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WELCOME AND CONFERENCE OPENING

Ladies and Gentlemen, friends, colleagues, and guests. Three years ago, having arrived in New Zealand only a few months earlier, I was introduced to this Society at its first annual conference as the New Zealand Agricultural Economics Society. Little did I suspect, at that time, that it would be my duty and my privilege, just a few short years later, to open this same conference. It gives me great pleasure to welcome you all to the 4th Annual Conference of the New Zealand Agricultural and Resource Economics Society, and the 22nd Annual Conference of the New Zealand branch of the Australian Agricultural and Resource Economics Society.

In last year's conference, we took the opportunity to reflect on the future as we approach the 21st century. Naturally, a strong component of any such reflection is the change we expect to be faced with in that future. This year, we turn our attention to the nature of 'change' itself and how we manage that change in a dynamic environment. Note my use of the word "manage". That's important, because we really have three choices when faced with change: we can ignore it and let the future pass us by, we can react to it and scramble to keep up, or we can manage it and take advantage of the opportunities it presents. I would like to think that members of this society would choose the last wherever possible. With that in mind, our focus this year is on the tools and policies we use to manage change.

Over the next two days, these issues, and many more, will be addressed. We are fortunate to have with us a talented group of invited speakers to add to the expertise of our members. In this morning's Plenary Session, we will examine change in land use and rural communities. Tomorrow, we will examine change in international markets and the environment. I am also pleased to report that we have a full slate of submissions in our contributed papers program for the third year in a row.

Now, I would like to invite you all to listen, to learn, to contribute and to enjoy during the next two days. I am pleased to declare this conference open.

Dr Robert R Alexander
1997 President
New Zealand Agricultural and Resource Economics Society

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New Zealand Agricultural and Resource Economics Society

1997 President's Report to the AGM

This year may well be characterised by the old cliché, "the calm before the storm" as we attempted to lay the foundation for some major upcoming events. Last year, the AGM gave us the option of finding a new site for this conference. It soon became obvious that such a change is more than a one-year undertaking given the long lead times required to book sufficient facilities. So, members of the executive committee have laid the groundwork for helping the incoming committee to make such a change if they so choose.

In fact, it may well be time to make such a move as we have completely filled our paper schedule for the third year on a row. It's time that we considered either how to expand our contributed paper sessions or how to select amongst a growing number of papers for limited sessions. I hope that with the direction provided by this AGM, the incoming committee will have the information they need to take whatever action is needed.

The other major event on the horizon is our hosting of the 1999 AARES conference. Traditionally, the society president during the year we host the AARES conference is chair of the local organising committee. That would be this year's president-elect. Luckily, much of the information collected for our own possible change in venue will also be useful to the new LOC and they will need to move somewhat quickly in planning that conference.

The 1996/97 AARES undergraduate student award was presented to **Sam Richardson** of the Massey University Department of Agricultural Economics and Business. This award was announced at the AARES conference in January on the Gold Coast. The three winners of the NZARES Postgraduate Award are **Sue Cassells** of the Massey University Department of Applied and International Economics, **Svetlana Bohorova** of the Waikato University Department of Economics, and **Ross Lambie** of the Lincoln University Department of Economics and Marketing. On behalf of the Society, I would like to extend my congratulations to all four of these exceptional students for their academic achievements.

I represented the NZARES at the AARES Council meetings held before and after the conference on the Gold Coast in January. As many of you already know, the two journals of the Society, the AJAE and the RMAE, have now been combined into a single Australian Journal of Agricultural and Resource Economics. By now all AARES members should have received their renewals from Blackwell Publishers. There have been some kinks in the new systems, but they should be worked out soon. One of the editors of the new journal has asked me to relay to you that they feel New Zealand members are under-represented in the journal as are papers on resource economics. They are particularly interested in receiving papers from New Zealand members.

The 1998 AARES conference will be held in Armidale next January. Following the success of the 1997 conference, the Society has suggested that LOCs consider choosing resort venues for future conferences. Since the Armidale venue was already selected, this suggestion would seem first to be directed toward the 1999 meetings in New Zealand.

Finally, I would like to extend my thanks to the outgoing committee members, Shamim Shakur (Treasurer), Ganesh Rauniyar (Secretary), Phil Journeaux (President-elect), Irene Parminter, Katie Bicknell, and Anton Meister. I would like to extend my best wishes to Phil and his new committee for a successful upcoming year.

Dr Robert R. Alexander
President

INVITED PAPERS

Impacts of Recent Economic Reforms on Rural Communities

Keynote paper: New Zealand Agricultural and Resource Economics Society Conference
July 4-5, 1997 Blenheim
Dr Ann Pomeroy, Manager, Rural Affairs and Social Science Policy
Ministry of Agriculture, PO Box 2526, Wellington

Outline

Introduction

Rural communities have changed considerably since the economic reform process began following the change of Government in 1984. However, the real social and economic situation of farmers and rural communities has become clouded by modern folklore. Rural communities are perpetually changing. This paper will attempt to de-myth the perceptions, and answer such questions as:

- what changes have occurred in rural communities since the reforms?
- what changes are due to the reforms?
- what changes are due to other identifiable factors?
- how have those changes affected rural communities?
- what particular factors contribute to the on-going success of rural communities?

The impact of economic reform on rural communities will be discussed in the context of these questions and in the process agriculture will be decoupled from other economic activities which are taking place in rural New Zealand. I will start by looking at the context in which economic reform took place and in doing this will recognise the importance of other global and societal trends in changing the face of rural New Zealand. I will then make some observations about the processes which lead to socially and economically robust communities.

The context - New Zealand's rural communities in the 1970s

Before looking at the impacts of the recent economic reforms on rural communities it is necessary to cast our minds back to how New Zealand's rural communities were seen in the era before reform. At that time rural communities tended to be seen as synonymous with the agricultural sector. People not directly involved with production either provided services to those who were, or to businesses and people involved in processing or transporting agricultural products. Other industries did not have the financial or political clout of the farm sector. Farmers regarded themselves as the backbone of the country and particularly sheep farmers had high social status.

In the 1970s, four broad inter-related themes dominated the literature and debate on farming and the rural sector (CAPS, 1982). The themes were:

- agricultural production (how to increase it and diversify land-based exports);

- farm income (the concern of particularly traditional pastoral farmers with rapidly rising costs, changes in the use, value and ownership of land, and the change in the balance of power between farmers, the Government and the rest of society);
- rural depopulation (a concern of many people in the more isolated rural communities with a continuing loss of population and decline in social and commercial services);
- regional and district planning issues.

Rural population loss was seen as critical because people were needed to attract and maintain social services in rural areas. Without such services available locally it was thought that living in rural areas would be more expensive and less attractive and "agricultural production may not reach its technological potential and may well decline... The recent surge in production .. may represent a short-term response to economic incentives which is not sustainable under longer-term economic and social constraints" (CAPS, 1982: 3).

As table 1 shows, this concern over population loss was quite real. The rural population as a whole declined between 1956 and 1971. Yet the Planning Council Task Force noted there was

Table 1: Rural Population Trends (1981 boundaries)

Year	Number living in rural areas	% of Total Population
1926	449,527	32
1936	503,884	32
1945	472,076	18
1956	543,727	25
1966	526,507	20
1971	496,171	17
1976	511,004	16
1981	520,487	16
1986	535,107	16

(Census night population)

considerable diversity between and within rural areas. In some places the rural population was growing. This was seen to be due to the growth of part-time farming near cities (lifestyle blocks), the growth of retirement populations "in areas with a favoured climate", and government activities such as forestry development, hydro-electric dam construction, tourism, and the building of railways and public works depots (CAPS, 1982:12-13). Local rural population growth was seen by analysts in the early eighties as localised, and unlikely to last, as the developments it was based on tended to have a limited life-span. For population growth to last analysis has shown it needs to be based on a solid foundation of local resources developed to meet market needs (Pomeroy, 1996).

Because of the agricultural focus of commentators, the growth in the non-full time farm population in many rural communities has been ignored, and there has been a continuation of

uncritical discussion about "rural depopulation". While it was acknowledged that rural communities were composed of more than agriculture ("the complexity and diversity of the rural sector should be more widely recognised" CAPS, 1982:4), other industries, and the potential of local resources and amenities, tended to be ignored prior to the eighties. Diversity was diversification into deer, horticulture or forestry.

People interviewed by the Task Force for their opinions on the changes which had taken place in the rural sector and rural communities (particularly depopulation and decline in services) were farmers, farm advisory officers and local body executive staff or local elected representatives. The problems they saw facing rural communities were (CAPS, 1982):

- rising land prices (had improved the asset wealth of established producers, but reduced the income of new entrants);
- it was unlikely that growth in production could be sustained;
- the cost/price squeeze was affecting the profitability of all parts of the rural sector, and costs were rising faster than prices;
- incentives such as the Supplementary Minimum Prices (which went well beyond market prices) did not necessarily solve famers' income problems, and had became capitalised into land values
- an increasing concern over government interference in price (and wage) setting, and its stranglehold of control over the economy.

The cost/price squeeze was also seen to be affecting the provision of retail and other services. Commercial and some public service providers sought economies by centralising operations and moving some of the costs of transport on to their customers (CAPS, 1982: 3). While the arrival of new people to rural areas reduced the pressure for centralising services, these people frequently carried a range of different values and were not seen as fitting in with the traditional farm community. They were literally ignored in farmers' perception of the rural community.

Thus the Task Force concluded that "a healthy rural sector is ... impossible if the agricultural production on which it is based is depressed". This perception that agricultural production was the key driver of rural economic growth and social well-being, was the general attitude of most New Zealanders at that time. This remains the attitude of many farmers today - but other New Zealanders no longer (rightly or wrongly) have the same reverence for agriculture they once had.

Yet there were seen to be important exceptions to this perspective. An example was given by the Task Force of Tokonui in Southland, where it was specifically acknowledged that it was not changes in the productive base of the area which had caused major population loss, but "spatial economics".

> *First, the local carrier had been taken over by a larger firm and the carrying business became centralised. The same service was available but from a depot in the nearest town. Then the stock and station agency had been centralised, and another two or three families had left. Subsequently most of the other services - banks, police, stores - had left the immediate locality. Improvements in transport technology had made all the moves possible, and basic economics had decided that they should take place.* (CAPS, 1982: 55-56)

Even before the economic reforms, the requirement to maximise profits to remain in business meant business location was shifted if this allowed business owners to reduce overheads or to capitalise on new opportunities (I will return to this theme below).

Against this background, what did the post-1984 economic reforms achieve?

Key reforms - and their impact

From being, in the early eighties, one of the most regulated economies in the OECD, New Zealand is now one of the least regulated. The reforms improved the way the price and incentive system operates in individual markets through more efficient allocation of resources. In particular, international trade was liberalised and markets deregulated, the taxation system was fundamentally transfigured, the delivery of income support, health and education was significantly changed, the efficiency of core government departments was extensively improved, and many government trading activities were corporatised and privatised (Brash, 1996: 24; Fairweather, 1989: 1).

The reforms rectified distortions in the economy, especially costly service inefficiencies. Waterfront reform and transport deregulation (particularly removal of the government owned railway and domestic air services monopoly) improved returns to farmers (see for example, Pomeroy, 1990). The lifting of controls on prices, wages, credit, dividends, foreign exchange and out-bound overseas investment freed up the environment in which farmers make business choices. They brought New Zealand's economy back on track by reducing debt. They allowed the relative profitability of alternative farm enterprises to reflect returns received in world markets, and opened the way to realising opportunities for social and economic growth based on local resources.

At the same time, the removal of supplementary minimum prices led in the short term, to reduced farm incomes, falling land values, a decline in farm profitability, and an increase in farm debt (Fairweather, 1989: 3). These trends were compounded by low international prices for most commodities during the mid-to-late eighties and increasing interest rates (OECD, 1997). The domestic recession which followed was felt throughout the rural community leaving several commentators to suggest that economic restructuring provided no benefits up to 1991 (Sandrey and Reynolds, 1990: 311; Martin, 1995:3).

The outcome of these trends was the loss (between the 1986 and 1991 censuses) of 9,700 male sheep farmers and 2,800 female sheep farmers (full and part-time labour-force 15 years or more living in rural or minor-urban areas). There were also loses of male and female farmers from dairying, beef and fruit growing during this time - but they were largely offset by the increase in the numbers of farmers involved in mixed and 'other' farming. During the same period 2,000 rural men left the building and construction industry, 2,800 left other primary industries, and 2,600 rural men left manufacturing.

Some of these losses were made up by the increase in the numbers of rural men engaged in the retail trade, real estate and business services, but overall there was a 10% loss of males from the rural labour force (a decline which is, however, in line with the decline in the total male workforce). Also, while the numbers of rural women involved in farming and manufacturing

declined, this loss was more than offset by the increased involvement of women in the service sector. Overall there was a 31% increase in the rural female workforce in the decade 1981 to 1991 (also in line with the increase in the size of the total female labourforce).

Table 2 shows the change in the type of industry in which rural people were employed between 1981 and 1991. The 5% drop in the proportion of rural people involved in the agriculture sector over the decade was taken up by the movement of people into the service sectors.

Table 2: Proportion of Rural Workforce 15+ yrs in Main Industry Groups

	1981	1991
Agriculture	47%	42%
Other Primary Industry	3%	2%
Manufacturing	11%	11%
Utilities, Trspt, Communic, Bldg, Property, Finance	13%	13%
Retail, restaurants and Accommodation	9%	12%
Community, social and Personal services	16%	18%
Not Adequately Defined	1%	2%
TOTAL NUMBER	223,930	232,220

(Source: Census of Population MAF customised tables)

Unemployment rose - from 6.8% in 1986 to 10.5% in 1991. However, its impact was not spread evenly across the community. Rural centres and minor urban areas took the brunt of job losses (table 3).

Table 3: Proportion of workforce unemployed and actively seeking work by location (1991)

Location	Male (%)	Female (%)
Main urban	10.6	10.9
Secondary urban	10.0	11.8
Minor urban	11.5	12.3
Rural centre	11.1	11.7
Countryside	7.6	8.2

(Source: Census of Population - Regional Summary)

Unfortunately, 1996 population census figures on industry employment and unemployment are not yet available. However, agricultural census data (table 4) shows that since 1992 farm employment at least has increased as the agriculture sector has restructured.

It is important to keep in mind the differences between the two census data sets (tables 2 and 4). The population census identifies industry affiliation by the main source of income - and here only those living in rural areas are under consideration. The agricultural census on the other hand provides information on the basis of farms - so includes people living in urban areas who are

Table 4: Farm Labour [June year]

Year	Working Owners, leaseholders & sharemilkers	Paid Perm Full-time Employees	Paid Permanent Part-time Employees	Casual	Total
1991	86389	23310	6353	19325	135377
1992	84515	20459	5417	11106	121497
1993	81535	26276	6749	20089	134649
1994	83596	25548	6685	21771	137600
1995	87663	26459	7301	25544	146967

(Source MAF, SONZA: 1996 - from the Census of Agriculture)

owner/operators or farm workers and may be counting people who (own and) work on several farms, more than once. Nevertheless, the farm data shows a recovery in farm employment. In line with the increase in rural population (see below), and the growth in rural tourism and teleworking, 1996 data may also show an increase in the numbers of rural people involved in the service sector.

Although total stock units have fallen, there has been substitution of sheep by beef, dairy, deer and forestry. Recent research has showed that farm families are also receiving income from off-farm income sources (Rhodes and Journeaux, 1995; Taylor and Little, 1995) and from non-agricultural on-farm businesses (Taylor *et al*, 1997). A survey of 619 farms showed that in 1992/93 73% of farms reported some source of off-farm income - ranging from around $19,000 for dairy and sheep and beef farms, to around $35,000 for kiwifruit properties. While lack of farm income can motivate off-farm work - it does not necessarily do so. Fairweather's (1995) research shows that farming has increasingly become just one of a number of economic activities undertaken by farm people.

Farming operators who were in a weak financial position were displaced. Some of these operations have been taken over by new operators, while others have been absorbed into existing farm operations (a trend which also received considerable attention in the seventies). Farmers who remain now have less debt exposure (i.e. improved equity), and pay less to service debt (as interest rates have declined).

Several analyses have been undertaken about people who left, or were forced out of, farming (Christie, 1990; Smith, 1994). Of interest is the finding that those who left farming (as a consequence of loss of income and so on after the removal of subsidies), predominantly improved their position:

> *All notice the reduced levels of stress, including those still struggling with ongoing financial insecurity. Lifestyle has changed, and usually for the better. Standards of living are much more likely to have increased once re-established...Most would choose not to return to farming if given the option..*
>
> (Christie, 1990: 77)

According to the OECD New Zealand's economy has picked up since 1991, farm incomes have recovered (see appendix 1) and fears of a rural collapse have not materialised.

> *The rural population and farm households have proved remarkably resourceful in adapting to the dramatic changes that have swept the sector. Despite the hardships, very few farmers were forced to leave the land. The rural economy and the agricultural sector as a whole have become more efficient and competitive.* (*OECD, 1997: 3*)

A snapshot view of male farmers' incomes in 1991 compared to those of other self-employed males living in rural areas, shows that the incomes of male farmers parallels the incomes of all self-employed men (figure 1).

Global and societal trends

The shape of rural communities has been transformed not only by the reforms - but by economic pressures which led to Government intervention in the first place. The impact of international market trends, particularly the loss of favoured trading status with the UK, and the oil shocks/energy crisis of the seventies have been well documented (see for example, Sandrey and Reynolds, 1990). Less well understood, but equally influential in their impact on rural communities, have been the radical macro-social changes which have occurred in New Zealand society, particularly in the last 25 years. Many of the trends apparent in the post-reform era are a continuation of long-term patterns and are a reflection of the global capitalist economy (eg, labour market transformation and population trends).

The impact of macro-social and demographic change, especially that which occurred in the eighties, has been largely under-estimated. The changes which have occurred in New Zealand parallel and have often been propelled by changes occurring overseas on a global basis (Pool and Bedford, 1996). For example, since 1975 there have been changes in:

- fertility and family formation;
- household composition;
- dependency burdens;
- international migration flows (including emigration by Maori to Australia);
- internal migration;
- labour force transformation (including casualisation of work); and,
- the education, employment and income status of women.

While most people are familiar with the international post-war baby-boom, few people are aware that the New Zealand "boom" was longer, more intense and with higher fertility levels than elsewhere. From a pre-war low, there was increase in the non-Maori total fertility rate to a peak in 1960. The numbers of babies born in any one year peaked around 1961 and again around 1971 and there was a smaller peak around 1991 (Pool and Bedford, 1996). These peaks are to do with changes in the timing and spacing of births (which are influenced by attitudes and values, which in turn are influenced by education, economic pressures and access to effective contraception), and the size of the population producing children. Total fertility rates have continued to decline since 1960, leading to a reduction in completed family size.

Rural communities have felt the impacts of these patterns. In those communities where large numbers of "rehab farmers" were settled in the late forties and fifties, trends were accentuated

as families followed the same life-cycle pattern simultaneously. This in turn placed pressure on services for short periods of time (like maternity services and schools). Because New Zealand does not have a history of evaluating social trends as an integral part of policy analysis and planning, the on-going local impacts of these population trends have not been monitored. For example, the current pressures for meeting the urban and rural schooling needs resulting from the 1991 baby-blip has apparently taken officials by surprise (Newell, *pers comm*).

Rural areas with a high proportion of Maori like the East Cape and Northland have a much younger age structure than the general population, and rural Northland in particular has continued to grow each census.

Another trend is longevity of life which, reflecting the national situation, has increased the numbers of fit and healthy elderly people (70+ yrs) living in rural areas, especially in rural centres. A shift in attitudes means that older women are continuing to run the farm or business after the death of their partner, so are remaining in rural areas. Some rural communities have capitalised on the economic potential from this population shift by establishing retirement centres and providing services for the elderly (eg Aparangi in Te Kauwhata which contributes 150 extra potential patients to the Te Kauwhata health centre which previously "had difficulty providing an economic practice for a doctor" *Straight Furrow* 26/6/97). Other rural areas are less well favoured and older people in those communities have considerable difficulty accessing services (see for example, Joseph and Chalmers, 1995)

As a general rule rural (and minor urban) areas experience high levels of out-migration of young people (aged 10-24). This pattern reverses with rural areas experiencing in-migration of people 30-44 years. Minor urban areas and rural centres experience in-migration of older people (aged 55 plus). While these patterns (particularly those related to middle-aged people) are not experienced uniformly by all regions (Press and Newell, 1994), the economic reforms have not altered these general trends appreciably.

Labour force changes include the shift of males from the primary sector to services (noted above), and the increased participation by females in the paid-work force. As Pool and Bedford (1996: 32) note "there was always under-enumeration of women in the remunerated labour-force, above all failure to count their contribution to family workforces and thus household income, particularly family-operated businesses and farms". The organisation of work has changed, there are changes in the skills required of workers, and part-time work and casualisation have increased. Stresses associated with the dual-earner or dual-career family have been documented for both urban and rural families (Le Heron and Pawson, 1996:101-103; Taylor and Little, 1995), but rural families lack the infrastructural and support services available in urban areas (such as childcare and long shopping hours).

While the Centre for Population Studies has analysed macro-social changes since the 1840s, there has been little analysis of how these changes are affecting rural communities. Thus the historical continuity of rural social change remains largely unacknowledged (with the exception of some ad hoc analyses such as that by Press and Newell, 1994).

Other global trends have also made a major impression on rural communities. These include:

- improved communication technologies;
- improved transportation and roading;
- an increased interest in managing the environment;
- the explosion in tourist travel - and the commodification of culture and environment to promote the tourism industry; and,
- changes in people's attitudes and approaches to life (new values and norms) - such as an interest in improving people's sense of well-being.

How rural communities have changed

The economic reforms have accentuated the impacts of global and macro-social change in rural communities. For example, the impact of improved transportation and roading in shifting services from rural areas to larger urban communities was identified in the late seventies as an issue (see for example Cant, 1980), and this trend has and will continue. At the same time, new business has developed in rural areas taking advantage of, among other things, increased numbers of rural tourists and improved roading and communications (see for example, Taylor and Little, 1995; Taylor, *et al*, 1997 and Fairburn, 1994). The net outcome has been an overall increase in rural population numbers (as table 5 shows), and rural New Zealand has maintained its share of total population.

Table 5: Population Usually Resident in Rural NZ (1996 boundaries)

	No.	% of total NZ Population
1986	483,905	15%
1991	490,567	15%
1996	527,893	15%

When the country is divided into rural area units and small centres, it is clear that more of these rural places are gaining people, than are losing people. Table 6 shows the growth pattern experienced by the 299 rural area units (open countryside outside settlements of 300 or more people), 133 rural centres (settlements 300 to 1,000 people), and 99 minor urban areas (settlements 1,000 to 10,000 people) between recent census periods.

Table 6: Proportion of rural places which gained population

Census period	Rural Area Units	Rural Centres	Minor Urban Areas
1981-1986	64%	66%	56%
1986-1991	50%	56%	56%
1991-1996	67%	62%	56%

Many of the regions (and areas within regions) which declined between 1986 and 1991, grew between 1991 and 1996. As has been the case across rural New Zealand in the past, the reasons why some regions grow and other do not vary. However, local and international research points to one common variable with respect to the on-going viability of rural communities - growth relates to predominantly local utilisation of the local resource base (Pomeroy, 1996).

Some examples

Changes in agriculture, forestry and mining in rural Southland, and associated economic, technological and employment shifts, has resulted in population loss in the region at least since 1976, and possibly before. The changes are complex. While there has been a decline in the numbers of people involved in sheep production since the mid-eighties, there has been an increase in the numbers, both on- and off-farm, involved in dairy production in Southland. The change in land use to dairying has brought new dairy farm families into the area from the North Island. This has seen a small increase in population in the area. This increase has not been experienced widely in the region and has not been sufficient to offset losses from other trends.

A similar trend has been recounted for Taupo District (Journeaux, 1997). However, here the influx of dairy families in a particular location boosted local primary school numbers to the extent that a new (third) classroom needed to be added to the school (*Te Awamutu Courier* 15/5/97).

The nationwide interest in environmental issues has seen a general ban on cutting indigenous timbers, and the placing of forest land into the conservation estate. This has had a major effect on the town of Tuatapere in Southland where half of all employment in the town had directly served the forestry industry in logging, milling, and timber processing. Tuatapere's population dropped from 873 in 1986, to 739 in 1996. Local enterprises which have been developed since the change in the employment opportunities available in this town include a craft industry and tourism (reflected in new outlets for crafts, backpacker accommodation and an information centre). These new developments have meant that the population loss is not as high as it would otherwise have been (Houghton, *et al* 1997).

The fortunes of businesses in two towns of similar size - Kaikohe and Carterton - were tracked during the eighties and again in the nineties (Le Heron and Pawson, 1996). Both are towns of around 4,000 people which grew between 1986 and 1991, then declined between 1991 and 1996 - but in 1996 they are still larger than they were in 1986.

