known as Asociaciones Civiles (Johnson III). But the transfer of irrigation schemes in New Zealand has a character different from merely transferring the operation and maintenance tasks to irrigators. In New Zealand, the Government sold the irrigation schemes and transferred the ownership of the assets to the irrigators or irrigation companies (Farley, 1994) registered under the Companies Act 1955.

2.3 Privatisation of Irrigation Schemes in New Zealand

The transfer of irrigation schemes in New Zealand seemed to be the result of PIM and economic reforms. This section reviews the downsizing of the involvement of the state in many areas of economics through privatisation and the influence of that tendency on the sale of irrigation schemes in New Zealand. Here is one of the definitions of "privatisation":

> The transfer of ownership rights of public enterprises from the

> government to the private sector. It might involve a share float or outright sale of government businesses. It is sometimes used to describe the contracting out of public sector activity and the removal of competition restrictions on public-sector monopolies (Stanton and Launder, 1998).

2.3.1 Brief Description of Privatisation in New Zealand

Principally, the process of privatisation in many countries, such as New Zealand was led by the Thatcher Government in the UK (Johnson, 1998; the Economist, 1985). On 12^{th} December 1985, the Minister of Finance, in an Economic Statement to the House of Representatives said:

> "...there is scope for improving efficiency within the public sector. This will increase our ability to reduce the Government deficit, lower taxes, ... In the case of trading operations inefficiency can represent a tax on their customers. The essence of the problem is that the public sector needs to be adapted to meet the management needs of a modern economy" (The Economist, 1985).

The initial response of the Government was not to turn to privatisation; instead, it chose corporatisation. This has been defined as a process of restructuring government-owned trading enterprises from departmental form into a limited liability company with balance sheet structures and performance criteria similar to those of private companies (Peter, 1987).

Labour Ministers had avoided the label *privatisation*, preferring instead to talk of *asset sales* (Chew, 1989). To a point, that is understandable - privatisation is an ugly word (Heald, 1983). The root of the word is "private", and its original meaning was "not holding public office or official position" (Hirschman, 1982).

The reasons why State-owned assets did perform better in the private sector could be, as the Honourable Roger Douglas, Minister of Finance (1988), stated attributable to several different factors, contributing to the change of ownership of SOE (seminar, 1988, pp. 5, in: Institute of Policy Studies, 1988):

- governments are not very good at being business managers; they have other concerns which inevitably take priority in daily political life;

- poor performance. Poor performance of state businesses is not necessarily easy to identify as it involves efficiency studies, committees, political squabbles, and potential delays of all kinds before the situation is faced up to and remedied.

In the meantime, the following assumptions have been used to justify why the private sphere will perform better (Veljanovski, 1988):

- one of the fundamental objectives and alleged benefits of privatisation is that it improves the efficiency and level of services provided by the state.

- a belief in the private sector's efficiency supports the argument that if the state-owned assets are privatised, this will result in overall improvement of the economy, increase the government's tax take and the proceeds from the sale will make a dent in the public debt.

Privatisation has extended to almost all sectors of the economy, including the provision of water services such as irrigation.

2.3.2 Sale of Irrigation Schemes

As introduced earlier in Section 2.2.2, the PIM concept in New Zealand is characterised by privatisation of irrigation schemes.

2.3.2.1 Overview of Previous Policy and Regulatory Frameworks

The New Zealand Government extensively controlled both the delivery and allocation of water. Historically, this is broadly consistent with water policies in other countries such as the USA or Australia, where water has generally been considered a "special" or public good, regardless of its economic values (Watson et al, 1987; OECD, 1987; Garner and Huffaker, 1988; Farley, 1994; Farley and Simon, 1996).

As stated previously in Section 1.1.3, the Government of New Zealand was the principal agent in developing all community irrigation schemes. The Audit Office (1987) reported the Government assistance in the development of 49 community irrigation schemes (see Appendix 3). It involved funding of the majority of costs required to develop schemes, including investigation costs, costs of headworks, distribution systems and - in some cases - even on-farm delivery systems (Audit Office, 1987; Lethwaite and Martin, 1987, Appendices 8 and 9).

The effectiveness of the past policies was characterised by its strengths. It appeared that special targeting for irrigation development occurred, as assistance rates were considerably higher for this than for other agricultural projects (The Treasury, 1984). Without the high subsidy rates it is doubtful that a large number of pastoral irrigation schemes would ever have been developed on private grounds (Audit Office, 1987) although Greer (1984) found that private benefits in some cases were significant.

However, the past policy could not avoid its drawbacks. Moore and Arthur-Worsop (1989) stated that the taxpayers were concerned about the transfer of large amounts of their monies to irrigators, as this did not result in major net welfare, and instead the returns were not positive. Moore and Arthur-Worsop (1989) also explained that the subsidies and regulatory environment could cause resource misallocation and misuse of water resources, as national resources were locked into investments which, in some instances, had low or negative returns.

The resultant efficiency problem was that the water delivered to irrigators in community irrigation schemes had been undervalued. While water charges, to recover operating, maintenance and some financial costs, had been in place since the 1960s, actual revenues did not always meet average delivery costs, let alone any opportunity costs of the water. This promoted inefficiency in water consumption, with subsidy benefits captured only by initial landowners (The Treasury, 1984).

2.3.2.2 Privatisation of Irrigation Schemes

The combination of management inefficiencies and scheme cost overruns has imposed high costs on the taxpayer, and caused concern and frustration to Government and irrigators. Selling the irrigation schemes to the users was seen as the best way to achieve the Government's policy objective of:

- seeking to place all community irrigation schemes on a fully commercial basis including full operating cost recovery;

- removing Government from ownership and management of community irrigation schemes and eliminating all Government funding (Moore and Arthur-Worsop, 1989).

The selling of irrigation schemes was consistent with other Government efforts underway at the time to privatise many other functions which were previously performed by the central Government. The initiative for the sale process was associated with the lack of financial and operational accountability on the part of the Ministry of Works and Development (Farley and Simon, 1996).

2.3.2.3.1 The Sale Process

Between 1988 and 1990, 52 Government-owned irrigation projects, ranging in size from 100 hectares to over 20,000 hectares and involving from three to over 300 individual irrigators, were put up for sale (Farley and Simon, 1996). The most appropriate solution for overcoming the current difficulties was seen to be the transferring of ownership and control to a party with strong incentives to improve the management and efficiency of operation. Several options for future scheme ownership were considered including (Moore and Arthur-Worsop, 1989; Touche Ross & Co., 1988; Farley, 1994):

a) the irrigators,
b) a State Owned Enterprise (SOE) to be created from the commercial arm of the Ministry of Works and Development,
c) territorial local authorities, or
d) some other corporate entity.

Although the first two options were considered to have gained priority in meeting the objectives of least cost commercialisation, the Government decided that irrigator ownership would provide greater incentive for efficient operation and maintenance of the schemes through direct involvement and therefore greater accountability. Schemes owned and operated by an SOE or a territorial local authority would be in a position of monopoly of supply with rent-seeking potentials (Moore and Arthur-Worsop, 1989).

A further consideration was one of fairness or equity. Community irrigation schemes have been a joint undertaking between the Crown and irrigators, and it was considered fair to offer irrigators the first right of refusal for the Crown's share. The Government therefore decided to offer existing users (i.e., the irrigators) the first opportunity to purchase the Government's interest (Moore and Arthur-Worsop, 1989). In the event that the irrigators did not wish to purchase at the arbitrated price, the Government would seek other buyers at a price not less than that offered to the irrigators (Farley, 1994).

2.3.2.2.2 Benefits of the Sale

The sale of irrigation schemes was assumed to give benefits to both irrigators and the central Government.

Benefits to Central Government. The transfer of ownership was expected to improve the efficiency of irrigation management and provide a clear opportunity to restructure the existing debt as recorded in the Government's accounts for each scheme. Additional benefits to Government included a reduction or elimination of the current operating deficit, revenue from the sale of the Crown's interest, and the transfer of responsibilities, and liabilities for refurbishment and development of schemes to the owners (Moore and Arthur-Worsop, 1989).

Benefits to Irrigators. The transfer of ownership to irrigators was expected to benefit irrigators by removing the central Government from the operation of the scheme. This would lead to more efficient operation, greater flexibility, more security and long term investment incentives. Additionally irrigators would have direct representation before - and in negotiation with - Regional Water Boards.

Water would be priced at its marginal delivery costs, with generally improved operational efficiency. There were many examples of privately owned irrigation schemes operating successfully in New Zealand. There was ample precedent that schemes could be privately owned and managed (Touche Ross & Co., 1988; Moore and Arthur-Worsop, 1989).

2.3.2.2.3 Rationale for Irrigator Ownership

Irrigators own the irrigation schemes in order to secure the means for the supply of water. However, irrigators, who are farmers or horticulturists, obtain supplies of other essential products or services from organisations which they do not own or control. But, the facts are that:

- they do not have sufficient control over the operating costs of the irrigation scheme;

- getting water at a realistic and sustainable cost is essential, and improving efficiency is an objective of many irrigators (Touche Ross & Co., 1988).

Irrigators are aware that they can obtain maximum returns from their land by irrigating and also from control over the irrigation system. From this, it can be concluded that the objective of most irrigators is not to own shares in an irrigation business, but to obtain reasonable control over the cost of obtaining water. It is therefore appropriate to examine the possibility of irrigators' satisfying their concerns within taking on the responsibility of ownership (Touche Ross & Co., 1988).

2.4 Lessons from Transfer of Irrigation Schemes in New Zealand

Farley (1994) presented key lessons for private ownership of irrigation schemes as follows:

- Government involvement in irrigation has not been shown to produce any net national benefit and there are strong reasons to suspect that it has resulted in a net loss of national welfare.

- Privatisation of irrigation schemes in New Zealand has produced very large efficiency gains.

- Although irrigators were acutely aware of the frustrations and efficiency of Government ownership and management, many initially feared that they would be worse off with a loss of a Government support.

- Irrigators-owned schemes operate satisfactorily under normal commercial law and institutional forms. In New Zealand, special legislative structures and systems were not required.

- The privatisation of irrigation schemes in New Zealand has been a very successful, albeit complex, exercise.

2.5 Performance on Transfer of Irrigation Schemes

Chambouleyron (1996) stressed that performance parameters have lately acquired great importance in evaluating decentralised and participatory administrations (e.g., in Argentina) as they render it easier to assess the way in which activities are carried out, and the results to be expected. Rusche (1985) states that performance parameters are ratios which make it possible to assess readily the most relevant elements in a management system.

Vermillion (1997), in a review of the evidence of the impact of irrigation management transfer in many countries, characterised some basic performances such as financial performance, quality of operation and maintenance, and agricultural and economic productivity.

2.5.1 Financial Performance

The aspects of financial performance of irrigation which are most closely related to management transfer are costs of irrigation to farmers, levels of water costs, levels of management staff and fee collection rates. Three parameters can be reviewed such as: water costs by expressing in life cycle-costs, relative water costs, and personnel employment ratio.

Water Costs: Water costs can be presented by Life-Cycle Costs, LCC (Roberts and Hagan, 1986) over irrigated areas or volume used. Life-cycle costing sums the net costs of purchase and installation (P) with the operating costs of a system over its life cycle (less any salvage value, S), together with maintenance (M), repair and replacement (R). A general formula for the LCC of irrigation system is represented by:

$$LCC = P - S + M + R + L + E \quad \ldots\ldots \quad 1$$

The life cycle is the period of time between the starting point and the cut-off date of analysis, over which the costs and benefits of a certain alternative are incurred.

Relative Water Cost: Chambouleyron (1996) expressed Relative Water Costs (RWC) as a ratio between the value of the water rate and the production cost of the most important irrigated crop. It is expressed in percentage:

$$RWC = \frac{\text{Total Cost of irrigation Water}}{\text{Total Production Cost of Major Crop}}, \% \quad \ldots\ldots \quad (2)$$

Employment Factor: is the Personnel Employment Ratio (PER), a relationship between the irrigation company personnel assigned to administrative and technical activities, and the irrigated areas it served (Chambouleyron, 1996).

$$PER = \frac{\text{Irrigation Society Employees}}{\text{Total Irrigated Area}}, \text{person/1000ha} \quad \ldots\ldots \quad (3)$$

2.5.2 Operation and Maintenance Performance

Operation and maintenance performance can be characterised as qualitative statements by scheme managers, farmers, rapid appraisal valuers and researchers (Vermillion, 1997). The statements can be farmer satisfaction and scheme's managers (Plusquellec et al., 1994). Farmers have an interest in several performance criteria such as, a) adequacy; b) reliability; c) timeliness; d) flow rate; e) equity and f) cost - whereas managers of irrigation schemes have their own set of objectives and problems; politics, finance, personnel affairs, and environmental concerns dominate their daily schedules.

Regarding irrigation system maintenance, the deterioration of irrigation structure very much depends on how the maintenance works are carried out. Chambouleyron (1996) presented one indicator, operation and maintenance ratio (OMR).

Operation and Maintenance Ratio: OMR, is the total length of maintained secondary and tertiary irrigation and drainage canals divided by the total irrigated areas in hectares served by the irrigation company.

$$OMR = \frac{\text{Length of Canals, drains}}{\text{Irrigation Company's Irrigated Area}}\text{, km/ha} \quad \text{.................................... (4)}$$

2.5.3 Agricultural and Economic Productivity

The relationship between management transfer and agricultural and economic productivity is less direct than the relationship between transfer and O&M performance or financial viability (Vermillion, 1997). The most common indicators for agricultural productivity on management transfer are: increase in area irrigated, cropping selection, and yield. The most common economic measures mentioned are gross value output, net farm income per hectare, and economic returns to irrigators (Vermillion, 1997).

2.6 Summary and Conclusion

The background of statutory frameworks for resource management was reviewed. PIM evolution was focused. Privatisation of economic sectors in New Zealand was stressed. The sale of irrigation schemes in New Zealand was emphasised. Key lessons from privatisation were presented. A number of performance indicators of New Zealand irrigation systems were identified and reviewed.

To find out the "performance of irrigation and community water supply systems after transfer", two hypotheses from the key lessons, suggested by Farley (1994) in Section 2.4, are to be tested. The two hypotheses stated are as follows:

a) privatisation of irrigation schemes in New Zealand has produced very large efficiency gains; and

b) the privatisation of irrigation schemes in New Zealand has been very successful.

CHAPTER 3

METHODOLOGY

This chapter presents the procedure with which the data and information were systematically gathered to determine the performance of New Zealand irrigation systems after transfer. It contains two parts: a) a conceptual framework of the study, and b) a description of the research design.

3.1 Conceptual Framework of the Study

The assessment of the performance of irrigation schemes resulting from privatisation was based on a series of suitable and workable concepts which enabled the researcher to collect the necessary data in such a logical manner that they could be used effectively to reach the objectives stated in Section 1.3.

From the review of the literature (see Section 2.6), two hypotheses were formulated:

1. privatisation of irrigation schemes in New Zealand has produced very large efficiency gains; and

2. the privatisation of irrigation schemes in New Zealand has been very successful.

The relationship among the key factors considered relevant to this study, as supported by the review of the literature (see Section 2.5), was presented by four sets of variables. These are: (a) financial performance, (b) operation and maintenance performance of irrigation systems, (c) agricultural and economic productivity, and d) community satisfaction.

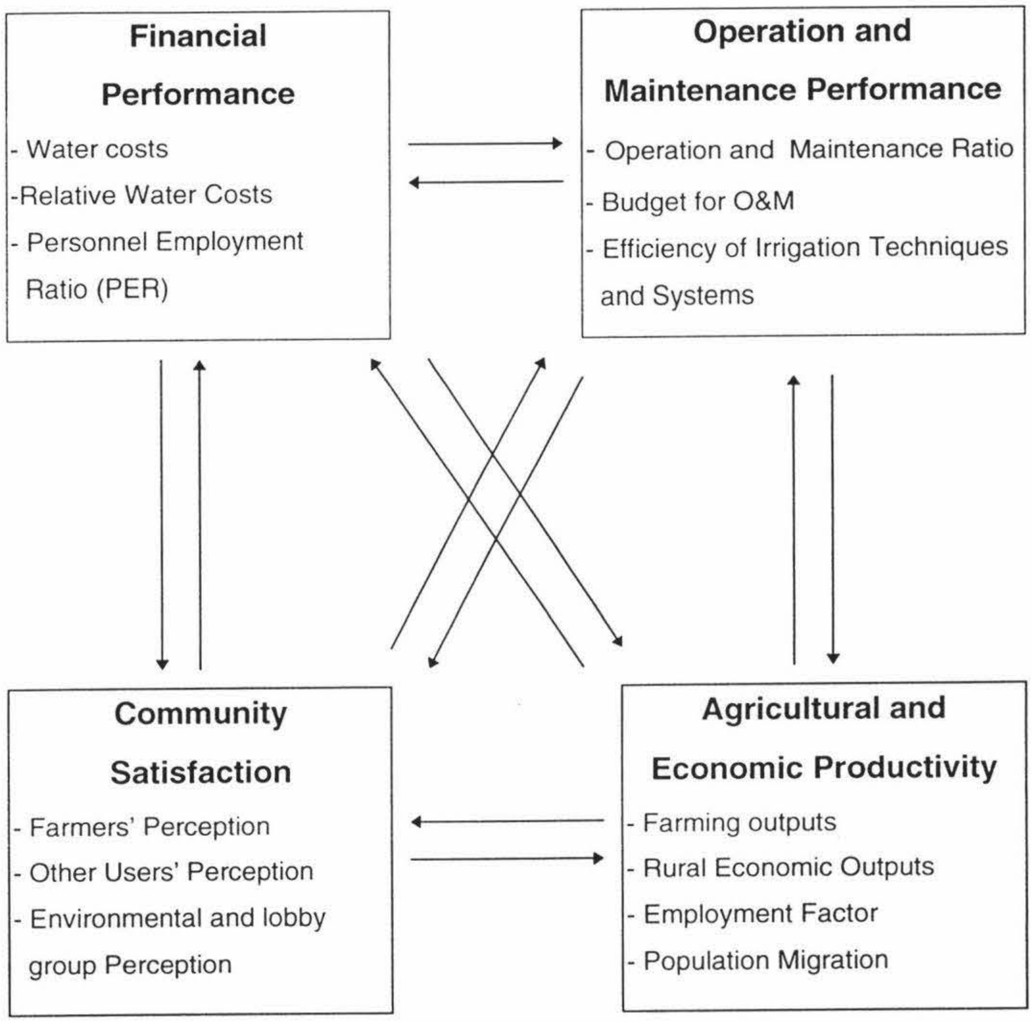


Figure 1 Conceptual framework for the study

Financial Performance. Financial performance includes such factors as water costs, relative water costs, and staff levels.

Operation and Maintenance Performance. This factor covers such variables as the total length of maintained canals and drains, the budget for the repair and maintenance activities, and the efficiency received from the irrigation techniques used and from the irrigation systems.

Agricultural and Economic Productivity. These criteria may not be directly affected by the transfer. However, they can contribute to the discussion because the change in irrigation management, to some degree, would create an atmosphere in which rural, agricultural and other economic activities are undertaken. This factor includes farming outputs, rural economic outputs and also local population trends.

Community Satisfaction. This demonstrates how the whole community responds to the irrigation management transfer. Primarily, it refers to farmers' perception and other water users' satisfaction. However, the viewpoints of other groups such as environmental and lobby groups could be valuable assets in assessing the performance of the transfer.

3.2 Research Methods

Two models were used to collect data. First, a *before-and-after* interrupted time series design was used. Based on the recommendations made by Vermillion (1997), this approach should include data at least 3 to 5 years before and 3 to 5 years after the occurrence of the transfer. However, the actual interrupted time series in this study were 8 years before (in 1982/83) and 8 years after (in 1998/99). The transfers were assumed to have taken place simultaneously in 1990, when the Irrigation Schemes Act 1990 was enacted in New Zealand. The data on methods of payment for water costs, and the water costs, were collected based on that design. In the second model, data were gathered from the 1998/99 irrigation season only, and analysis was made between irrigation companies, as the before-transfer data might not be available. The rest of the data were collected based on the second model (see questionnaire in Appendix 5).

3.2.1 Location

The study was conducted in New Zealand. It included 31 irrigation companies, comprising 2071 irrigators who were using water to grow their crops (see Appendix 4).

3.2.2 Sampling

One questionnaire was developed (see Appendix 5) for irrigation companies. The questionnaire used both closed-ended and open-ended questions. It was designed and structured to elicit the data needed to meet the objectives of the study as outlined in Section 1.3. Closed-ended questions provide a uniform frame of reference for respondents to use in determining their answers to the question. It easy to work with such data. One kind of closed-ended question used in the questionnaire was the "Yes" or "No" question. Open-ended questions allow the respondent great freedom in framing the answers. For example, two such questions were: "How do you calculate the price of water?" and "What happens to farmers who do not pay the water charge?". But it takes more time to analyse the answers to open-ended questions.

There were two kinds of data collection procedure: a) sending questionnaires to all irrigation companies; and b) visiting selected irrigation schemes. The questionnaires were sent to all - 31 irrigation companies (see Appendix 4), but only 16 companies returned the replies. The names of the companies which replied were not specified, but were coded in Roman numbers from I to XVI (see Chapter 4). The samples studied represented 51.6% of total irrigation companies in New Zealand. The visits to 7 irrigation companies in the South Island were conducted in mid October 1998, and their names were coded in the Latin alphabet in upper case from A to G (see Chapter 5).

3.2.3 Data Collection

Data collection is essential for the management of any activity, including the assessment of performance for the management of irrigation water. Both primary and secondary data were used in the study. The primary data were derived from the survey questionnaires and visits to the irrigation companies. Secondary data were derived from official institutions, publications and reports.

The questionnaire data were edited, tabulated, coded and entered into a computer file using an Excel spreadsheet. The open-ended responses for each questionnaire were coded and categorised at the completion of the survey. Open-ended questions posed some difficulties in coding, because most respondents provided unique answers.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter contains two parts: presentation of the results of the questionnaires and discussion of the findings. The first part presents the information, received from 16 out of 31 questionnaires sent to irrigation companies. The questionnaire included questions relating to water costs, operation and maintenance, employment, research and training activities, and additional information about the irrigated area increase, current price of farmland and most important crops grown in the schemes. The second part discusses the results from the first part.

4.1 Presentation of the Results

The names of irrigation schemes were not identified, but were coded in Roman numbers from I to XVI. The results from the questionnaires are provided in Appendices 6, 7 and 8.

4.1.1 Water Costs

4.1.1.1 Methods of Payment of Water Costs

Table 1 shows the water costs by method of payment in the 1982/83 and 1998/99 irrigation seasons. In the study, different techniques of payment for irrigation water were used by irrigation companies. Three methods reported in the survey were as follows: (a) payment per hectare or acre of irrigated land; (b) payment per unit of water (volumetric method); and (c) fixed payment.

A. Payment per Hectare or Acre of Irrigated Land

Farmers pay a fixed amount annually per hectare or acre as a water rate. In this study, the majority of irrigation companies used that method to allocate the water costs. This method was used by 10 out of 16 irrigation companies in the 1982/83 irrigation season and by 11 companies in the 1998/99 irrigation season. They represented 62.50% and 68.75% of the samples studied for the time of analysis. The water rates, however, varied with the irrigation technique employed. Company I reported that the water price was higher for border dykes ($20/ha) than for sprinklers ($12/ha).

B. Payment per Unit of Water (Volumetric Method)

The payment is expressed in dollars per cubic metre. This technique was used by 2 companies in the 1982/83, and by 1 company in the 1998/99 irrigation seasons. However, several irrigation companies used a combination of methods of payment in conjunction with the amount of water allocated. In one case (company I), the water used under a basic rate of 800mL per second (or equivalent to 2.88 m^3 per hour) was charged constantly at $20/ha. But, when the use exceeded that level, the extra charge per cubic metre would be paid. In the other case, annual administration fees were included directly.

C. Fixed Payment

In the 1998/99 irrigation season, one of sixteen irrigation companies used this modality. Company XI reported that each irrigator had a water allocation, and the water was charged at a fixed payment of $675 per annum.

In summary, among the payment methods reported, payment per area irrigated was the most common. So, in the following discussion, the water costs per area irrigated only are used. It appeared to be rare that the irrigation companies used only one method of payment for water costs. Many of them reported that they used a combination of methods (see in Section 4.1.1.3).

4.1.1.2 Difference between 82/83 and 98/99 Irrigation Season Water Price

In the 1982/83 irrigation season, ten of the irrigation companies studied reported that water was charged for on the basis of dollars per hectare, and only two (12.50%) of them - on volumetric method. The remaining (25%) did not report on which basis water costs were charged. The cost of irrigation water varied greatly. The water price per area irrigated varied from \$2.25 to \$80 /ha. However, \$80/ha was the (exceptionally) highest rate in the study. The average water price - including that highest rate - was \$20.50/ha between irrigation schemes, and only \$13.90/ha with the highest value excluded. In the meantime, the water rated per unit of water varied from \$1.2/m^3 to \$28/m^3 and was \$14.6/m^3 on average (see Table 1).

In the 1982/83 irrigation season, all irrigation companies reported that the water costs were actual - rather than estimated - except for one case (company XVI), in which the water price was reported to be an estimate.

Table 1 The water costs in the 1982/83 and 1998/99 irrigation seasons

	Number of Irrigation companies	Water Costs		
		Means	Minimum	Maximum
In 1982/83 irrigation season				
a. payment in \$/ha	10	20.50 (25.09†) 13.90 (14.72†)	2.25	80
b. payment in \$/m3	2	14.60 (18.95†)	1.20	28
d. non-reported	4			
In 1998/99 Irrigation Season				
a. payment in \$/ha	11*	30.03 (19.02†)	4.55	59.50
b. payment in \$/m3	1*	66	66	66
c. fixed payment, \$	1	675		
d. non-reported	4			

† standard deviation,
* one company used both methods of payment - per area irrigated and per water unit

In the 1998/99 irrigation season, there was 1 response on the basis of payment per cubic metre and there were 11 other responses for payment on basis of the area irrigated. Only one company (company I) used both payment per area irrigated and payment per unit of water consumed. Four (or 25%) companies did not report either the method of payment, or the water costs. The average water rates were \$30 per hectare and \$66/m^3 (see Table 1). The average water price per hectare in the 1998/99 irrigation season increased 46% or 116% (respectively if including or excluding the highest rate, \$80/ha) compared to that in the 1982/83 period.

Figure 2 shows the water prices per area irrigated among 10 irrigation companies reported in the 1982/83 and 1998/99 irrigation season. The price of water in 7 companies (companies I, IV, VI, IX, XII, XIII and XVI) increased after the transfer. The water costs in two companies dropped. For company II, the water costs dropped from \$80/ha to \$4.55/ha, and for company XIV, from \$50/ha to \$45/ha. The price of water stayed the same (\$16/ha) for company XV only following the transfer, but the company may raise it from \$50 to \$60/ha in the future.

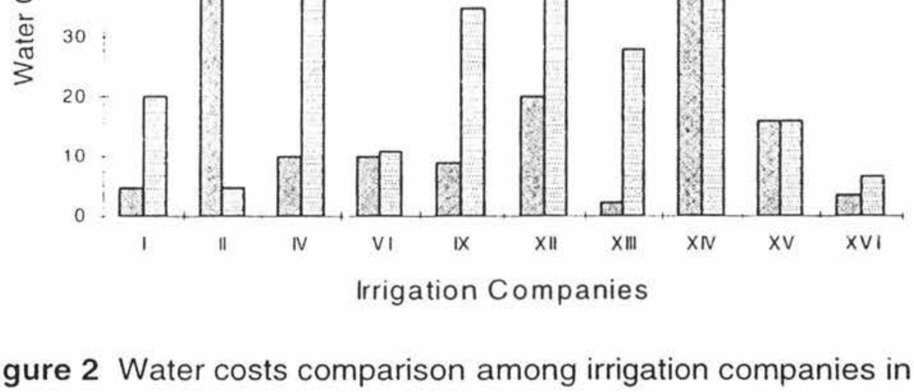


Figure 2 Water costs comparison among irrigation companies in the 1982/83 and 1998/99 irrigation seasons

4.1.1.3 Methods of Calculation of the Water Price

Eleven companies did not use life-cycle cost (LCC) to calculate the water price, but two of them reported that they were not aware of LCC. Four other companies did not respond. Only one of the 16 irrigation companies (company XV) reported that it used LCC to calculate the water price.

The guidelines for allocation of the water price varied from one company to another. However, they can be grouped into four substantial categories such as:

a. year to year basis cost to cover administration, operating and maintenance costs;
b. a combination of a standard subscription fee plus the payment for irrigation water per area irrigated;
c. an amount of water allocated for each irrigator in the scheme with the water costs were being charged on that percentage;
d. share allocated on the area of land; sometimes the share could be transferred with the land, but not always.

4.1.1.4 Payment of the Water Costs

The irrigation companies set up different instalment systems. Twelve companies reported that two or more instalments (from 2 to 6 payments per annum) were used, and 4 others used only one payment per annum.

Twelve irrigation companies reported that water costs were paid on time, with the range from 66% to 100%. The average proportion of the payment for water price was 92%. Ideally, the highest percentage of water costs should be paid on time. But, if the irrigators failed to do that, then the companies set up rules to control this occurrence. Several measures were found from the questionnaires, and attitudes changed from one company to another, but all shared the final purpose of ensuring that the water costs were paid. Two systems could be characterised as soft and hard approaches when the water rate was not paid. At the early stage, the farmer received a warning, and either paid interest or was charged penalties on the overdue amounts or was not entitled to water until after the debt has been cleared. In a serious situation, the water would be cut off, or the water agreement would be cancelled.

4.1.2. Operation and Maintenance of Irrigation Schemes

The responding irrigation companies reported on their schemes' maintenance conditions in the 1998/99 irrigation season as shown in Appendix 8. The budgets for maintenance varied considerably - from \$6,300 to \$310,000 - with an average expenditure of \$77,642. This budget was spent to repair and maintain the irrigation system in the scheme. The total length of maintained canals varied from 10 to 320 km, for the corresponding irrigated areas from 250 to 32000 hectares. The maintenance conditions of irrigation systems could be assessed by using the "Operation and Maintenance Ratio" (OMR), in Formula 3 in Section 2.5.1, as a ratio of the total length of maintained canals over the irrigated area. This indicator was found to vary from 0.0068 to 0.387 km/ha. The average OMR was 0.049 km/ha.

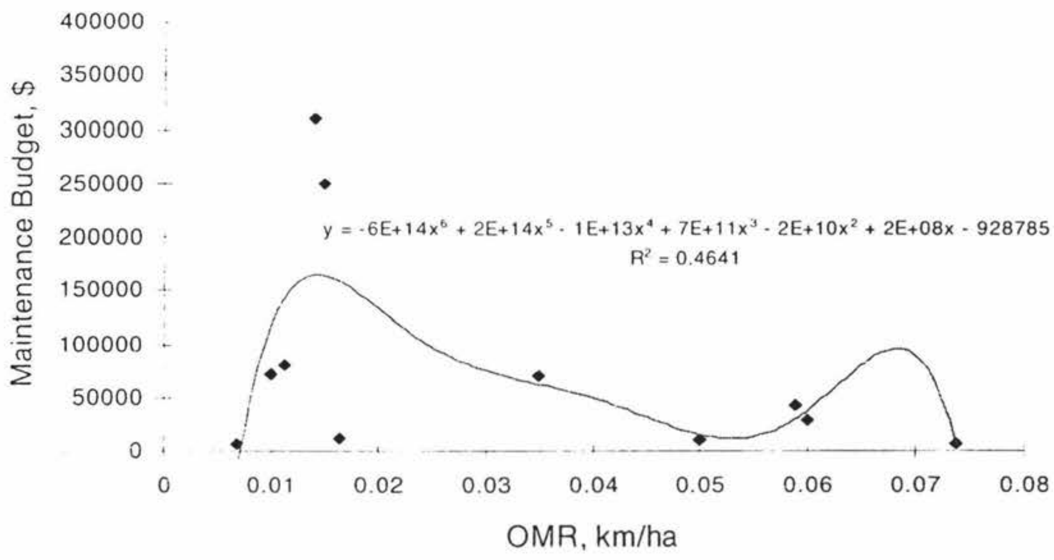


Figure 3 Relationship between maintenance budget and OMR in the 1998/99 irrigation season

Figure 3 shows the relationship between the budget value for maintenance and OMR in the 1998/99 irrigation season. Overall, they did not have a strong relationship, because of the low value of the R^2 (R^2= 0.4641).

4.1.2.1 Determination of Maintenance Budget

For maintenance activities, the irrigation companies established their maintenance budgets using different approaches. Two schemes reported that, their maintenance budgets were derived from the 8 previous after-transfer years actual expenditure including the known, or planned, maintenance requirement. One company claimed that the account was charged to irrigators on their water allocation percentage when the races required cleaning.

4.1.2.2 Who Carried out the Maintenance

The maintenance works were reported to be undertaken by irrigators themselves, either by the company's staff (racemen) or by being contracted out to private contractors. Most of the major repair and maintenance activities were contracted to local private contractors.

Three out of sixteen irrigation companies (or 18.75%) reported that minor maintenance works were carried out by farmers themselves, and major ones were contracted to local contracting firms; but the other 3 companies (or 18.75%) reported that all maintenance works were contracted; and 9 others (56.25%) replied that minor maintenance jobs were carried out by staff, while major works were contracted. Another company (company XVI) did not report who carried out the maintenance activities of the scheme.

4.1.2.3 Asset Management Plan

Five out of the irrigation companies which replied (or 31.25%) had an asset management plan, but the 10 others or 62.50%, did not (see Appendix 8). One of those companies having an asset management plan reported that the director established it, but the other one claimed that it was prepared by the "work committee", or by the operations director of the company.

4.1.3 Employment Factor

Staff employment in the irrigation companies was divided into 4 classifications: full-time, 3/4 time, 1/2 time and 1/4 time; and finally, the number was converted to full-time equivalent employees (FTE). The employment status and the number of employed staff varied from one company to another as shown Table 2.

Table 2 Staff employment situation in irrigation companies in the 1998/99 irrigation season

	No. of Companies	%
Full-time employment only	3	18.75
Full-time with part-time employment	2	12.5
Part-time employment only	5	31.25
No staff	6	37.5
TOTAL	16	100

The number of staff employed full-time varied from 1 to 3. No 3/4 time staff were mentioned, but 1/2 and 1/4 time employees were reported. One unit employed 1/2 time staff, whereas 1/4 time employees varied from 1 to 4 units in the schemes. The number of FTE staff varied from 0 to 3 units. The maximum number of FTE staff (3 units) was employed by company VII.

For the companies which did not employ full or part-time staff, administration was carried out by: a) the board of directors who were voluntary, or b) a self-employed administrator who is acting as a secretary, treasurer and/or accountant. In one case, one of the farmers was employed part-time to oversee the operation of the scheme for the company.

4.1.3.1 Personnel Employment Ratio (PER)

All employed staff numbers were converted into the FTE as stated in Section 4.1.3. The employment characterised by personnel employment ratio (PER), as in Formula 4 (see Section 2.5.1), varied from 0 to 1.287 person per 1,000ha of irrigated land (1.287 per/1,000ha was an exceptionally high rate for company XII in this study), but averaged at 0.184 per/1,000ha. Figure 4 shows the PER value of all irrigation companies. The PER was nil for companies IV, V, IX, XI, XIV and XVI, because they did not employ any staff.

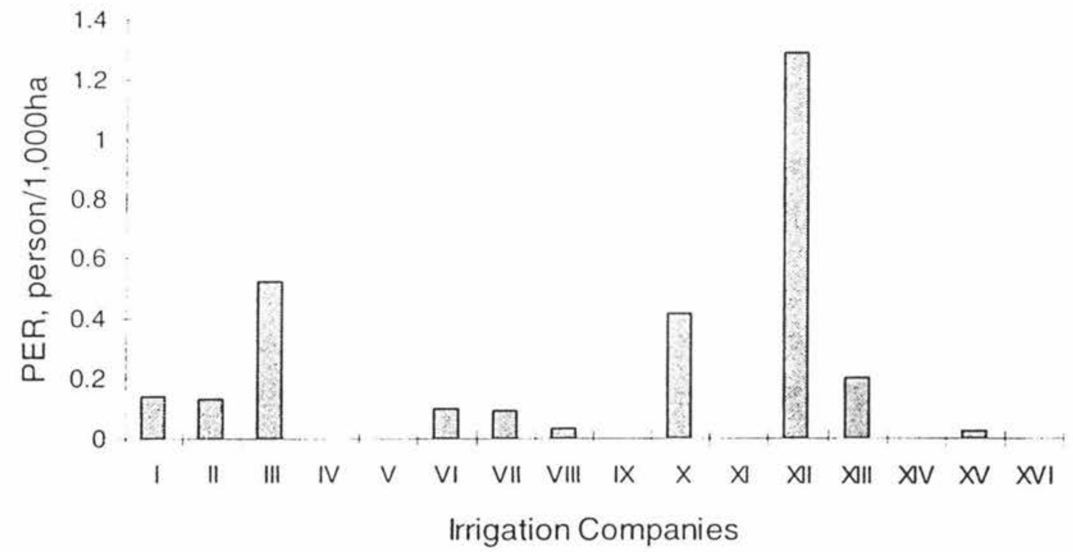


Figure 4 PER values among the irrigation companies in the 1998/99 irrigation season

4.1.3.2 Staff Salaries

The staff salaries budget was reported to have varied from $15,112 to $102,2000 per year among the irrigation companies. The board of directors carrying out administration activities in the companies where no staff were employed received honorarium fees but have not reported the amounts. Staff salaries expressed in $/1,000ha were shown in Figure 5. They varied from

$6375 to $41956/1,000ha. The staff salaries in companies IV, V, VI, VII, VIII, IX, XI, XIV, XV and XVI were not reported.

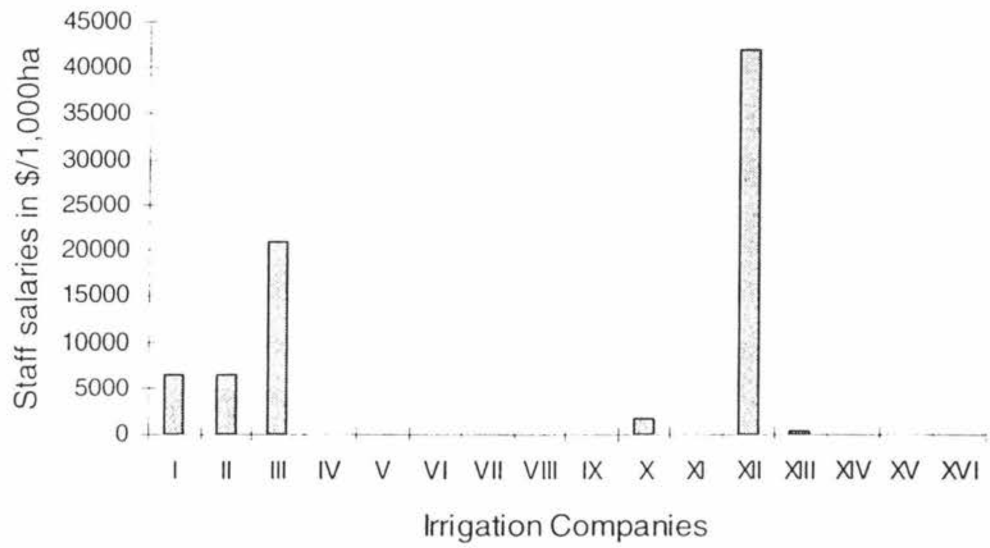


Figure 5 Staff salaries among irrigation companies in the 1998/99 irrigation season

4.1.3.3 Staff Training Activities

It was found that few training activities for staff and farmers were undertaken. As shown in Appendix 8, such training, (e.g., health, safety or forestry and welding courses) was mentioned by 2 companies only (companies VI and XII).

4.1.4 Research

Only one out of 16 irrigation companies (6.25%) reported that it spent money on research (an amount of $10,000). The other companies (93.75%) did not report any contributions to research activities.