* Kaikohe's role as rural service centre is being challenged by two towns of similar size (Kerikeri and Kaitaia which are both growing). The town features local retail, finance, business and personal services and hospitality businesses. The businesses were tracked between 1987 and 1994. While some firms ceased operations, others started up (and many changed ownership). Forty per cent of the current businesses had started since 1987. Around 75% were owned locally, other owners resided in the region (some were franchises or belonged to a marketing group) 7% were owned by external firms. While some owners wished to sell there was apparently a ready supply of people prepared to buy the business.

* Carterton's twenty small to medium-sized manufacturing businesses were studied in 1982 when its local economy was buoyant, and again in 1994. By then only 12 of the factories were in operation, and all surviving firms had changed their product in some way. Job losses occurred in the town because of the loss of several large employers (some due to consolidating operations in other locations). Clothing and food processing closed down, two footwear factories and an electrical plant withdrew. However, eight new factories opened up. These were much smaller firms and included joinery, processed fish products, disability aids, jewellery, leather goods, bacon, and agricultural machinery.

Other areas have been less affected by changes within the agriculture industry *per se*, but have benefited from the reforms. For example, the service community of Methven in Canterbury supported five major stock and station firms at the height of its prosperity in the sixties. Over time the district lost people, partly due to new technology which allowed fewer people to manage larger farms, and partly due to declining returns from sheep meat, wool and arable crops. The ski resort at nearby Mt Hutt was opened in 1973 and while Methven provided some accommodation and services for tourists, it has been the more recent improvements in communication and transportation in the post reform era that has made the difference to the operation of farms and other businesses in Methven and its surrounding district.

Fifteen years ago the district depended solely on Methven for services. Improvements in the telephone system, reduction in calling charges, and improvements in roading (from a gravel to a sealed road) have brought Methven into close proximity to two service centres (the city of Christchurch is now 1.5 hours away and the town of Ashburton is now 20 minutes away). High-tech local business and farms can now easily obtain speciality services from Christchurch. This has strengthened the business environment of the district. The improved communication links have enabled Methven to capitalise on its close proximity to the Mount Hutt ski resort and businesses servicing the ski and tourism industries have proliferated. As a consequence the town is now growing (from 922 people in 1986 to 1,073 in 1996). Its function is now as much a local service centre to the tourism sector as it is to the sheep industry.

The Marlborough district has also grown, from 7,024 people in 1986 to 8,781 in 1996 as a consequence of a number of initiatives, particularly the viticulture industry, and the tourism sector which is developing as an offshoot of it.

On the positive side, the reforms have meant that individual farmers and other rural business people have been able to take greater control of their businesses and their lives and plan for their future. This has brought a new sense of confidence into rural New Zealand. Farmers and local business people are now making use of opportunities for diversifying their businesses. There are many examples of farmers who are using their farms as a base for other business activities, including light manufacturing (especially of farm equipment and food products), artworks, fashion garments, and various tourism undertakings (Taylor *et al,* 1997, Little and Taylor, 1997). Local communities are equally developing new sources of business income. By allowing farmers and other rural business people to be in control of their own futures, the reforms have unleashed innovative ideas which have resulted in new enterprises and generated new growth from a diversified economic base.

On the less positive side are the pockets of unemployment and underemployment, and their attendant issues of poverty and inter-related elements of socio-economic disadvantage (CFA, 1995; CAB, 1993). In Northland in 1994, the Community Funding Agency reported that 39% of people aged 15-59 years received income support (49% in the Far North District), 12% of the households had no transport (27% in Kaikohe). In some districts (Northland CEG *pers comm*) there is 100% unemployment and MAF's research indicated that 17% of households in the Te Wahapu o Hokianga Takiwa had no running water. The recent tragedy of a fire killing three children living in sub-standard accommodation in Northland highlights these issues.

Community Funding Agency data also shows that poverty is not restricted to Northland: 36% of

the East Coast's eligible rural work force was on income support and many households lack transport and have difficulties accessing services. The same figures apply to the rural part of the West Coast of the South Island, while in the rural part of Nelson/Motueka 32% of the population receive income support, and similar problems are experienced in the rural parts of Otago and Southland (CFA, 1995). Social deprivation is associated with poorer health status as the Midland Regional Health Authority has shown (MRHA, 1995, 1996).

These effects tend to be hidden in rural communities (Pool and Bedford, 1996). They are not, however, new. Since monitoring of rural social issues began (see for example Lloyd, 1974) services have been moving out of rural areas. The take-over of locally owned stock and station firms by national firms resulted in the national head-office driven firms to close local outlets. Methven's five major stock and station firms were reduced to two as a consequence of centralisation policies (Campbell and Fairweather, 1991). Firms like Hannahs (footwear) closed their rural stores and concentrated their activities in larger centres. Likewise processing businesses have responded to economic signals and government restructuring processes from the time they were established, for example, the closure of flour mills in Canterbury and dairy factories in Taranaki.

The restructuring of the meat processing industry, which has become synonymous with the shutdown of Whakatu in 1986, was a change which was long overdue. While this process began in the early eighties it was assisted by the economic reforms. The outcome has been a considerable improvement in the efficiency and competitiveness of the industry. The restructuring process continues, and all the rural communities, particularly Maori communities, were initially hard hit by freezing works closures. Some communities have recovered, others have not, and may be replaced as service centres by other larger, but more distant centres. Le Heron and Pawson (1996: 149-150) use Balclutha and Kaiapoi as examples of towns which, dependent on their local freezing works, have taken different directions since the closure of these works. Of similar size in 1976, Kaiapoi has since grown while Balclutha has declined. In 1984 Balclutha had 96 service units, Kaiapoi had 82. By 1992 Balclutha had lost 39 services and gained 32; Kaiapoi lost 21 and gained 23 (see Figure 2). Kaiapoi took advantage of Christchurch City Council's green belt policies and has become a dormitory/retirement centre. In both centres, the social services which were lost or threatened were those which were used on an infrequent basis: particularly health, advisory and counselling. Education, shopping and recreation services have been maintained.

Policy issues - managing change

The key to dealing with service problems and economic development issues in rural areas is to ensure rural people have the information and skills they need to define the problems, find solutions, and act on them (or take the appropriate action to ensure that whoever is responsible for creating the problem works to resolve it).

To a large extent problems faced by rural communities are to do with un-managed change. This occurs when rural people lack information and when monopoly providers of services (whether government or private business) make decisions, which adversely impact on local people, without consulting those people.

Service provision has not always kept up with changes in community requirements as the structure

of the community changes - fewer or more young families, more elderly, more people commuting to work outside the local community, increasing demands on women. These changes bring as many opportunities as they do threats. Local people may not, however, be skilled in recognising and acting on the opportunities, or in seeking new ways to overcome the problems associated with change.

Innovative ways are needed to meet servicing needs involving partnerships between local communities and government agencies. Equally agencies need to be more pro-active in evaluating the impact of policies (especially decisions to close) on rural communities. This requires active consultation with all sectors of the community, particularly key service users who may not be accustomed to participating in decision-making processes.

The economic and social viability and health of a community ultimately depends on the success of its people to earn a living. The pockets of high unemployment, the widespread concerns over access to rural servicing, all reflect a need for communities to find a new approach to community development. In most cases this requires rural people to reassess the resources available to them and find new opportunities for developing businesses, either as individuals or as community groups, from local resources.

The skills which lead to success in the agricultural sector can equally be applied to individual business establishment and to community rejuvenation projects. Skills development is a key feature of development and business growth. Rural people need information on how they can lift their management, business and marketing skills.

Perhaps the most important aspect of community development, as for business development, is strategic planning to realise the commercial opportunities of local resources. For this to take place there is a need for effective leadership and management and investment of local resources, energy, ideas, and co-operation to capitalise on economic development opportunities (while maintaining social cohesion and sustaining resources), in addition to partnerships between local community leaders, private enterprise and government (local and central).

The future wellbeing of rural areas will not come from government edicts but the dynamism of local initiative. The survival and prosperity of New Zealand's rural communities in the future will depend on people - on their ability to cope with change, on their ability to work together, on their ability to pull themselves up, on their ability to build community capacity and on their ability to create innovative projects and community networks (Gannon, 1994).

Conclusion

In looking at changes which have taken place in New Zealand's rural communities there is a need to recognise that while some are very much the result of the reforms, other changes are the result of long term economic and social trends. Prior to the reforms logical business adjustments were postponed because Government 'protection' or controls impeded recognition of the need for economic and social diversification. The reforms were needed to enable the realisation of economic opportunity.

Some rural communities have responded positively to the opportunities offered by the reforms

and have dealt positively with the threats posed by economic and social change. Other communities have lacked the resources or the imagination to cope effectively with change. Most communities are learning, however, that change is inevitable, and that change will continue.

How change is managed is a key consideration in determining whether rural communities will survive, flourish or fail. In particular, the ultimate economic success of rural communities may well depend on how much attention these communities direct towards managing the social component of community and family life, and towards addressing social processes in realising economic opportunities.

While agriculture needs healthy rural communities for social and to a lessor extent economic support, most rural communities are now far less reliant on the agricultural industry for survival than they were in the seventies. Alternative sources of economic livelihood, such as that provided by the rural tourism industry, play an important role in smoothing the fluctuations inherent in agricultural production and are broadening the economic base of rural communities.

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Appendix 1: Annual Average Farm Profit Before Tax[1]

The population census provides the only source of data on farmer income. Only farm profit before tax is available for the period after 1991

Farm Profit Before Tax ($)

Year	Sheep & Beef Farms	Factory Supply Dairy Farms
1991	28,784	25,145
1992	31,065	41,925
1993	36,216	51,772
1994	48,702	54,756
1995	36,972	50,601
1996p	30,220	69,250
1997e	32,600	76,500

(Source: SONZA various years from NZDB and NZ M&WB Econ Serv)

[1] Before all drawings, capital repayments and development costs

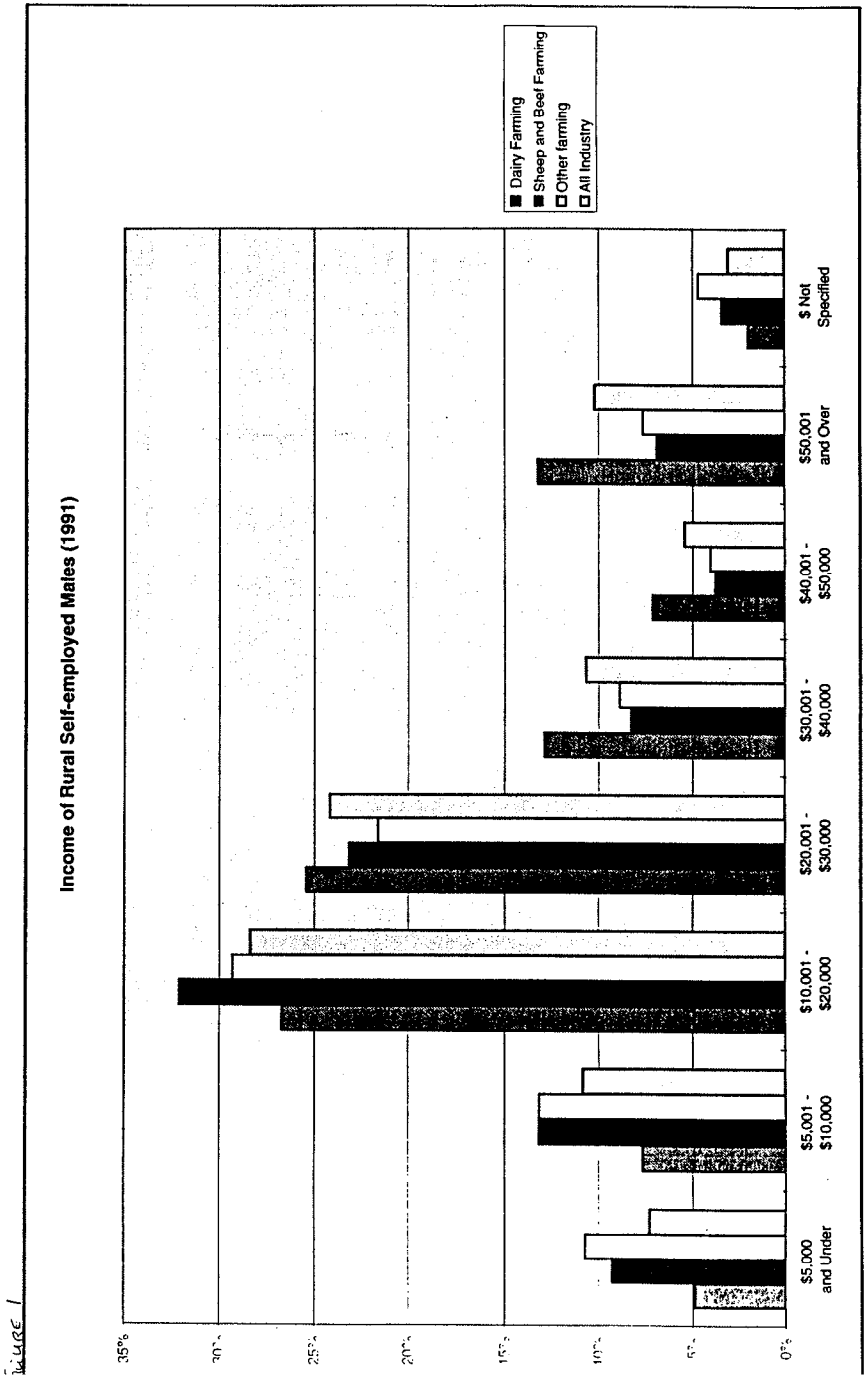

Figure 2:

Change in the number of service units 1984-1992, Balclutha and Kaiapoi

	Balclutha	Kaiapoi
Total 1984	96	82
Total 1992	89	84
Total losses 1984-1992	39	21
Total replacements	23	6
New services	9	17
Net loss/gain	-7	+2

Source: Brad Coombes (1992) 'Rural Services and Change' unpublished BA(Hons) dissertation, Otago University.

IMPLICATIONS AND IMPACTS OF LAND USE CHANGE (Adventures With Agricultural Statistics)

For New Zealand Agricultural and Resource Economics Society Conference, Blenheim, 4 July

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Summary

Agrarian restructuring was last examined in detail by the author in 1992. This paper updates that earlier research by examining long-term changes in numbers and sizes of farms, the extent of smallholding subdivision, changes in farm types and changes in farm employment. The agricultural statistics are used to develop tables and charts showing the broad character of change and to highlight the problems deriving from continuing changes to the statistics themselves. The main changes include: farm numbers increased to 1989 then decreased; average farm size has decreased to 1993, then increased; there are more small farms and fewer medium-sized farms; smallholding subdivision has contributed to the increase in farm numbers when it occurred, meanwhile there has been a decrease in the number of significant farms; and while total farm labour (in labour units) has been relatively constant, working owners and permanent workers have decreased in number while unpaid family workers have increased in number.

Introduction

The study of implications and impacts of land use change is founded upon a good understanding of changes in New Zealand farm structure. This topic was last addressed by the author in 1992 (Fairweather, 1992) and presenting this paper provides an opportunity to update the data using the Agricultural Statistics. However, at the present time the results to hand are more of a preliminary nature and represent work in progress rather than the results of a completed study.

While the current research is largely descriptive in nature it is not entirely an empirical exercise. Two broad questions have guided the research. First, attention is given to the timing of changes to see whether post-1984 deregulation has had any obvious effects on farm structure. However, only tentative suggestions are possible at this stage. Second, attention is given to changes in numbers of farms. This latter question derives from recent research by Hebling (1996) who carefully examined the economic factors underlying the prevalence of family farming in New Zealand. Hebling used the New Zealand case to examine the question of whether deregulation threatens family farming and favours corporate farming (a belief popular in Europe) and argued that it does not. His results showed that economies are insignificant beyond the size of family farms, that family farms have the potential to better economise on transaction costs, and that family farmers derive a substantial share of their total farm income as non-pecuniary benefits. However, Hebling has stated that his argument does not say anything about the number of family farms. It remains possible that family farms survive well under deregulation, but their number may decline. Thus, by 1997, it is timely to examine the data to see if there is any decline in farm numbers.

A major difficulty in updating the agricultural statistics has been ongoing change in the nature of the statistics themselves. These changes make long-term sequences difficult to maintain and at times make them meaningless. Giving attention to these problems has distracted attention away from understanding the changes in land use or in analysing the changes in detail in terms of causes of change. This paper is, as a result, largely descriptive in approach. It is unable to examine effectively possible future changes in farm structure because of a significant change in the agricultural statistics in 1994 when the base changed to include only GST-registered farms.

This paper proceeds in summary form rather than discursively by considering a number of key questions, providing data relevant to the question and then highlighting the main points. This procedure is followed for all the main sections including: numbers and sizes of farms, smallholding subdivisions, changes in farm status, changes in farm types, and changes in farm employment. Finally, a summary and conclusion is provided and this includes an attempt to indicate future directions using recent trends in the data.

1. Numbers and Sizes of Farms

Question 1: How has the overall average farm size in New Zealand changed up to 1984 and after 1984?

Data: Figure 1: Average Farm Size 1972-1996.
Note: The 'best' average excludes idle, other, research/educational and plantations.

Main point: Gradual easing off in the decline.

Data: Figure 2: Number of Farms, and Average Farm Size 1972-1996.

Main points: Pre 1984 there was a steady increase in farm numbers.
Levelling off since 1984.
Maximum in 1989, and apparent ↓ to 1993.
↓ since 1994.

Data: Figure 3: Area Occupied by Farmland and Average Farm Size 1972-1996.

Main point: The occupied area has decreased steadily, but slightly.

Result: overall decrease in average farm size to 1990, then ↑

Question 2: In which size ranges were there changes in farm numbers?

Data: Figure 4: Number of Farms in Each Size Range 1972-1996. (Not adjusted).

Main points: Increase in total numbers to 1987 with no ↓ after 1987.
Increase in 1-39 ha. range.
Slight decrease in 40-199 ha. range.
Little change over 200 hectares.

Data: Figure 5: Proportion of Total Farms in Each Size Range 1972-1996.

Main points: While total number constant between 1987 to 1993 there were relatively more small farms (1-39 ha.) and relatively fewer large farms (40-399 ha.)

Data: Figure 6: Number of Farms in Each Size Range 1972-1996 (line graph).

Main points: Same as above
- 4 lines going up (1-39 ha.)
- 3 lines going down (40 - 199 ha.)
- 200-399 ha. ↑ to 1987 then ↓.

Result: more smaller farms, fewer mid-sized farms, larger forms static.

Question 3: In which main farm types were there changes in size distribution?

Data: Figure 7: Number of Dairy Farms in Each Size Range 1972-1993.
Note: 1996 data not yet available.

Main points: ↑ 1-39 ha.
20-39 ha. static
↓ 40-99 ha.
↑ 100-799 ha.

Data: Figure 8: Proportions of Dairy Farms in Each Size Range 1972-1993.

Main points: While total numbers constant between 1990 and 1993, similar trend of:
↑ 1-19 ha.
↓ 40-199 ha.
↑ >299 ha.

Data: Figure 9: Number of Sheep/Beef farms in Each Size Range 1972-1993.

Main points: ↑ in all size ranges to 1987.
Rapid ↓ in 1990.
For 1987-1993: 1-59 ha. static
↓ > 50 size ranges.

Data: Figure 10: Proportions of Sheep/Beef Farms in Each Size Range 1972-1993.

Main points: While there were fewer sheep/beef farms in 1993, there were increased proportions in the 1-39 ha. ranges, and decreased proportions in the 100-399 ha. range.

Data: Figure 11: Number of Horticultural Farms in Each Size Range, 1972-1993.

Main points: ↑ in all size ranges and total numbers.
Slight easing off after 1987
↑↑ in 1-19 ha. range.

Data: Figure 12: Proportions of Horticultural Farms in Each Size Range, 1972-1993.

Main points: Few significant changes over time; ↓ in < 5 ha. range.

Result: dairy farms have increased in number in the small and larger size ranges and decreased in number in the mid-sized ranges. Horticultural farms have increased in number in all size ranges. Sheep-beef numbers declined or are static across all size ranges since 1987.

2. Some Details on Smallholding Subdivision

Question 4: What impact has smallholding subdivision had in the increase in farm numbers?

Data: Table 1: Number of Small and Significant Farms in Each Size Range.
Table 2: Number of Small and Significant Farm in Selected Size Ranges 1986-1994.

Main points: Over all: Gain of 2,959 small farms between 1986 and 1972
- a gain of 7% of 1986 total.

By size range: <5 ha. + 403 4%
6-10 ha. + 1,066 13%
11-19 ha. + 1,176 18 %
20-49 ha. + 929 10%
For 1-49 ha. $\Sigma = 3{,}574$
Were 78% of all farms < 49 ha., by 1992 = 83%.

Result: smallholdings have played a role in the increase in farm numbers.

Question 5: How well did the Agricultural Statistics keep up with subdivision?

Data: Figure 12: Number of Smallholdings/Lifestyle Blocks 1980-1996.

Main points: Total number (90,178) in 1996 exceeds Agricultural Statistics total number of all farms at 79,666 in 1992 (the highest, recent number).

Data: Figure 13: Farms Less than 20 ha. - Stat. NZ cf. Val.NZ 1986-1996.

Assume that most smallholdings are less than 20 ha. Note: Valuation New Zealand data show that the average size of improved smallholding sold was between 5.9 and 4.2 hectares for 1991 to 1996.

Main points: Agricultural Statistics accounted for:
- in 1986, 59%
- in 1992, 39%
- in 1994, 23%.

Also note: In 1992 there were 8,328 farms producing $0 in value of output or 20,724 farms producing $0-5,000 cf. Val. NZ number at 69,694.

Result: Subdivision has significantly exceeded the measured rate and has been a major factor in the increase in farm numbers less than 20 hectares.

Question 6: What do Valuation New Zealand report on the net effect of sales?

Data: Figure 14: Number of Freehold Open Market Sales by Enlarging/Subdividing. and Net Effect June 1992-December 1996.

Main Points: Both enlargement and subdivision
Net effect of more subdivisions: highest net effect in 1987-93. Rate slowing down.
Net effect of subdivision generally follows pattern of sales.

About 100-165 per 6 month period, 1982-1996.
Sum of +3,104 since 1982.
Note: the ratio of 'all sales' to 'freehold open market' sales has been, on average, 1.19 between 1985 and 1996.
3,104 x 1.89 = 5,863
But the 1981 to 1993 increase in farm numbers was 8,681
8,681
∴5,863 = 1.5 properties on average resulting from subdivision.

3. Changes in Farm Status

Question 7: What have been the changes in the number of small and significant farms?

Data: Table 1: Number of Small and Significant Farms in selected Size Ranges 1986-1994.

Main Points:
- Corresponding to the gain in smallholdings 1986 to 1992, there was a loss of 3,117 significant farms, a loss of 8% of the 1992 total.
- Losses in significant farms in all size ranges.
- From 1992 to 1994 apparent gain in proportion of significant farms.

Result: small decrease in significant farms.

4. Detailed Analysis of Change in Farm Types

Question 8: What was the effect of the change to only GST-registered farms in 1994?

Data: Table 3: Comparison of EVAO 1992 and 1994.

Main Points:
- Farms <$30,000 EVAO ↓ 15,218, most very small.
- Farms >$30,000 EVAO ↑ 5,012, most very large.
- Net loss of 10,206 farms.

N.B.
- No correspondence between the two years.
- Cannot identify new farms.
- Cannot link farms in 1992 to 1994.

Result:
- higher estimate of EVAO
- on 4.2% fewer farms.
- ↓ of 6,697 farms as idle or horse training.
- 1994 data cannot be compared with earlier data.

Question 9: Among all types of farms how did the numbers change to 1992?

Data: Figure 15: Total Number of Farms by Farm Type 1986 to 1996.

Main points:
- Total number steady to 1990 then ↓ by 1,965 to 1992
- ↓ by 3,207 from 1994 to 1996
- From 1986 to 1990: ↓ sheep/beef and cropping, ↑ for all others
- From 1990 to 1992: ↓ of 1,965, across all types.
- From 1994 to 1996: ↓ sheep/beef, slight ↑ in horticulture.

Result: adjustments include movement of sheep/beef farms into dairy, horticulture, other animal and deer farms.

Question 10: Were these patterns followed by both small farms and significant farms?

Data: Figure 16: Significant Farms by Farm Type 1986-1994
Note: data not available for 1996.

Main points:
- ↑ in totals to 1988 then ↓ to 1992, overall loss of 2,678.
- ↓ sheep/beef, other animal and cropping.
- ↑ in deer and dairy.

Result: significant farms show a similar pattern to all farms.

Data: Figure 17: Small Farms by Farm Type 1986-1994.