4.1.5 Irrigated Area Increase

Another factor was the trend towards increasing irrigated area. Five companies replied that their irrigated area had increased since the privatisation of irrigation schemes in New Zealand. The reason for the increase in the irrigated area was largely because of the increase in water use efficiency with the same amount of water usually consumed. But one company explained that the increase in irrigated area in the scheme was due to both the efficient water use and the increase in water volume. Six other irrigation companies reported that the irrigated areas were not increased within the schemes, whereas the 5 remaining companies (or 31.25%) did not give any response.

4.1.6 Current Price of Farmland

The current price (in 1998) of land was significantly different between irrigated and non-irrigated farmland. The price varied from \$2,000 to \$11,000 per hectare for irrigated land, against from only \$540/ha to \$5000/ha for non-irrigated farmland. The price averaged at \$5300 and \$1800 respectively for irrigated and non-irrigated farmland. The average price of irrigated farmland was nearly 3 times higher than that of non-irrigated land.

4.1.7 Most Important Crops

There were different types of crops grown in the schemes. At the time of study, they were grouped and listed in descending order of importance as stated below:

1. dairying
2. stonefruits
3. grape vines
4. cereals
5. small seeds.

4.2 Discussion of the Findings

4.2.1 Financial Performance

Aspects of financial performance which are most related to management transfer are costs of irrigation to the Government, costs of irrigation to farmers, levels of management staff (often the largest component of O&M costs), levels of water charges and collection rates, budget solvency, and revenue sources (Vermillion, 1997). This section discusses 3 aspects: 1) water costs, 2) staff, and 3) fee collection rates.

4.2.1.1 Water Costs

A. Methods of Payment for Water Costs

Among the methods of payment for irrigated water costs, the payment per area irrigated was found to be the most common. This method was used both before and after the transfer, and became more popular in the 1998/99 irrigation season among the samples studied. 62.50% and 68.75% of irrigation companies used this method before and after the transfer respectively. It has both advantages and disadvantages. Sagardoy et al., (1982) stated that the great advantage of the method was its simplicity and relative ease of measurement, billing, charging and accounting. However, this mode of payment has its own disadvantages. Sagardoy et al., (1982) indicates that it is not equitable for many of the farmers, as it may imply that farmers pay for the water not on the basis of the real volume consumed by different crops, but only on the basis of the area irrigated, as it is known that volume equals area times depth applied. Sagardoy et al., (1982) indicates that deviation of the average depth applied in the scheme may usually occur. The bigger the deviation of the depth, the greater will be the inaccuracy and , therefore, the unfairness of this method becomes obvious. Another reason for the unfairness of this modality may occur when crops having large differences in water consumption are gown in the scheme (Sagardoy et al., 1982). Furthermore, Sagardoy et al., (1982) highlight that the payment per area irrigated dissociates the commodity (water) from the rate paid - which does not encourage the efficient use and saving of water.

In contrast, Sagardoy et al., (1982) add that the volumetric method is seen as the most desirable technique of payment, since it encourages efficient water use by maintaining a constant relation between the amount of water used and the payment to be made. The price per cubic metre may be made progressive in order to limit consumption beyond the point at which the cost of the water becomes higher than its value in use. This method of charging is indicated when water is scarce.

The transfer was designed to ensure that the WUAs had adequate financial resources to be self-sufficient; this meant that the irrigation fees or water tariffs had to reach a level where the costs of operation, administration, and maintenance were covered (Johnson III, 1997). Moreover, in centralised irrigation management, "water rates offer a powerful instrument of policy which is usually neglected by public irrigation authorities. Rates are seldom equivalent to full costs; often they are below operating costs" (Carruthers and Clark, 1982).

However, farmers expected that through the transfer, they would not only improve management but would also contain or reduce the cost of irrigation water (see Section 2.3.2.2.2). But, in line with the policy of making irrigation companies more financially sustainable, it was recognised that the users would have to pay the real O&M costs for the irrigation service. This meant significantly higher water costs for the farmers (Johnson III, 1997).

In the 1998/99 irrigation season, the trends of water costs per area irrigated were mixed. They dropped, stayed the same, but mostly increased compared to those in the 1982/83 irrigation season (see Section 4.1.1.2). The average water costs per hectare, in the 1998/99 irrigation season, increased 46% or 116%

compared to those (including or excluding the highest rate ($80/ha) respectively) in the 1982/83 period (see Section 4.1.1.2). Figure 2 illustrates the changes in irrigation fees as a result of transfer. Figure 6 shows the fact that the water costs rose compared to the Producer Price Indices (PPI) in Section 4.2.2.2.

The 8-year after-transfer water price increase might contradict what was stated in Farley's report (1994), that water charges on privatised schemes were one-half to a quarter the costs on Government "pre-privatised" schemes, even though Government schemes still retained subsidies for O&M costs while privatised schemes paid the full cost of operations. Vermillion (1997) explained that this was attributed to privatised schemes' cutting operational costs by 66%, on average, reducing overhead costs and designing simpler repair and maintenance works.

Therefore, it was important to find out why the water price increased, and if this increase implied that the privatisation of irrigation schemes was not successful.

B. Water Costs and Irrigation Subsidy Removal

The increase in water costs after transfer could be characterised by the removal of Government financial assistance. In New Zealand, the Government funded all investigation and design costs throughout the 1912-1986 period, and totally eliminated its responsibility for financial involvement in controlling the design, construction and operation of irrigation schemes by selling them to private entities (Farley, 1994). While the share of Crown funding of these schemes has varied over time, the majority of community schemes were built with over 50% of off-farm capital costs being borne by the taxpayer (Moore and Arthur-Worsop, 1989), as shown in Appendices 8 and 9. The subsidy rates for irrigation schemes which used to be high during the pre-transfer period (The Treasury, 1984), were completely cut off just after the sale of the schemes. Consequently, it affected high-cost systems, such as pump irrigation, also operation and maintenance works. Therefore, the removal of Government subsidies might, especially, result in the increase in water costs to farmers as the water would be charged at the real cost to cover the actual expenditure on the scheme. This could be explained by Farley (1994), Sagardoy et al., (1982) and Vermillion (1997). Water charges had often been set too low to recover O&M and capital costs (Farley, 1994), and Sargadoy et al., (1982) states that "there could not be a gap between the income arising from water rates and the actual expenditure" for the irrigation company which was solely dependent on funds from water rates. Vermillion (1997) suggests that where significant subsidies which existed before transfer are dropped, the cost of irrigation to farmers may rise substantially.

C. Water Costs and Producer Price Indices (PPI)

Apart from the absence of subsidy assistance, the increase in water costs could be associated with other factors. Johnson III (1997) states: "although increased water costs to match O&M fees are important, the change in costs as a function of the overall costs of production is equally important". The Producer Price Indices, PPI (New Zealand Official Yearbook from 1984 to 1998) in the agricultural industry were variables chosen to assess the change in water costs. Figure 6 below illustrates the trend of PPI for agricultural inputs and outputs from 1982 to 1997, and average water costs (excluding the highest water rate, $80/ha) in the 1982/83 and 1998/99 irrigation seasons. The PPI for other variables in the agricultural sector, such as those for sheep and beef farming, dairy farming, horticulture farming, cropping and other farming, all farming and farming contracting are presented in Appendix 11.

The average water costs increased 46% or 116% in the 1998/99 irrigation season compared to those (including or excluding the highest rate) in the starting year of analysis. But the PPI of agricultural inputs and outputs increased at the rates of 76% and 57% (see Figure 6) respectively during the same years of study. Equally, the average water costs showed similar trends to the PPI of other factors (sheep and beef farming, dairy farming, horticultural

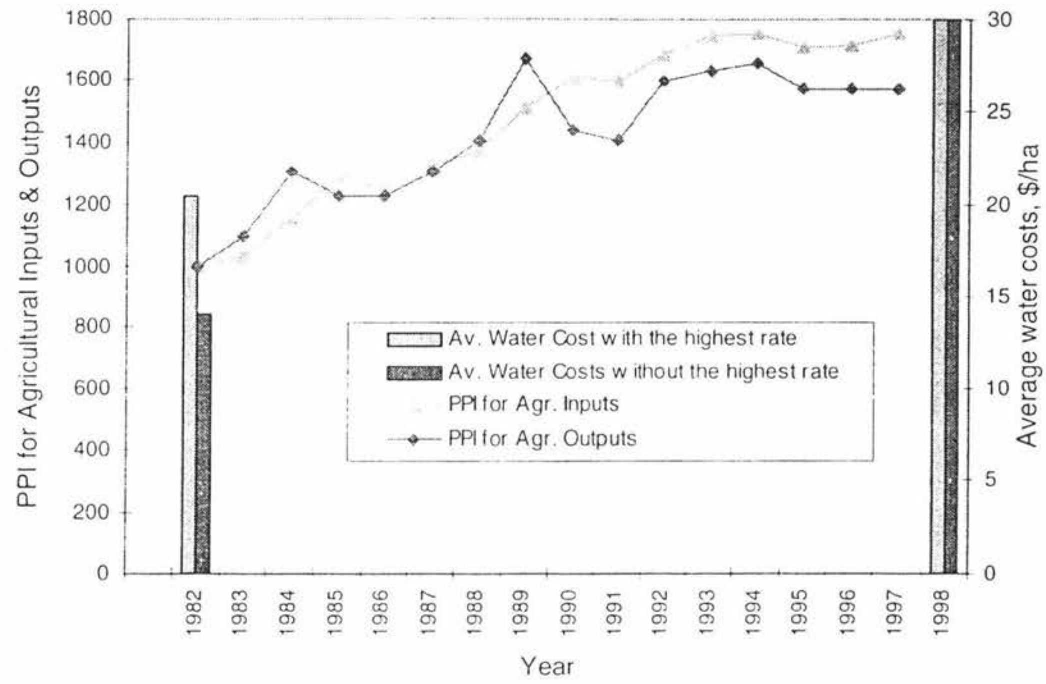


Figure 6 Graphs of trends of the average water costs in 1982/83 and 1998/99 irrigation seasons vs the Producer Price Index of agricultural inputs and outputs from 1982-1997

farming, cropping and other farming, all farming and farming contracting) in the agricultural sector (see Appendix 11) with the rates increased from 66 to 79%. Therefore, it seemed that the water costs did not increase alone, but rather that they increased with the PPI.

Another factor to be considered was the operational age of irrigation schemes before they were privatised. It is known that the Government schemes had a 7 year period in which to reach the full water costs. Newer schemes were paying less than they had anticipated after transfer. Without the transfer, prices would certainly have increased.

The Public Works Amendment Act 1975 states the Government policy on irrigation before transfer. The water charges were graduated from the year the

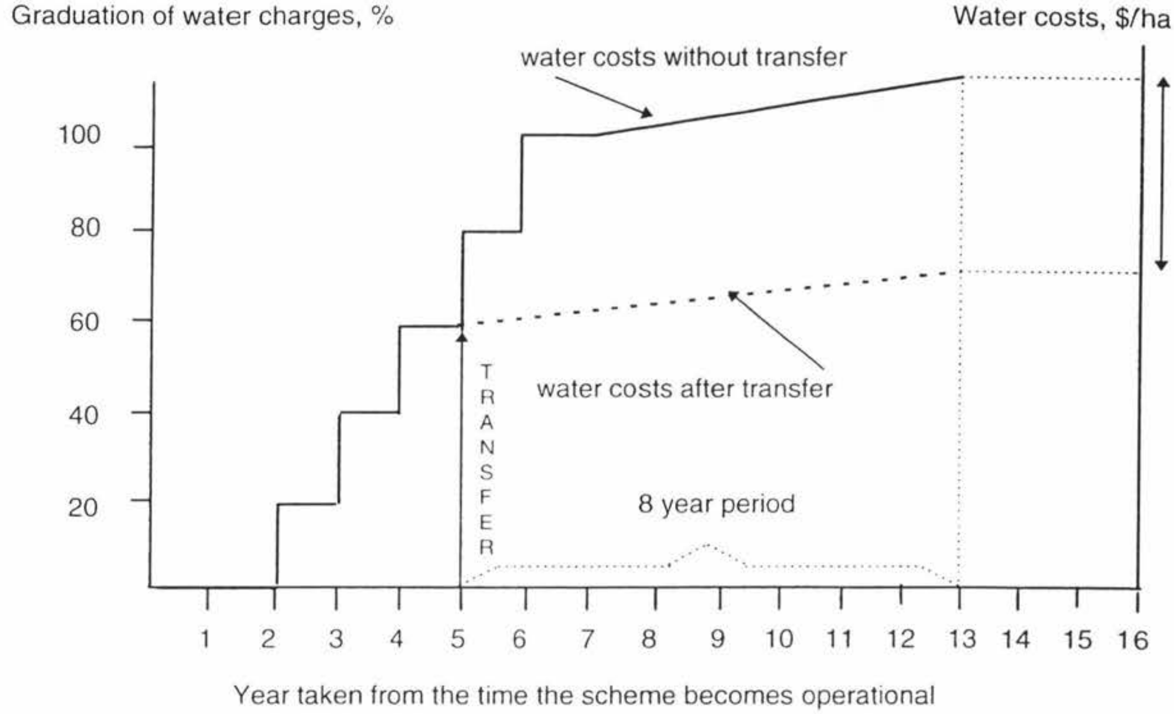


Figure 7 Model representing the water costs "without transfer" and "after transfer" of a new irrigation scheme "X"

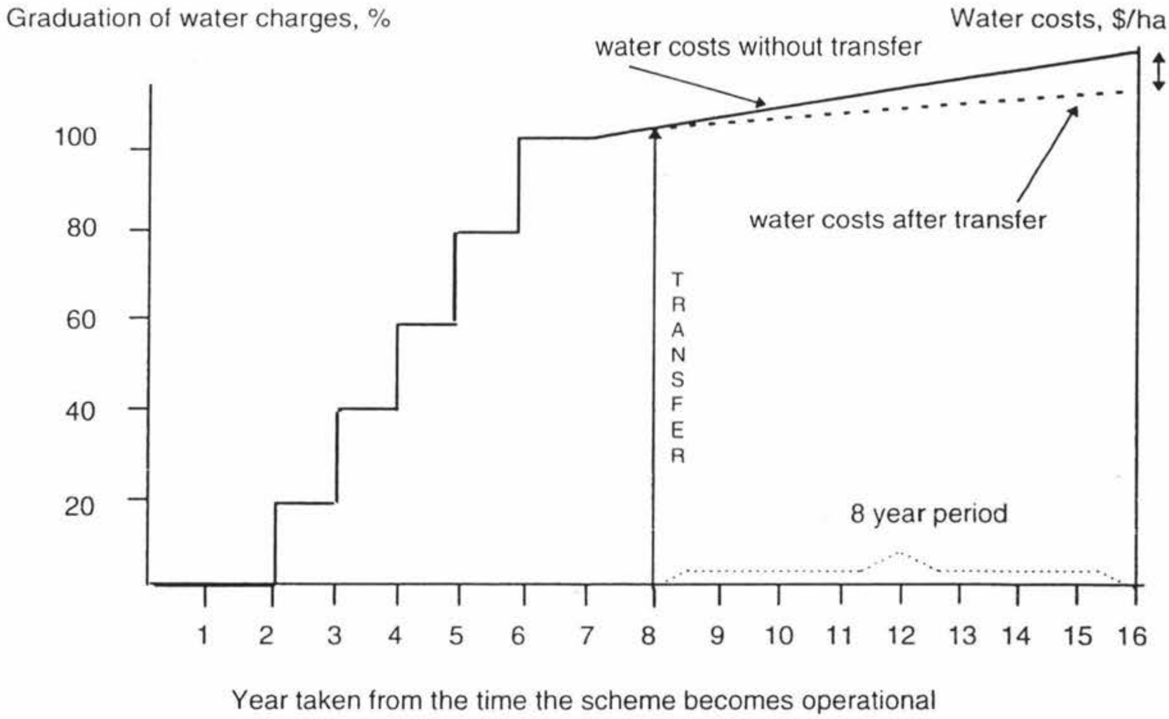


Figure 8 Model representing the water costs "without transfer" and "after transfer" of an older irrigation scheme "Y"

scheme became operational, and the graduation according to the year is shown as follows (New Zealand, 1980):

1st year	no charge
2nd year	no charge
3rd year	20% charge
4th year	40% charge
5th year	60% charge
6th year	80% charge
7th year	100% charge

For example, the irrigation scheme "X" has started to operate for 5 years before transfer (see the model in Figure 7). After transfer, the water costs started to rise. But if the scheme was not privatised, water would be charged with an increasing rate of 20% every year until the seventh year, and then would rise at a rate similar to PPI. At the eighth year after transfer, the "without transfer" water costs would have been higher than those which followed the transfer.

For the older scheme (for example, scheme "Y" in Figure 8) which had already reached the full costs, the water costs were also different when the scheme was privatised compared to that which they would have been had they remained under Government control. The water costs in the privatised scheme were lower than in the Government-run scheme. But for the newer schemes "X" (see Figure 7) the water costs seemed to be lower than those of the older schemes "Y" (see Figure 8) at the 8^{th} year after transfer, because the water costs of the newer scheme started from the lower rate, whereas the older scheme started to charge water from the higher costs.

D. Water Costs and Operation and Maintenance Expenditure

The other factor which might be related to the composition of water costs was the operation and maintenance expenditure over the irrigation system. The most widespread cause of poor operation and maintenance is the lack of sufficient funds to undertake this work adequately (Sagardoy et al., 1982; Appendix 12). This is supported by Johnson III (1997) as he stated: "the reduction in public funding for O&M led to deterioration in the performance of the irrigation systems". When the government subsidies were eliminated completely, the costs of irrigation to farmers rose after transfer. However, the irrigation companies allocated sufficient O&M budget in relation to the rise of the water costs. This could be seen in Figure 9. The graph in Figure 9 shows the

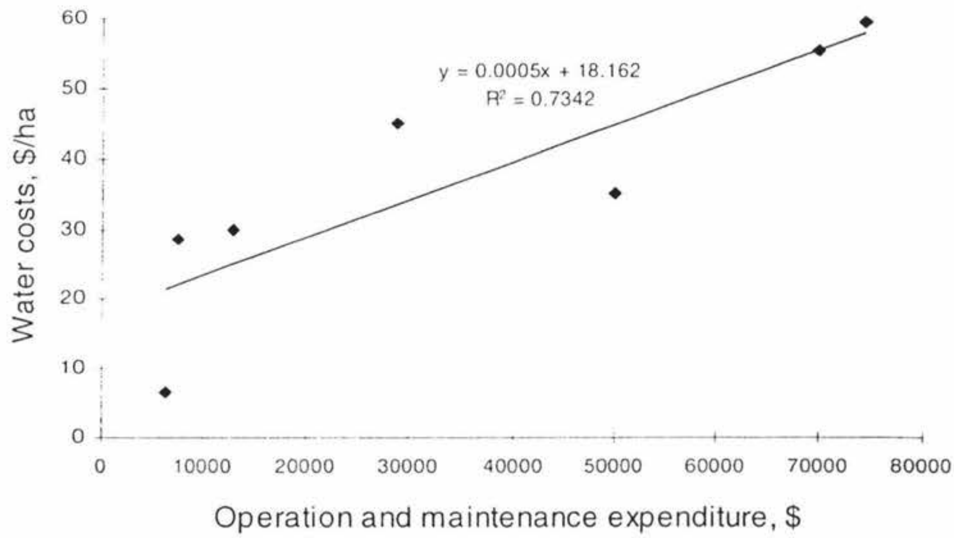


Figure 9 Relationship between the water costs and operation & maintenance expenditure in the 1998/99 irrigation season

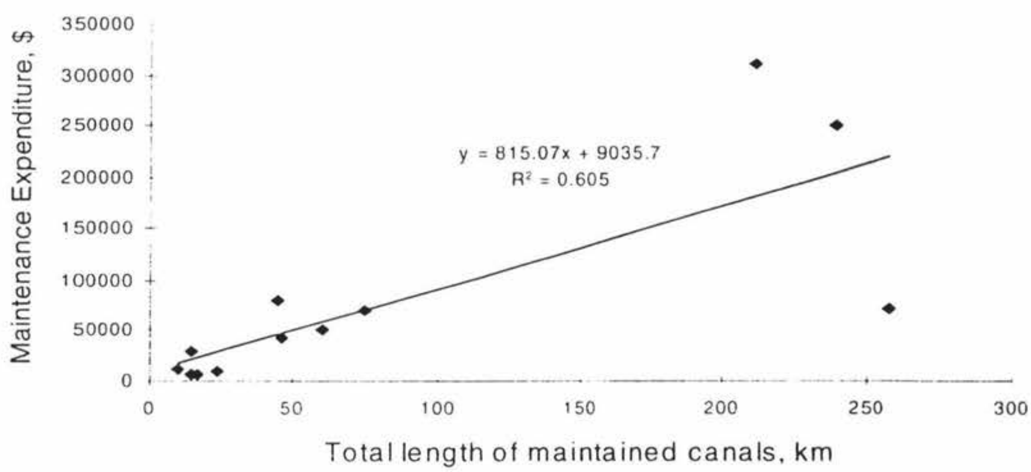


Figure 10 Relationship between maintenance budget and total length of maintained canals in the 1998/99 irrigation season

relationship between the water costs and O&M expenditure in the 1998/99 irrigation season. Water costs had strong linear relationship (R^2 = 0.7342) with the operation and maintenance expenditure. This meant that funds seemed to be adequately distributed, according to the water costs, by irrigation companies to operate and maintain irrigation systems in the 1998/99 irrigation season. Figure 10 shows that the maintenance budget had strong linear relationship (R^2 = 0.605) with the total length of maintained canals, which might include buried piped systems. Graph in Figure 3 illustrates a weak relationship between maintenance budget and OMR (see Section 4.1.2). It could be seen that the two irrigation schemes allocated the highest values of maintenance expenditure in the 1998/99 irrigation season ($310,000 and $250,000) had the lowest with low OMR (0.014 and 0.015) respectively. This could be linked to two factors. The first factor could have been that, in the 1998/99 irrigation season, the expenditure in those schemes was required for the maintenance of heavy irrigation structure rather than for the cleaning long distance of canals or races. The other factor could have been that the expense on the O&M included high costs of electric energy to pump water from the water sources to the system of distribution. However, the result was inconclusive.