Main points:
- ↑ in totals to 1992 of 1,818 farms.
- ↓ sheep/beef and cropping.
- ↑ in all others.
- other animal increases then decreases.
- Note the ↑ in horticulture from 'new' farms.

Result: small farms show a different pattern of increasing total numbers to 1992, with the increase across all types except cropping.

Question 11: What has been the increase in plantations?

Data: Figure 18: Area and Numbers of Plantation 1972-1996.

Main Points:
- Steady ↑ in numbers: - gain of 920 from 1986 to 1992 and a gain of 2,326 from 1986 to 1996.
- From other data, most (92%) is on plantations and the remainder spread over other farm types.

Result: plantations appear to have absorbed only a small proportion of the decrease in sheep/beef farms.

5. Changes in Farm Employment

Question 12: How have the main farm worker categories changed over time?

Data: Figure 19: Farm Worker Categories 1970 to 1996.

Main Points:
Note 1: Cannot compare 1994 onwards with earlier data.
Note 2: 1993 permanent is an odd year.
Note 3: 1991 casual is an odd year.
Note 4: Data from 1988 adjusted to a 'loss' of 8,774 (23%) unpaid workers. Overall total will be considered later as labour units.
- ↑ working owners to 1982 then ↓.
- Permanent gradually ↓ to 1992, suspicious rise in 1993.
- Unpaid family gradually ↑ and by 1985 clearly exceeds permanent workers.
- Casual is small and constant (and estimated for 1996!)
- Post 1994: -suspicious rise in working owners
  - permanent exceeds unpaid family.

Question 13: As for Question 20, but for Labour Units.

Data: Figure 20: Farm Work Categories in Labour Units 1976-1996.
Note: Full-time =1
Part-time = 0.5
Casual = 0.2 (from Campbell, 1994)

Main points:
- Same general patterns but smoother.
- Permanent exceeded unpaid family for longer, i.e. until 1986.
- By 1988 unpaid clearly exceeds permanent workers.

Data: Figure 21: Total Employment in Labour Units 1972-1996.

Main point: ↑ to 1983, ↓ to 1989 then erratic to 1993 but considering 1991 and 1993 the total may be steady.

Data: Figure 21: Proportions of Farm Work Categories in Labour Units 1976-1996.

Main points: Same as above:
↓ working owners since 1982
↓ permanent
↑ unpaid family.

Result: within a relatively constant total there have been fewer working owners and permanent workers, and more unpaid family.

Question 14: What change has there been in the relative contribution of men and women?

Data: Figure 23: Total Employment in Labour Units by Gender 1976-1996.

Main points:
- Gradual ↓ in male contribution.
- Gradual ↑ female contribution to 1987 then steady.

Data: Figure 24: Total Working Owners in Labour Units by Gender 1974-1996.

Main points: ↑ male contribution to 1982, ↓ to 1986, slight ↓ to 1993.
Steady ↑ in female contribution to 1987, then steady.

Data: Figure 25: Total Unpaid Family in Labour Units by Gender 1974-1996.

Main points: ↑ to 1991 then decrease for both males and females.
Slightly more males than females before 1981.

Data: Figure 26: Permanent Work in Labour Units by Gender 1974-1996.

Main points: ↓ in male contribution to 1992, possibly continuing after 1994.
Slight ↓ in female contribution to 1992.
General ↓ from 1974 to 1992

Result: The decrease in total labour units (beginning before 1984) and was due to fewer working owners and permanent workers, counterbalanced by an increase in unpaid family. Overall there have been fewer men and more women employed in agriculture, although the female participation rate has levelled off in recent years.

Summary and Conclusion

Average farm size has ↓ over time until 1990 and then increases. It appears that deregulation after 1984 may have contributed to the decrease in farm numbers and slowly led to an increase in average farm size. The increase in average farm size recently may reflect the removal of smallholdings from the agricultural register: the remaining commercial farms are fewer on a decreased total area but are larger. The overall 'trend' in recent years has been for farm numbers to decrease and if this trend continues we can expect there to be fewer significant farms.

Within the total number of farms there are more small farms (1-39 ha.) and fewer mid-sized farms (40-199 ha.). There has not been a corresponding increase in the larger-sized farms (>200 ha.) to prevent the overall loss in farm numbers. Within farm type, horticultural farms have increased in number in all size ranges; dairy farms increased in number in both small and large size ranges, and sheep/beef farms have declined or are static. Restructuring and low sheep/beef returns appear to have caused significant downward adjustment in the latter, while more buoyant dairy and horticultural returns appear to support the traditional adjustment of more small and large farms. Present trends suggest that overall we can expect more small farms and fewer mid-sized farms.

Smallholdings have played a major role in the earlier increase in farm numbers even though they have not been adequately counted. They have not offset the decrease in total farm numbers (1986-1992/3), thus there has been a small but noticeable decrease in significant farms between 1986 and 1992 - the only years where there are data on the same basis. Further, when examining farm type using adjusted data, farm numbers declined to 1992 and from 1994. Deregulation and low sheep/beef returns appear to have contributed to a reduction in the number of farms. (Sheep/beef real farm profits have been constant over this period.) Plantations have not absorbed all of the decrease in sheep/beef farms and some have gone to dairy, horticulture or deer, while others have been bought by sheep/beef farmers who have enlarged their farms. Present trends suggest that overall we can expect fewer sheep/beef farms.

Total farm labour (in labour units) has decreased and then been relatively constant but working owners and permanent workers decreased while unpaid family workers have increased. These trends began before 1984, suggesting that deregulation has not significantly affected the general patterns. While female contribution increased to 1984 it has been constant since 1985. Overall we can expect the unpaid family contribution to increase. Permanent workers may decrease in number.

Generally, the results suggest that deregulation has not had a dramatic effect on farm structure. Long-term trends in average farm size, number of plantations and total labour unit seem little affected by deregulation. Sheep/beef farming seem to be most affected, even under conditions of constant real farm projects. Farm numbers are decreasing and this seems to be one of the longer-term affects of deregulation.

Implications for Statistics New Zealand

The Agricultural Statistics have been found wanting in a number of ways:

(1) Intermittent censuses raise doubts about the validity of the survey - based data in the other years (seven out of the last ten years). Some years have inexplicable and large changes in farm numbers and workers (e.g. 1991 and 1993).

(2) Failure to provide comparison between 1993 and 1994 ruptures data series and prevent s trend analysis.

(3) By omitting smallholdings the agricultural statistics misrepresent important social dimensions of land use. Land uses on smallholdings that are presently insignificant economically may develop into viable industries. By ignoring these incipient land uses the statistics tend to suggest a future much like the present.

(4) Re. labour statistics:

   (a) 1991 to 1995 working owners and family data are for February not June (not a major problem.

   (b) Instructions for the labour question have changed four times in 13 years.

   (c) The format for the labour question has changed five times in 13 years.

   (d) For 1996 casual labour are lumped in with other categories.

   (e) The Agricultural Statistics draw attention to the 1995 numbers of permanent workers in June exceeding the February number.

Research requires orderly data series that accommodate to real changes when they occur. The changes in the agricultural statistics subvert research and require that valuable research time be spent on attention to the data, not what the data contribute to our understanding of land use change in New Zealand.

References

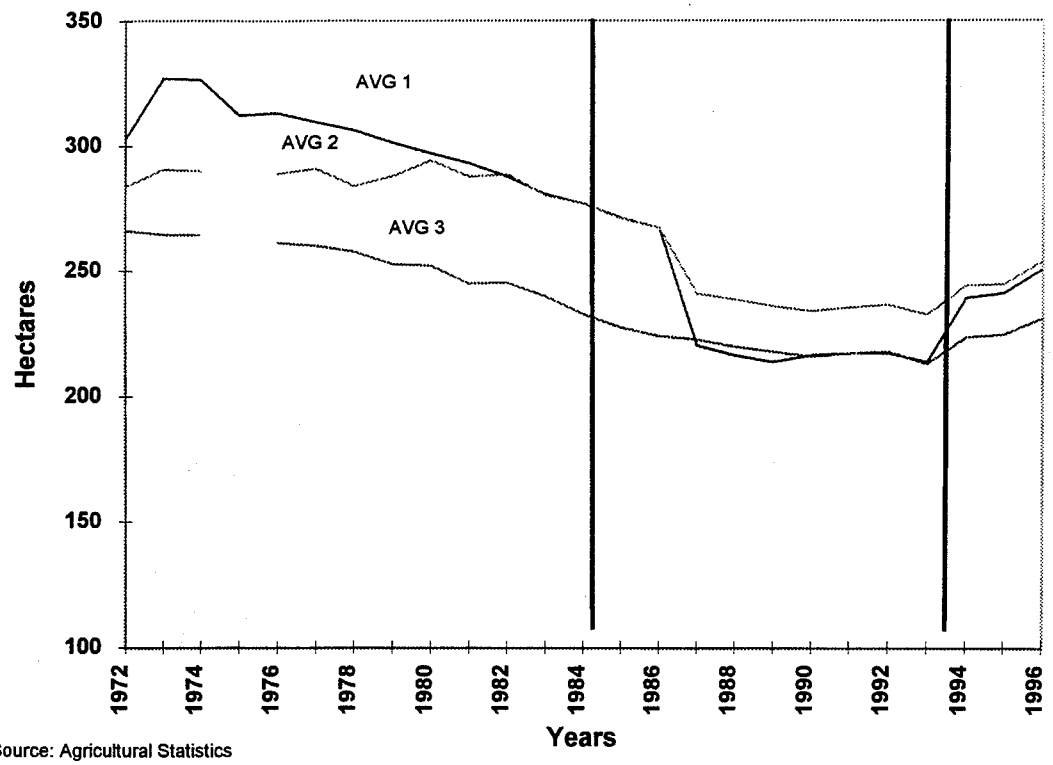
Fairweather, J.R. (1992) "Agrarian Restructuring in New Zealand". Research Report No.213, Agribusiness and Economics Research Unit, Lincoln University.

Hebling, R. (1996) "Family Farming Without State Intervention". Research Report No.234, Agribusiness and Economics Research Unit, Lincoln University.

Campbell, H.R. (1994) "Regulation and Crisis in New Zealand Agriculture: The Case of Ashburton County, 1984-1992". Unpublished Ph.D thesis submitted to Charles Sturt University, Wagga Wagga, Australia.

CHT Avg Size Comparison

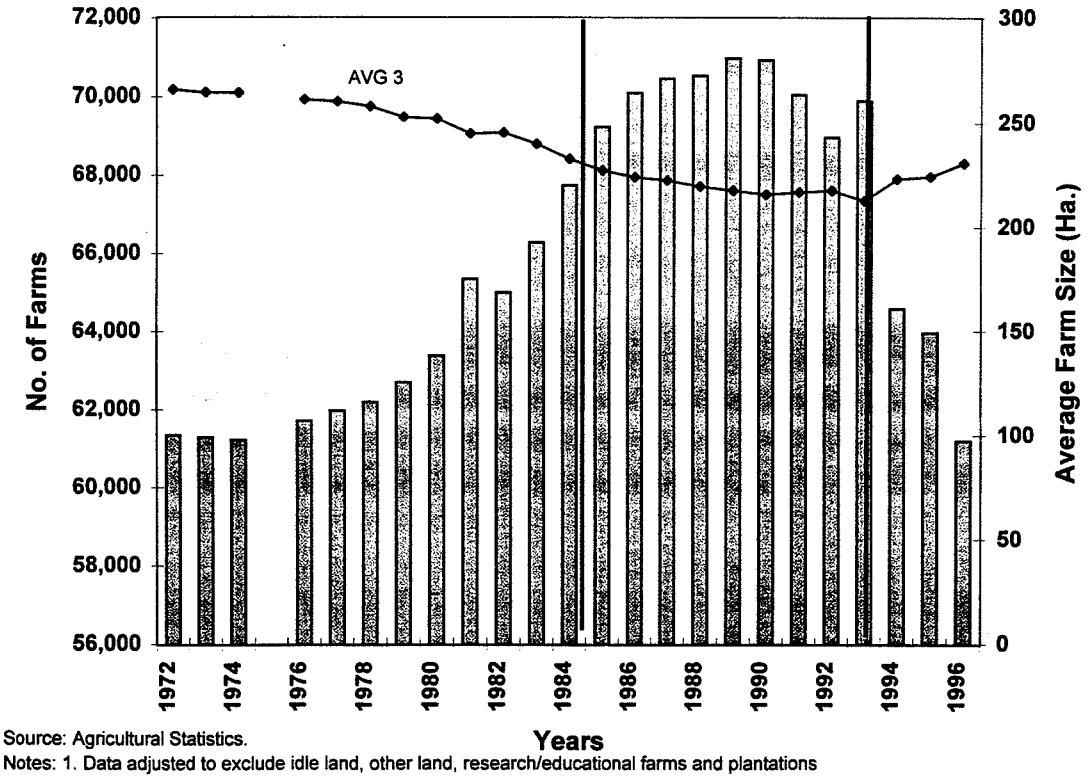
AVERAGE FARM SIZE 1972-1996



Source: Agricultural Statistics
Notes: 1. AVG 2 excludes "research and education", "idle" and "other ".
2. AVG 3 excludes the above and "plantations".

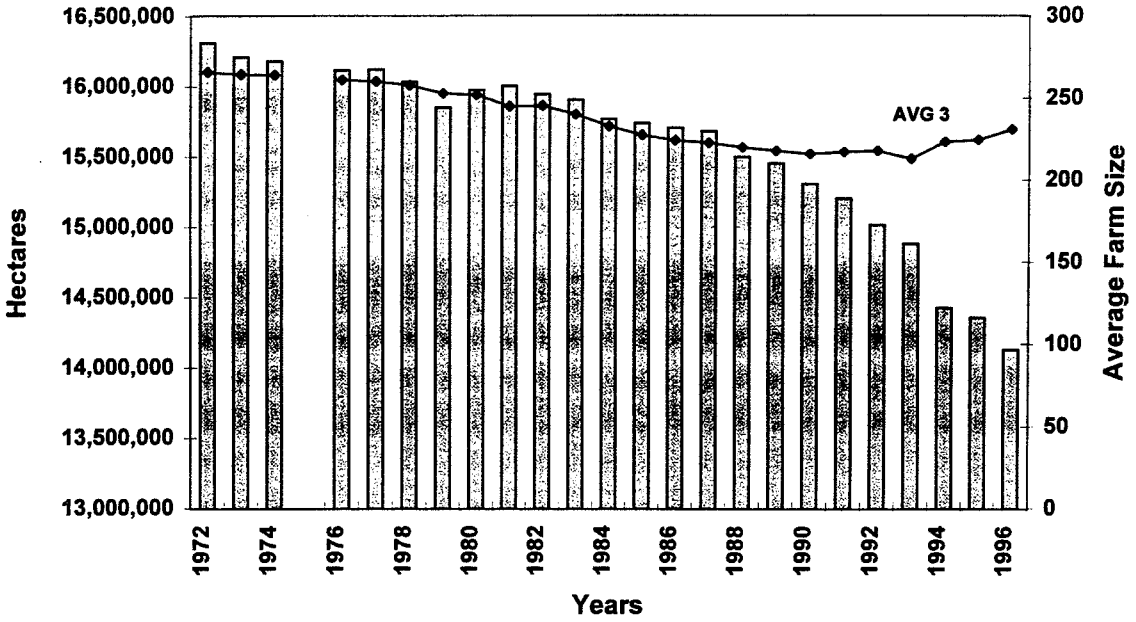
CHT Farm #'s and Avg Size 72-96

NUMBER OF FARMS AND AVERAGE FARM SIZE 1972-1996



Source: Agricultural Statistics.
Notes: 1. Data adjusted to exclude idle land, other land, research/educational farms and plantations
2. 1994 onwards includes only GST registered farms
3. No data available for 1975

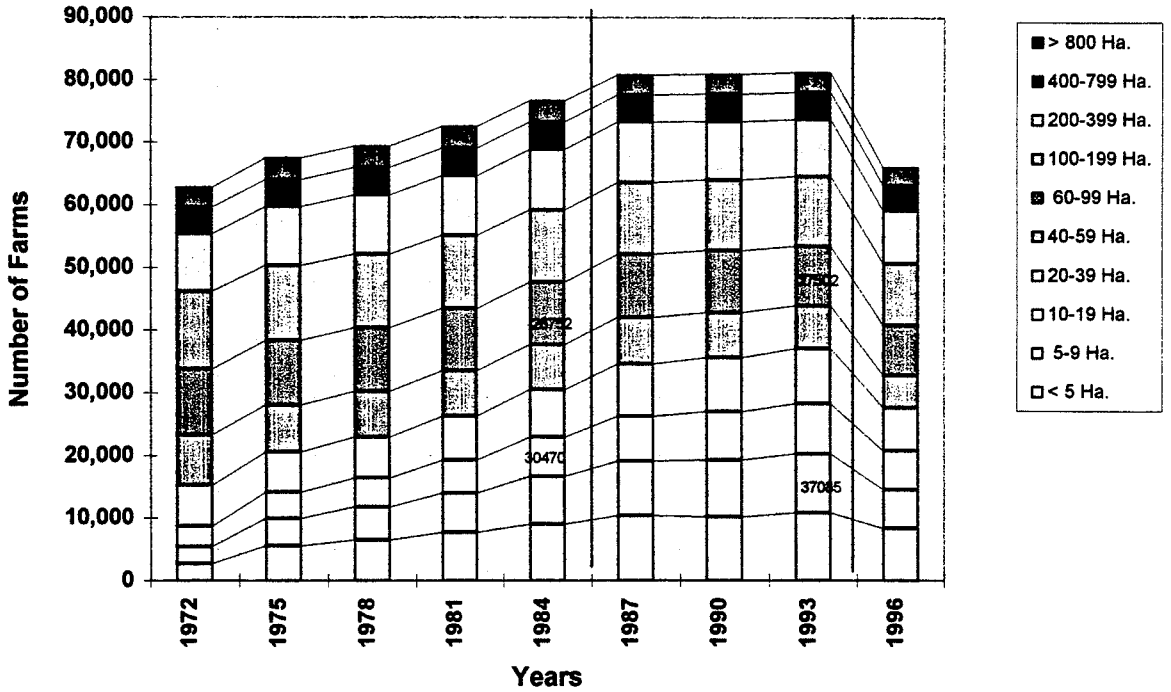
AREA OCCUPIED BY FARMLAND AND AVERAGE FARM SIZE 1972-1996



Source: Agricultural Statistics.
Notes: 1. Data adjusted to exclude idle land, other land, research/educational farms and plantations
2. 1994 onwards includes only GST registered farms
3. No data available for 1975

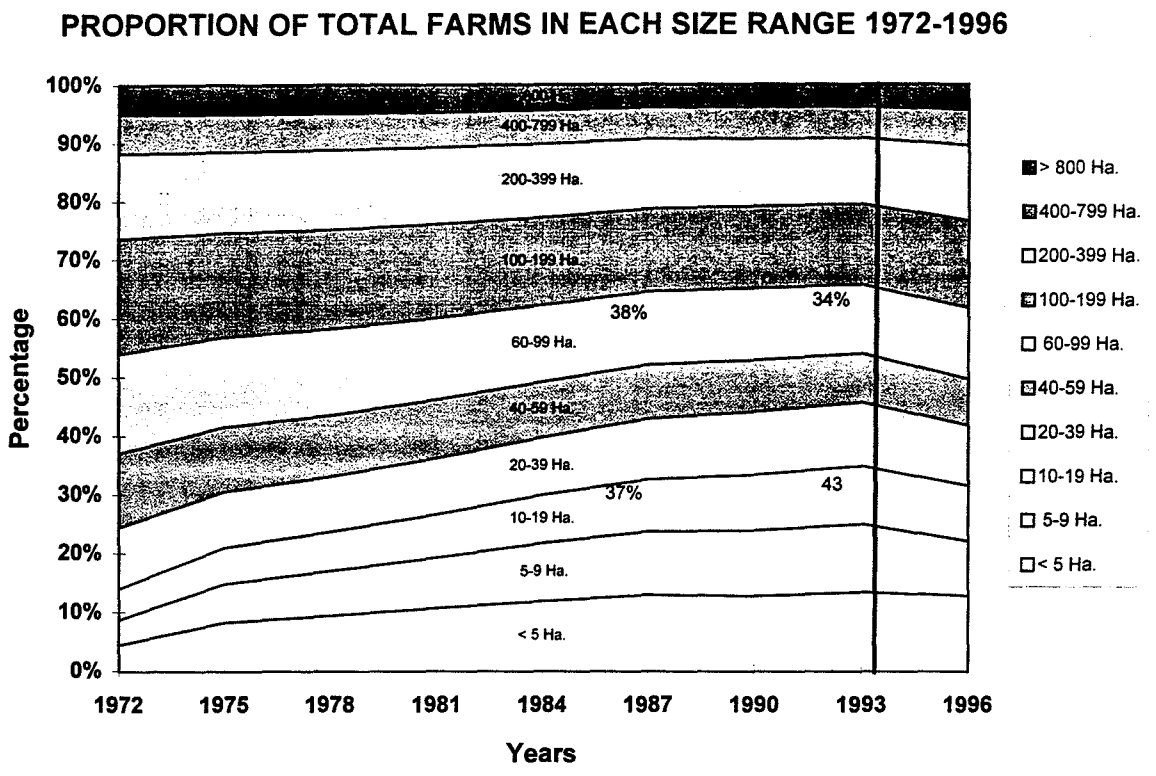
CHT #'s of Farms All Activities Chart 1

NUMBER OF FARMS IN EACH SIZE RANGE 1972-1996



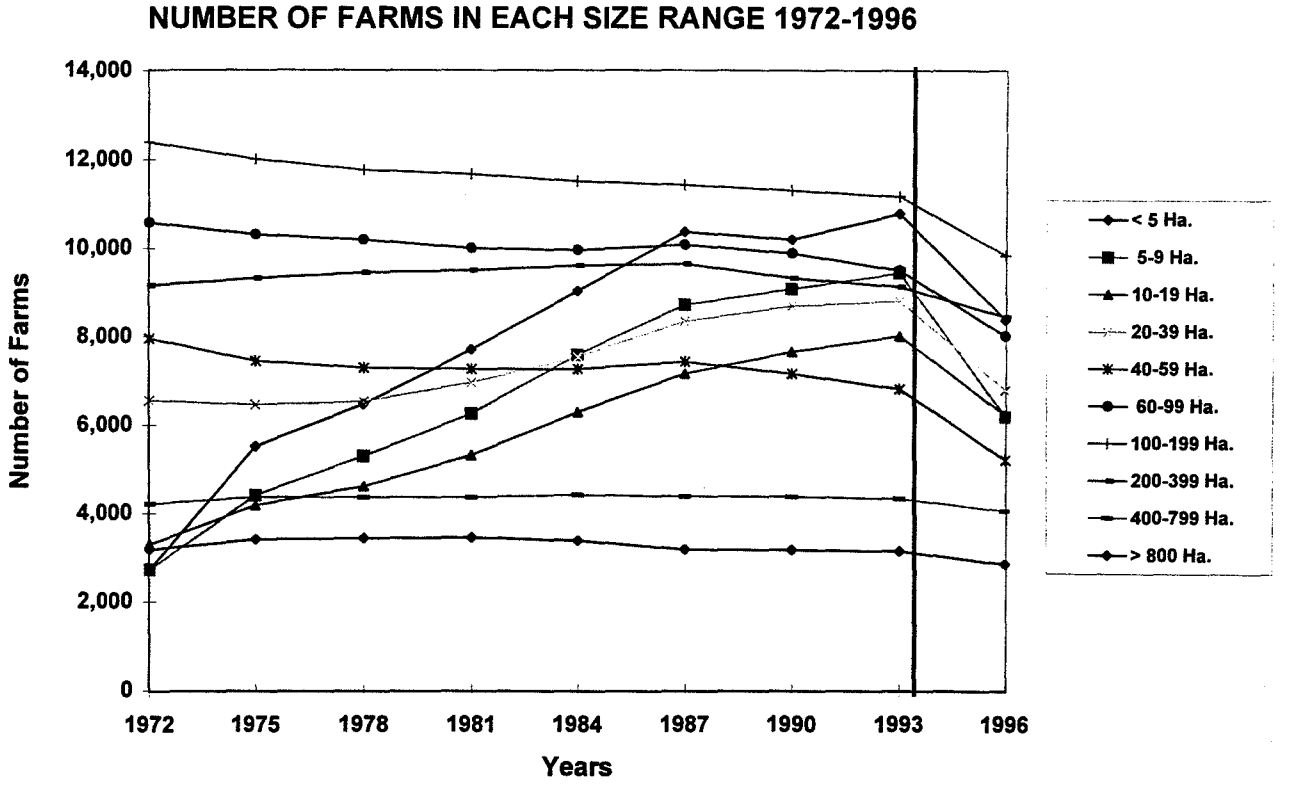
Source: Agricultural Statistics

CHT% Farms per Size Range



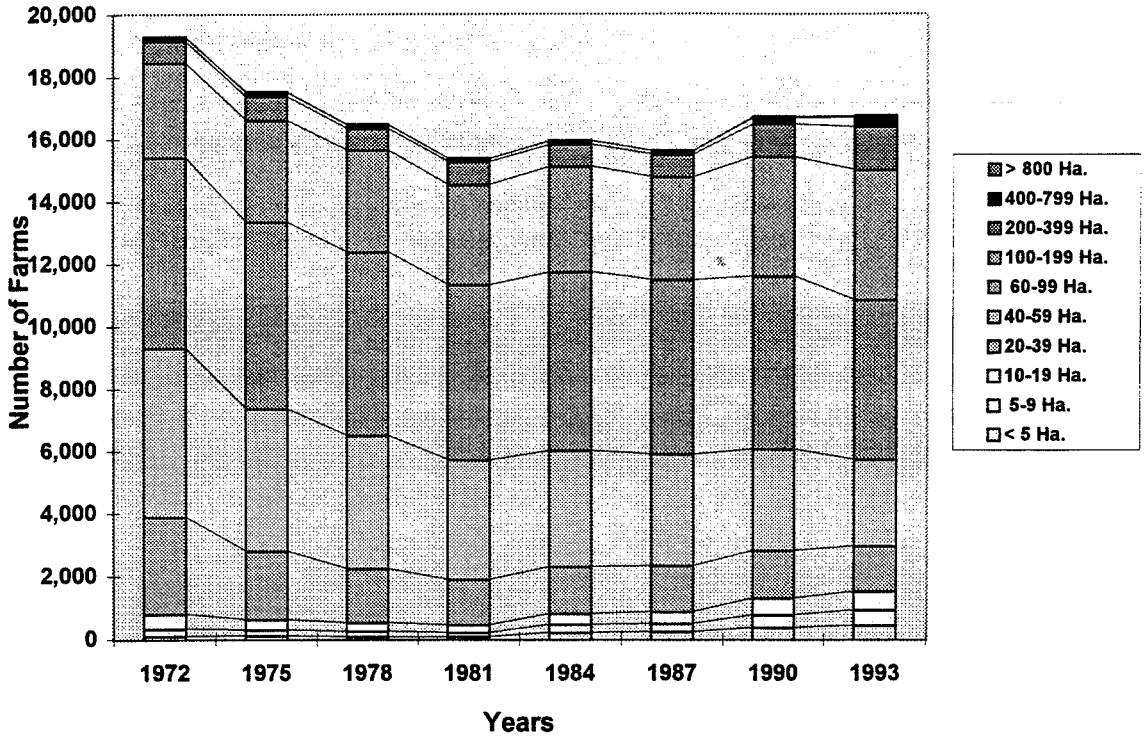
Source: Agricultural Statistics

CHT All types (lines)



CHT Dairy Farms by Farm Size

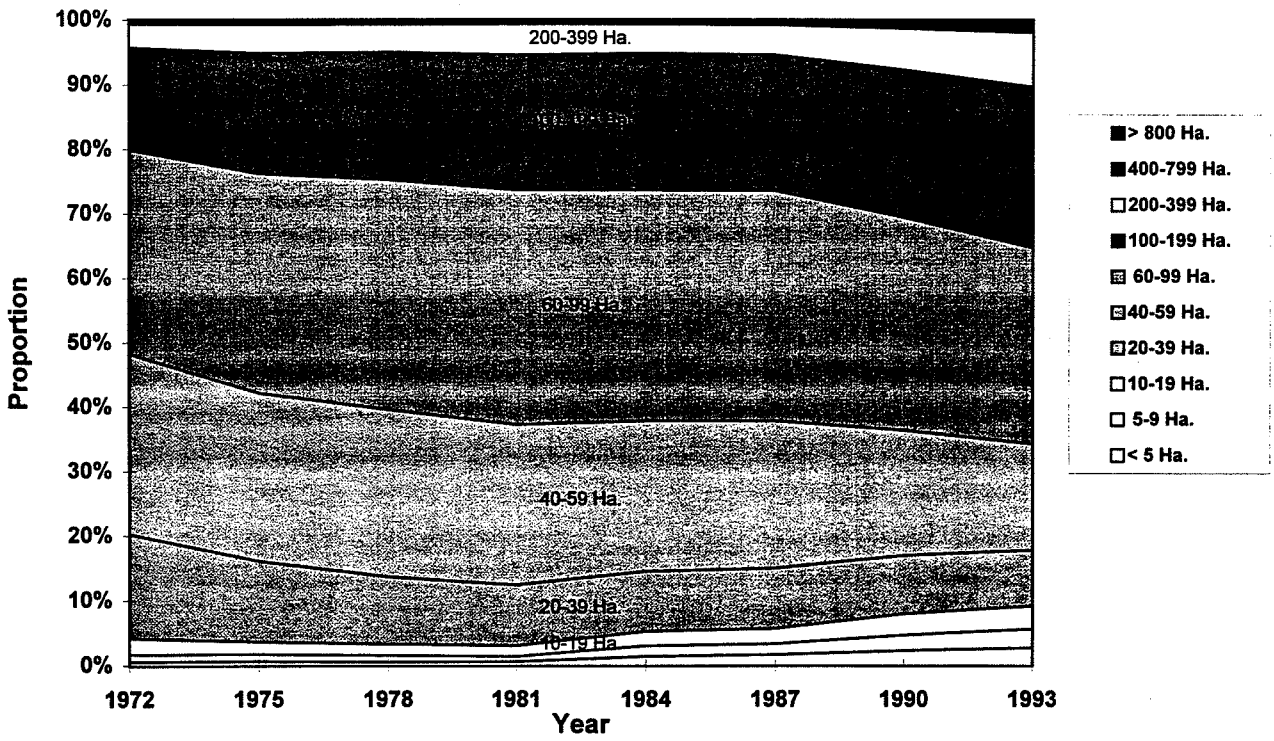
NUMBER OF DAIRY FARMS FOR EACH SIZE RANGE 1972-1993



Source: Agricultural Statistics

CHT % Dairy Farm Rang

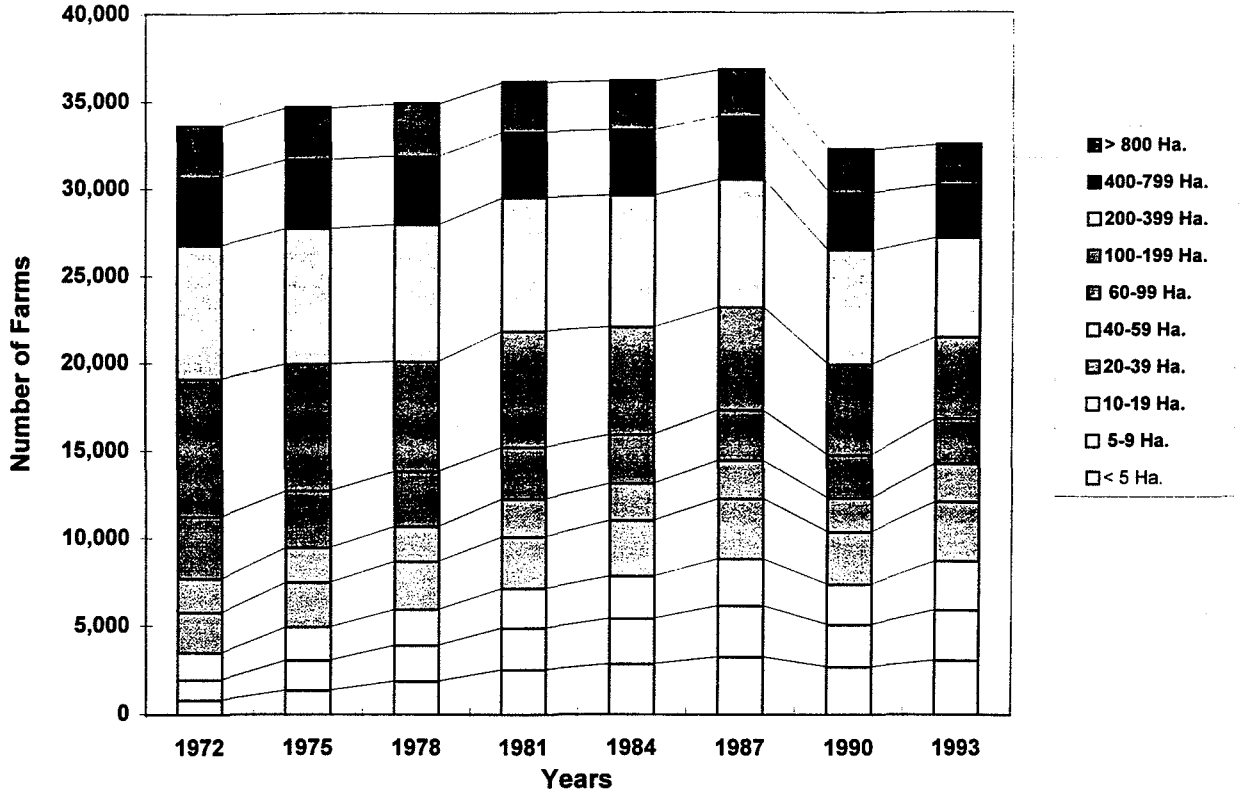
PROPORTION OF DAIRY FARMS IN EACH SIZE RANGE 1972-1993



Source: Agricultural Statistics

CHT #'sSheep and Beef F by size Chart 1

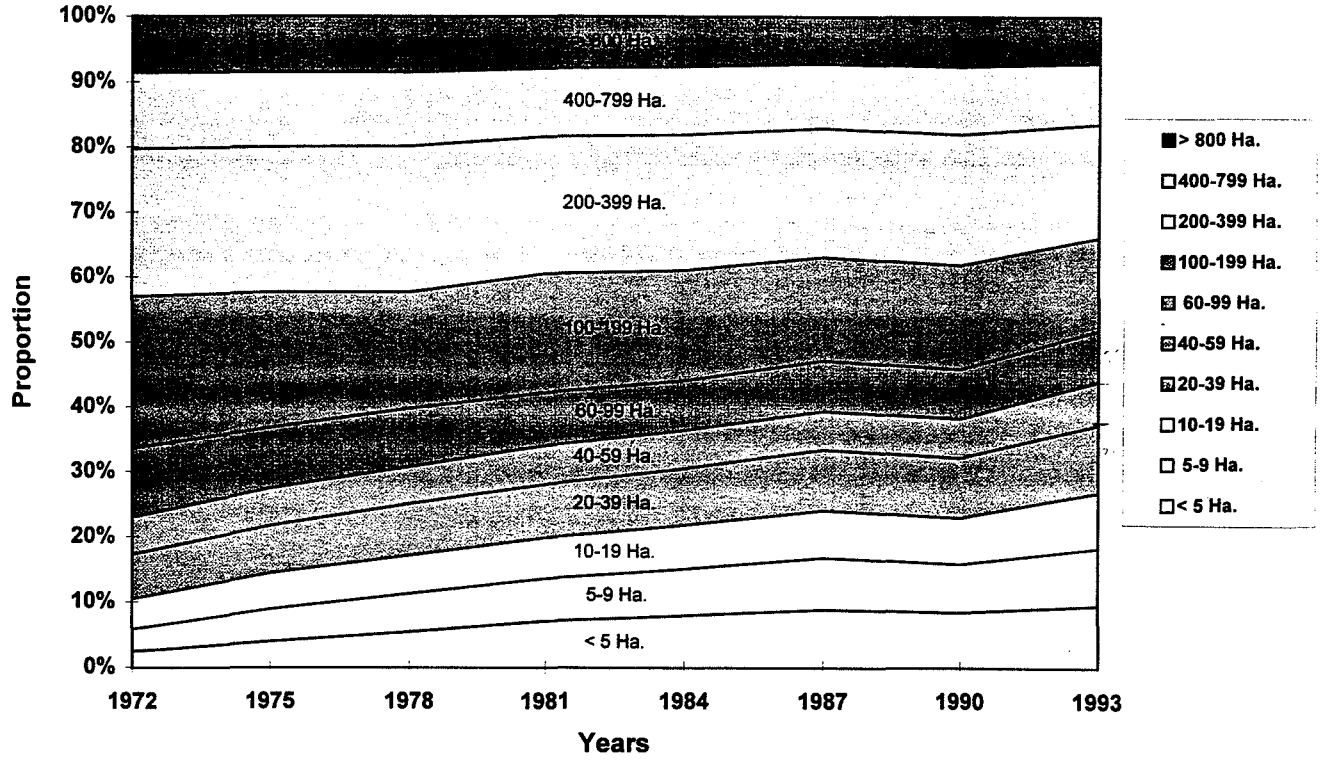
NUMBER OF SHEEP/BEEF FARMS FOR EACH SIZE RANGE 1972-1993



Source: Agricultural Statistics

CHT Prop of Sheep + Beef Farms

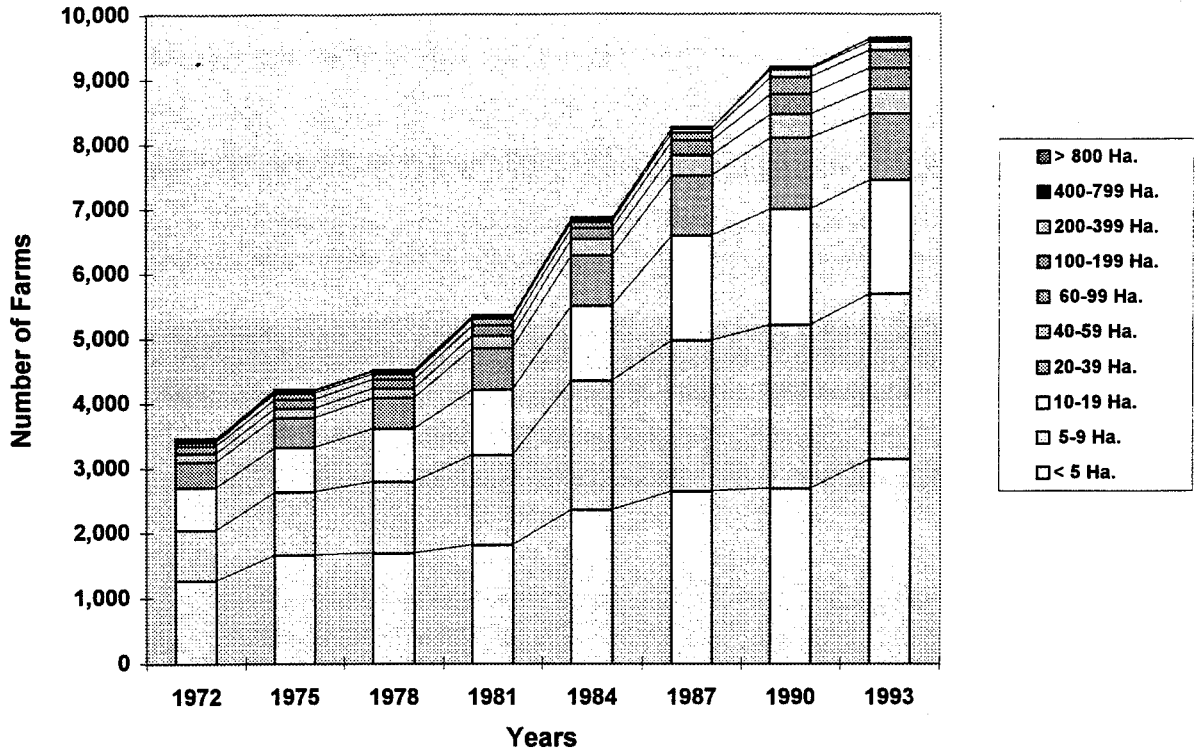
PROPORTION OF SHEEP/BEEF FARMS IN EACH SIZE RANGE 1972-1993



Source: Agricultural Statistics

CHT Horticulture Farms by Size

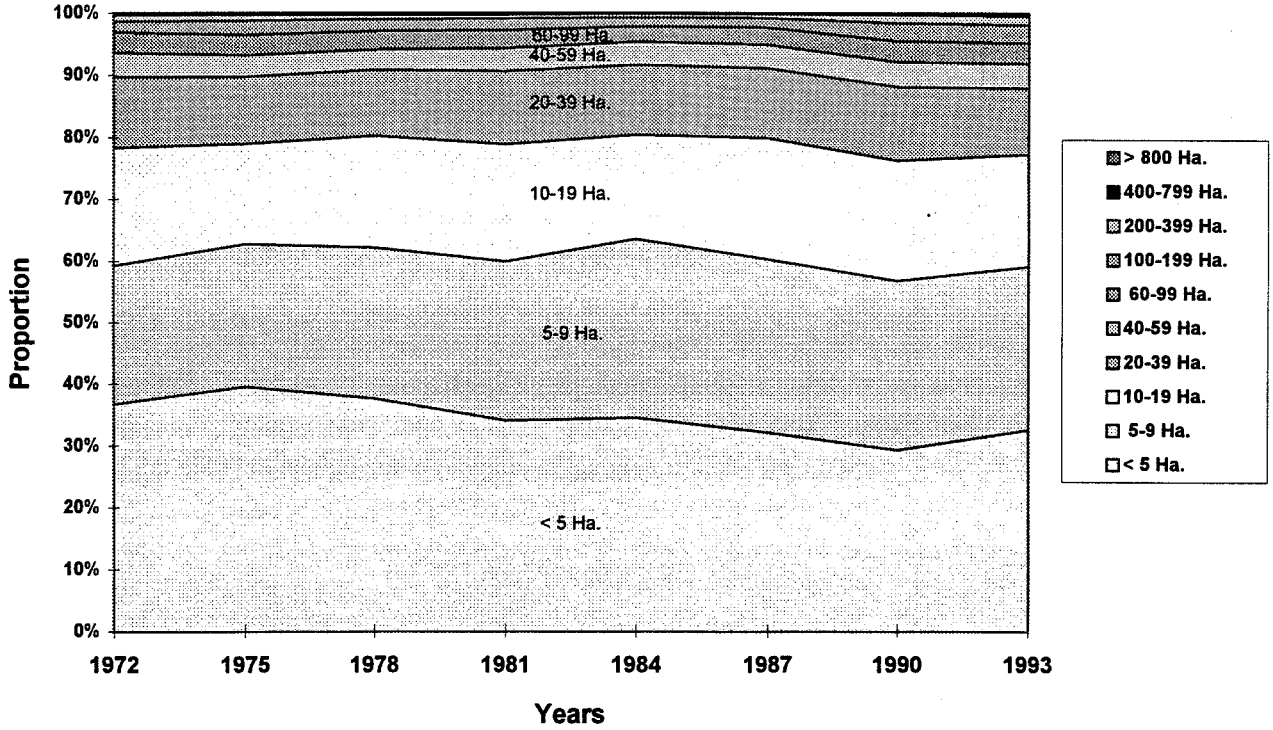
NUMBER OF HORTICULTURAL FARMS IN EACH SIZE RANGE 1972-1993



Source: Agricultural Statistics

CHT Prop of Hortic. Farms

PROPORTION OF HORTICULTURAL FARMS IN EACH SIZE RANGE



Source: Agricultural Statistics

NUMBER OF SMALL AND SIGNIFICANT FARMS IN SELECTED SIZE RANGES 1986-1994

Hectares		1986		1988		1990		1992		1994	
<49 Ha.	Small	29,410	78%	31,787	79%	33,193	84%	32,984	83%	22,273	73%
	Sign.	8,189	22%	8,392	21%	7,519	19%	6,578	17%	8,125	27%
	Total	37,599	100%	40,179	100%	39,712	100%	39,562	100%	30,398	100%
50-199 Ha.	Small	6,886	28%	6,365	26%	6,158	25%	6,538	28%	5,596	25%
	Sign.	17,870	72%	18,387	74%	18,161	75%	16,997	72%	17,211	75%
	Total	24,756	100%	24,752	100%	24,319	100%	23,535	100%	22,807	100%
>199 Ha.	Small	1,384	8%	1,017	6%	994	6%	1117	7%	713	4%
	Sign.	16,085	92%	16,115	94%	15,879	94%	15452	93%	15542	96%
	Total	17,469	100%	17,132	100%	16,873	100%	16569	100%	16255	100%
Totals	Small	37,680	47%	39,169	48%	40,345	50%	40,639	51%	28,582	41%
	Sign.	42,144	53%	42,894	52%	41,559	51%	39,027	49%	40,878	59%
	Total	79,824	100%	82,063	100%	80,904	100%	79,666	100%	69,460	100%

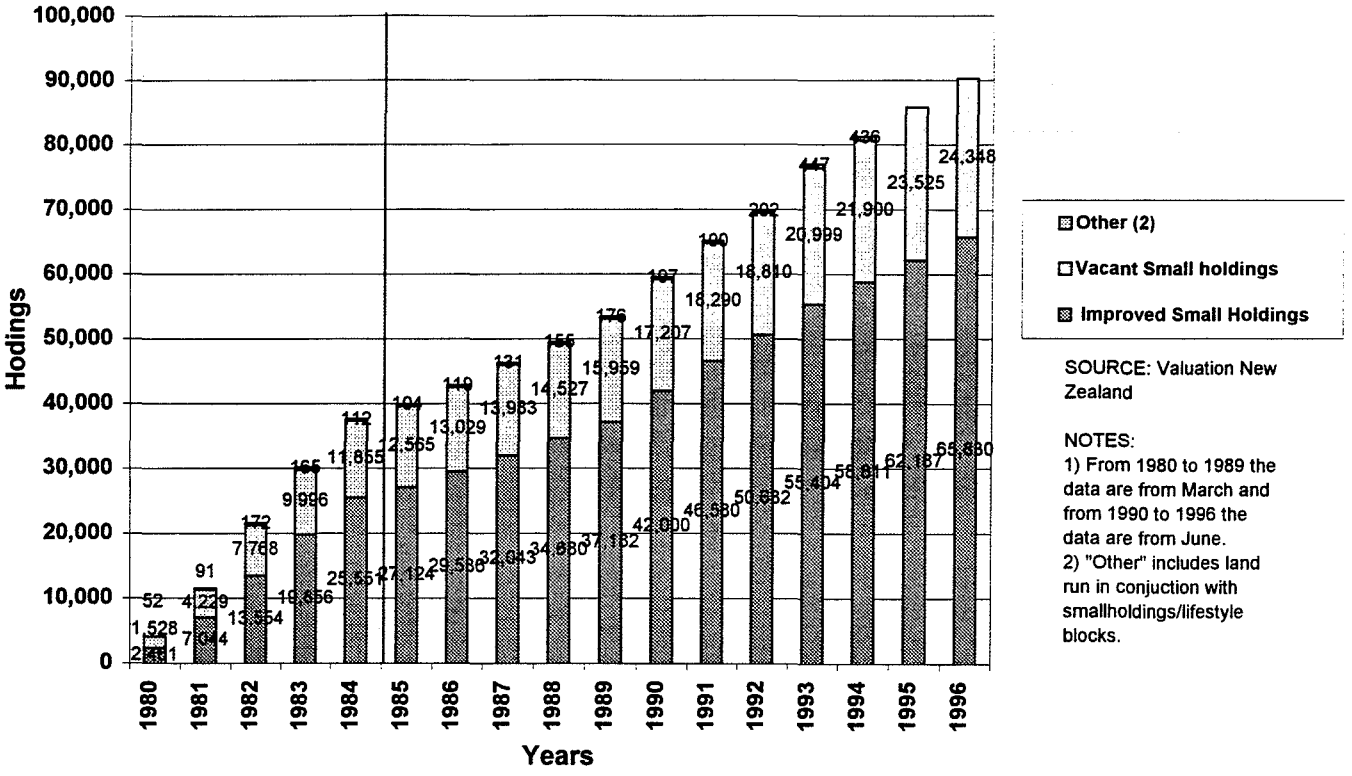
Farm by size signif&small (copy

NUMBER OF SIGNIFICANT AND SMALL FARMS IN EACH SIZE RANGE

Hectares		1986		1988		1990		1992		1994		Change	
		No.	%	No.	%	No.	%	No.	%	No.	%	86-92	% of 86
<5 Ha.	Small	9283	91%	9871	91%	9545	94%	9686	94%	6620	81%	403	4%
	Sign.	884	9%	980	9%	658	6%	650	6%	1543	19%	(234)	-36%
	Total	10167	100%	10851	100%	10203	100%	10336	100%	8163	100%	169	2%
6-10 Ha.	Small	6924	82%	7458	82%	7848	86%	7990	88%	4398	71%	1,066	13%
	Sign.	1500	18%	1627	18%	1239	14%	1128	12%	1765	29%	(372)	-33%
	Total	8424	100%	9085	100%	9087	100%	9118	100%	6163	100%	694	8%
11-19 Ha.	Small	5276	78%	5763	78%	6239	81%	6452	84%	4424	74%	1,176	18%
	Sign.	1516	22%	1629	22%	1422	19%	1265	16%	1520	26%	(251)	-20%
	Total	6792	100%	7392	100%	7661	100%	7717	100%	5944	100%	925	12%
20-49 Ha.	Small	7927	65%	8695	68%	9561	75%	8856	71%	6831	67%	929	10%
	Sign.	4289	35%	4156	32%	4200	33%	3535	29%	3297	33%	(754)	-21%
	Total	12216	100%	12851	100%	12761	100%	12391	100%	10128	100%	175	1%
50-99 Ha.	Small	4505	34%	4424	33%	4227	33%	4376	35%	3751	32%	(129)	-3%
	Sign.	8775	66%	8881	67%	8775	67%	8068	65%	8112	68%	(707)	-9%
	Total	13280	100%	13305	100%	13002	100%	12444	100%	11863	100%	(836)	-7%
100-199 H	Small	2381	21%	1941	17%	1931	17%	2162	19%	1845	17%	(219)	-10%
	Sign.	9095	79%	9506	83%	9386	83%	8929	81%	9099	83%	(166)	-2%
	Total	11476	100%	11447	100%	11317	100%	11091	100%	10944	100%	(385)	-3%
200-499 H	Small	986	8%	794	7%	778	7%	885	8%	598	6%	(101)	-11%
	Sign.	10622	92%	10638	93%	10432	93%	10068	92%	10123	94%	(554)	-6%
	Total	11608	100%	11432	100%	11210	100%	10953	100%	10721	100%	(655)	-6%
500-999 H	Small	194	6%	154	5%	139	4%	157	5%	85	3%	(37)	-24%
	Sign.	3098	94%	3133	95%	3119	96%	3066	95%	3100	97%	(32)	-1%
	Total	3292	100%	3287	100%	3258	100%	3223	100%	3185	100%	(69)	-2%
>1,000 Ha	Small	204	8%	69	3%	77	3%	75	3%	30	1%	(129)	-172%
	Sign.	2365	92%	2344	97%	2328	97%	2318	97%	2319	99%	(47)	-2%
	Total	2569	100%	2413	100%	2405	100%	2393	100%	2349	100%	(176)	-7%
Total	Small	37680	47%	39169	48%	39345	49%	40639	51%	28582	41%	2,959	7%
	Sign.	42144	53%	42894	52%	41559	51%	39027	49%	40878	59%	(3,117)	-8%
	Total	79824	100%	82063	100%	80904	100%	79666	100%	69460	100%	(158)	0%