E. Principles of Charging for Water

The principles of charging for water varied greatly from one irrigation company to another. They can be classified according to the general philosophies underlying them. Bergmann and Boussard (1976) distinguished three broad categories as defined by their main objectives:

a. to cover only the working costs of the system;
b. to allocate the benefits of irrigation between farmers and the community or shareholders;
c. to charge a marginal cost.

But the study found that only the first category was used by most companies. The irrigation companies (V, IX, XI, XII, XIII, XV and XVI) reported that the water price in the scheme was charged to cover operation and maintenance costs. The objective of this method is to supply agriculture with cheap water. As supported by Bergmann and Boussard (1976), the price of the water was thus based on the working costs of the system, namely:

- expenditure on personnel and labour for management and maintenance;
- raw materials (power) and other (spare parts, office equipment, etc.);
- provision of renewal of certain items of equipment required for the system.

Another factor to be considered in projecting the water costs is reserve funds. "The absence of district reserve funds, a fixed base fee, ... means that the irrigation companies will be financially vulnerable in the event of drought (when there is no water to sell or even water was charged per area irrigated) or when major repairs or rehabilitation are needed" (Vermillion, 1997). Two of the companies (X and XIV) reported that they had reserve funds. Company XIV reported that it had capital for capital upgrades, whereas company X claimed that the reserve funds were a part of water costs to cover future repair and maintenance or capital items, also damage from floods or earthquakes.

F. Life Cycle Costing Approach to Calculation of Water Costs

The study found that only one of the irrigation companies calculated the water price by using the life-cycle costing method. Generally, it appeared that all the irrigation companies used an approach similar to that of LCC in calculation of water rates. The difference might be only that the life span of the irrigation structure had not been projected, and a year-to-year basis calculation mainly dominated.

Life-cycle analysis (LCA) is an objective process for evaluating the economic, environmental and possible social impacts associated with the "energy industry" in many Member countries of the Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA) (OECD, 1993). Equally, LCA can be used in other sectors also (e.g., in irrigated agriculture), which is "increasingly confronted with economic, environmental, and social challenges, such as increasing resource use efficiency". One of the financial performance for irrigation companies in New Zealand after the transfer can be the trend of water costs, and (especially) how they are calculated as well. An irrigation system is like a "product that has a long life span in the organisation of a circular economy" (Behrendt et al., 1997). Life-cycle costing, by Roberts and Hagan (1986) stated that the best way to compare costs of alternative irrigation systems was by calculating life-cycle costs for each.

As shown in formula 1 in Section 2.5.1, LCC is computed as a sum of the net costs of purchase and installation (P) with the operating costs of a system over its life cycle together with (less any salvage value, S), Labour (L), maintenance (M), repair and replacement, (R).

Moreover, Roberts and Hagan (1986) mentioned that life-cycle costs could be expressed as either present value, or annual value, dollars. Present value is defined as "the equivalent value of past, present, and future dollars corresponding to today's values". Annual values are past, present, and future costs converted to an equivalent constant amount recurring annually over the evaluation period. Past and future costs are converted to present values using the process of discounting.

Discounting is the process by which costs occurring at different times during the life-cycle are put on a time equivalent basis to take into account the time value of money. The time value of money reflects the fact that money can be invested over time to yield a return over and above inflation. The present value of a future cost is calculated using the single present worth formula:

$$P = F\frac{1}{(1+i)^n}$$

The present value of a uniform series of costs is calculated using the uniform present worth formula:

$$P = A\frac{[(1+i)^n - 1]}{i(1+i)^n}$$

If the annual costs are escalated, a modified uniform present worth formula is used:

$$P = A\frac{(1+e)}{(1-e)}(1 - \frac{1+e^n}{1+i})$$

where:

P = present value

F = future value

i = discount rate (or interest rate) as a decimal

n = numbers of years

A = an end-of-period payment in a uniform series of payments over n periods

e = rate of escalation of A in each of n periods

There is a tendency to diversify revenue sources after management transfer. Usually this occurs where the post-transfer organisation has full responsibility for financing the costs of irrigation and where farmers exert pressure to keep water fees as low as possible (Vermillion, 1997). In New Zealand, the other revenue sources could be seen as forestry or power generation.

4.2.1.2 Staff

One clear performance measure of the transfer process is the low number of irrigation companies' employees working in O&M activities. The staff size can be characterised by Personnel Employment Ratio (PER) as in Formula 4 (See Section 2.5.1) from Chambouleyron (1996). The average PER was 0.184 person /1,000ha in the 1998/99 irrigation season (see Section 4.1.3.1).

In this study, there were no data about the number of staff employed in the schemes before the transfer. It is known that several agencies of Government were involved in irrigation. The main agencies, and their roles, are listed in Appendix 17. With the exception of the National Water and Soil Authority, these agencies were confined in their activities to providing Government services - and they do not have an explicit task of promoting the development of community irrigation schemes (Martin, 1986).

From 1912 until 1987 the Ministry of Works and Development (MWD) had responsibility for the engineering investigation, design, construction, operation and maintenance of Government-owned irrigation schemes, as well as responsibility for recommending annual water charges to the Minister for approval (Farley, 1994). The estimate of pre-transfer staff input was made difficult by the organisational structure of the MWD, and by the fact that the MWD was involved in more than irrigation construction and management.

There is connection between Figure 11 and Figure 9. Figure 9 shows a strong relationship between the water costs and O&M costs (see Section 4.2.1/D), whereas Figure 11 shows the strong relationship between staff salaries and the number of full-time staff (R^2 = 0.9871). For the company which employed more staff, the expenditure for their salaries was also higher than that which employed fewer or no staff. The reduction in staff size results in the minimising of O&M expenditure and leads to low water costs. The difference in staff salaries between the low and high FTE was substantial. The staff salaries were $1000

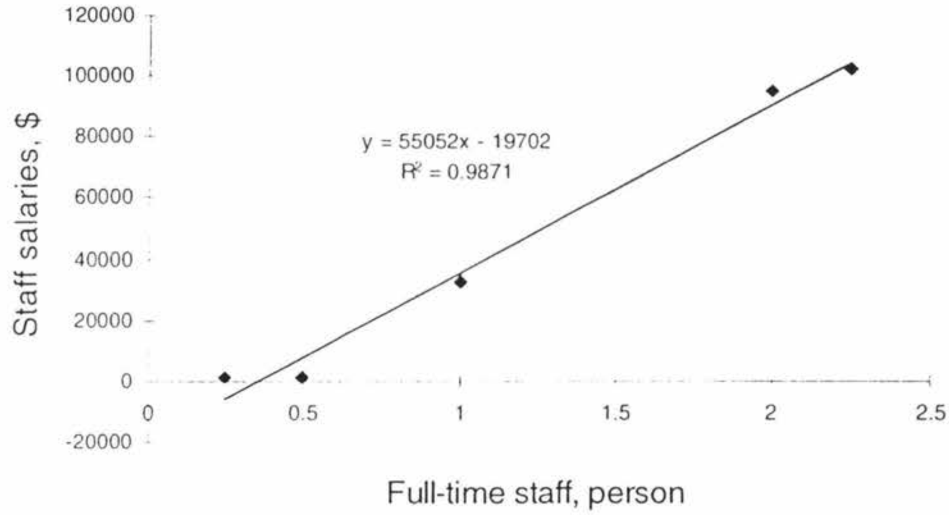


Figure 11 Relationship between staff salaries and full-time staff in the 1998/99 irrigation season

for the company whose FTE was 0.25, and $10200 - when FTE was 2.5. As shown in Section 4.1.3, for the company which did not employ full or part-time staff, administration was carried out by the board of directors, or a self-employed administrator acting as a secretary, treasurer and/or accountant. The board of directors were paid only honorarium fees.

The low PER was proved to be a good indicator for the financial success of transfer of irrigation schemes, as stated by Sagardoy et al., (1982) and Vermillion (1997). Sagardoy et al., (1982) stated that the tendency in the "irrigation associations" was to reduce the services to a minimum so that water rates were kept as low as possible. Decreases in expenditures (mainly due to staff layoffs) and increases in revenue (primarily from increases in water charges) accounted for the improved financial conditions (Vermillion, 1997).

Moreover, the involvement of professional services was found to be important. Especially, when the complexity of agricultural technology makes it difficult for farmers to apply this technology on a day-by-day basis (Gilley, 1999). It appeared that the companies had a wide range of choices - to hire solicitors, accountants, technicians or contractors instead of permanent staff to do non-permanent jobs when necessary. For the maintenance of irrigation systems, the study found that minor maintenance works were conducted, in 18.75% of irrigation companies, by farmers, 56.25% of them by staff. In these schemes, all major maintenance activities were carried out by contractors. In addition, the irrigation systems of the other companies (18.75%) were completely contracted out for all minor and major repair and maintenance works.

The hiring of professional service can reduce the staff size in the irrigation company. When the number of full-time staff dropped to nil (companies IV, V, IX, XI, XIV), the maintenance activities were either totally carried out by contracting firms - or by farmers for minor repair and maintenance jobs, with the major ones being done by contractors. Although the selection of a good consulting (or contracting) service may be difficult; increased production and/or decreased operating costs can be the best criteria by which the performance of the service can be evaluated (Gilley, 1999).

But even in the companies which employed permanent staff, the major maintenance activities were still contracted. The staff performed only minor maintenance jobs.

The study did not have enough information about the skill level to which the staff were qualified. It was known only that 3 companies employed former staff of the Ministry of Works and Development full-time. It appeared that the performance of these companies was more impressive than that of the others, in the spheres of collecting and storing data and information, and maintaining better financial transparency by using a computer. Moreover, it seemed that those 3 companies which employed former MWD staff had optimistic viewpoints with broad perspectives for increasing and sustaining their activities in irrigation and water management as a whole.

4.2.1.3 Fee Payment Rate

New Zealand has achieved a high percentage of irrigation service fee collection rate with frequent instalments. The collection rate was around 100%, and the instalments varied from 2 to 6 per annum in most of the schemes. Only in a small number of schemes was the collection rate sometimes below 100%, and the frequency only one payment per year (see Section 4.1.1.4).

The current legislation governing the operation of irrigation schemes provides strong powers for the collection of charges. Irrigators see these powers as important both in terms of fixing charges and in ensuring compliance (Touche Ross & Co., 1988). In the case of company IV, where the fee collection rate was the lowest (66%), the company expected to recover the total payment either by charging interest on the overdue amount at 24% per annum to the water user who did not pay the water charges by the commencement of the next season, or by ensuring that water was not supplied until the debt had been cleared.

It seemed that the fee collection rates were controllable, because the company management established soft and hard measures in order to force the users to pay the water costs on time (see Section 4.1.1.4), and that no complaints were found about financial deficits due to the failure of payment for water charges. The users might well understand that, if they failed to comply with the requirements set by the company, then they would face losing their water contract; and it was certain that they did not want to get into any trouble for this reason.

When the irrigation schemes are private, or are community entities, they are completely dependent upon the irrigation fees paid by the users, and they could not survive unless the users paid their irrigation water costs. Johnson III (1997) stated that: "For total revenue generation from irrigation service fees, the percentage which the users pay is as important as the irrigation service rate itself". It is different when the Government controls the irrigation schemes, i.e., "All the expenditure for running the water management organisation should, in theory, be covered by the water rates, and the Administrative Service should ensure that income and expenditure are in equilibrium. There is often a large gap between the funds collected from the source, and actual expenditure on the scheme. This gap is sometimes bridged with a subsidy from the Government, particularly in public irrigation schemes, or more commonly by not undertaking the necessary maintenance" (Sagardoy et al., 1982).

4.2.2 Operation and Maintenance Performance

The constraints which most frequently affect the sustainability of irrigation systems are those associated with the operation and maintenance activities of the system (Sagardoy, 1996). Long and wide experience indicates that maintenance, if properly planned and carried out, can significantly extend system life, sometimes by an order of magnitude (Skutsch, 1993). Maintenance may be subdivided (FAO, 1992) into:

- *routine* or *normal maintenance* which comprises work necessary to keep the system functioning adequately;
- *special maintenance* which covers repairs of damage caused by unforeseen natural or manmade hazards;
- *deferred maintenance* which is the work required to restore the system's capacity following cumulative degradation over time.

This section discusses three main aspects such as: a) fund allocation for maintenance; b) manpower to carry out maintenance; and c) impact of maintenance activities.

The first aspect was the O&M expenditure. The problems of infrastructure deterioration, weed infestation and sedimentation are all greater for earth than for lined canals (Ciancaglini, 1993). Sagardoy (1996) presented the vicious cycle of deteriorating maintenance, as shown in Appendix 12. One of the components in this vicious cycle is insufficient maintenance funds. That matter was stated previously in Section 4.2.1.1.4.

As stated by Skutsch (1993): "The major obstacle to the efficient maintenance of irrigation systems is the inability or unwillingness of the companies to allocate sufficient resources to ensure that initial capital investment is safeguarded". As discussed in Section 4.2.1.1.4, the budget was distributed adequately by irrigation companies, to operate and maintain irrigation systems, in accordance to the water costs in the 1998/99 irrigation season (see Figure 9). Moreover, Figure 10 shows a strong relationship between maintenance expenditure and the total length of maintained canals.

The second factor related to maintenance of irrigation systems was the personnel by whom the maintenance activities were carried out. The repair and maintenance activities could be conducted by 3 groups of people such as: a) farmers; b) staff; and c) contractors. Where the staff size of the company became zero, the maintenance activities were carried out by farmers and/or contractors. Where staff were employed, the minor maintenance works were carried out by them. Farmers and staff conducted only minor maintenance activities. Contracting out service was the common option for irrigation companies for the performance of major maintenance works. But, rising labour costs and growing concerns about the environmental effects of the use of chemicals have led to an increasing interest in mechanical equipment for maintenance of irrigation and drainage canals (Jurriëns, 1993).

Proper and planned maintenance can contribute, to some extent, to the improvement of water supply to irrigated areas by enhancing water supply efficiency. Five companies reported that irrigated areas had been increased since the privatisation (see Section 4.1.5). The reasons for the increase in the irrigated areas were mostly from the increase in water use efficiency with the same amount of water usually consumed. But one company explained that the increase in irrigated area in the scheme was due to both the increase in water use efficiency and also the increase in water volume. Improvement in water use efficiency should be considered in association with research and training activities in water management.

4.2.3 Research and Training Activities

"World-wide irrigation efficiency is estimated to average less than 40%, which means the bulk of water diverted for agriculture never benefits a crop. Although some of the "lost water" returns to streams or aquifers, where it can be trapped again, its quality is often degraded as it picks up salts, pesticides and toxic elements from the land" Postel (1992). Goussard (1996) added to the quotation from Postel (1992) that, even if the "lost water" can be reused, the money spent to capture, divert, store, convey and deliver it had been absolutely wasted.

Improvement in water use efficiency requires investment in the software as well as in the hardware of irrigation development (Carruthers, 1996). The software of irrigation development can include farmer education, improved management systems, and company staff training (Goussard, 1996). The "software" can be carried out by disseminating knowledge from the research centre to the field. But the study showed that most irrigation companies (93.75%) did not report contributions to research activities (see Section 4.1.4). Sound education, training, and technical assistance programmes are essential to sustainable irrigation practice. Institutions must ensure that good information is developed and provided to the trainer and the end user (Hassan et al., 1993). Improved on-farm water management is an essential area requiring additional training. Inefficient water use, poor distribution of water and low farm incomes are related to inadequate education and training (Bucks et al., 1990).

In New Zealand irrigation research was undertaken by a number of Government agencies and other organisations throughout the country in the 1980s. Male (1985) listed these organisations which carried out research in irrigation in the 1980s as follows: a number of divisions of the New Zealand Department of

Scientific and Industrial Research (DSIR), Ministry of Works and Development (MWD), New Zealand Agricultural Engineering Institute (NZAEI), Meteorological Service, and the Universities. But a search for research reports relating to irrigation management in New Zealand has proved that no recent published research report can be found.

The design and operation of irrigation schemes are influenced by both physical and socio-economic factors. In the past, proposals seeking Government support had to show that a "scheme is practical and economic and would result in increased productivity of the land" (Public Works Act, 1981, cited in Male, 1985). However improved productivity is attained only when farmers apply their ability and adopt the necessary management changes to make effective use of the water supply (Male, 1985). Goussard (1996) indicated that, in hard economic times, it was the software investments which were most vulnerable to cuts. There were few training activities, but they become even less or were not related to improving water use efficiency in irrigation systems (see Section 4.1.3.3).

In order to respond to the need for improvement of water use efficiency, there is considerable potential for research in irrigation. There is a need to demonstrate that science is the foundation of good environmental policy and to link the findings of research to policy development. And training is necessary to ensure that scientists are available to solve future problems (Smith, 1993).

The research results must be distributed and linked to a publication network. For this purpose, (Jensen, 1996) stated: "All researchers that have completed a research project resulting in good, usable data, whether positive or negative, should publish the results in national journals. If the results are generic, or have potentially broad applications, the researcher should also consider publishing the results in an international journal or national journal that has wide distribution. This is a first step in making better use of limited resources for irrigation and water conservation research". Moreover, Jensen (1996) added that networking could produce synergistic effects, i.e., greater benefits could be obtained from limited research resources by establishing either formal or informal research networks. Networking could also reduce the gap between what was known and what was being applied.

In New Zealand, Male (1985) admitted that the lack of coordination between the many researchers involved in irrigation research, the inevitable conflicts, and the possibility of duplication of effort and the consequent waste of resources were ever present. Furthermore, Male (1985) stated that: "users do not always know where to turn to get the information they require. Therefore, our greatest need is an organisational structure responsible for the coordination of irrigation research and for communication of the information to the end users in a useful form".

4.2.4 Agricultural and Economic Productivity

In the review of the evidence of transfer in many countries, Vermilion (1997) mentions that the relationship between management transfer and agricultural and economic productivity is less direct than the relationship between transfer and O&M performance or financial viability. In New Zealand, irrigation is not an "optional extra", that is irrigation supplementing rainfall (Kearney, undated). With improved irrigation services, reliable water supplies which are essential for perennial orchard crops are expected to be assured. If there is no water for a period, trees will die. Replacement would take 3 to 5 years - if existing growers had the financial resources to replant and wait for that period with no income. For example, over the fortnight ended December 7 1997, there were 62 mm of potential evapotranspiration on the Waimea Plains. Deducting rainfall and applying a crop factor suitable to apples over that period gives an estimate of water extracted by plants from the soil of 33 mm. If there had been no irrigation over this period, then the soil reserves of 38 mm would have been nearly consumed. Trees and crops would have been under severe stress (Kearney, undated).