Source: Agricultural Statistics
Notes: 1. 1994 includes only farms registered for GST

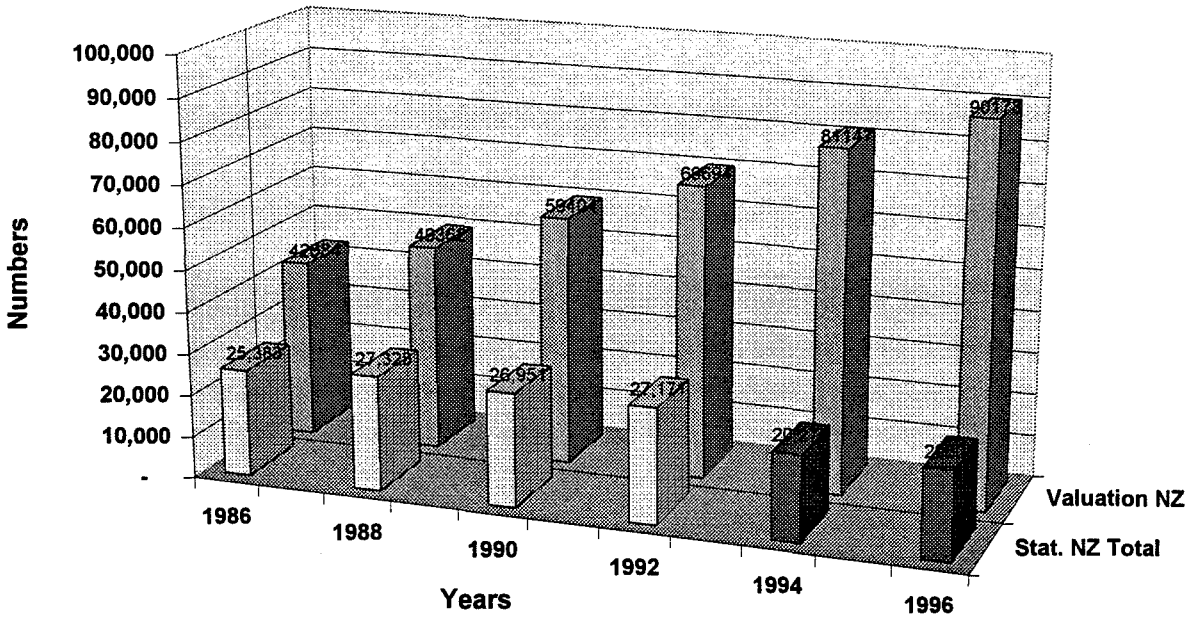
NUMBER OF SMALLHOLDINGS/LIFESTYLE BLOCKS 1980-1996



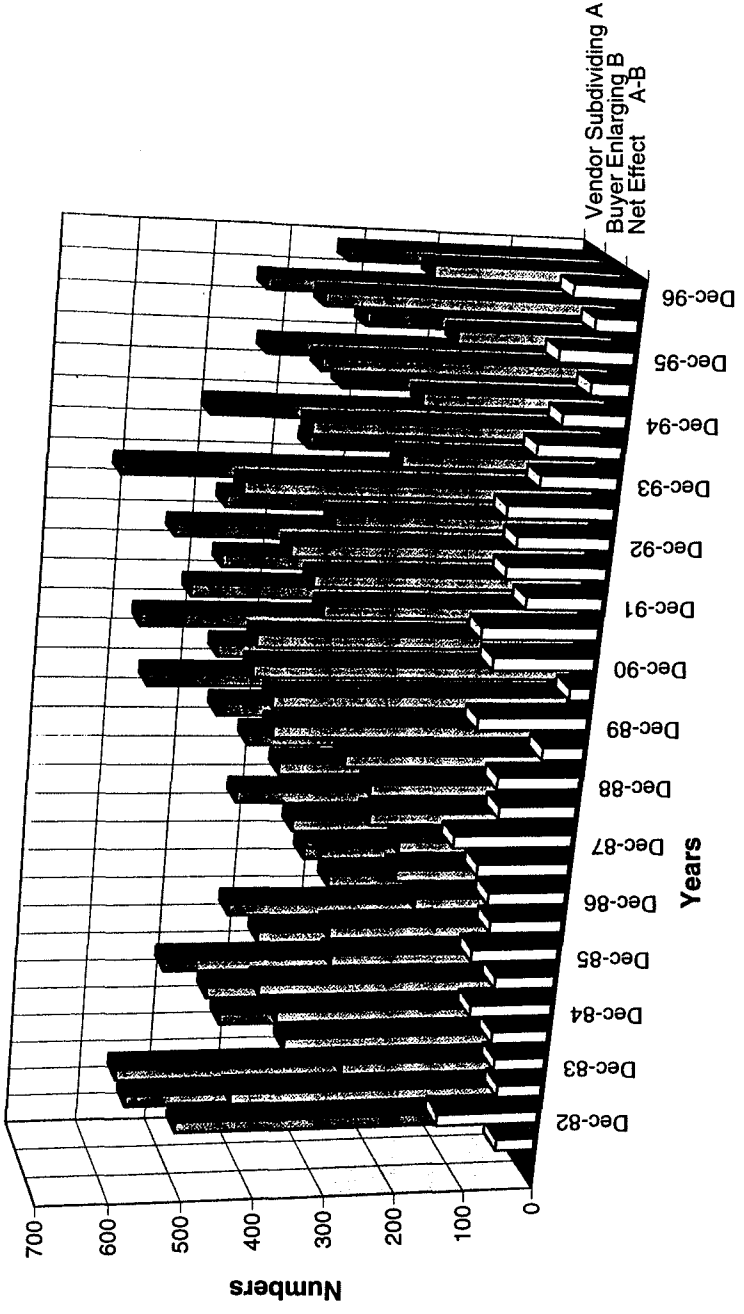
SOURCE: Valuation New Zealand

NOTES:
1) From 1980 to 1989 the data are from March and from 1990 to 1996 the data are from June.
2) "Other" includes land run in conjuction with smallholdings/lifestyle blocks.

FARMS LESS THAN 20 HA- STAT. NZ CF. VAL. NZ 1986-1996



NUMBER OF FREEHOLD OPEN MARKET SALES BY ENLARGING/SUBDIVIDING AND NET EFFECT JUNE 1992- DECEMBER 1996

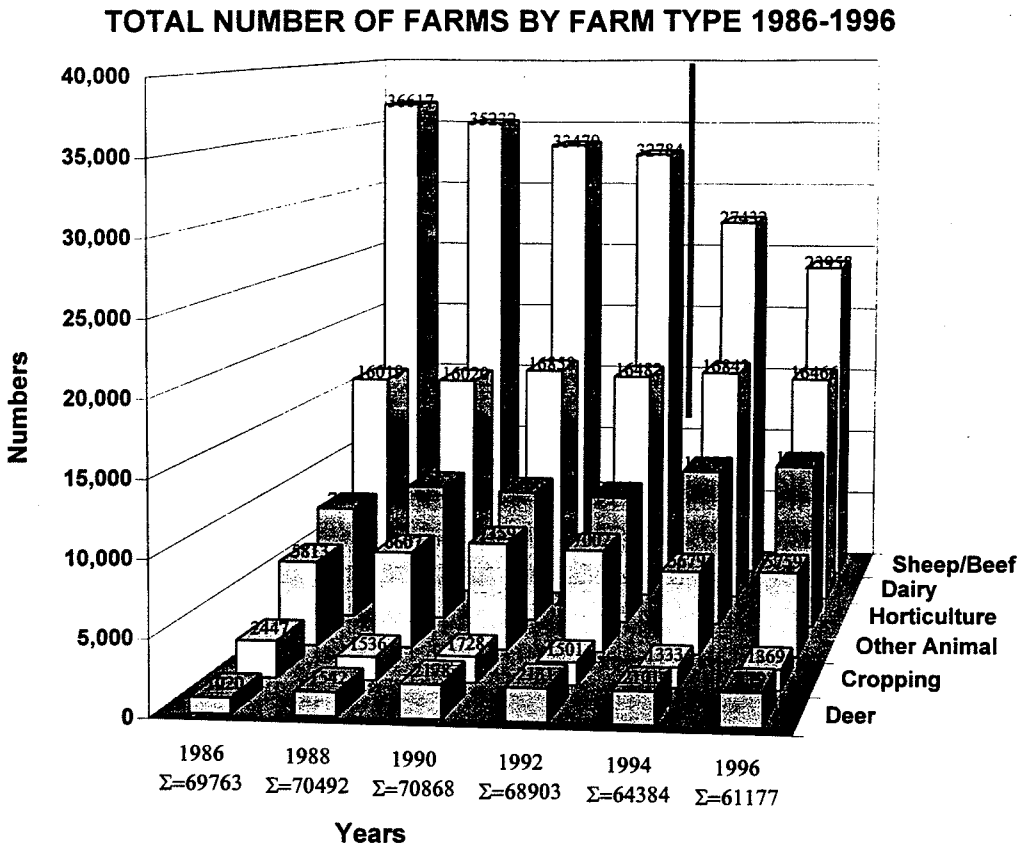


Comparison of EVAO 1992 vs 1994

EVAO Size Group	1992	1994	Difference
0	8,328	1,975	-6,353
1 to 5,000	12,396	5,846	-6,550
5,001 to 10,000	5,919	4,412	-1,507
10,001 to 15,000	3,631	3,203	-428
15,001 to 20,000	2,692	2,555	-137
20,001 to 25,000	2,140	2,072	-68
25,001 to 30,000	1,921	1,746	-175
Subtotal	**37,027**	**21,809**	**-15,218**
30,001 to 35,000	1,588	1,493	-95
35,001 to 40,000	1,562	1,590	28
40,001 to 45,000	1,268	1,303	35
45,001 to 50,000	1,183	1,268	85
50,001 to 55,000	1,183	1,202	19
55,001 to 60,000	1,171	1,240	69
60,001 to 65,000	1,142	1,118	-24
65,001 to 70,000	1,234	1,218	-16
70,001 to 75,000	1,157	1,301	144
75,001 plus	31,151	35,918	4,767
Subtotal	**42,639**	**47,651**	**5,012**
Total	**79,666**	**69,460**	**-10,206**

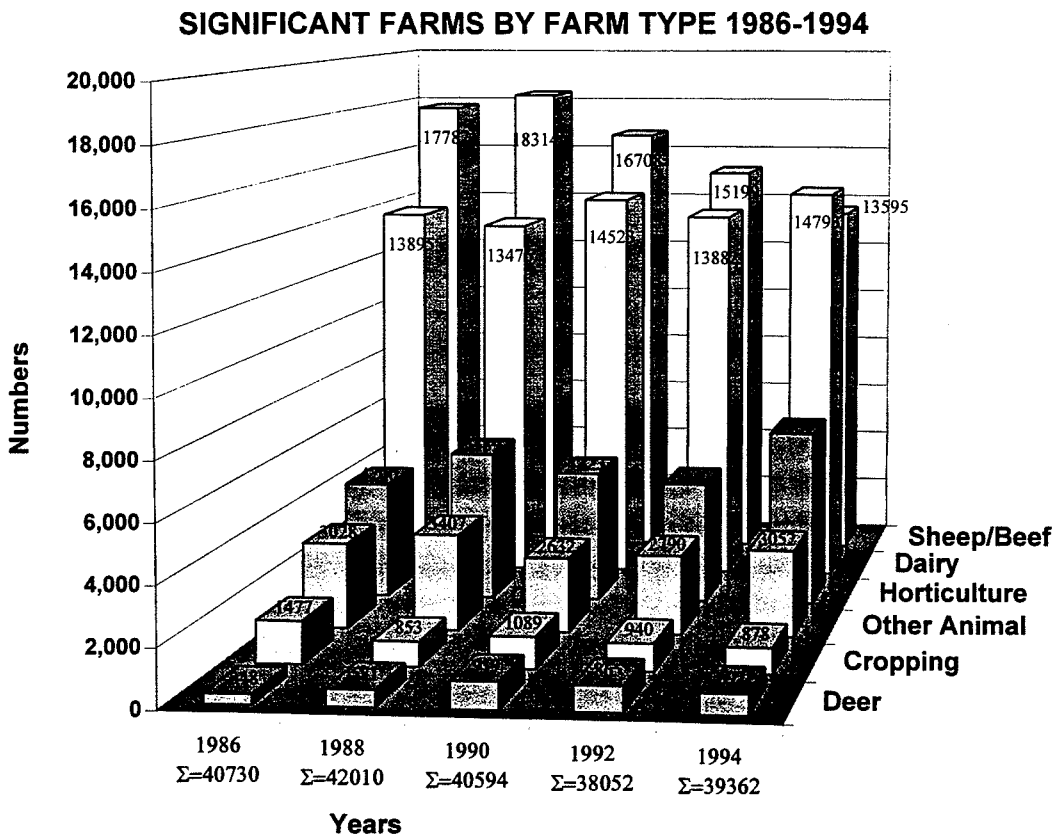
Source: Agricultural Statistics

CHT Total Farms by Farm Type



Source: Agricultural Statistics
Note: 1. Totals exclude "Other Land"

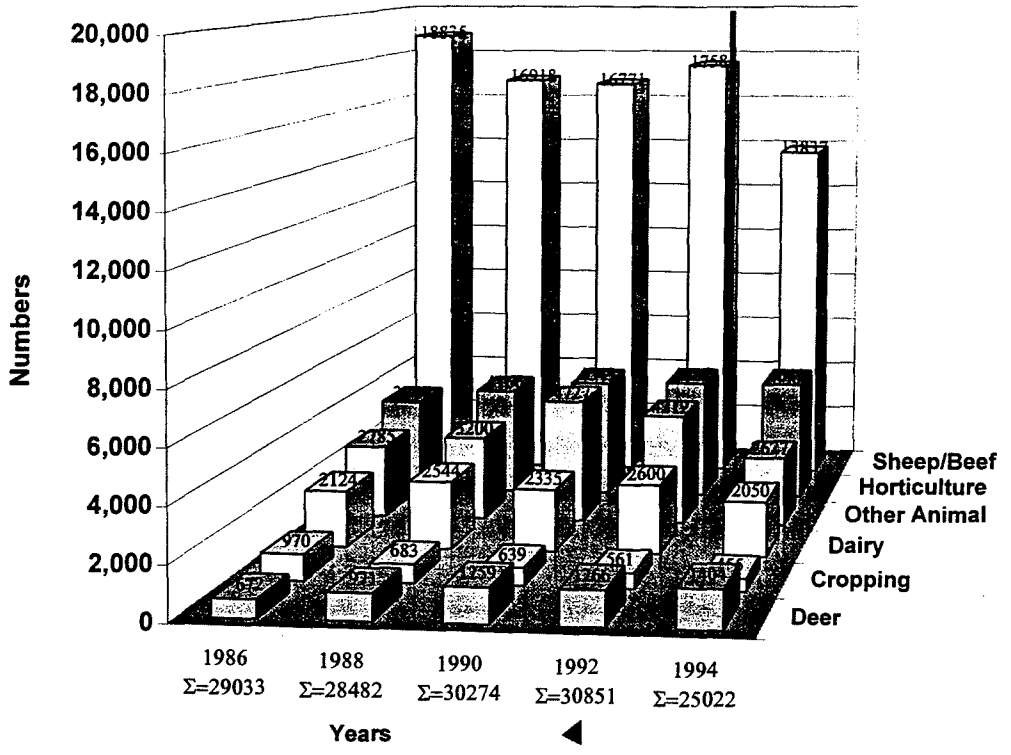
CHT Signif Farms by Farm Type



Source: Statistics New Zealand, Agriculture Census 1986, 1988, 1990, 1992, 1994.

CHT Small Farms by Type

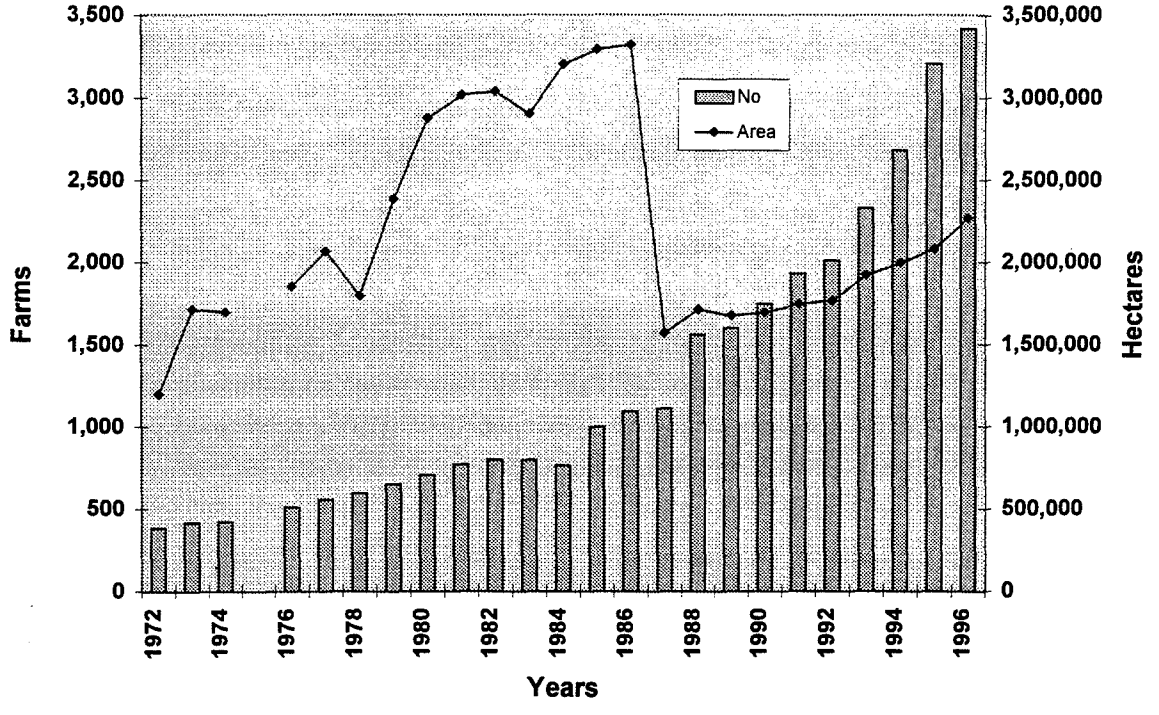
SMALL FARMS BY FARM TYPE 1986-1994



Source:Agricultural Statistics

CHT Plantations

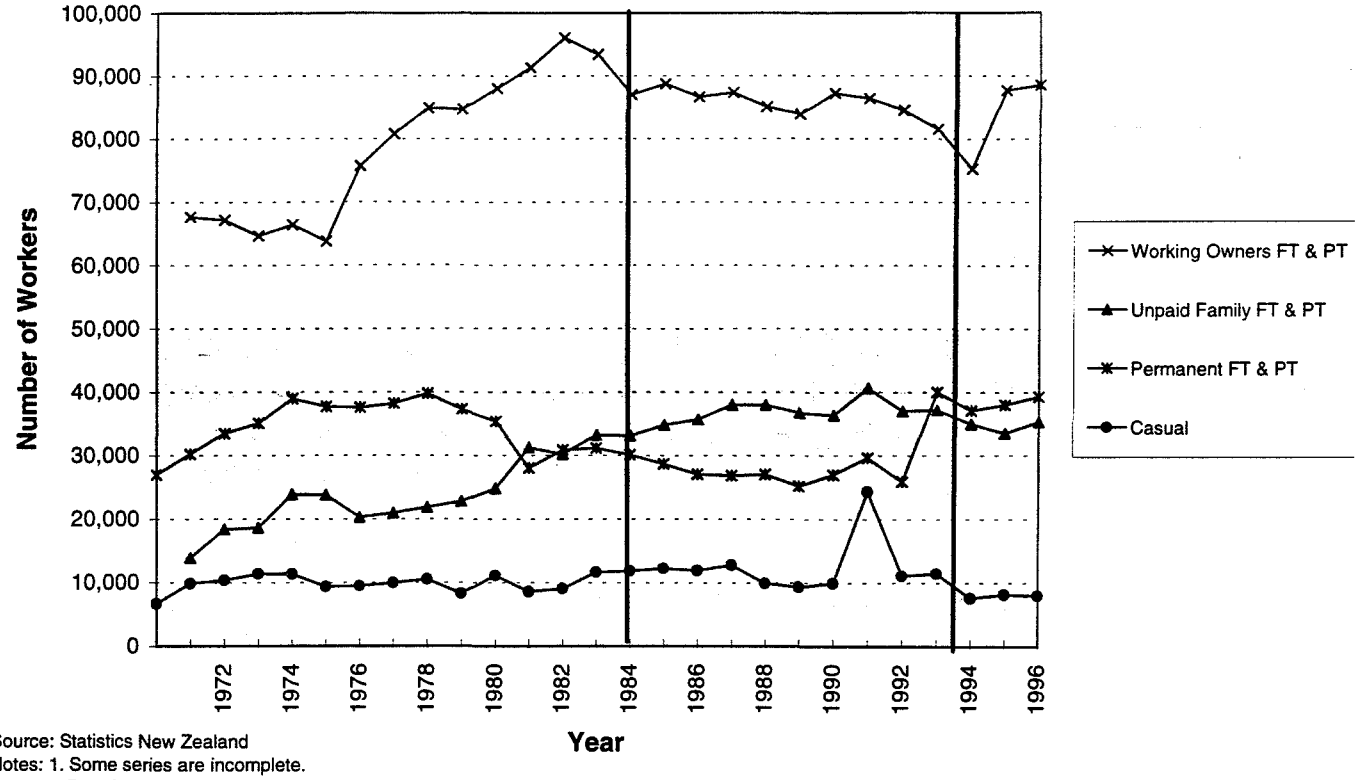
AREA AND NUMBER OF PLANTATIONS 1972-1996



Source: Agricultural Statistics
Note: 1. From 1987 3.5 million hectares mainly used for recreation or conservation now classified with DOC and not as agricultural land.