Two aspects of agricultural and economic productivity, current price of farmland and crop selection, are discussed below.

4.2.4.1 Current Price of Farmland

The behaviour of the rural land market in New Zealand is of interest to all those who have a concern for farming in this country. Prospective purchasers want to know more about current prices, land agents want to know about turnover and future prospects, policy advisors want to know about the economic health of the farm industry and where the trends are pointing (Burorough, 1992).

The price varied greatly between irrigated and non-irrigated farmland in the 1998/99 irrigation season (see in Section 4.1.6). There were no data about the price between these two types of farmland before transfer. According to Burorough (1992), the price of farmland in North Otago from 1982 to 1990 varied from one type of farmland to another (see Appendix 16). Burorough classified the North Otago farmland into 7 major sub-categories: a) farm land; b) arable land, c) dairying land, d) fattening land, e) grazing land, f) specialised livestock land (including deer), and g) horticultural land.

Over the period 1982 through 1988, sharply divergent trends occurred in farmland values and inflation. The farmland value index fell by 22% while the consumer price index rose by 80%. The index of farmland value fell from a level of 1000 in 1982 to 778 in 1988 (Johnston and Sandry, 1990). The picture of a very active land market emerged in the early 1980s, then a marked depression in turnover and unit prices occurred in the mid 1980s, followed by a considerable recovery in 1989 and 1990. The majority of land sales concerned fattening land, with dairy land and arable land making up a much smaller proportion (Burorough, 1992). The price of farm land, dairy land, fattening land and horticultural land rose from 1982 to 1990, whereas the price of arable land and specialised livestock land declined for the same period. However, the price of specialised livestock land and horticultural land were the highest among the other land types. The average price of farm land, arable land, dairy land, fattening land, horticultural land, and specialised livestock land were $670, $2300, $4200, $900, $22,200 per hectare, and $70,000 per unit respectively.

Changes in farmland values are far from uniform across regions or among types of farm units, being influenced in some cases by urban and near-urban pressures, by variations in regional production alternatives, and by changing economic conditions affecting regions and types of farming enterprises (Johnston and Sandry, 1990).

4.2.4.2 Crop Selection

Although increased production was not an explicit objective of the transfer programme (see Section 2.3.2.2.2), with improved irrigation service, crop production was expected to increase over time.

Seckler et al., (1998) stated that the degree to which the increased demand for water in 2025 was projected was to be met by increasing water productivity in agriculture. The productivity of irrigation water can be increased in essentially four ways: (i) increasing the productivity per unit of evaporation (or, more precisely, transpiration) by reducing evaporation losses; (ii) reducing flows of usable water to sinks; (iii) controlling salinity and pollution; and (iv) reallocating water from lower-valued to higher-valued crops.

The cropping pattern may need to be adjusted to the available water supply over time. In addition to water available, climate and soils, the preference of farmers, labour requirements and markets among other factors must be considered (FAO, 1977).

With significantly increased irrigation service fees, the cropping patterns are expected to change from lower-value to higher value crops (Johnson, III). This was happening in irrigation schemes, with the change in land use from sheep in areas more suited to dairying (Agriculture Statistics, 1994-1995). However the shift to higher-value crops is driven by financial changes in the economy as well as by changes in the agriculture sector and, hence, can only partially be attributed to the transfer programme (Johnson III, 1997). The shift to dairy farming in the South Island, especially in 1994 and 1995, is illustrated by the changes in specific territorial local authorities. For example, within the Southland District Council the dairy cattle population has increased at a rate of 73% from 1993 to 1995. In turn, the dairy population within the Ashburton District Council has risen over the same period by 50% (Agriculture Statistics, 1994-1995).

The irrigation companies reported that the different types of crops grown in the schemes, in descending order of importance, are: a) dairying; b) stonefruits; c) grape vines; d) cereals; e) small seeds (see Section 4.1.6). The importance of crops appeared to bring together two factors: a) the change in land use by farm type in 1985 and 1995; b) contribution to total agricultural output (Agriculture Statistics 1994-95).

Appendix 13 shows the areas in hectares used by different farming activities. The change in land use for dairy, cattle and horticulture were positive (35%, 24% and 114% respectively). The decrease in land use for agricultural occupation was due to the reclassification of farm land, in terms of the land scientific, historic and cultural or recreational values.

Dairy products, cattle and horticulture made the first, second and third largest contributions to the March 1994 total agricultural gross outputs. The dairy products, cattle, and horticulture output values were $2,584 million, $1,531 million and $1,303 million respectively (Agriculture Statistics, 1994-1995).

4.3 Summary

The main points of Chapter 4 are as stated below:

1. Payment per area irrigated was the most common method before and after transfer. It was recognised that this method provided no incentive for farmers to save water. The average water costs (in $/ha) in the 1998/99 irrigation season were higher at 46% or 116% (including or excluding the highest rate) than those in the 1982/83 irrigation season. The increase in water costs in the 1998/99 irrigation season might be related to the Government subsidy removal from irrigation schemes just before transfer. The increased rates of the average water costs (including or excluding the highest rate) were on the same rising trends as the Producer Price Indices (PPI) for the agricultural industry. The water costs of the newer schemes were lower than those of the older schemes, due to the transfer.

2. Irrigation companies allocated sufficient O&M budget in relation to the rise of water costs. The relationship between maintenance expenditure and OMR was inconclusive.

3. Life Cycle-costing was employed by only one company to calculate water costs.

4. The companies seemed to be consistent with the O&M budget with regard to water charge.

5. The staff size of irrigation companies diminished until it reached nil in some schemes. Where no staff were employed, the board of directors carried out administrative and financial functions - minimising the staff size led to reduction in operating costs, and eventually, lowering of the water costs.

6. The major maintenance activities were contracted, whereas the minor maintenance works were carried out by farmers, staff or contractors.

7. There were few training activities conducted by irrigation companies for farmers and staff. Research activities seemed not to be considered important

by many companies. Only one company contributed funds for research. No recent published research reports on New Zealand irrigation management were found.

8. In order of importance, the main crops in the schemes after transfer are dairying, horticulture, grape vines, cereals and small seeds. The price of irrigated farmland varied greatly, at an average of $1500 to $6000 per hectare compared to the non-irrigated farmland in the 1998/99 irrigation season.

CHAPTER 5

CASE STUDIES

This chapter presents and discusses the results from the seven irrigation companies visited. This chapter contains the background of the companies, SWOT analyses, sources of professional advice, community satisfaction, economic outputs, financial sustainability, technical sustainability, documented environmental side-effects, and farmers' perception.

5.1 Background of Irrigation Companies Visited

All seven irrigation schemes visited were in the South Island. The names of the schemes were not mentioned, but instead, their names were coded in upper case characters of the Latin alphabet from A to G. In these schemes, there were 665 irrigators and 39,647 ha of irrigated land. The respondents represent 27% of all irrigators and 33.35% of irrigated land from among all irrigation companies in New Zealand (from Appendices 3 and 4).

5.1.1 Company Structure

Touche Ross & Co., (1988) described the corporate structure, which could be summarised as follows:

- limited liability company formed under the Companies Act 1955
- co-operative company formed under the Companies Act and the Co-operative Companies Act 1956
- partnership- Partnership Act 1908
- incorporated societies formed under the Incorporated Societies Act 1908
- industrial and provident society formed under the Industrial & Provident Societies Act 1908.

5.1.1.1 The Company Structure

A company is a legal entity created in terms of the Companies Act 1955. The company format has been proved to be an acceptable and recognised structure by which a number of people join together to pursue a common objective.

The Companies Act lays down certain requirements and responsibilities of Companies and their officers (Directors and Secretary). Many of these legal requirements are designed to protect the interests of third parties who may enter into contracts with, and rely on, the financial stability of a company. As regards the internal relationships between shareholders, and between shareholders and directors, the Companies Act stipulates certain requirements - and provides guidelines for other areas. In many areas, the shareholders have considerable flexibility as to the nature of the arrangements which they agree between themselves. These arrangements are generally embodied in the Articles of Association which is essentially a contract between the shareholders of a company, setting out the rules which apply to them as joint owners.

5.1.1.2 Co-operative Companies

The major distinction between a co-operative company and a normal limited liability company is that a co-operative company may, and in certain circumstances, must accept a surrender of shares from its own shareholders. Such surrendered shares may then be reissued as though they were new shares. At no time, however, may surrendered shares exceed once - fifth of the shares remaining issued.

5.1.1.3 Partnerships

The limitations of a partnership are identified on the schedule. The statutory limitation of partnership numbers confines the use of this structure to those schemes with fewer than 26 members. Even with those limited numbers there will be periodic changes in ownership of irrigated properties. This could result in the termination of one partnership and the creation of another, bringing with it the need to amend or re-negotiate supply contracts and contracts with third parties. If nothing else, however, the unlimited liability of each individual partner makes the partnership structure unsuitable for most irrigation schemes. Possible exceptions could be very small schemes with simple structures.

5.1.1.4 Incorporated Societies

The incorporated societies have been suitable vehicles for giving irrigators, as users, a common voice in dealing with the owners and managers of schemes. With irrigators taking on the additional roles of ownership and operation, these vehicles are no longer appropriate. They are not legally empowered to carry on business for pecuniary gain, nor do they provide flexibility as regards members' capital contributions and voting power. Incorporated Societies do not have a fixed capital, and membership is fluid. They lack the security of capital and membership required by most long - term lenders. They are, therefore, too restricted to be considered as potential owners and operators of scheme assets.

5.1.1.5 Industrial and Provident Societies

An industrial and provident society is very similar to a co-operative company, but suffers from the following limitations: a) it must have at least 7 members, b) a member's capital contribution is generally limited to $4,000, c) it must be a bona-fide co-operative, d) it is a corporate structure which is not often used, and is not well understood, by the business community.

5.1.2 Management of Individual Schemes

Touche Ross & Co., (1988) indicated ways in which irrigators and other parties joined together in the joint operation of headworks. Based on their common features, the irrigation schemes visited could be grouped into 4 categories:

1. *Independent schemes*: These schemes indicated preference for irrigator ownership and control with operational management either undertaken by irrigators or contracted out. Engineering requirements for these schemes are likely to be within the capacity of the company to cope with either on their own, or after taking professional advice when necessary. Irrigation companies A, C and G were in this group.

2. *Joint management company*: The five schemes in the Waitaki river region were forming an "umbrella" company. Objectives of the "umbrella" company include: a) to provide strong common interest representation in the event of there being political or community interest issues to be addressed; b) to arrange public liability insurance to protect the schemes from any claims against them by third parties; c) to build a shared reserve fund for emergency works; d) to undertake billing and collection of accounts on behalf of all schemes. Irrigation company D was in that category.

3. *Owned and operated by local government*. A number of scheme committees have indicated that they would prefer their scheme to be owned and operated by local government. Reasons given for this include: changing land use; requirement of distribution system for potable water supply; larger financial base; legal access and spreading of risk. No company visited belonged to this group.

4. *Owned by irrigators in partnership*. As with a number of schemes where other stakeholders are involved, there is something of a consensus that

suggests ownership should be vested in all the users of the scheme. Company B was in this group.

According to Touche Ross & Co., (1988), it was not known to which category the other companies (E and F) belonged.

5.2 Strengths, Weaknesses, Opportunities and Threats (SWOT) Analyses

Successful strategic management depends on matching internal strengths and weaknesses to external opportunities and threats (Andrews, 1987). In the following, SWOT analyses, an anagram of strengths, weaknesses, opportunities and threats, was used as a mechanism to analyse the internal resources of an irrigation company and the external environment in which it operates.

Table 3 Three key questions

Key question	Steps	Tools/methods
1. *Where is the irrigation company now?*	• Present position analysis	• SWOT analysis • Key success factors
2. *Where does the irrigation company want to be?*	• Objectives	• Objective setting
3. *How does the irrigation company get there?*	• Strategies	• Strategy setting • Driving force analysis • Sustainable advantage

The irrigation company's "success could be assessed by three key factors" (Coulthard et al., 1996), as developed and shown in Table 3. From Table 3, the discussion starts from the strategic objectives, then the specific objectives and lastly the SWOT (strengths, weaknesses, opportunities and threats) of the irrigation companies visited.

5.2.1 Strategic Objectives

Dess and Miller (1993) indicated that: "to keep an organisation on track, there must be a sense of constancy in its overall purpose. Constancy of purpose requires that managers have a common vision, an accepted mission, and clear objectives". Objectives are essential for organisational success because they provide direction, aid in evaluation, create synergy, reveal priorities, allow co-ordination, and provide a basis for effective planning, organising, motivating and controlling activities (David, 1993). The need to adapt to change in irrigation management after the transfer of irrigation schemes leads irrigation companies to make measurable, consistent, reasonable and clear strategic objectives.

The management objectives of irrigation companies were from the shareholders, and for the shareholders. The common strategic objective among the 7 irrigation companies was *to supply irrigation water to their shareholders.* However, apart from that point, some companies had their additional strategic objectives. Company C was focusing on maintaining the irrigation systems in good condition and good value. But the second specific objective for company D was to take bigger resource consent, company E - to contemplate the next power generation, company F - to charge water as cheaply as possible, and company G - to operate the scheme as efficiently and economically as possible (see Table 4).

5.2.2 Specific Objectives

Specific objectives are short-term milestones which irrigation companies must achieve to reach strategic objectives. Like long-term objectives, specific objectives should be measurable, quantitative, challenging, realistic, consistent and prioritised. Although the strategic objectives were commonly similar, the specific objectives varied slightly from one company to another as presented in Table 4.

Table 4 Strategic and Specific objectives of the irrigation schemes visited

<table>
<tr><th>Irrigation companies</th><th colspan="2">Strategic Objectives</th><th>Specific Objectives</th></tr>
<tr><td>A</td><td rowspan="7">To supply water to shareholders</td><td></td><td>- To renew resource consent;
- To take optimal daily seasonal operation;
- To keep the costs down, but not to shy away from investment.</td></tr>
<tr><td>B</td><td></td><td>- To get easement for installation of irrigation structure.</td></tr>
<tr><td>C</td><td>- To maintain irrigation system in good conditions & good values.</td><td>- To take responsibility for supplying water to shareholders.</td></tr>
<tr><td>D</td><td>-To take bigger resource consent.</td><td>- Commercial focuses: investigation Into power generation, attempt to supply water to other businesses, sale of water to farmers outside the scheme area</td></tr>
<tr><td>E</td><td>- To contemplate the next power generation.</td><td>- To be keen to take bigger resource consent for power generation.
- To obtain full co-operation and active support of farmers.</td></tr>
<tr><td>F</td><td>- To charge water as cheaply as possible.</td><td>- To protect community irrigation infrastructure</td></tr>
<tr><td>G</td><td>- To operate the scheme as efficiently and economically as possible.</td><td>- To improve water efficiency in the system.
- To attempt to work with the transferability of share with land.</td></tr>
</table>

5.2.3 SWOT Analyses

SWOT analyses was presented in a matrix in Table 5. Table 5 contains information about strengths, weaknesses, opportunities and threats of each company as determined by the representative or directors of irrigation companies. This section was divided into: 1) analysis of opportunities and threats, and 2) analysis of strengths and weaknesses.

5.2.3.1 Analysis of Opportunities and Threats

In the analysis of opportunities and threats, the key issues were found to be as follows (see Table 5):

Opportunities:

- supply other farmers outside of the scheme;
- tradable water rights;
- water source was not a permanent river, so the issues of stream life were less of a problem;
- supported birdlife in the area;
- crop diversity;
- forestry and power generation were being considered on a commercial basis;
- pro-active in education for farmers.

Threats:

- the resource consents seemed to be a common threat confronting many irrigation companies;
- pressure from environmental and lobby groups to limit water taken;
- small or non-permanent water resource, global climatic changes resulting in fluctuation of available water for irrigated agriculture;

- power generation might reduce water flows.

5.2.3.2 Analysis of Strengths and Weaknesses

To exploit opportunities and minimise threats in the external environment, managers must carefully analyse a firm's internal strengths and weaknesses (Dess and Miller, 1993). The process of internal analysis is often subjective because of difficulties in quantifying a company's strengths and weaknesses. "Value chain analysis", a major analytical tool for assessing a company's strengths and weaknesses, was used to divide the activities of a company into separate primary and support activities (Porter, 1985). The value chain is presented in Figure 12.

A. Primary Activities

The three categories of primary activities were: a) financial performance, b) operation and maintenance of irrigation scheme, and c) shareholders' service. Table 6 provides a summary of some of the important factors which a company should consider when analysing primary activities in the light of a company's strengths and weaknesses.

Financial Performance. Payment per area irrigated, which was a common method used in the schemes visited, did not encourage farmers to save water (see Section 4.2.1.1). One company (E) used life cycle-costing to calculate the water costs. None of the irrigation companies had developed an asset management plan. Fee collection rates were high. Three companies (A, E, and F) reported that they employed full-time staff for operation and management of the scheme, but in the four other schemes the board of directors managed the companies.

Operation and Maintenance. Funds were spent to maintain, clean and repair the irrigation in the schemes. All major repair and maintenance works were

Table 5 SWOT Analysis in a matrix

Company	Strengths	Weaknesses
A	- Covered large number of farmers; high efficiency with piped schemes; was cash rich; had an operating and maintenance manual; board acted in a professional manner and staff had a high degree of commitment and enthusiasm for the scheme.	- limited water resource; no incentive to save water; had no specific asset management plan
B	- had a partnership arrangement; example of farmers working together in partnership	- had loose arrangement for maintenance of inlet structure
C	- owned and work with the community; water in scheme was cheaper than individual schemes	- lifestyle blocks caused reduction of water
D	- share tied to land; each cubic metre had same basic charge for both irrigation and industry; strong sense of community ownership; company paid no tax: paid a rebate to shareholders	- people wasted water (water was too cheap)
E	- all farmers were member of the schemes; stable land tenure	- got stuck with water allocation but less worried about where the water went
F	- operated as cost centre; preparing asset management plan; had professional expertise management and high level of information; had financial basic reserve	- none, if a raceman got into trouble, or had long-term injury no-one came to do the job.
G	-small scheme kept water costs down	- one or two people put a lot of time into the scheme and a directorship was not keenly sought after
	Opportunities	**Threats**
A	- supply water to other farmers outside of schemes; had tradable water rights, i.e., could buy up other water rights	- resource consents terminated in the near future; tradable water rights
B	- not a permanent river, so the issues of stream life were less of a problem; pumped and stored water in the constructed dam when the stream was in "flood"	- water resource; shift to high value crop; not permanent river; permeable soil in dams; uncertainty about legal status
C	- supported the birdlife in the area; had crop diversity	- resource consent-minimum flow provision (35 years duration but may be reviewed at anytime)
D	- had crop diversity	- fish life in races and helped with financial costs of research to eliminate this
E	- had considered forestry and power generation; hydraulically the scheme was sound;	- the water resource was under pressure (because of hydrologic factors); pressure from environmental lobby group-DOC-mean annual low flow; company was very protective of the takes of water
F	- pro-active in education for farmers in better irrigation practices	- not received all drawings as it was supposed to at time of sale
G	none	- level of restrictions/small river/; had applied to Regional Council to change conditions of consent

carried out by contractors, except for most of the minor activities, which were conducted by the company's staff or farmers; but sometimes they also were carried out by contractors. Company B, as the stream was not permanent, built dams to store water during a flood. Company C had spare pumps for use in the event of breakdown. Moreover, it was convenient that, in many companies (A, D, E and F), information was collected and stored in a computer.

Shareholders' Service: Supplying water as cheaply as possible was the first priority for all companies. However, the management perspectives varied from one company to another. One company seemed to be conservative, as it limited its responsibility for other issues such as expansion of scheme area by admitting new shareholder(s), or supplying stockwater, - except for supplying irrigation water to its shareholders. In contrast, several companies showed their willingness to work with the community and had a strong sense of community ownership. Aside from supplying water to farmers, they were looking also to supplying water to other users; and they wanted to become a water company instead of an irrigation company.

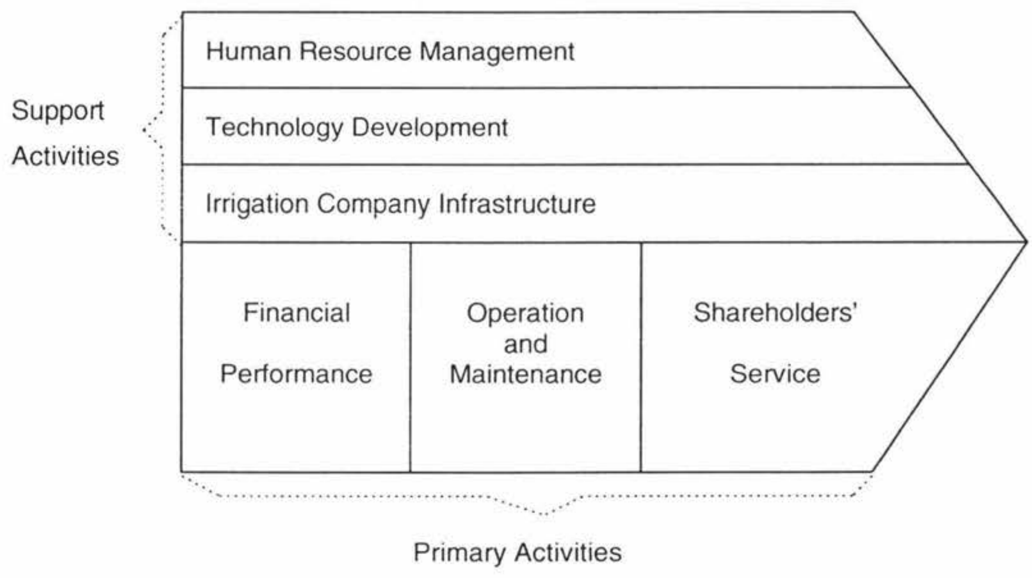


Figure 12 The value chain of irrigation companies: primary and support activities (derived from Porter, 1985)

B. Support Activities

Human resource management, technology development and company infrastructure were the three categories of support activities which are presented in this section. As with primary activities, each of these support activities might be further divided into a number of distinct activities. Table 7 summarises some of the important factors to be considered.

Table 6 Evaluating an irrigation company's value chain: primary activities

Financial Performance	• Appropriate method of payment for water costs to encourage the users in saving water • Life cycle costing to calculate the water costs • Asset management plan • Fee collection rates • Levels of management staff • Staff skill levels
Operation and Maintenance	• Adequate O&M budget • Spare pumps/equipment in the event of breakdown • High level of information, professional expertise, and management
Shareholders' Service	• Supplying water in a timely manner as cheaply as possible • Having a strong sense of community ownership • Having the ability to respond to the shareholders' needs

Table 7 Evaluating an irrigation company's value chain: support activities

Human Resource Management	• to recruit, train, and develop all levels of staff and farmers.
Technology Development	• Selecting and upgrading appropriate irrigation techniques to obtain high efficiency • Upgrading irrigation system to supply water efficiently
Company Infrastructure	• Ability to identify potential opportunities and threats • Fund research and development activities • Information flow and experience dissemination

Human Resource Management. As companies tended to minimise the staff size, recruiting new staff was not seen as a priority. But the companies would focus on training and developing all levels of staff and farmers in order to respond to fast-moving changes in technology. However, there was no strong evidence of training, or developing skills in farmers and staff in the schemes visited.

Technology Development. In order to minimise threats posed to irrigation companies, technology development was considered to be part of supported activities. Technology development consists mainly of selecting suitable techniques with high efficiency, and upgrading irrigation systems to reduce water losses and wastage.

Irrigation techniques. Three main irrigation techniques commonly used in schemes visited were: border dykes, sprinkler irrigation and drip irrigation. Of these three techniques, border dykes were recognised as being inefficient. Company D stated that farmers border-dyking must embark on a progressive re-boarding using modern technology to eliminate some of the wastage which was occurring. Sprinkler and drip irrigation were considered to be highly efficient, but sprinklers seemed to be prone in the windy area as they had low uniformity. Drip irrigation was mostly suitable for horticulture.

Irrigation systems. Success in supplying water to shareholders could be achieved if efforts have been put into enhancing the performance of irrigation infrastructures. Evaporation, seepage and spillage are the most common causes for water losses. In the meantime, infrastructure deterioration, weed infestation, and sedimentation also result in creating more problems in the systems.

Irrigation Company Infrastructure. Research in irrigation and water resources management would provide basic information and findings to reduce or mitigate the adverse effects caused by human activities, global climate change and natural catastrophes. Inadequate research funding and activities would leave New Zealand's science reputation below international standards. Moreover, lack of information flow and experience dissemination would result in obstructing irrigation companies' capability to identify potential opportunities and threats. Information flow and experience dissemination would be assured if all irrigation companies were part of a group such as a New Zealand Irrigation Association. Many companies' managers and directors reported that the New Zealand Irrigation Association disappeared just after the transfer. The proceedings of the latest seminar held in Ashburton were found to have been published in 1991. A similar kind of organisation should be continued or re-established to serve not only irrigators but also those who need water and desire to conserve it.

5.3 Sources of Professional Advice

Due to the complexity of many issues, such as legislation, finance and agricultural technology basis, all irrigation companies visited used 3 different sources of professional advice: a) solicitors for legal advice, b) auditors/accountants for financial service, and c) technicians- for technical assistance. Without external resources for professional advice and consultation, the irrigation companies would face difficulties in managing their irrigation schemes. The type of advice service offered by agencies might vary considerably in its scope, level and content - but include advice, consultation, report, or repair and maintenance activities.

5.4 Community Satisfaction

Many of the schemes reported that they received full co-operation and active support from farmers. Shareholders were satisfied with the companies' leadership in supplying of water (see more in Section 5.10). In addition, companies A and C reported that farmers not currently served by them were prepared to invest in their companies in order to gain access to irrigation water. The implication here is that the companies are perceived as being well run and are a good business risk from the point of view of the potential investor (farmer). Conversely, if the companies were perceived as being poorly run, new investors would not be attracted to them.

With regards to land, company D reported that minimal land was purchased from the landowners, but a small amount of compensation was paid for the loss of use of the land where farms were disproportionately affected by the area taken for scheme race construction.

No reports about complaints or dissatisfaction from the other water users were mentioned during the visits.

In most cases, the schemes were well run with very low water losses and wastage. Environmental and other lobby groups seemed to pose a threat to company F.

5.5 Economic Outputs

As shown in Appendix 14, Small and Svedsen (1990) developed the nested set of systems into which five systems were incorporated. These five systems are as follows:

- the *irrigation system*, which has as its function the conveyance of water from the source to the farmers' field. The output from this system, water delivery at the farm gate, then becomes an input into

- the *irrigated agriculture system* where farmers use water and other inputs to produce crops; these crops become the inputs into

- the *agricultural economic system* which includes rainfed agriculture as well as irrigation; the value of the crops produced then forms part of

- the *rural economic system* which deals with the entire set of economic activities in rural areas which in turn form part of the highest level

- the *national political-economic system.*

This section focuses mainly on 3 systems: agricultural economic, rural economic, and national political-economic systems. Data about economic outputs from the schemes visited were not always available. Therefore, the economic profile of the Timaru District was taken as an indicator, because the Timaru District was located in the centre of the South Island, with its own port, a diverse agricultural base, reasonably priced land and an attractive landscape, in which three irrigation schemes visited (D, E and F) were located. The key economic indicators in this section were: a) population data; b) farming and other related sectors' outputs.

5.5.1 Population Data

There was no information about the population data in the schemes visited. But there was a trend towards lifestyle blocks in schemes C and G. People from urban areas bought land in the scheme, used and paid for water. The companies had a negative perception about lifestyle blocks, because these groups used water in their properties; which, consequently, resulted in a reduction in water in the schemes.

The data about population changes in the whole country are taken from New Zealand Official Yearbook 1998. Rural population represented 15.10% of the total population in 1981 and slightly decreased to 15.05% in 1996 - whereas urban population rose from 84.80% of the total population to 84.95% in 1996.

The population movement was reported in company D at production period, when extra workers were employed by dairy-farmers and horticulturists. The Timaru population remained static at around 42,700 until the turn of the twentieth century. The key influence in terms of boosting the district population would need to be migration. Reducing emigration from the district and encouraging immigration from other parts of the country and from overseas was a key focus of the Timaru District community. To some extent the effects of low population growth on the local economy have been offset in the past by increased business inputs. However the ability of the Timaru District to attract people to dwell and work would be critical to the future viability of the Timaru economy's industrial and agricultural base, and its subsequent social and financial benefits to the community (Economic profile, 1997).

New Zealand farmers are among the most educated and technically literate in the world (Choudhary and Baker, 1994). They use modern techniques, including equipment such as the neutron probe, laser beam for levelling of the fields. They receive professional advice from many kinds of sources such as solicitors, auditors/accountants, and also private agricultural firms.

5.5.2 Farming and Other Related Sectors' Outputs

Irrigation schemes had a direct influence on the increase in farm outputs - and most other industries within the Timaru District were also directly and indirectly related to Timaru's agricultural and processing sectors. According to Statistics New Zealand, there were 1,125 farm holdings in the Timaru District in 1995, the majority of which were sheep farms or mixed and other livestock farms (see Appendix 15). However, there has been a major increase in dairy farming and in dairy factory capacity over the past few years, as well as a major increase in process vegetable production (Economic profile, 1997). At the national level, dairy products continue to be the main contributor, whereas cattle and horticultural products made the second and third largest contribution to the March 1994 agricultural gross output (Agricultural Statistics, 1994-1995).

Job Creation. Historically, parts of the District have not been able to maximise their productive potential because of the lack of a reliable water supply, particularly during summer. The Opuha Dam construction (begun early in 1996, will be fully operative by the summer of 1998/99) and increased farming production due to irrigation will create more employment and economic activity in South Canterbury in both the short and long term. Farm production would be expected to increase by 12.5%, with conservative estimates of a $16.2 million boost to the economy and the creation of 171 jobs (Economic profile, 1997).

Fertilisers. Over the decade ending June 1995, the total volume of fertiliser applied has increased by 5% from 3.11 million tonnes to 3.27 million tonnes over the whole country. According to Agriculture Statistics (1994-95),there has been a trend of shifting from sheep to dairy, beef and other farming activity. Moreover, dairying has made a significant contribution to the overall volume increase in fertiliser consumption. This could be explained by the rise in the area in dairy farming and by the fact that dairy farms generally apply more fertiliser per hectare than sheep farms. In the meantime, according to Economic profile (1997), local fertiliser manufacturer Ravensdown Ltd anticipates good growth within this sector in the South Canterbury region over the next five years, due to the move towards dairying and intensive farming as a result of the Opuha Irrigation Scheme.

Electricity Generation. The Opuha Dam will provide a secure water source for irrigation for 16,000 hectares of farmland. It will also generate 7.2 MW of electricity and increase the residual flows in the Opihi River for environmental and ecological enhancement (Economic profile, 1997).

Transport. The growth potential for Timaru's transport is very strong, mainly as an indirect spinoff of growth in the agricultural and processing sectors stemming from such things as the Opuha Irrigation Scheme. Although the port handles very little dairy products or vegetables, there have been some obvious upward trends over the years in relation to such things as fertilisers, fruit, fish and container freight (Economic profile, 1997).

Business and Financial Services. Activity in the business and financial services was forecast to grow slightly faster than economic activity in general. Most industries in the sector were tending to increase capital relative to labour, in an effort to contain costs while expanding their range of services. The district is served by well-established local accountancy and law firms, and the advent of the Opuha Dam would result in increased requirements for legal services, particularly in the commercial area and property development. Some finance firms were keen to see Timaru promoted more to attract new business and people to the area. But some finance sectors suffered, as people were using new technology and were doing telephone banking and paying by Eftpos, while the farming community was serviced by mobile bank managers (Economic profile, 1997).

Price of Farmland. The current price of farmland in the schemes varied greatly between irrigated and non-irrigated farmland. Supplying secure irrigation water as a means against droughts was considered as one of the main factors in making a difference in the price of farmland.

5.6 Financial Sustainability

Water Costs. Company D reported that water costs were divided by irrigation techniques: a) spray irrigation ($11.00/ha); border dikes ($27.50/ha), and assessed dry ($11.00/ha). A basic or annual minimum water charge is payable whether water is used or not. The company had a net surplus after tax ending 30 June 1998 ($16,650) and cash reserve ($324,000) for emergency intake repair work. Directors received remuneration paid during the year. All assessed irrigable land was allocated a $1.00 share per hectare. Commercial water users were allocated shares on the basis of a \$1 share per $399m^3$ allocation. Every water user is a shareholder.

Fee Collection Rates. There was no report about problems of payment for water costs by farmers. As with in Chapter 4, the fee collection rates were reported to be high.

Management Staff. The staff size of irrigation companies diminished following transfer, either at system or at administrative levels. One reason for the decline in companies' staff was to reduce operation costs. In Companies B, C, D and G, the staff size was zero and only the boards of directors managed the schemes. They were paid remuneration during the year.

5.7 Technical Sustainability

Irrigated agriculture is by far the greatest user of water on earth. The limits to the availability of water and land for irrigated agriculture necessitate the careful use of these resources (Wolters, 1992). Martínez-Austria (1994) stated a number of factors affecting the water supply such as depletion of sources, deterioration, pollution and climatic change. Focusing on only the climatic change, global warming was calculated at between 0.3 to 4 degrees per decade for the coming years in different parts of the world (Houghton, 1991). The main effects of climatic change are: a) increase in crop water requirements; b) change in rainfall patterns, and c) reduction in snowfall in the higher latitudes (Martínez-Austria, 1994).

In view of the factors described above and the threat of resource consent (see Section 5.2.3), to achieve the strategic objective: *"supply water to shareholders"* (see Section 5.2.1) irrigation companies should operate irrigation schemes in a technically sound manner, i.e., through improvement of efficiency in the use of irrigation water. The positive effects of increasing the efficiency of irrigation water use are (Wolters, 1992):

- A larger area can be irrigated with the same volume of water;
- The competition between water users can be reduced;
- The effect of water shortage will be less severe;
- Water can be kept in storage for the current (or another) season;
- Groundwater levels will be lower, which can lead to lower investment costs for the control of waterlogging and salinity;
- There will be less flooding;
- Better use will be made of fertilisers and pesticides and there will be less contamination of ground water and less leaching of materials;
- Health hazards can be reduced;
- Energy can be saved;
- There will be fewer irrecoverable losses;
- Instream flows, after withdrawals, will be larger, thereby benefiting aquatic life, recreation, and water quality.

An efficiency is generally defined as the ratio of output over input, and is expressed as a percentage. In irrigation, efficiency was first defined by Israelsen (1932) as:

> *"The ratio of irrigation water transpired by the crops of an irrigation farm or project during their growth period, over the water diverted from a river or other natural resource into the farm or project canal or canals during the same period of time."*

As discussed in Section 5.2.3.2, one of the support activities was technology development. Martínez-Austria (1994) characterised the trends of technology development in Mexico in four groups. These are: a) improved operation; b) improved catchment and conveyance, c) improved irrigation techniques for on-farm irrigation; and d) basic research. Only the last three categories are discussed in the irrigation schemes visited.

5.7.1 Improved Catchment and Conveyance

There were two kinds of irrigation systems: buried pipeline and open canals.

Buried Pipeline. Company A had a piped system in its scheme. PVC has good strength, holds its shape well, is easily installed and repaired, does not rust or corrode and has a very long life. It has an indirect benefit to farmers when the saved land area is used for new and improved roads for better access to their fields (easement). Company A reported that the contract was signed by the landowners to ensure that the area of easement must be clear from big tree plantation. The data about water saving from piped system were unknown. But company A reported that the piped scheme was efficient. It is known that there is no evaporation in buried pipeline systems.

Open canals. Open canals provide lower efficiency, compared to the buried pipeline. The common causes are: a) evaporation from channels and rivers, b) seepage in conveyance lines, c) leaks from structures in poor condition, and d) wastage due to incorrect operation (Martínez-Austria, 1994). To maintain low flows restricted by the resource consent but increase the water volume in the system, one company manager was seeking to enlarge the section area of the intake canal. Regular desilting can substantially improve the watercourse. An improved watercourse not only reduces water losses but also increases delivery efficiency.

5.7.2 Improved Irrigation Techniques For On-Farm Irrigation

There are three main irrigation techniques being used in New Zealand: a) border dykes (or border strip), b) sprinkler irrigation, and c) drip irrigation. But the technique used was determined to a large extent by land use - whether cropping, horticulture or grazing. It was also dependent on the farmer's personal preference, labour requirements, the shape of the farm, its terrain, soil types and availability of water.

As border-dykes were less efficient, company D indicated that farmers border-dyking must embark on a progressive re-bording using modern technology to eliminate some of the waste which is occurring. With the evolution of sprinkler irrigation equipment, the labour requirement has been reduced dramatically. The labour required to operate a sprinkler system has reduced from 198 min/ha for a hand move system, to 6 min/ha for a centre pivot system. The technique is more efficient than the border dykes. On suitable soils, trickle irrigation systems - the most efficient irrigation technique - offer the opportunity of irrigating a crop with a controlled volume of water which can be placed in the root zone. These systems can be fully automated so that no labour is required for their operation (MWD, 1984).

5.7.3 Basic Research

There was no available information about the research funds and activities to which the irrigation companies contributed. Moreover, no recent published research reports have been found.

5.9 Documented Environmental Side-Effects

There was no evidence of documented environmental side-effects in the irrigation schemes visited, although many irrigation companies considered that the resource consent was a strategic threat to the operation of irrigation schemes. The companies were concerned that environmental lobby groups may use the resource consent as a means to suspend their rights to take and use water from the water sources. Company E reported that it received pressure from an environmental lobby group and the Department of Conservation about mean annual flow, and the company was very protective of the takes of water from the river.

5.10 Farmers' Perception

Farley (1994) stated that: "Although irrigators were acutely aware of the frustrations and lack of efficiency of Government ownership and management, many initially feared that they would be worse off with a loss of Government support". But after 8 years from the transfer date they made a clear decision to stay with the irrigation companies. They did not intend to return to the system in which they received support from the Government. Even though the water costs rose, the long administration process was shortened, and they experienced better communication with leadership. Farmers were feeling confident with the transfer programme and provided full co-operation and active support to the irrigation companies . They paid the fees regularly, had share(s) in their schemes, and had their voice in the meetings.

As an example, company A stated that, under Government control, farmers never received a rebate and there was no incentive to save money. But after transfer, there was an incentive for the farmers (who were equally the owners) to invest and save money as they saw best.

5.10 Summary

The main points of Chapter 5 are shown as follows:

1. The specific objective of irrigation companies was to supply water to shareholders as cheaply as possible. They were threatened by: a) the resource consents; b) pressure from environmental and lobby groups (Co. E or F); c) global climatic changes. They were challenged by forestry development and power generation (in some schemes). They were strengthened by strong support from farmers with community spirit to work together. They were weakened by a lack of information flows and experience sharing among themselves. The key success factors for

irrigation companies were: a) human resource management; b) technology development; and c) companies' infrastructure.

2. The running of the companies had received professional advice from solicitors, auditors/accountants, engineers, hydrologists, resource management specialists, and others.

3. Most of the schemes had obtained community satisfaction.

4. The management of the schemes was technically sound. However, border dykes were less efficient and are not sustainable in the long run because wastage of water is occurring due to use of this technique.

5. The farmers were satisfied with the transfer and did not wish to return to the previous management when they were obtaining financial support from the Government.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

The primary objective of this study was "To establish potential performance indicators related to efficiency gains and success of the privatisation of irrigation and community water supply schemes at pre- and post-transfer times".

This objective was achieved by testing two hypotheses which were, in fact, conclusions drawn by Farley (1994):

1. privatisation of irrigation schemes in New Zealand has produced very large efficiency gains; and

2. the privatisation of irrigation schemes in New Zealand has been very successful.