CHT Farm work-time

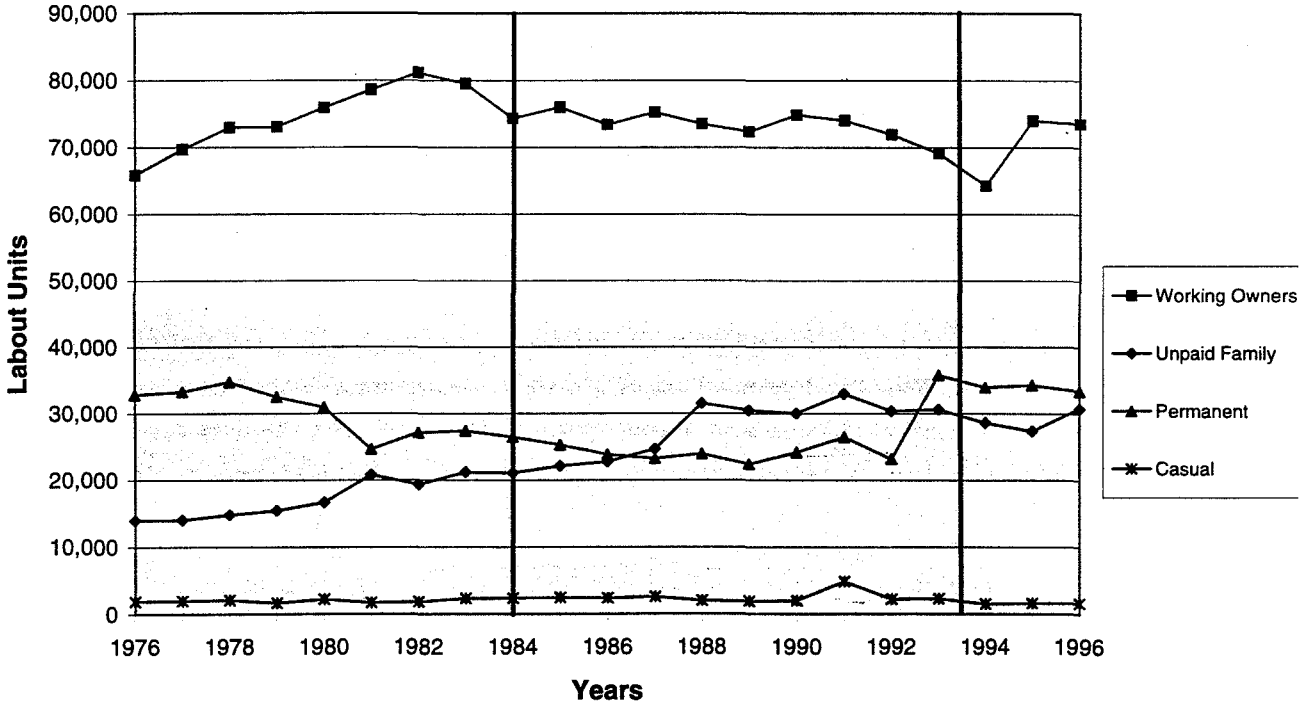
FARM WORKER CATEGORIES 1970-1996



Source: Statistics New Zealand
Notes: 1. Some series are incomplete.
2. Data for unpaid family members adjusted 1988 to 1996.

CHT Work Comp In LU (lines)

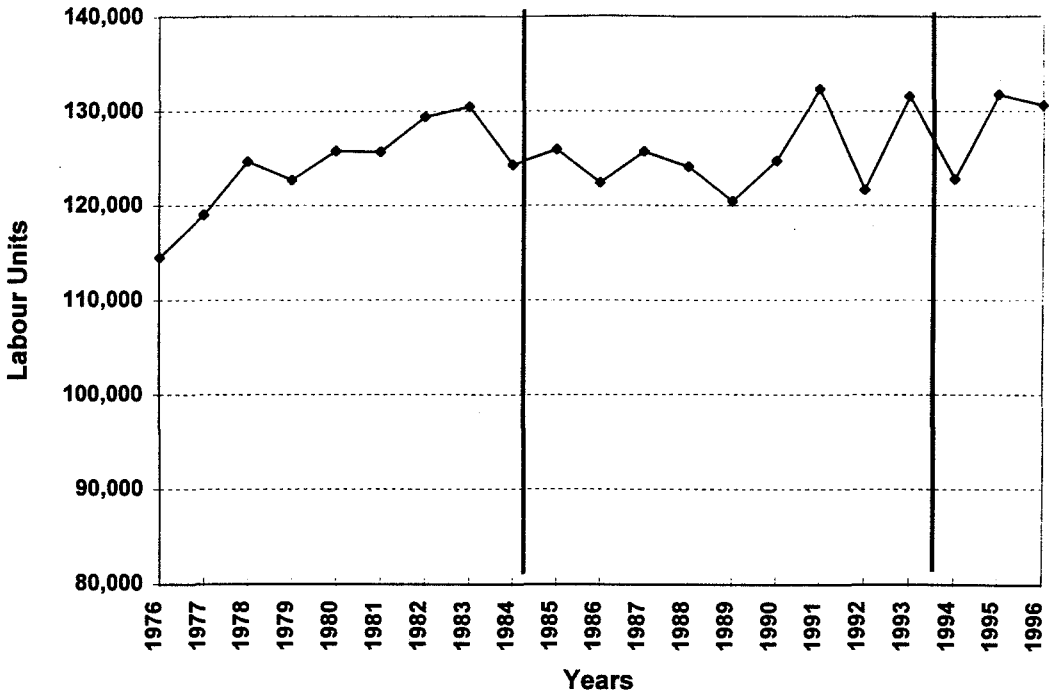
FARM WORK CATEGORIES IN LABOUR UNITS 1976-1996



Note: Labour Units as: FT=1.0, PT=0.5, Casual = 0.2

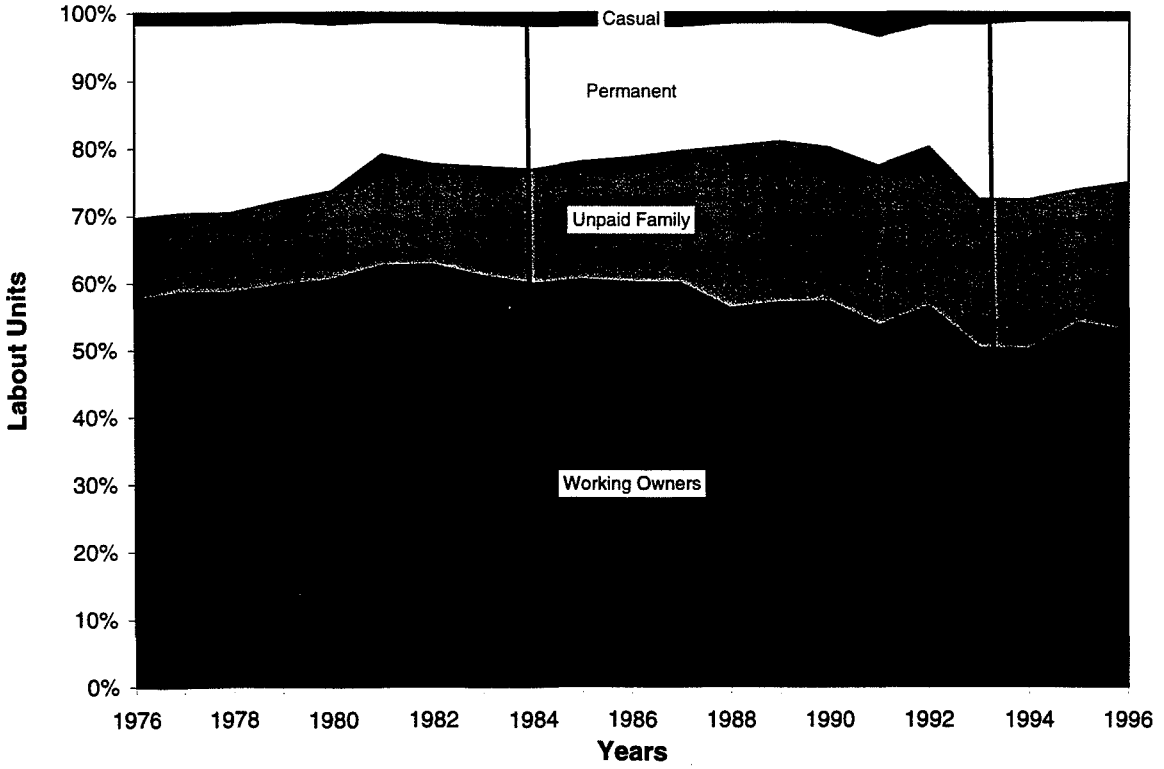
CHT Total LU

TOTAL EMPLOYMENT IN LABOUR UNITS



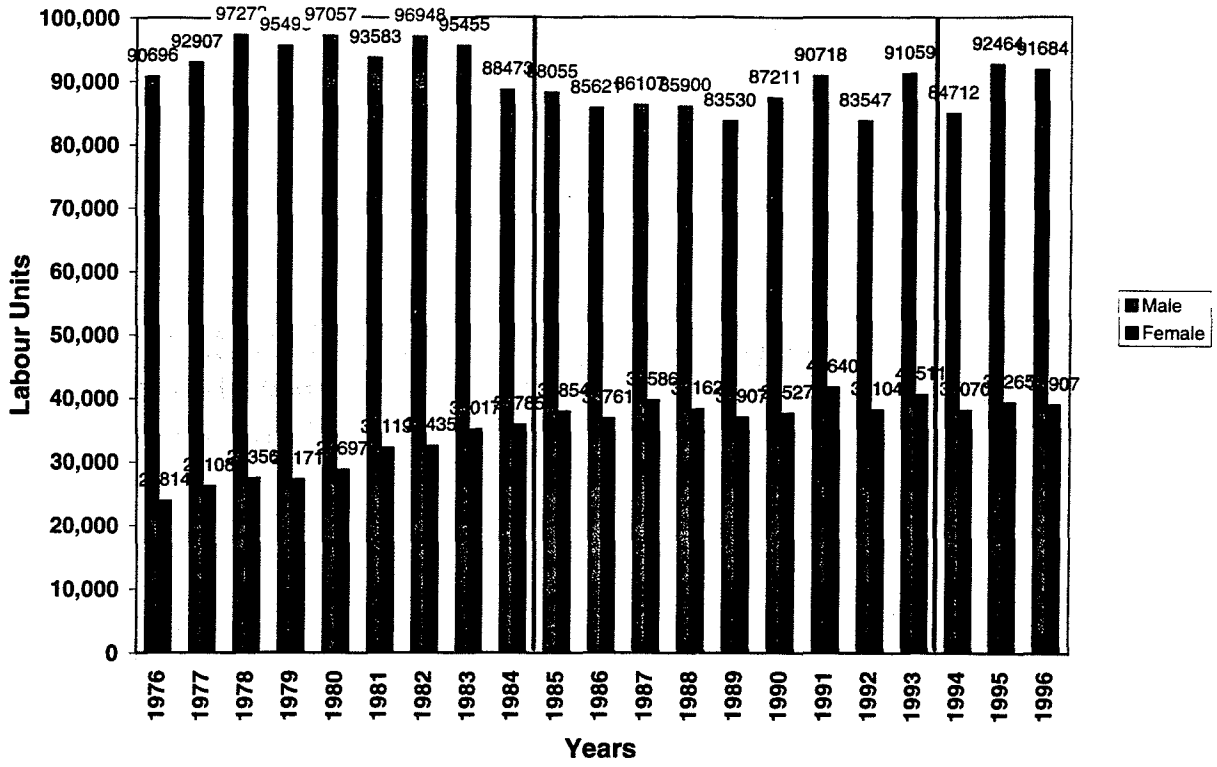
CHT % Work Compos In Lab Uni

PROPORTIONS OF FARM WORK CATEGORIES IN LABOUR UNITS 1976-1996



CHT Total Labour in Lab Units

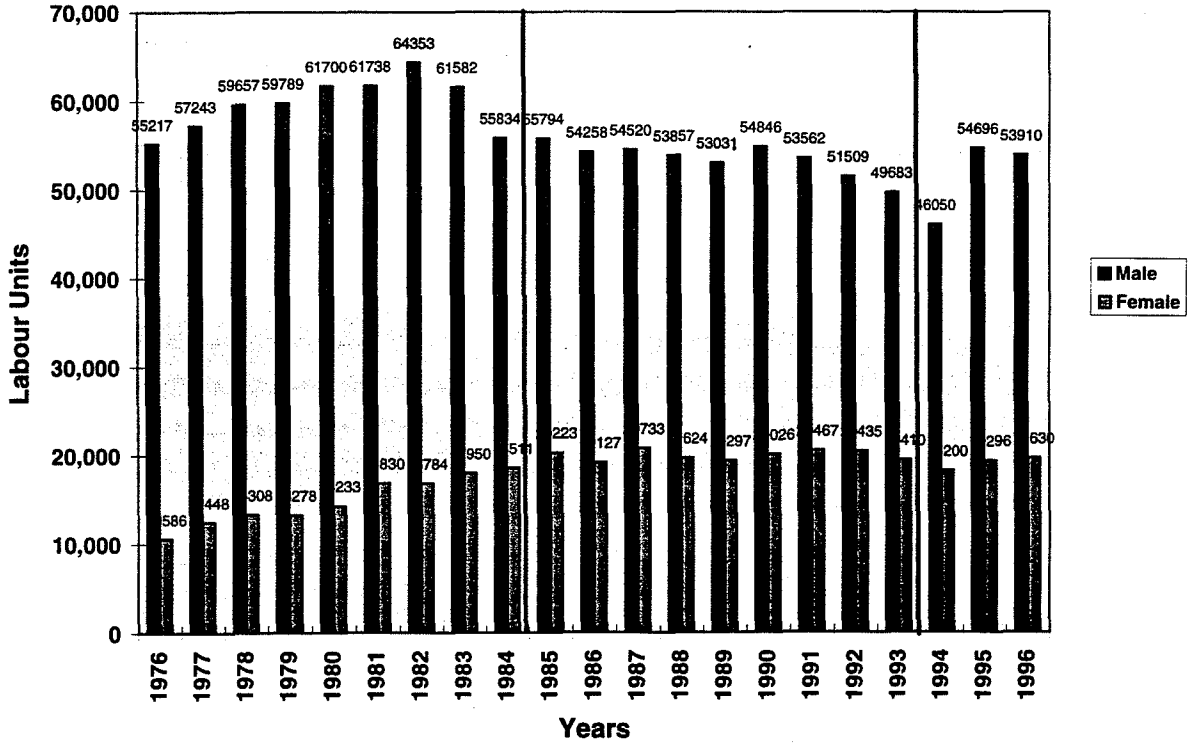
TOTAL EMPLOYMENT IN LABOUR UNITS BY GENDER 1976-1996



Note: Labour Units as: FT=1.0, PT=0.5, Casual = 0.2

CHT Owners Work FT&PT LU

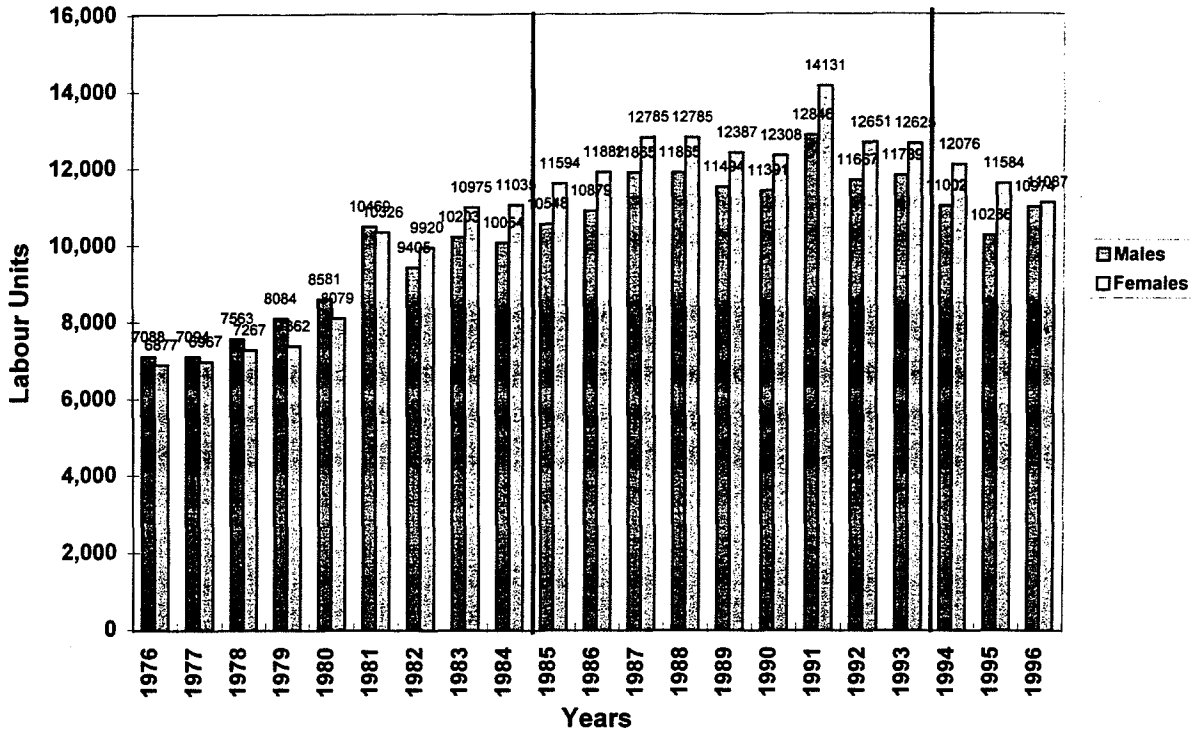
TOTAL WORKING OWNERS IN LABOUR UNITS BY GENDER 1976-1996



Note: Labour Units as: FT=1.0, PT=0.5, Casual = 0.2

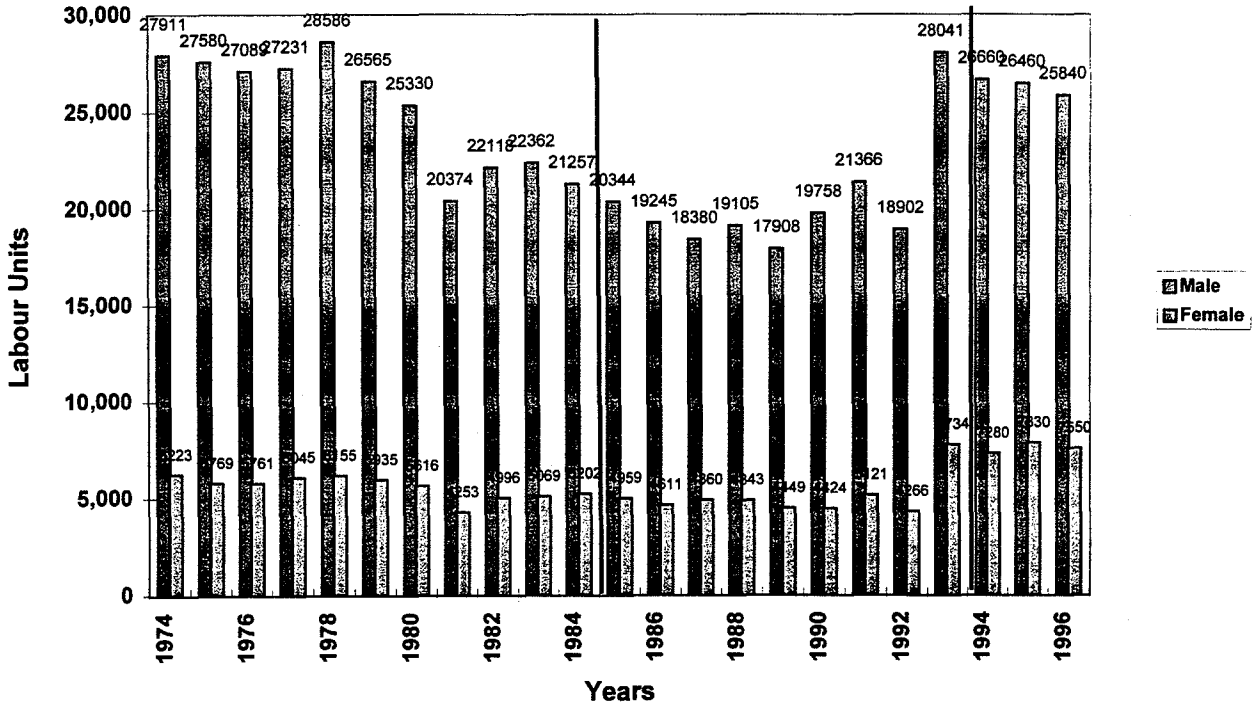
CHT Unpaid Fam FT&PT in LU

TOTAL UNPAID FAMILY IN LABOUR UNITS BY GENDER 1976-1996



CHTPerman Wk in LU by Gender

PERMANENT WORK IN LABOUR UNITS BY GENDER 1974-1996



Note: Labour Units as: FT=1.0, PT=0.5, Casual = 0.2

KEY ELEMENTS FOR ACHIEVING NEW ZEALAND'S ENVIRONMENTAL GOALS

Jenny Boshier
Office of the Parliamentary Commissioner for the Environment

Address to the 1997 Annual Conference of the New Zealand Agricultural and Resoucre Economics Society, Blenheim 5 July 1997

New Zealand's environmental goals
To achieve New Zealand's environmental goals, we first have to articulate them. *Environment 2010* is the Government's medium term strategy for the environment. The goals in this document are ones that Government believes New Zealand can and should aspire to. They indicate a broad sense of direction and a state of environment to be aspired to overall.

The *Environment 2010* goals are:
- Managing our land resources;
- Managing our water resources;
- Maintaining clear, clean breathable air;
- Protecting indigenous habitats and biological diversity;
- Managing pests weeds and diseases;
- Sustainable fisheries;
- Managing the environmental impacts of energy services;
- Managing the environmental impacts of transport services;
- Managing wastes, contaminated sites and hazardous substances;
- Reducing the risk of climate change; and
- Restoring the ozone layer.

The purpose of the Resource Management Act is essentially a goal for New Zealand's environment. The purpose of this Act is to promote the sustainable management of natural and physical resources (s 5).

The Parliamentary Commissioner for the Environment's vision or goal for New Zealand is: *A healthy environment, highly valued by people and managed responsibly for the current and future benefit of all.* (Draft Strategic Plan 1997)

But New Zealand is more than a natural environment. It is a trading nation. A goal for us as a trading nation is found in Project 98. Their goals are:
- To lift the environmental performance of mainstream (food) producers through continuous improvement at lowest possible cost.
- To facilitate the winning of market preference for large volumes of eco-labelled produce.

New Zealand is also a tourist destination but there appears to be little recognition of the environment in their goals which are more related to visitor numbers.

Key elements to achieving our goals
The following key elements to achieving New Zealand's environmental goals have been derived from the Parliamentary Commissioner for the Environment's draft strategic plan. They are:
1. Responding to market demands for higher environmental standards;
2. Value of environmental monitoring;
3. Development of environmental plans and policies;
4. Environmental literacy in the community; and
5. Adequate legislation

Responding to market demands for higher environmental standards
- the need to invest in environmental management. Good environmental management is too frequently seen as a cost to New Zealand. If New Zealand is to continue as a supplier of quality foods and fibres then we must regard investment in environmental management as an asset building process.
- who is demanding higher environmental standards? Consumers, supermarkets in the US and the UK and a farmers' union in the UK are promoting higher environmental standards in food production.

For example the demand for organically grown food is growing. The U.K.market for organic food was £40 million in 1987 and £150 million in 1994. Premiums for milling wheat, vegetables and milk are well established in the UK and a premium for meat of up to 20% is developing (NFU Newsletter March 1997).

Value of Environmental Monitoring
Environmental monitoring refers to both monitoring of the natural environment and the business environment. Companies need to know:
- their impacts on the use of natural resources;
- their impacts on the business environment; and
- the strategic risks to the business.

Strategic monitoring information includes:
- what are our market trends internationally?
- what are farmers in our overseas markets doing?
- New Zealand's Environmental Quality Assurance: Project 98
- New Zealand State of the Environment report
- OECD environmental performance review of NZ

Development of environmental plans and policies
This is a core part of doing business:
- the public sector is leading edge in New Zealand for environmental reporting eg. WaterCare Services Ltd and ECNZ.

the private sector is faring badly in environmental reporting. It is 13th out of 13 countries in the KPMG Survey (International Survey of Environmental Reporting KPMG March 1997)

Local authority plans and policies are part of the overall monitoring framework. The RMA has mandated the development of some plans and policies and enabled the development of others.

Environmental literacy in the community
Most essential for the community which includes businesses, public authorities, politicians, citizens to understand the ecological basis for environmental management. There is a lack of environmental education in New Zealand. Do New Zealanders understand environmental issues? A survey conducted in 1994 (Gendall and Russell, 1994) found that:

"Knowledge (scientific) has relatively little to do with age or sex, but everything to do with education. People with higher levels of education have a greater understanding of science."
and
"50 percent of respondents believed that all-man made chemicals can cause concern if you eat enough of them ... 30 percent thought that all pesticides and chemicals used on food crops cause cancer in humans".