Based on the above mentioned hypotheses, the performance of New Zealand irrigation systems after transfer is linked to two terms: "Efficiency gains" and "Successful".

Generally speaking, *efficiency* is defined as the ratio between the outputs and the inputs. In the context of the transfer of New Zealand irrigation systems, efficiency gains might imply that private schemes would run more efficiently than those subject to Government control. This might be related to many indicators, four of which were financial performance, operation and maintenance performance, agricultural and economic productivity, and community satisfaction.

Following the efficiency gains, the privatisation of irrigation schemes was *successful* when: a) water costs were lowered or stayed the same, b) staff size become smaller, c) budget was adequately allocated for maintenance of irrigation infrastructure, d) there was evidence of agricultural productivity and economic growth, and d) irrigators supported the company management by paying the water fee regularly, also when community or other water users did not object to the running of irrigation schemes to take water for irrigation.

The objectives of the study were carried out by many steps presented as follows:

In the introductory part, the background of New Zealand was overviewed through its physical setting, background of water resource development and history of irrigation development and management until the irrigation schemes were privatised. The problem of the study was stated and objectives of the study were identified.

The review of literature started with the statutory frameworks related to the latest legislation - the Resource Management Act 1991. Then the focus directed to the evolution of Participatory Irrigation Management (PIM). The review of privatisation of economic sectors in New Zealand was carried out. The transfer process of irrigation schemes was reviewed. Key lessons from the transfer were presented. Finally, a number of potential transfer performance indicators for New Zealand irrigation schemes were identified.

In the methodology part, four interrelated key factors were determined and a questionnaire was developed to collect data. The questionnaires were sent to all irrigation schemes in New Zealand. The responses to the questionnaires and other secondary data from official publications were used in the results and discussion part.

The main points from the discussion are as follows:

Payment per area irrigated was commonly used. This method was used by 50% of schemes studied in the 1982/83 irrigation season, but increased to 62.5% in the 1998/99 irrigation season. This method did not provide any incentive for farmers to save water.

The average water costs (in $/ha) in the 1998/99 irrigation season were higher at 46% or 116% (including or excluding the highest rate, $80/ha) than those in the 1982/83 irrigation season. The increase in water costs after transfer was explained, on one hand, by the Government subsidy removal from irrigation schemes. On the other hand, the average water costs, as well as the PPI for agricultural industry were on rising trends (see Section 4.2.1.1/C, and Figure 2). If the privatisation of irrigation schemes had not occurred, then the water costs would have rise much higher.

The 1998/99 budget was adequately allocated, compared to water costs, for the maintenance of irrigation systems. There was a strong relationship between the maintenance budget and the total length of maintained canals. But the relationship between the maintenance budget and OMR was inconclusive.

The 1998/99 staff size of irrigation companies diminished, to zero in some schemes. The average PER was 0.184 per/1,000ha. Where no staff were employed, the board of directors carried out administrative and finance work and were paid minimal honoraria. However, there was no information about pre-transfer staff inputs of MWD which had been involved in irrigation schemes.

The major maintenance activities were contracted, whereas the minor maintenance works were carried out by farmers, staff or contractors, in the 198/99 irrigation season.

There were responses concerning the irrigated area increase after transfer. The increase was, on one hand, due to the increase in volume of water, but on the other hand, due to both the increase in volume of water and the increase in water use efficiency.

There was no strong evidence of capacity building for staff and farmers, or of any research activities carried out by irrigation schemes in the 1998/99 irrigation season.

From the case studies, the results can be summarised as follows:

The strategic goal of irrigation companies was to supply water to shareholders as cheaply as possible, whereas the specific objectives varied from one company to another. They were threatened by: a) lack of resource consents; b) pressure from environmental and lobby groups (company E); c) global climatic changes. They were challenged by forestry development and power generation (in some schemes). They were strengthened by strong support from farmers with community spirit to work together. They were weakened by lack of information flows and experience sharing among themselves. The key success factors for irrigation companies were: a) human resource management; b) technology development; and c) companies infrastructure. The irrigation schemes were technically sound. However, border dykes was less efficient and not sustainable in the long term.

The companies received necessary professional advice from solicitors, auditors/accountants, engineers, hydrologists, resource management specialists, and others.

The community was satisfied and provided strong support for the companies. There was no evidence of documented environmental side-effects in the schemes visited, although the resource consent was thought to be a strategic threat. Farmers were satisfied with the transfer and did not wish to return to the management whereby they were receiving support from the Government.

6.2 Conclusions

From the summary part, the two proposed hypotheses were proven.

1. the privatisation of irrigation schemes in New Zealand has produced very large efficiency gains, because:

   Water costs for the same scheme would have been higher if it had not been privatised. The staff size was at minimum level. The companies seemed to be consistent with the O&M budget for water charge. Legal, financial and technical advice and services from professional groups were made available to the irrigation companies.

2. the privatisation of irrigation schemes in New Zealand has been very successful because:

   The water costs were controlled by irrigation companies. The schemes received strong physical, financial and spiritual support from farmers and shareholders. No evidence of documented environmental side-effects was found. The farmers indicated that they would stay with the current management instead of returning to the past system under which they received financial supports from the Government.

   Although the 8-year period after transfer of irrigation schemes was proven to show efficiency gains and to be successful, the future situation is unknown. As the resource consents was considered to be a strategic threat and the irrigation companies seemed not to be prepared to enhance their capability in human resource management, technology development and company infrastructure, the irrigation companies may face difficulties in the future.

6.3 Recommendations

A number of recommendations were made as follows:

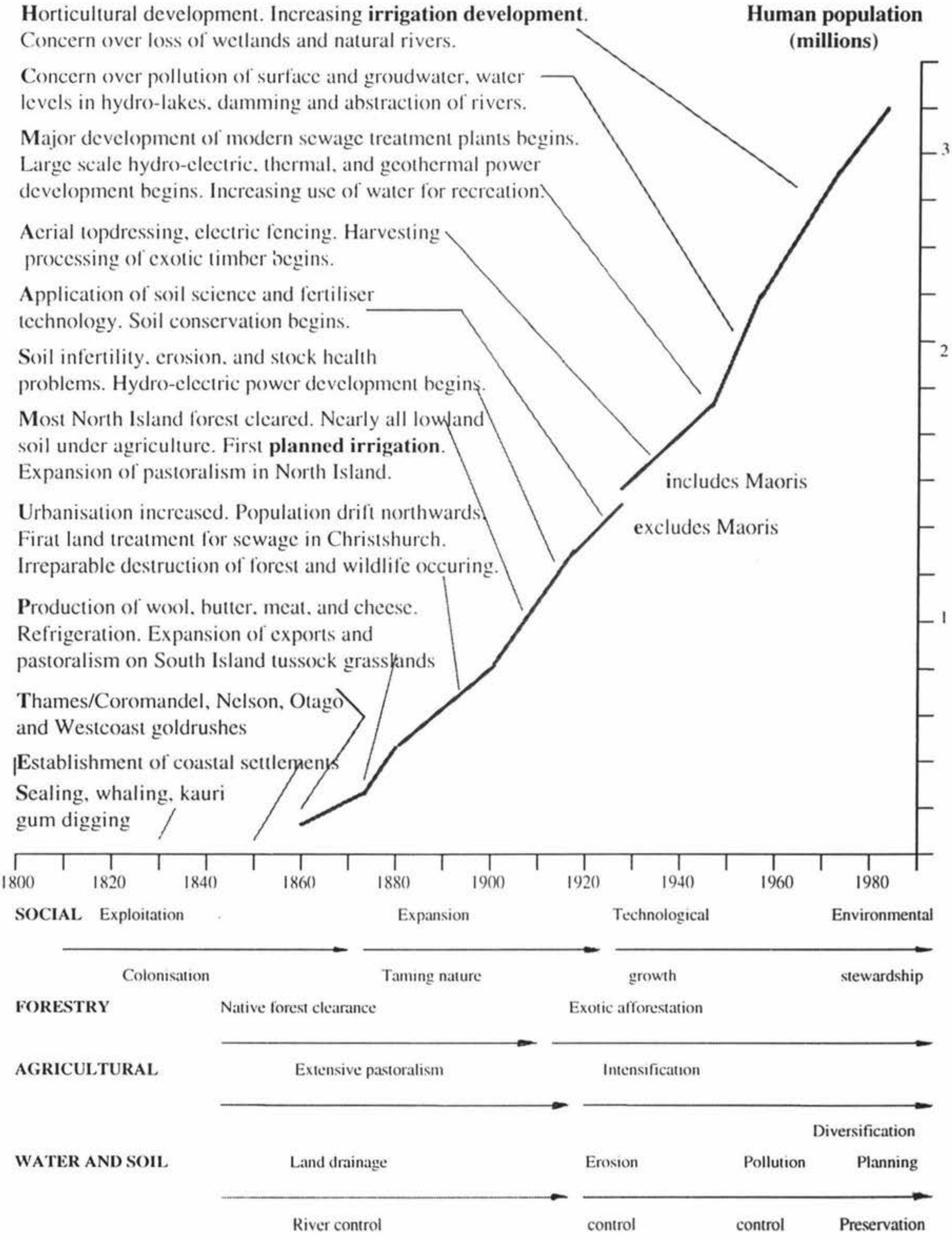
- The water costs should be calculated on the basis of life cycle-costing.

- To minimise the strategic threat posed by resource consent, irrigation companies should pay attention to contributing funds to training and research activities to achieve high efficiency for irrigation systems and irrigation techniques. Research would not only bring about improvement of efficiency in irrigation, but also gain glory for New Zealand science at the international arena.

- The irrigation companies may need to consider re-establishing the New Zealand Irrigation Association to act as a focal point for irrigation companies. This type of organisation would facilitate its members to network their information and share experience among themselves.

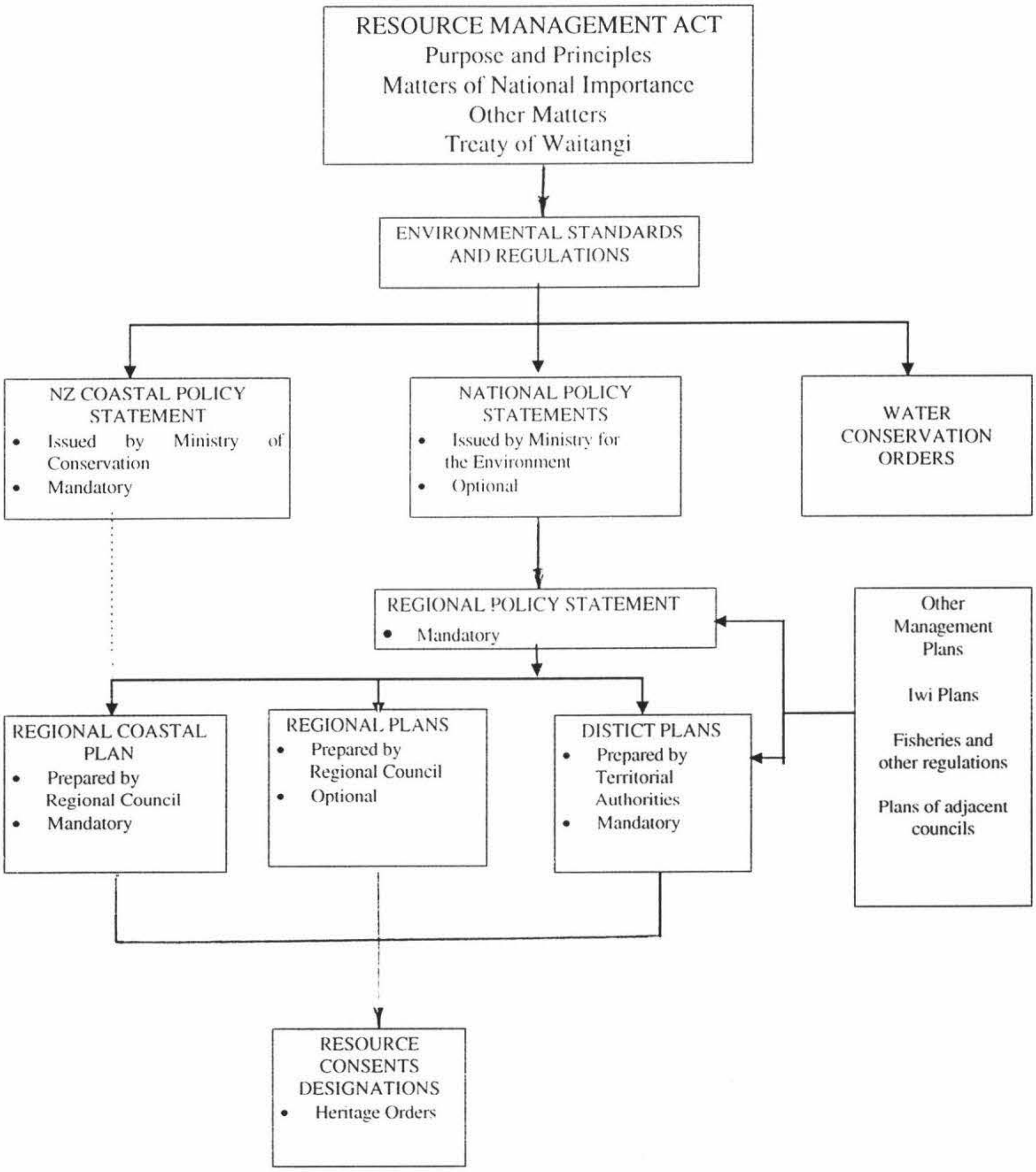
APPENDIX 1

A brief history of New Zealand social changes as they relate to water and soil (Source: Viner, 1987)



APPENDIX 2

Resource Management Framework
(Source: Manawatu-Wanganui Regional Council, May 1995)



APPENDIX 3

Historic Costs and Unpaid Capital and O&M Costs

(Source: NZ Treasury and Ministry of Agriculture and Fisheries, 1989 cited in Farley, 1994)

Scheme	Date of Scheme Approval	Date of First Approval	Number of Irrigators	Irrigated Area, ha	Historical Off-farm Capital Cost	O&M Costs 1987/88 [b]	Total 1987/88 Revenue	Unpaid Capital and O&M Costs at end of 87/88
					NZ$			
NORTH ISLAND								
1 Kerikeri	1980	1982	298	1,640	17,271,941	65,000	63,000	(3,050,000)
2 Puketotara	1982	1983	17	combined with Kerikeri	558,466	10,000	7,000	(271,000)
3 Kapiro Puriagaere	1984	1987	39	combined with Kerikeri	3,502,498	40,000	0	(1,125,000)
4 Glenbrook	1986	1987	20	28	546,837	32,000	21,300	(355,000)
5 Te Kauwhata	1984	1985	56	218	2,312,502	40,000	36,400	(1,302,000)
6 Pukerimu	1985	1986	29	90	2,312,502	40,000	63,000	(786,000)
7 Tebbuts Road	1984	1983	4	45	429,150	16,000	15,000	(211,000)
8 Tablelands	1981	1983	45	185	1,550,290	50,000	70,000	(318,000)
9 Waiaua	1984	1984	16	53	639,237	32,000	22,000	(357,000)
10 Maungatapere	1988	1990	na	150	Scheme sold before it was completed			
SOUTH ISLAND								
11 Waimea East	1981	1984	163	570	3,767,199	200,000	58,000	(1,647,000)
12 Waiau	1977	1976	80	8,000	12,441,507	159,500	138,000	(12,124,000)
13 Balmoral	1981	1985	25	1,840	7,704,061	57,000	0	(4,071,000)
14 Waiareka Downs	1975	1975	7	419	259,000	15,200	3,700	(319,000)
15 Glenmark	1979	1975	10	618	3,823,691	7,500	7,500	(433,000)
16 Loburn	1977	1983	52	285	526,538	11,000	11,000	197,000
17 Mayfield Hinds	1935	1949	142	20,000	2,805,389	375,100	486,000	128,000
18 Rangitata Diversion Race	1936	1945	na		4,160,000	288,000	Redistributed among all users	
19 Valetta	1957	1959	49	4,500	521,062	90,900	97,000	(97,000)
20 Ashburton Lyndhurst	1936	1945	222	18,000	1,791,799	427,100	454,500	(240,000)
21 Greenstreet	1971	1975	25	2,100	2,036,180	Scheme operated independently by irrigators		
22 Effelton	1983	1987	22	2,296	593,024	46,000	46,000	(173,000)
23 Levels Plain	1935	1936	103	2,650	786,774	80,000	70,000	(210,000)
24 Lower Waitaki	1970	1974	167	14,500	8,955,445	203,4000	115,000	(2,943,000)
25 Morven Glenavy	1969	1974	65	7,850	4,107,441	136,700	56,000	(1,048,000)
26 Redcliff	1933	1934	15	1,460	79,412	40,000	41,000	(2,940,000)
27 Maerewhenua	1975	1981	16	500	558,364	12,300	8,100	(499,000)
28 Upper Waitaki	1961	1965	21	1,419	523,409	85,100	108,620	(262,000)
29 Upper Waitaki Ext	1969	1970	11	456	121,406	Combined with Upper Waitaki		
30 Hawea	1963	1968	18	943	376,585	37,500	72,900	(430,000)
31 Tarras	1923	1925	12	723	354,572	82,500	58,300	(1,534,000)
32 Ardgour	1923/24	1923	8	495	86,913	44,000	30,100	(598,000)
33 Pisa Flats	1955	1956	17	1,019	199,287	52,500	53,500	(505,000)
34 Arrow River	1926	1930	50	700	317,079	110,000	62,700	(1,927,000)
35 Ripponvale	1955	1957	35	375	193,390	170,000	25,100	(685,000)
36 Manuherikia	1923	1922	158	1,950	691,360	200,000	132,200	(3,168,000)
37 Earnscleugh	1924	1922	88	908	358,060	76,500	55,700	(988,000)
38 Hawkdun	1926	1929	60	3,255	272,752	330,000	162,800	(3,651,000)
39 Idaburn	1931	1931	6	288	19,802	34,500	11,400	(158,000)
40 Omakau	1962	1936	67	5,803	701,677	259,000	270,300	(2,792,000)
41 Ida Valley	1912	1917	49	5,580	740,469	311,000	200,411	(4,273,000)
42 Galloway	1924	1920	28	447	Combined with Ida Valley			
43 Bannockburn	1957	1922	26	277	14,282	2,200	2,200	(1,000)
44 Maniototo	1975	1985	26	3,574	26,869,100	35,000	3,000	(99,000)
45 Last Chance	1923	1923	30	963	248,751	121,000	54,500	(1,529,000)
46 Teviot	1923	1924	49	1,386	212,620	146,500	100,900	(1,825,000)
47 Blackstone	1920	1920	6	300	na	na	na	na
48 Burn Cottage	1990	na	9	na	191,000	na	na	na
49 Luggate	1920	1920	2	na	Scheme operated independently by irrigators			
TOTAL			2463	118,198	117,129,757	4,572,000	3,294. 131	(58,852,000)

na Indicates data not available.

a At current exchange rates NZ$ 1= US$0.60

b Excludes refurbishment, other capital costs, and "non-recurring" maintenance costs. Also excludes MWD management and overhead coasts, estimated to be approximately $1-2 million per year.