Adequate legislation
Adequate legislation is needed to ensure we have a cohesive and consistent framework within which to conduct business. There are many acts that are concerned with environmental management including: the RMA, Fisheries Act, HSNO, and Local Government Act.

Conclusion
We need to be clear on New Zealand's environmental goals and the way environment underpins our economic and social goals.
There are some key elements for achieving New Zealand's environmental goals which have been outlined in this address.
The business sector is a key deliverer of environmental management results.

KEY ELEMENTS FOR ACHIEVING NEW ZEALAND'S ENVIRONMENTAL GOALS

Jenny Boshier

OFFICE OF THE PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT

5 July 1997

Office of the
PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT

ENVIRONMENT 2010

Goals Government believes New Zealand can and should aspire to

They indicate a broad sense of direction and a state of environment to be aspired to overall

ENVIRONMENT 2010 GOALS

- **Managing our land resources**
- **Managing our water resources**
- **Maintaining clear, clean breathable air**
- **Protecting indigenous habitats and biological diversity**
- **Managing pests weeds and diseases**

- **Sustainable fisheries**
- **Managing the environmental impacts of energy services**
- **Managing the environmental impacts of transport services**
- **Managing wastes, contaminated sites and hazardous substances**
- **Reducing the risk of climate change**
- **Restoring the ozone layer**

RESOURCE MANAGEMENT ACT

The purpose of this Act is to promote the sustainable management of natural and physical resources

Section 5(1)

PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT

OUR VISION

A healthy environment, highly valued by people and managed responsibly for the current and future benefit of all.

(Draft Strategic Plan 1997)

PROJECT 98

To lift the environmental performance of mainstream (food) producers through continuous improvement at lowest possible cost.

To facilitate the winning of market preference for large volumes of eco-labeled produce.

KEY ELEMENTS

1. **Responding to market demands for higher environmental standards**

2. **Value of environmental monitoring**

3. **Development of environmental plans and policies**

4. **Environmental literacy in the community**

5. **Adequate legislation**

KEY ELEMENT

1. **Responding to market demands for higher environmental standards**

   - **need to invest in environmental management**

   - **who is demanding higher environmental standards?**

1. Responding to market demands for higher environmental standards

Organically grown food.

- The U.K.market for organic food
  £40 million in 1987
  £150 million in 1994

- Premiums for milling wheat, vegetables and milk are well established

- Premium for meat of up to 20% is developing

1. Responding to market demands for higher environmental standards.

Who is demanding/promoting organic food

- consumers

- supermarkets

- the National Farmers Union of England and Wales

KEY ELEMENT

2. Value of Environmental Monitoring

- **what are the impacts on the use of natural resources**
- **what are the impacts on the business environment**
- **what are the strategic risks to the business**

- **what are our market trends internationally?**
- **what are farmers in our overseas markets doing?**
- **New Zealand environmental Quality Assurance: Project 98**
- **New Zealand State of the Environment report**
- **OECD environmental performance review of NZ**

KEY ELEMENT

3. Development of environmental plans and policies

- **the public sector is leading edge in New Zealand for environmental reporting**

- **the private sector is faring badly in environmental reporting**

13th out of 13 countries in KPMG Survey

3. Development of environmental plans and policies

- **RMA has mandated the development of some plans and policies**

- **RMA has enabled councils to develop other plans and policies**

- **These are part of the overall framework**

KEY ELEMENT

4. Environmental literacy in the community

- **Community includes businesses, public authorities, politicians, citizens.**
- **Do New Zealanders understand environmental issues?**
- **Lack of environmental education in New Zealand**

Basic Science Facts: How much do New Zealanders know?

"Knowledge (scientific) has relatively little to do with age or sex, but everything to do with education. People with higher levels of education have a greater understanding of science."

Gendall and Russell, 1994.

Basic Science Facts: How much do New Zealanders know?

"50 percent of respondents believed that all man-made chemicals can cause concern if you eat enough of them .... 30 percent thought that all pesticides and chemicals used on food crops cause cancer in humans.

Gendall and Russell, 1994

KEY ELEMENT

5. Adequate legislation

RMA

Fisheries Act

HSNO

Transport

Local Government Act

SUMMARY

Need to be clear on New Zealand's environmental goals

There are some key elements to achieving these environmental goals

The business sector is a key deliverer of environmental management results.

Office of the
PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT

CONTRIBUTED PAPERS:

RURAL COMMUNITIES

SCIENCE / RESEARCH POLICY

CONSUMER DEMAND

AG SECTOR IMPORTS / MODELLING

Modelling Off-Farm Employment And Investment Decisions

A paper presented to the
New Zealand Agricultural and Resource Economics Society Conference, Blenheim
on 4 July, 1997

Irene Parminter
MAF Policy,
Hamilton

Abstract

A static labour demand and supply model for off-farm work is briefly described in this paper, along with the implications of the model for farm productivity and profitability, the adoption of innovation, stress, and health and safety. Case studies are used to test the implications. The results suggest that a static model based on the farm operator, is inadequate to describe farmer behaviour. A dynamic, farm family based model is proposed in the paper.

1.0 Introduction

A recent survey (Rhodes and Journeaux, 1995) found that more than 70% of New Zealand farms received income from off-farm work and/or investments in 1992/93, with the amount received ranging from an average of approximately $19,000 for dairy and sheep and beef farms (*cf* average gross profit from farming on these farms of $50,000 - $55,000), to an average of approximately $35,000 for kiwifruit properties (*cf* average gross profit from farming on the surveyed kiwifruit properties of nearly $17,000).

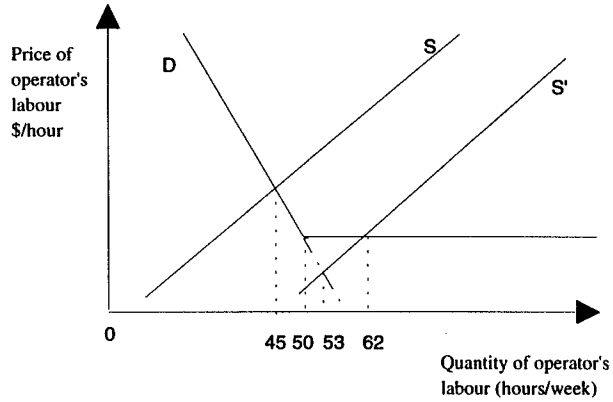
The survey by Rhodes and Journeaux provides a "snapshot" of the magnitude of off-farm income, but does not indicate whether the incidence and significance of off-farm income are increasing or decreasing. Time series data for off-farm income in New Zealand is not available, so a modelling approach is taken in this paper. A static model of off-farm income, as described by Parminter (1996) is briefly reviewed, and case-studies are used to explore the adequacy of the model. The results suggest that a dynamic model may be more appropriate.

2.0 The Static Model

The allocation by farmers of their labour and capital to off-farm enterprises may be understood in the context of a demand and supply framework. Economic theory suggests that the demand

curves for the operator's[1] labour and capital are kinked (Bollman, 1979; Parminter, 1996) (Figure 1).

Figure 1: Demand and supply curves for the operator's labour



If the supply curve cuts the demand curve to the left of the kink in the demand curve (S in Figure 1), then no off-farm work will be undertaken. If the supply curve cuts the demand curve to the right of the kink in the demand curve (S' in Figure 1), then some off-farm work will be undertaken. Supply curve S' in Figure 1 demonstrates the increase in total hours worked (from 53 to 62 hours per week in this hypothetical example), and the decrease in hours devoted to on-farm work (from 53 hours to 50), when off-farm work is undertaken after previously working only on the farm.

The same framework can be used to explain investment in off-farm enterprises (Parminter, 1996). The demand curve describes the demand for the owner's *capital*, which is available for investment either on-farm or off-farm. It follows that a kink in the demand curve exists for these investment funds. The kink occurs where the return from off-farm investment is equivalent to the return from on-farm investment.

[1] The same analysis can be applied to the spouse's labour and capital, ie, the spouse is also able to work either on- or off-farm, or both, and a demand curve is able to be constructed for their labour and capital.

3.0 Implications of the Model

3.1 Implications for National Trends in Off-farm Income

The agricultural sectors of other developed economies have experienced the same trends towards the substitution of capital for labour and declining primary product prices as New Zealand. The increase in reliance on off-farm work predicted by the model under these circumstances has in fact been documented in the US, Canada, Sweden, France and Japan (Gasson, 1988). However, time series data on off-farm work is not currently available in New Zealand.

3.2 Implications at the Farm Level

The model can also be used to predict the effect of engaging in off-farm work on the farm. As illustrated in Figure 1, the model suggests that engaging in off-farm work results in a reduction in the number of hours spent working on the farm by the operator, and an increase in the number of hours worked in total. Parminter (1997, in press) notes that such changes have implications for (*inter alia*):

3.2.1. Output from the farm: as hours of labour devoted by the operator to farm work fall, output from the farm would also be expected to fall. However, off-farm earnings may be invested on-farm, resulting in maintained or increased output.
3.2.2. Adoption of innovation: as the operator works longer hours in total after taking on off-farm work, they may be less interested in adopting labour-intensive production-enhancing innovations, but may adopt suitable labour-saving innovations.
3.2.3. Stress and social participation: longer working hours seem likely to increase stress levels and reduce social participation by the operator.
3.2.4. Health and safety: longer working hours and driving to and from work may increase the risk of accidental injury or death.

These issues are explored in a case study context in section 4.

4.0 Farmers with Off-farm Work: Seven Case-studies

In order to compare the implications of the model at farm level with farmer experience, seven farming families were interviewed as case-studies.

Off-farm investment was not directly investigated, but the case studies highlight some interesting aspects of these farmers' investment decisions.

4.1 Methodology

Case studies are a form of qualitative research. Qualitative methods such as case-study

research, are useful for their ability to address process and to reconceptualise the unquestioned or the taken for granted (Opie, in Davey et al, 1994). They add depth, detail and meaning to the results of quantitative research, such as the survey of off-farm income conducted by Rhodes and Journeaux (1995). However, definitive conclusions cannot be drawn from qualitative research, only indicative trends, ie, the results cannot be *generalised* without reference to quantitative research, or other sources of validation (using the process of triangulation (Stake, 1995)). However, useful and policy relevant conclusions are able to be drawn from case-studies, especially when combined with other sources of data (Patton, 1990).

In this instance, seven information-rich cases were purposefully selected (Patton, 1990). The study was narrowed to sheep and beef farmers who had recently taken on off-farm work, to obtain a degree of homogeneity[2]. Within that group, a range of situations and locations[3] was selected in order to provide maximum variation. This process provides central themes that cut across a variety of circumstances (Patton, 1990).

The interviews were conducted during December 1996 and January 1997, using a semi-structured questionnaire. Where possible, both husband and wife participated in the interview.

4.2 The Case Study Farms

All seven of the case-study farms were sheep and/or beef farms in the upper half of the North Island, and had off-farm income (both partners combined) exceeding $20,000 per year. In all seven cases, both husband and wife worked off the farm, although not all worked full-time, and not all worked throughout the year. Important features of the farms are summarised in Table 1. In order to preserve the anonymity of the farms, they have been designated as Farm A, farm B etc. The farms are described in more detail in Parminter (1997, in press).

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2 However, it eventuated that two of the farmers had worked off the farm for some time. These farmers were nonetheless interviewed, and provided helpful insights.

3 All the farmers were located in the upper half of the North Island.

Table 1: Features of the Case Study Farms

	A	B	C	D	E	F	G
Number of stock units (s.u.) and nature of farm	3000 s.u., S&B Moderate hill country	1000 s.u., S&B Moderate hill country	4000 s.u., (run by 2 families[5]) S&B, deer &dairy grazers, forestry Moderate hill country	3000+ s.u., S&B& deer Moderate hill country	4000+s.u., S&B Hard hill country	2000+s.u., S&B plus stud sheep, forestry Moderate hill country	200 s.u. beef fattening Easy hill country 250 s.u.[5] dairy grazing on leased block.
Stage of development	Fully developed. and grassed	Partly developed. 1/4 bush.	Partly developed. 40% bush	Fully developed and grassed	Partly developed 20% bush & scrub	Fully developed and grassed	Fully developed and grassed
Stage in life	No dependent children	Children at university	Primary school age children	High school age child	Pre-school age child	High school age children	No dependent children
Type of off farm work[6]	m. professional	m. professional, related to agriculture	m. professional, related to agriculture	m. professional	m. farm work	m. agricultural processing	m. agricultural contractor
	f. clerical	f. professional	f. professional	f. manager	f. professional	f. professional	f. manager
Off-farm work decision	late in farm career, partly a forced decision	purchased farm expecting to work off-farm	purchased farm expecting to work off-farm	voluntary decision, aims to serve community	purchased farm expecting wife to work off-farm, not husband	late in farm career, a forced decision	purchased farm expecting wife to work off-farm, not husband

4 Only one of the families was interviewed. The family that was not interviewed are at a similar stage in life to the interviewed family, but only the male partner works off-farm.

5 The leased block had formerly supported 350 beef cattle stock units.

6 In this row, the abbreviations m. and f. refer to the male and female partners in the farming family interviewed.

4.3 The Case Study Farmers' Responses

Details of the case-study farmers' responses are presented in tabular form in the appendix, and summarised in the following sections.

4.3.1 Off-farm Work and the Productivity and Profitability of the Farm

The static model described in section 2 suggests that engaging in off-farm work will reduce the amount of time spent working on the farm, and therefore the output and income generated by the farm.

The effect of off-farm work on the case-study farms' labour inputs, output and income is summarised as follows:

- On all seven case study farms, the total labour input to the farm by the farm family had declined as a result of off-farm work. However, hours worked *in total* had increased, as predicted by the static model.
- In three of the seven cases (Farms A, D, and F), gross farm output in dollar and volume terms had clearly declined as a result of taking on off-farm work. On farms A and D sheep numbers had been reduced, and on farm F, lambs were sold store rather than fat.
- In one case (Farm G) output from the land had been maintained by leasing some of the land out to another farmer. The stock type carried on the leased block had changed from beef to dairy cattle, and the stocking rate had fallen. It is likely that the output in dollar terms from the leased block had improved, given the current relative profitabilities of beef and dairy farming.
- In one case (Farm E) output had been maintained because of the seasonal nature of the off-farm work, and to some extent, because of the compensating effect of employing a labour unit
- Farms B and C are somewhat different to the others in that the farmers have always worked off the farm. In the case of Farm C, the farmers felt they would intensify production if they were not working off the farm, whereas the farmers on Farm B would not.
- On farms A, C, E and F, extra farm contracting and labour costs have been incurred, to compensate for the reduction in labour hours applied by the farmers.
- In the short term, net farm income from all the case study farms except Farm B is lower because of off-farm work, as a result of reduced output and/or increased costs

- In the long term, the use of off-farm income for farm operating costs and development on all the case study farms except Farm A, may result in higher output and net farm income from these farms than would otherwise have been the case, as illustrated by the historical performance of Farm B[7].
- Off-farm work did not seem to affect the amount of time spent on management tasks in any systematic way on the case-study farms.

In brief, all seven case study families devoted fewer hours to working on the farm because of their off-farm jobs, and most had developed strategies for reducing their on-farm workload, including reducing stock numbers, changing stock policies to stock classes or types requiring lower labour inputs, the use of contractors, the employment of labour, and leasing land to another farmer. Some of these strategies reduce physical production, and all tend to reduce the profitability of the case study farms. However, these short term effects are likely to be offset in the long run by the use of off-farm income to maintain or develop six of the seven farms - expenditure which would not have occurred without off-farm work. For example on Farm B, the farmers viewed the productivity improvements they had been able to achieve through the investment of off-farm income in farm development, as a personal triumph. Similarly, on Farm C, the farmers viewed their off-farm jobs as the factor which enabled them to continue to farm and improve the land, which they were personally very attached to.

A further productivity implication of off-farm work on the case study farms is implied by the frustration of the two younger farmers in the study, at their inability to allocate sufficient time and energy to farm development. Farm development which is not carried out while the farmers are relatively young, is less likely to be completed when the farmer is older and less physically energetic and able-bodied. However, farm development may be carried out by contractors when the farmer is older, if the farmer has sufficient disposable income.

4.3.2 Adoption of Innovation

As all seven case study farmers were working longer hours in total after taking on off-farm work, it seems reasonable to expect that they would not be interested in adopting labour-intensive production-enhancing innovations, but would quickly adopt labour saving innovation.

However, the case study farmers' answers to the questions posed about adoption of innovation illustrate the complexity of the relationship (if any) between off-farm work, and the adoption of innovations. On three of the five farms where the male partner[8] had off-farm work that was both related to agriculture in some way, and provided useful information, production-enhancing/labour-intensive innovations were being adopted despite time constraints. Only one farmer (Farm F) reported no effect of off-farm work on the adoption of innovations as assessed by proxy measures (attendance at field days and use of consultants), and the direct questions on the subject.

7 Five of the seven farmers stated that they would not give up off-farm work even if the farm fully supported the family (i.e, for these farmers, off-farm work was not seen solely as a temporary measure to provide income for farm development).

8 In all cases where off-farm work provided access to information that was useful on the farm, it was the male partner's work that provided the information. This may partly be explained by the non-agricultural nature of the female partners' jobs on the case-study farms.

4.3.3 Stress

As the case study farmers devote increased amounts of time to work (on- and off-farm combined), it is reasonable to expect that the farmer and the farm household will experience increased stress levels, and reduced social participation rates. If stress reaches a critical level, changes will be instituted by the farming household. These changes may have productivity implications, or may result in the sale of the farm and the loss of the farmer from the industry (with the accompanying loss of human capital). Similarly, if farming families reduce their participation in recreation, sport, family activities, and voluntary and community work in response to time pressure, the social fabric of rural areas is weakened. In the long term, this may make remote rural areas less attractive as places to live and work.

The case study farms showed a range of responses to the questions on stress and social participation. For two of the seven case study farmers the reduction in financial difficulties and the challenge of the off-farm job more than compensated for the time and energy requirements. However, in five of the seven cases, increased stress was experienced by the family[9] as a result of off-farm work. The reasons varied, but all of those reporting increased stress mentioned tiredness and lack of time as sources of stress. One farmer reported frequent acute fatigue because his job involves night shift work. Sleeping in the morning sometimes proved impossible because of the demands of running the farm business. This situation was perceived as unsustainable by the farming family, and alternative options for the future were being considered[10]. Although farm sale was being considered[11], the farmer was not planning to leave farming completely, but to downsize the farming enterprise, so the industry would not completely lose the farmer's accumulated human capital. Another factor exacerbating this situation was that the farmer felt forced into off-farm work - the farm is a family farm that had previously supported a number of generations of the family, and the necessity for off-farm work had not been part of the family's expectations. The case study farmers who had not *expected* to work off the farm when they purchased it, and felt forced into the decision, were the most obviously stressed, especially where the farming system had not been adapted in a planned manner to reduce the farmers' labour input. One farmer remarked on the sense of failure when the farm he had worked on for nearly thirty years of his life ended up as a business that was unable to support his family in the manner which he had strived for. On the other hand, stress appeared to be at more manageable levels on the case study farms where the family had expected to work off the farm from the time of purchase,

9 In two cases (Farms E and F), the farmers volunteered the information that the female partner was happy to be working off the farm, and this may have been the case for some of the other female partners as well. However, on Farm A, the female partner would prefer not to work off the farm.

10 By March 1997 the family had leased all but 50 ha of the farm, and were renting a home in the town where both partners work.

11 It is ironic that the farmer's children were enthusiastic about farming as a career, but were unlikely to be able to inherit the family farm, whereas anecdotal evidence suggests that many farmers with viable farms find that their children are not interested in farming as a career.

and/or where adjustments to the farming system had been made before off-farm work was taken on.

A significant source of stress for four of the farmers was a sense of frustration that the farm was either deteriorating, or not progressing fast enough, because of insufficient time and/or labour that the farmer was able to put into the farm.

In four of the seven farms, social participation had decreased as a result of off-farm work. On one farm, social participation had increased, because part of the farm has been leased out, reducing both stress and time pressure.

4.3.4 Health and Safety

One of the characteristics of farms is that they tend to be physically isolated from towns and cities where off-farm work is most likely to be available. The state of the roads used to travel to work may therefore be an important factor governing the decision to work off-farm. Farming is also a high-risk profession for accidents, and off-farm work may have an impact on farmers' susceptibility to accidents.

Despite driving some long distances to off-farm work in some cases, roading was not a particularly important issue to the case study farmers, with five of the seven experiencing no real problems with travel[12]. However, the three farmers who travelled the furthest were concerned at the possibility of car accidents, especially as they drove when tired after work. Two of the farmers were concerned at travelling over unsealed portions of the road.

Health and safety implications were considered an issue by two of the seven case study farmers, where the off-farm work carries relatively high levels of injury risk, and on three of the farms where particularly long distances are travelled. Although the farmers themselves were not particularly concerned about health and safety aspects of off-farm work, the reported levels of fatigue combined with driving long distances and operating agricultural machinery on the farm, suggest that health and safety is likely to be an issue associated with off-farm work.

12 Travelling to the farms in order to conduct this study entailed, in some cases, a long and difficult drive. It is surprising that more difficulties were not expressed by the farmers.

6.0 Conclusions

The seven case studies illustrate some shortcomings of the model that may limit its adequacy as a predictor of farmer decision making:

- Non-monetary factors: for example, the farmer may prefer to work on the farm, and/or invest in the farm, despite lower returns.
- The unit for decision-making: the decisions to work off the farm by the principal farmer and the spouse may not be independent ie, the decisions are made jointly (Huffman and Lange, 1989; Kimhi and Lee, 1996). A more complex farm household model may be required to describe off-farm work decisions if this is the case.
- Dynamic aspects of off-farm income: the stage in life of the farm family[13], and investment of labour or capital in the farm in the expectation of a future pay-off, are not automatically captured in the static model.

The static model described in section 2 suggests that farmers will work and invest off their farms if the return (at the margin) is higher. In relation to off-farm *work*, the model suggests that the hours devoted to on-farm work, and farm output, will fall as a result of engaging in off-farm work, and that total hours worked are likely to increase. The case study farmers followed the decision processes described by the demand and supply model to some degree. Six of the seven farmers were working off the farm because they were aware that they earned more by doing so[14]. However, non-monetary factors were also very important to the case study farmers.

All the case study farmers worked longer in total, and fewer hours on-farm, as a result of off-farm work, as described by the model. However, in only three of the seven cases has output clearly declined in the short term, and in the longer term, output from six of the seven farms is likely to be higher as a result of off-farm work. The case study farms illustrate an aspect of farmer decision making that has not been captured by the static model. The case study farmers were all either substituting other inputs (eg, employed labour, contractors) for their own labour, or investing off-farm earnings back into the maintenance or development of their farms, or both. These strategies are able to strongly offset any decline in output generated by the farmers' reduced labour input. The survey by Rhodes and Journeaux (1995) supports these findings. Of the respondents, 35% were employing more labour as a result of working off the farm, and 22% were using off-farm income for farm expenses[15] (debt servicing, farm working and/or development expenditure). Only 32% considered that their off-farm income was unimportant for the farm *business* (rather than the farm *household*).

13 Some research points to an inverted U shaped relationship between age and off-farm work ie, the farmer is likely to increase the hours devoted to off-farm labour up to a certain age, and then decrease them (Robinson et al, 1982; Kimhi and Lee, 1996).

14 The seventh (farm D) was also aware that he earned more off-farm than on-farm, but his *motivation* for working off-farm was entirely non-monetary.

15 A further 60% were using off-farm income to support personal drawings, household expenses and education, expenses which may have been drawn at least in part from the farm if they were not supplied from off-farm income.

In order to capture the relationships between off-farm income and investment in/output from the farm, and between investment in the current period and pay-off in future periods, a dynamic model is required. Dynamic aspects of off-farm income may also include debt reduction and changes in the value of the farm arising from reduced maintenance. Optimal control theory (Pontryagin et al, 1962) allows the calculation of the optimal path of off-farm employment over time, in order to maximise an objective function. For example, the objective function may be to maximise the present value of the income streams from the farm, off-farm earnings, and the salvage value of the farm at the end of the planning period; with respect to farm family labour hours devoted to off-farm employment. The model should recognise the links between hours devoted to off-farm employment, investment in the farm, and output. The equations of motion should include a function linking changes in the capital value of the farm with investment and depreciation, both of which are themselves functions of farm family labour hours devoted to off-farm employment.

On a scale of hard, damned hard and impossible, the generalised model as described (with unspecified functional forms) begins to look as if it is located towards the impossible end of the scale. However, once the functional relationships are established for an individual farm family, the problem may be soluble, and yield useful information on the optimal time path of off-farm employment for members of the farm family[16]. The experience of the case study farmers suggests that the objective function may be highly personal, and include production as well as monetary goals.