APPENDIX 4

Names of Irrigation Companies For the Survey Questionnaires and Case Studies

(Source: Ministry of Agriculture Fax, 1997)

Irrigation Company Name	No of Irrigators
1. Lower Waitaki Irrigation Co Ltd	180
2. Hawoa Irrigation Co	30
3. Morven Glenavy Ikawai Irrigation Co Ltd	80
4. Maerewhenua District Water Resource Co Ltd	15
5. Upper Waitaki Community Irrigation Co	40
6. Waimea East Irrigation Co Ltd	160
7. Amuri Plains Irrigation Co Ltd	120
8. Eiffelton Community Group Irrigation Scheme Inc	25
9. Levels Plain Irrigation Co Ltd	120
10. Arrow River Irrigation Co	50
11. Bannockburn Irrigation Scheme	25
12. Lindis Irrigation Co	30
13. Pisa Irrigation Co	20
14. Ripponvale Irrigation Scheme Committee	35
15. Omakaru Area Irrigation Co Ltd	70
16. Hawkdun/Idaburn Irrigation Co Ltd	70
17. Ida Valley Irrigation Co Ltd	50
18. Galloway Irrigation Society Inc	30
19. Manuherikia Co-operative Society Ltd	160
20. Last Chance Irrigation Co Ltd	30
21. Earnscleugh Irrigation Co Ltd	90
22. Teviot River Irrigation Co Ltd	50
23. Maniototo Irrigation Co	30
24. Greenstreet Irrigation Management Ltd	25
25. Glenmark Irrigation Scheme	15
26. East Side Irrigation Co (Moniototo?)	30
27. Loburn Irrigation Co Ltd	50
28. Blackstone Irrigation Co Ltd	8
29. Burn Cottage Irrigation Scheme	15
30. Wolds Irrigation Scheme	5
31. Rangitata Diversion Race Management Committee	412

APPENDIX 5

MASSEY UNIVERSITY

INSTITUTE OF TECHNOLOGY AND ENGINEERING

PERFORMANCE OF IRRIGATION AND COMMUNITY WATER SUPPLY SYSTEMS AFTER TRANSFER

SURVEY QUESTIONNAIRE FOR IRRIGATION COMPANIES

Section A: Water Costs

1- Are farmers charged for water on the basis of (please tick the response as appropriate):

- $/ha ? /___/ , or
- $/m^3 ? /___/ , or
- other ? Please explain. ____

____

2. What was the price of water in 1982/83 irrigation season ? (Please make an estimate if you do not know the actual figure) $ ____________

   Is the figure an estimate? /___/ Yes /___/ No

3. What will be the price of water in 1998/99 irrigation season ? $ ____________
4. Do you use Life-Cycle Cost to calculate the price of water ? /___/ Yes /___/ No

   If No, please answer question 5.

5. How do you calculate the price of water ? ________________________________

____

____

____

____

____

____

____

6. How do farmers pay for the water (please tick the response as appropriate):
   (I) two or more installments ? /___/
   (ii) one payment ? /___/
   (iii) monthly invoice on basis of water used ? /___/
   (iv) other? Please explain. ______________________________
   ____
   ____
7. Approximately, what proportion of your water charges are paid on time ? _____ %
8. What happens to farmers who do not pay ? ______________________________
   ____
   ____
   ____
   ____
   ____

Section B: Operation and Maintenance

1. What is your budgeted expenditure on maintenance for this financial year?
   $ ____________
2. Maintenance costs are related to the length of the races to be maintained.
   What are:
   (i) total lengths of canals/races to be maintained ? ____________ km
   (ii) total areas irrigated ? ____________ ha
3. How do you determine the maintenance budget ? ______________________________
   ____
   ____
   ____
   ____
4. How is maintenance carried out ?
   (i) all maintenance work is contracted. /___/
   (ii) minor maintenance is carried out by staff and
   major work is contracted out /___/

(iii) minor maintenance is carried out by farmers and major work is contracted out /___/

(iv) other. Please explain. ______________________________________

____

____

____

____

5. Do you have an asset management plan ? /___/ Yes /___/ No

If Yes, who was involved with its preparation ? ______________________

____

____

____

____

6. How many people does your company employ ?

full-time = _______

3/4 time = _______

1/2 time = _______

1/4 time = _______

7. What is the total budget for staff salaries in this financial year ? $ ___________

8. Please list the staff training activities that your staff participated in during the last financial year ?

1 ______________________________________

2 ______________________________________

3 ______________________________________

4 ______________________________________

5 ______________________________________

Section C: Basic Data

1. Have you spent any money on irrigation related research ? /___/ Yes /___/ No

If Yes, approximately what sum ? $ ______________________________

2. Since privatization has the irrigated area increased ? /___/ Yes /___/ No

If Yes, could the increase be due to:

(i) increase water extracted from the water source ? /___/

(ii) increase in water use efficiency thus allowing more land to be irrigated within the same amount of water ? /___/

(iii) other. Please explain. ______________________________________

____

____

____

3. Approximately, what is the current price of farmland in your scheme for:

(i) irrigated land ? $/ha ____________

(ii) non-irrigated land ? $/ha ____________

4. What are the most important crops in your scheme (please list in descending order of importance) ?

1 ______________________

2 ______________________

3 ______________________

4 ______________________

5 ______________________

THANK YOU FOR YOUR HELP.

Chantheavy Khieu

Gavin L. Wall

APPENDIX 6

Summary data from survey questionnaires, Part I

Companies	Water Costs, $/ha	Fee Payment Rate, %	Total Length of Maintained Canals, km	OMR, km/ha	Maintenance Budget, $	PER, per/1000ha
I	20	99	240	0.015	250000.00	1.41
II	4.55	99	212	0.014	310000.00	1.35
III	-	99.9	24	0.05	10000.00	5.24
IV	55.3	66	75	0.035	70000.00	0
V	-	-	10	0.015	-	0
VI	-	-	258	0.01	72000.00	1.02
VII	-	-	320	0.01	72000.00	0.94
VIII	-	-	70	0.01	-	0.34
IX	35	75	60	0.387	50000.00	0
X	30	90	10	0.0165	12000.00	4.13
XI	-	100	12	0.014	-	0
XII	59.5	85	46	0.059	42000.00	12.87
XIII	28.5	98	17	0.0068	6300.00	2
XIV	45	95	15	0.06	28750.00	0
XV	16	100	45	0.01125	80000.00	0.25
XVI	6.5	98	15	0.0738	6300.00	0
Average	30.035	92.075	89.31	0.0492	77642.31	1.847
Minimum	4.55	66	10	0.0068	6300.00	0
Maximum	59.5	100	320	0.3870	310000.00	12.87

- no response

OMR Operation and Maintenance Ratio

PER Personnel Employment Ratio

APPENDIX 7

Summary Data from Survey Questionnaires, Part II

Summary of water rates in the 1998/99 irrigation season

Irrigation Companies	Water costs			Using LCC	Number of Payment for water costs	Paymet rate, %
	\$/ha	\$/m^3	Other			
I	20			Unaware of LCC	6	99
II	4.55			-	6	99
III		66		-	3	99.9
IV	55.3			-	3	66
V	-			-	2	-
VI	-			-	2	-
VII	-			-	2	-
VIII	-			Unaware of LCC	2	-
IX	35			Unaware of LCC	2	75
X	30			-	1	90
XI			fixed payment	-	1	100
XII	59.5			-	2	85
XIII	28.5			-	1	98
XIV	45			-	3	95
XV	16			Use LCC	2	100
XVI	6.5			-	-	98
Average	30.035	66	\$675			92.07
Minimum	4.55	66	per			66
Maximum	59.5	66	annum			100

- no response
LCC Life cycle costing

APPENDIX 8

Summary data from Survey Questionnaires, Part III
For operation and maintenance information in the 1998/99 irrigation season from the survey questionnaires for irrigation companies

Irriga-tion Co.	Mainte-nance budget expen-diture, $	Total length of maintained canals, Km	Total irrigated area, ha	How mainte-nance carried out	Asset mana-gement plan	Emplo yment status	Staff salaries, $	Training activities
I	250000	240	16000	a & b	✓	e(2)& h(1)	102000	-
II	310000	212	14800	a & b	x	e(2)	9500	-
III	10000	24	477	b	x	h(1)	10000	-
IV	70000	75	2125	a	x	-	-	-
V	-	10	650	c	-	-	-	-
VI	72000	258	24500	b	✓	e(2)& g(1)	-	health & safety/ forestry
VII	72000	320	32000	b	x	e(3)	-	-
VIII	-	70	7300	b	x	h(1)	-	-
IX	50000	60	1550	d	x	-	-	-
X	12000	10	604	b	✓	h(1)	1000	-
XI	-	12	850	a	x	-	-	-
XII	42000	46	777	b	✓	e(1)	32600	welding courses
XIII	6300	17	2500	c	x	h(2)	1200	-
XIV	28750	15	250	c	x	-	-	-
XV	80000	45	4000	a		-	-	-
XVI	6300	15	2100	-	-	-	-	-
Average	77642	89	2116				26050	
Minimum	6300	10	250				1000	
Maximum	310000	320	32000				102000	

- no response
a all maintenance work contracted
b minor maintenance works done by staff and major maintenance activities contracted
c minor maintenance works done by farmers and major maintenance activities contracted
d other
e full-time staff
f ¾ time staff
g ½ time staff
h ¼ staff
have asset management plan
x don't have asset management plan
( ) number of staff correspondent to e, f, g, h categories

APPENDIX 9

Key features of Government legislative and policy changes for irrigation schemes, 1910-1986 (Source: Martin, 1986)

Date Effective		03.12 1910	06.10.1928	24.10.1960	01.01.1975
Legislative		1910 Amendement to PW Act 1908	PW Act 1928	1960 Amendement to Public Works Act 1928	1975 Amendement to Public Works Act 1928
Policy Base		-	-	Cabinet Policy to fit new legislation	New Cabinet Policy on finding level
Govern ment Funding	Off-Farm	100% Grant	Ditto	Ditto	100% grant for headworks- 50% grant for distribution works
	On-Farm	Nil	Ditto	Ditto	33 and one-third percent grant for approved capital works by 10 year abated suspensory loan
Individual Farmer Charges		Quota charge and extra water charge	Ditto	Haft quota charge plus extra water charge. Purchase in for development period of up to 10 years	Basic charge or availability charge Phase-in for development period. Extra water charge for use beyond assigned water allocation
Charge Composition		To pay O, M&R plus interest on quarter capital	Ditto	To pay O, M&R plus interest on quarter capital plus repay development period debt without interest	Charge as per PW Act. Basic charge recovers with interest the capital share of all potential irrigators. Availability recovers with interest the capital share & also O, M&R
Poll		No	Ditto	60% minimum support of votes cast	60% minimum support of votes cast or such greater percentage as set and notified by the Minister
Liability to Charge		Voluntary farmer agreements for irrigable land (lands not under agreement could be taken by Crown)	Ditto	All irrigable land liable within defined irrigation district	All irrigable land liable for basic charge. Liability for availablity charge if water availability agreement is entered into in which case liability for the basic charge ceases

APPENDIX 9 (continued)

Key features of Government legislative and policy changes for irrigation schemes 1910-1986, (Martin, 1986)

Date Effective		01.02.1978	01.02.1982	01.11.1982	16.12.1983	09.11.1984
Legislative		1975 Amendement to PW Act 1928	1981 PW Act	Ditto	1983 Amendement to PW Act 1981	Ditto
Policy Base		Revised Cabinet policy on funding level. Effect backdated to 1.1.1975	Cabinet Policy to fit new legislation	New Cabinet policy on funding level	-	New Cabinet policy on funding level
Government Funding	Off-Farm	Ditto	Ditto	70% grant for all off-farm works	Ditto	35% grant for all off-farm works
	On-Farm	50% grant for approved capital works by 10 year abated suspensory loan	Ditto	Nil	Nil	Nil
Individual Farmer Charges		Ditto	Ditto	Ditto	Ditto but with provision for differential charges for different types of supply	Ditto
Charge Composition		from holders of water supply agreements. Both charges include. recovery of development period debt with interest	Ditto	Ditto	Ditto	Ditto
Poll		Ditto	Ditto	Ditto	Ditto	Ditto
Liability to Charge		Ditto	Ditto	Ditto	Ditto	Ditto

APPENDIX 10

Government share of irrigation scheme capital costs in percentage
(indicative years only)
(Source: Audit Office, 1987, Estimates of Expenditure, cited in Moore and Arthur-Worsop, 1989)

	1960/61	1973/74	1978/79	1984/85	1988/89
Headworks	100	100	100	35	0
Distribution Works	100	50	50	35	0
On-farm Works	0	33	50	0	0
On-going Capital and Maintenance Expenditure ($ million)	NA	6.7	5.5	20.9	12.9

NB: Subsidies ended in February 1988 except for schemes already in approval.

APPENDIX 11

Producer Price Indexes (PPI) in Agricultural Industry

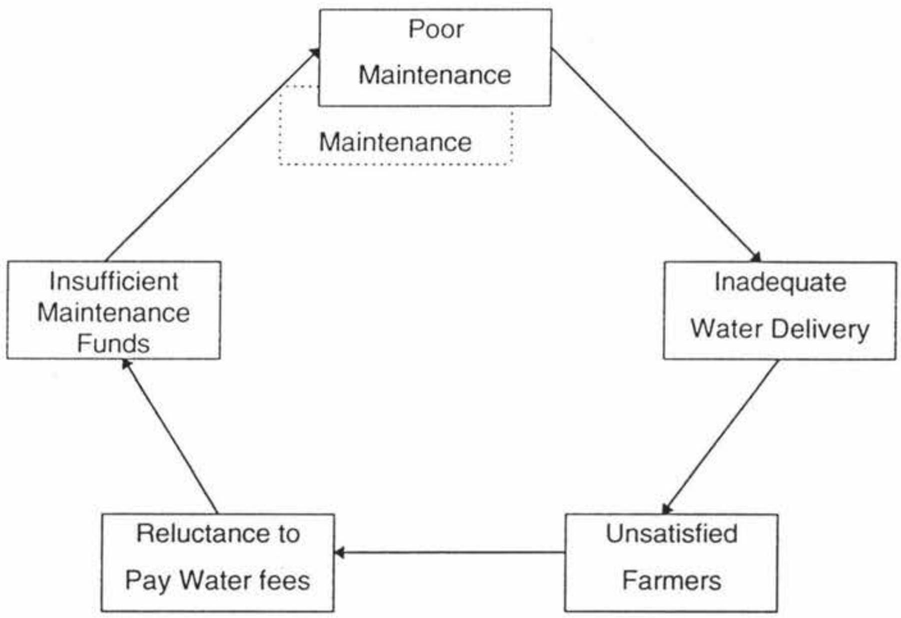
(Sources: New Zealand Official Yearbook, 1983 - 1998)

Years	Inputs	Outputs	Sheep & Beef Farming	Dairy Farming	Horticulture Farming	Cropping & Other Farming	All Farming	Agricultural Contra-ting
1982	1000	1000	1000	1000	1000	1000	1000	1000
1983	1033	1097						
1984	1159	1310	1184	1121	1148	1121	1160	1124
1985	1297	1229	1331	1248	1278	1282	1299	1252
1986	1251	1230	1248	1230	1313	1321	1250	1292
1987	1324	1308	1330	1289	1398	1382	1322	1494
1988	1372	1408	1358	1383	1453	1429	1370	1428
1989	1513	1670	1487	1589	1557	1507	1513	1484
1990	1611	1437	1626	1604	1571	1621	1610	1571
1991	1596	1408	1611	1587	1570	1627	1479	1596
1992	1682	1595	1699	1706	1670	1554	1685	1595
1993	1746	1632	1783	1764	1665	1651	1751	1609
1994	1751	1658	1796	1771	1671	1624	1755	1610
1995	1711	1567	1714	1768	1668	1628	1713	1611
1996	1713	1572	1711	1728	1648	1714	1713	1665
1997	1755	1570	1788	1725	1675	1747	1758	1663

APPENDIX 12

The Vicious Cycle of Deteriorating Maintenance

(Source: Sagardoy, 1996)



APPENDIX 13

Hectares by farm type 1985 and 1995

(Source: Agriculture Statistics, 1994 -1995)

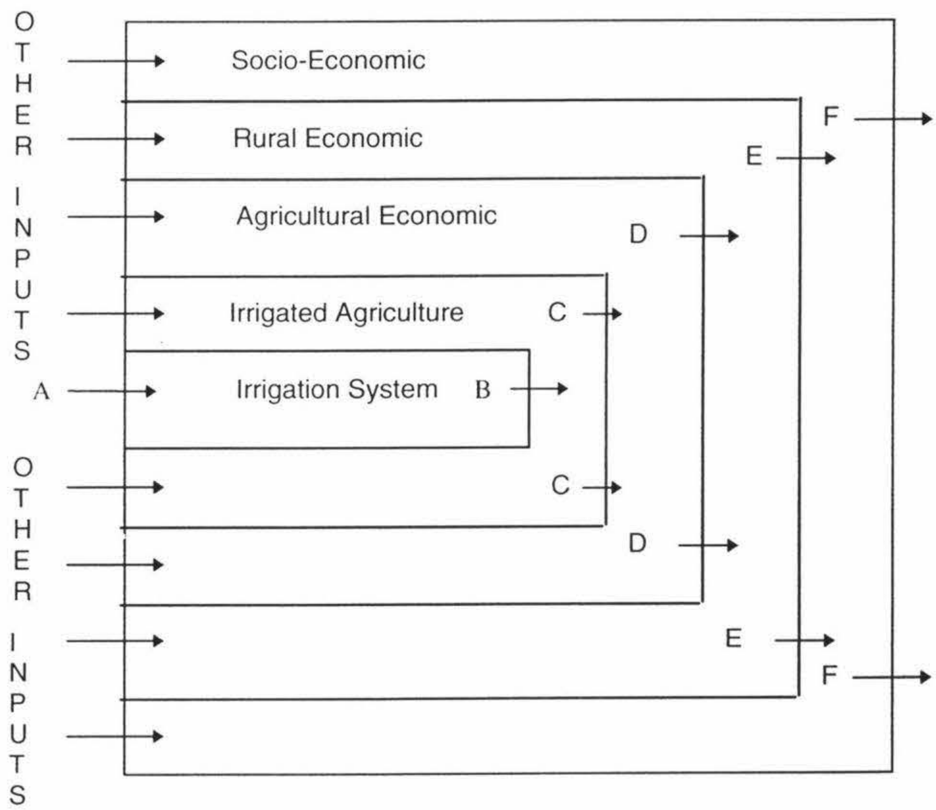
Farm type	1985	1995	Percentage change
Dairy	*1,378,607*	*1,864,302*	*35*
Sheep	11,324,763	8,277,926	-27
Beef	*1,577,888*	*1,958,725*	*24*
Horticulture	*119,474*	*255,502*	*114*
Other	3,684,459	2,138,716	-42
Plantations	3,291,628	2,082,771	-37
Total All Farm Types	**21,376,819**	**16,577,942**	**-22**

APPENDIX 14

Irrigation Purposes as Inputs and Outputs of Nested Systems
(Source: Small and Svedsen, 1990)

Inputs/Outputs

A - Operation of Irrigation Facilities
B - Supply Water to Crops
C - Agricultural Production
D - Incomes of Rural Sectors
E - Rural Economic Development
F - Socio-Economic Development



APPENDIX 15

Number of Farms by 4-digit NZSIC for Timaru District, 1995
(Source: Statistics New Zealand, cited in Economic profile, 1997)

Farm Type	Number of Farms	Percentage
Dairy farming	80	7.1
Sheep farming	406	36.1
Beef Farming	100	8.9
Mixed and other livestock farming	220	19.6
Horticulture	103	9.1
Cropping	95	8.4
Fruit growing	31	2.8
Farming n.e.c.	46	4.1
Plantations	44	3.9
TOTAL	**1.125**	**100.0**

APPENDIX 16

Land sales in North Otago from 1982 to 1990, $/ha
(Source: Burborough, 1992)

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990
Farm	493	561	538	770	780	524	524	865	1,008
Arable land	3,880	4,028	3,379	-	-	1,030	1,030	1,301	1,205
Dairying	-	3,823	-	-	3440	-	-	4,211	5,462
Fattening (A - F)	1160	2,070	451	755	596	452	452	1,018	1,281
Grazing properties	67	-	-	-	-	-	-	-	-
Specialised livestock (including deer)	110,500	114,000	155,728	-	68,800	4,245	4,245	36,476	-
Horticultural land	7,187	60,610	17,053	6,181	11,595	4,918	4,918	43,846	43,500

APPENDIX 17

Main agencies of Government involved in community irrigation before transfer

(Source: Martin, 1985)

Agencies	Role
Ministry of Works and Development	Engineering investigation, design and construction. Scheme operation and maintenance. Administration of the Public Works Act
Ministry of Agriculture and Fisheries	Agricultural and Horticultural research and advisory functions to government and farmers.
Department of Scientific and Industrial Research	Plant and soils research
Commission for the Environment	Environmental Impact Reporting
Rural Banking and Finance	Farmer Loan facilities
Treasury	Government Fiscal Advisors
National Water and Soil Conservation Authority	Government advisory on water and soil resource use and irrigation policies. Agency for distribution of Government funds for irrigation schemes

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