Acknowledges

The assistanace of the seven case study farmers is gratefully acknowledged. The review comments of Philip Journequx, John King, Murray Doak and Ann Pomeroy are also gratefully acknowledged, as is the assistance of Frank Scrimgeour in the development of the dynamic model concept.

Errors and omissions remain the responsibility of the author.

16 The model would be useful for any business, where the operator has both a business and a waged job.

Table A1: Impact of Off-farm Work on Output from, and Inputs used, on the Case Study Farms

	FARM						
	A	B	C	D	E	F	G
changes in total s.u.	10-15% down	none	none	10% down	none	none yet	15-20% down
change in stock policy[17] due to off-farm work	sheep numbers reduced	none	more breeding cows, fewer dairy grazers	sheep numbers reduced	none	lambs sold store not fat	dairy grazers on leased block
changes in inputs *necessitated* by off-farm work	contract spraying & crutching	none	casual labour	part-time labour, contract shearing	labour unit, nanny	casual labour, contract fencing	none
changes in inputs *allowed* by off-farm work	-	capital fertiliser and fencing	capital fertiliser	maintenance fertiliser, R&M	weed spraying (farm development)	maintenance fertiliser	maintenance fertiliser & weed control
capital purchases	4 wheel motorbike	4 wheel motorbike, utility, tractor, mower	utility	car	second vehicle	second vehicle	utility
% decrease in farm family labour input	25	45	23[18]	38	38	35	67
Change in time spent on management tasks	increase	no change	increase	decrease	no change	increase	decrease

17 On Farms B and C (where the farmers had always worked off the farm), the entries indicate how the current stock policy is different from that which would be in place if the farmers did not work off the farm, rather than how they had changed their policy when off-farm work was taken on.

18 This represents the decrease in labour applied by the family interviewed only. The change in labour hours applied by the other family involved in the operation of this farm is not known.

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Table A2: The Effect of Off-farm Work on the Adoption of Innovations on the Case Study Farms

	FARM						
	A	B	C	D	E	F	G
Attendance at field days, etc	decreased to nil	decreased but still try and attend	decreased but still try and attend	no change (not a regular attender anyway)	no change	no change	no change
Use of consultants	no change (not used)	no change (not used)	no change (used consultant)	no change (not used)	no change (not used)	no change (not used)	no change (not used)
Access to useful information at work?	yes - a little	yes - large amount	yes	no	yes - a little	no	yes - a little
Type of information	business skills	technical and marketing information, research results	research results, observing other farmers' practices	-	observing other farmers' practices	-	observing other farmers' practices, people skills
Production enhancing adoption	decreased (less break feeding, but adopted scanning)	increased eg use of Fecundin, scanning, new breeds	increased (have to be seen to be "up with the play")	no change	no change	no change	small management changes
Labour saving adoption	increased eg four wheeler	increased eg four wheeler	increased eg stock handling and weighing systems	no change	no change	no change	small management changes

Table A3: The Effect of Off-farm Work on Stress and Social Participation Levels of the Case Study Farm Families

	FARM						
	A	B	C	D	E	F	G
Change in stress level	much higher	higher	higher	lower	higher	lower (female) higher (male)	lower
Sources of increased or decreased stress	farm deteriorates, family friction, peer disapproval, tiredness, lack of time,	conflict of interest or loyalty, farm deteriorates, tiredness, lack of time, family suffers, but financial stress eased	family suffers, tiredness, lack of time, farm not progressing fast enough.	Outside interest, challenge	farm suffers, family suffers, tiredness, lack of time, conflicting role demands	severe fatigue, family suffers, but financial stress eased	financial stress eased, but dissatisfied with status of off-farm job.
recreation & sport	no change	no change	no change	decrease	decrease	decrease	increase
family activities	no change	no change	no change	no change	decrease	decrease	no change
voluntary or community work	decreased	no change	no change	decrease	no change	decrease	increase

Table A4: Roading, Health and Safety Aspects of Off-farm Work

	FARM						
	A	B	C	D	E	F	G
Distances travelled to work (one way)	male- 71 km, incl 5 km unsealed	male: 0-80 km; female: 10-40 km, incl short distance unsealed.	male: 20 km; female: 30 km, including short distance unsealed	male and female: 16 km, all sealed	male: 2-5 km; female: 65 km, incl 9 km on unsealed road	male and female: 40 km, of which 12 km is unsealed	male: ave 20 km; female: 8 km
Travel difficulties cited	5 km of unsealed road	none	none currently	none	long travel times for female, unsealed section of road	none	none
Health and safety implications cited	driving when tired	safer in off-farm work than on-farm	farm must be "state of the art" in safety, as it is used in association with the off-farm job.	none	male: accident while working off-farm disastrous. Female: driving long distances	tiredness, especially when driving home	some risk of injury associated with male partner's job.

Family Farm Viability and the Economics of Information

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1. Introduction

The family farm as an institution will survive as long as its managers are prepared to pay more for land than rival ownership and operational structures. While the "family farm" can be defined in many ways, it is assumed to be a land owner who also manages and operates the farm business. Frequently, the owner and his or her family will reside on the land. Traditionally farm families have been prepared to accept around 4% return on capital (see the NZMWB's Economic Service Reports). This rate is not normally acceptable to urban investors. Consequently corporate and other ownership structures have not acquired significant tracts of land. To obtain competitive rates of return they would need to pay lower prices for land than family farmers.

The current situation will continue provided non family farm institutions do not improve their relative efficiency to the point where they can pay current market values and still achieve competitive rates of 7-8%. Efficiency is dependent on managerial skill as well as access to resources at least cost to allow efficient resource combinations to occur. Currently there is no evidence to suggest corporate managers can necessarily be more efficient from a management skill sense than family farm managers. Indeed, often it is proposed that the reverse holds. However, one area where corporate managers could conceivably have an advantage is in acquiring decision information.

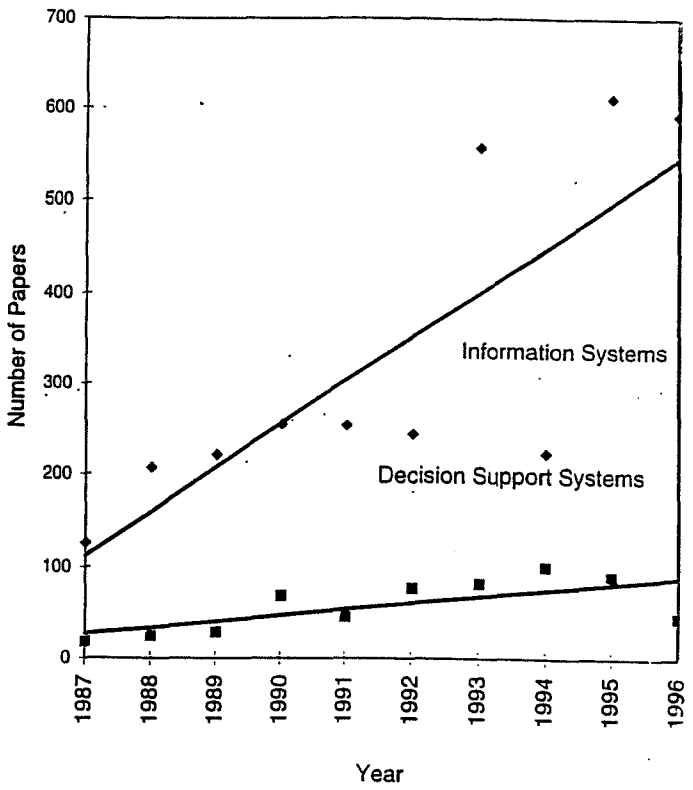
Thus, if family farms are to survive they must develop appropriate and cost-effective information systems. The discussion in this paper focuses on the issue of selecting and developing efficient information systems.

2. Background

The lifeblood of decision making is useful and accurate information. Agriculturists have been developing and providing farmers with information for centuries. More latterly the advent of electronic computers, and more particularly, micro-computers (since approximately 1980), has meant the opportunities for developing information systems has grown exponentially. Inspection of any of the many agricultural software catalogues (e.g. Moreira (1994)) available in most developed countries exemplifies what has happened. Furthermore many scientific journals contain descriptions of proposed (e.g. Scanlan et al, 1993, pasture information systems)and completed information systems (e.g. Udomprusert et al, 1990, dairy system) for a wide range of decision problems. Some even contain reports of systems that have not been as successful as the originators would have hoped (e.g. Macadam et al, 1990 - cotton growing).

A search of the Commonwealth Agricultural Bureau abstracts over 1987-96 for the key words 'information systems' and 'decision support systems' portrays the increasing amount of research and development work occurring. Fig. 1 presents this data.

Figure 1. Published Papers 1987-96 CAB Abstracts



Despite the vast investment that has occurred, the uptake rate of both computerised and non-computerised systems has been very much less than what the protagonists would have liked. This is due to many reasons, but a major one is that the developers have not worked sufficiently with potential users to assess requirements. Macadam et al (1990) report a belated effort to do this after the system in question had all but failed. If a producer can see net benefits in a system it will, in general, be used.

Some early workers believed providing simple data would be useful, and many videotex systems were developed (e.g. Houseman, 1982). Most have not survived, certainly not in their original form, as the farmers did not obtain real benefit. The developers often failed to distinguish between data and useful information. There are many definitions of each, but essentially the decision maker requires material that can be directly used in choosing between alternative courses of action.

System developers must return to simple economic principles when selecting systems to develop; and in deciding their structure. Any system must produce a positive return to the user, and to the developer and operator, so that the marginal cost of investment and operation is less than the marginal return. Unfortunately it is not a simple matter to calculate the net present value from proposed systems. This paper is aimed at commenting on the procedures available, presenting some of the data on the systems farmers are using (under the assumption that they vote with their decisions), and also looking at computer uptake as this similarly reflects what the farmers are saying to the developers. Some new data is contained in the paper, but the central idea is not new. The idea of putting the farmer first must, it seems, be repeated time and time again.

Information, and information devices, come in many forms ranging from, say, automated apple grading machines through to complex integrated computer data bases which process information to suggest optimal resource allocation mixes. The discussion in the paper concentrates on management information systems, not the former. Furthermore, the view that all data should be collected and stored, like endangered species, in case of some future need, is not taken.

3. Types of Information Required, and Used

For good management decision makers clearly require the information necessary to fulfill all the tasks of management. These involve the components of planning, execution and control, as noted by Huirne (1990) who provides a good review. Information is a commodity and can be created, bought and sold, though it does have special characteristics such as indivisibility (you can't sell half a wheat price estimate!) and inexhaustibility (the wheat price forecast can be sold many times - though the number of sales might affect the efficacy of the forecast!). Most producers use a mixture of buying, and creating, in that they purchase agricultural magazines, books, professional advice and so on as well as keeping their own data for personal analysis.

A major factor in determining the information required is the farmer's objectives. Seldom is financial profit the only concern so the information must cover all other components such as ease of management, attitude to risk (and therefore variable distribution factors), aesthetics (countryside appearance), and specific interests such as animal appearance, to name a few. Thus, records and the subsequent information must cater for all the variables that might appear in the objective function. In addition, the laws of the land usually demand certain data be furnished (e.g. tax and environmental records) and these clearly demand that certain procedures be put in place.

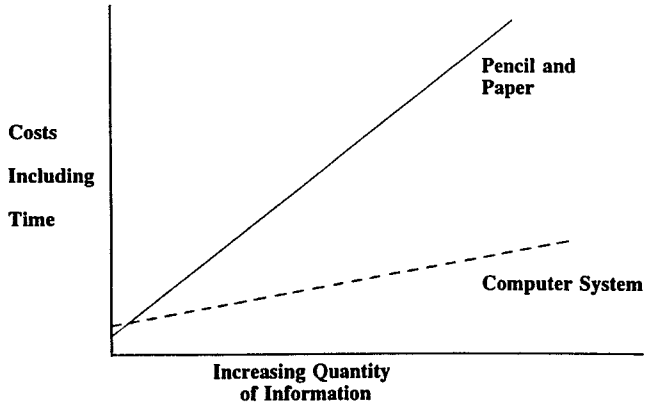
Converting data into information requires an understanding of what is required and how to do it. In this sense education might be regarded as a component of information. Huffman (1974) clearly demonstrated that education was related to financial success and it is likely that people with a clear understanding of the problems can better select, remember and utilise appropriate data, possibly without the need for extensive supporting systems.

Whether mental, written or computerised a total farm information system must include production function data, price/cost data, weather data, regulatory data, animal and crop production data, labour, machinery and building data, together with information on all state variables including financial information. In addition, the nature of the recording and analysis must depend on whether each variable is certain, risky, or non-certain. When it comes to the type of data actually recorded by farmers, surveys show that financial data is by far the most common. Nuthall (1992), for example, found 65.4% recorded detailed financial data (cash book), 30.1% recorded livestock production data, 11.7% kept field production records, 8.2% were involved in animal feed records, and 47.5% performed budgeting exercises. Ryde et al (1984) obtained similar data. Most of this is on-farm data so farmers have relied on external agencies to report on, for example, market data.

4. Information Systems Used by Farmers

The majority use a full range from intuitive mental systems through to written records with subsequent analysis (e.g. analysing past expenditure). It is still the minority that use computerised systems, though this is changing rapidly. Each system has its own costs, returns, and degree of accuracy. For example, Figure 2 portrays the possible cost/quantity of information relationships for two basic systems - pencil/paper as against a computer system each of which have different fixed costs.

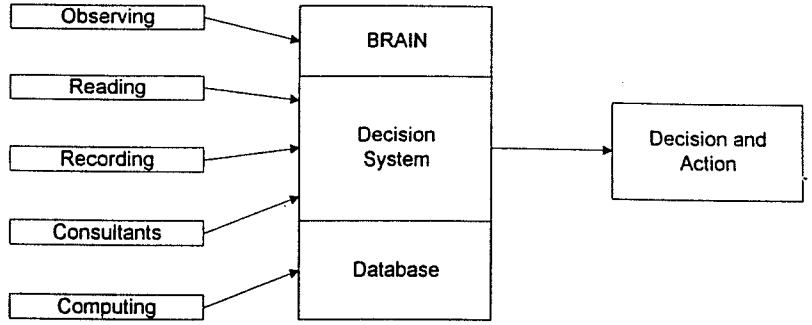
Figure 2 Schematic of Possible Cost/Information Relationships



Most systems require written records and personal observation in contrast to automatic, electronic or otherwise, recording, though some financial data collection is becoming electronic and automatic. Most farmers develop a system that suits their personality, objectives, and the way they operate. Information is sought and systems developed until the decision maker feels confident that more information activity will cost more than the marginal return, financial or otherwise. The farmer's knowledge base and experience influences the degree of information analysis - new, younger farmers tend to develop and seek more information until their skills and knowledge base is developed for the particular farm.

Figure 3 portrays the information/decision process - in the end it is the 'brain' that makes each decision with the help of the various information inputs.

Figure 3 Information - Decision Flow



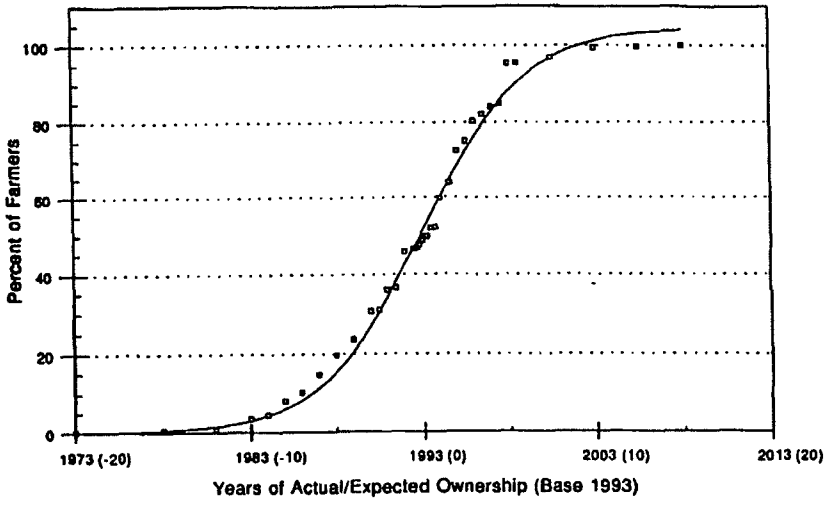
Proportions Vary with Individual

As indicated above, the data shows that farmers rely heavily on external agencies for information originating beyond the farm gate. They also rely heavily on other farmers in a co-operative approach, and also for off-farm data to assist in concluding on farm production possibilities (e.g. research station and plot trial data). Jones et al (1989) found that 35.3% of their sample of Ohio farmers used general farm magazines as a major source of information (a purchased information system). The next most important 'systems' were local market reports (31.2%), agricultural newspapers (25.8%), and radio reports (24.4%) and the co-operative extensive service (25.9%). It is also interesting to note 'salesmen' contributed significantly (18.2%); then came the public accountant (14.5%) and the tax preparer (14.6%). Similar conclusions can be drawn from New Zealand data (Lively et al, 1983), though the percentages all tend to be higher and include other farmers (23%) as an important source of information. Batte (1996) presents more recent US data (13 states) about on-farm recording which again shows the predominance of financial records (95%). Stock farmers record animal records mainly manually (84%) with only 10% using a computer system. In New Zealand (Nuthall et al, 1994) computer owners (some 24%in 1993) similarly spend most time on financial recording and analysis (4.79 hrs/month) followed by stock records (4.61 hrs/month), word processing (2.85 hrs/month), spread sheet calculations (2.34 hrs/month), and field records (1.77 hrs/month), to name the major activities. The ranges are, of course, greater. The clear message is that farmers keep a minimum of on-farm records and rely on off-farm sources as much as possible. Their intuitive observation, collecting and analysing abilities are important.

5. Computer Uptake

It might be presumed that farmers who invest in, and use, a micro-computer and associated software are attempting to enhance their supply of decision information, though another argument says they do so to easily meet the requirements of tax laws. Whatever the reason, the uptake is increasing exponentially and will continue until virtually all farmers have a computer. In due course business will not be possible without a personal computer as normal transactions will all be electronic due to the expense of paper systems.

Figure 4 Computer Uptake Rate



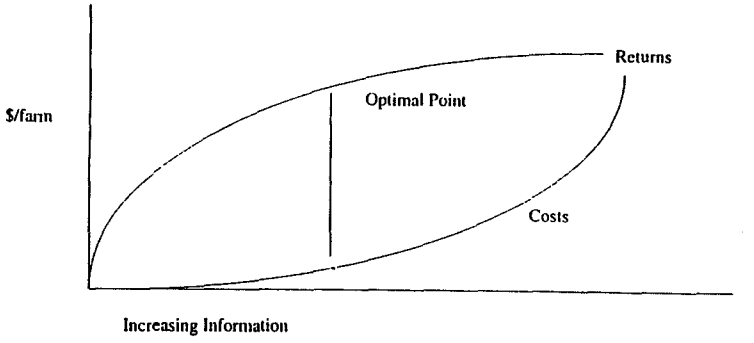
Nuthall et al (1995) found that computer uptake in New Zealand was following the classical sigmoid curve with 24.4% with a computer in 1993. The most recent data collected in February 1997 via a random telephone survey of approximately a hundred Canterbury, New Zealand, farmers showed the curve is continuing to prove to be correct with 35% now owning a computer. This contrasts with 1982 when 0.5% (Ryde et al, 1984) had a computer. Similar figures occur in other Western countries. Batte (1996) found 14% of North Carolina farmers had a computer while the Oregon figures was 40%, Worsley et al (1994) found 10% of Australian (NSW) farmers with computers and Woodburn et al (1994) noted 48% of South African (Natal) farmers had invested. Invariably, uptake is highly correlated with education, size of business, and youthfulness (Putler et al, 1988; Nuthall et al, 1995).

With the development of telephone line networks it is increasingly clear that computers will be pivotal to farm information systems. This means the proper assessment of system costs and returns takes on even greater importance, as does the assessment of what information is best left to 'human' systems.

6. Models of Systems

To assess the usefulness of an information approach or system it is essential to have a framework on which to base a decision. The framework or model may be formally utilised or at the other extreme, adopted mentally. In general it is fair to conclude that information discovery systems should be selected and invested in to the point where marginal return equates with marginal cost.

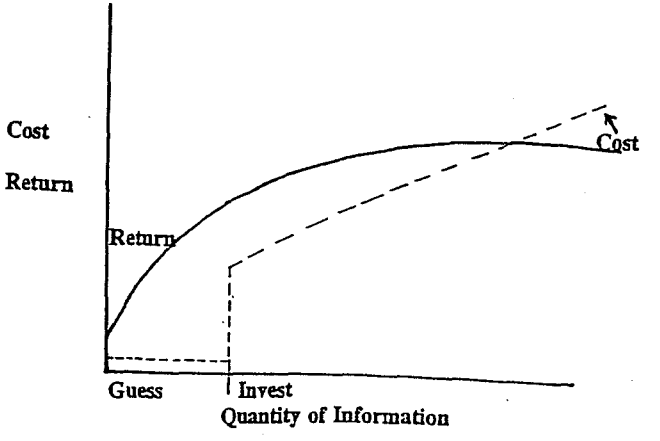
Figure 5 Information System Costs and Returns



While costs and returns are portrayed in dollars, clearly other factors are equally important. Furthermore a satisficing approach rather than maximisation might be appropriate in some cases. That is, farmers might be content developing systems that provide enough information to achieve minimum attainment levels.

Furthermore, the shape of the cost and return functions will vary with each type of information. For example, Figure 6 portrays likely relationships for information on soil moisture. A farmer may make a guestimate of varying time inputs at virtually zero costs, whereas the next move might be to use an instrument and thus give rise to a sudden increase in cost. As more samples are taken and/or more sophisticated probes are used, the costs of improving the reliability of the estimate increases.

Figure 6 Possible Cost/Return Relationships When Estimating Soil Moisture



Eisgruber (1978) developed general mathematical statements of the information problem and defines the decision theoretic, net social benefit, and scoring approaches. But he does note that formal quantification is difficult. Verstegen et al (1995a) review all the various approaches to decision analysis and conclude that normative approaches provide the greatest chance for success. Essentially decision models that allow changing the assumed knowledge level of important variables must be used for experimentation. As risk and uncertainty are crucial aspects of planning Bayesian approaches also have a theoretical role to play (Linder, 1987).

The worth of developing such detailed decision models to assess the contribution of an information system needs, however, questioning. In a general sense the worth of a system is a function of many factors including:

Value = f (farmer's objectives (risk attitude included), farm resource base, ease of use, current data base, managerial ability, manager's current knowledge ...)

The number of factors that are difficult to quantify means creating meaningful mathematical models is fraught with dangers. Informed estimates and farmer observations may be a more useful and realistic approach.

The concept of equi-marginal returns is a crucial principle to keep in mind. Farmers tend to do this intuitively but possibly not information scientists. In developing systems a common-sense mix of packages is important, as is the successful use of the information provided. The best available vector of information looses value if it is not utilised through appropriate implementation.

Another concept of importance is dominance and the relativity between competing courses of action. A farmer is interested in the correct mix of enterprises and production processes so having the best estimate of the return from each is not as important as knowing their ranking. Thus, an information system that puts, for example, prices and costs into relativities may frequently be sufficient.

There must always be an element of risk associated with information in that it can never be certain that more investigation will not alter conclusions. This means a farmer's attitude to risk has a bearing and, furthermore, stresses the fact that a system appropriate to one farmer will not be adequate to another. Farmers, and farms, are unique. Similarly, an experienced farmer that has built up a mental data base will manage with a minimal system compared to a farmer new to an area.

Despite the difficulties, some workers have developed models to value information though many more have carried out work to assess ex-post value. The next section comments on some of this work.

7. Value of Systems

Each farmer must determine the value of possible systems and decide whether to instigate. And this is what they do despite researchers' attempts to assess likely value. Verstegen et al (1995, a) review possible evaluation methods, but too few such studies have been carried out to guide farmers. Furthermore, few farmers would read the journals that have contained these studies. As noted by Verstegen et al both normative and positive approaches are possible.

Value clearly depends on the quality and usefulness of the information - quality can be perfect through to completely misleading (and therefore a major cost) and it is only history that helps decide on the usefulness of a particular information source, or system, so positive studies must have particular value. Examples of normative studies include Thornton et al (1994) who used a simulation model to assess the value of perfect knowledge in assessing

optimal nitrogen levels on maize (perfect information was worth $65/ha), and Swinton et al (1994) who found that the value of weed population information was not high in corn/soybean production. They also used a simulation model and allowed for different attitudes to risk. In contrast Verstegen et al (1995, b) used farm data to conclude that a sow farming package increased piglets by 0.56 per sow per year and returned 220% to 348% on the investment (though it was not clear whether the labour cost was included). These suggest, as would be expected, a wide range of values for specific systems. For computer based systems in general, Nuthall (1992) found farmers' believed their computer had a net annual expected return of NZ$5,519, and 67.8% believed costs were more than covered. In another survey Nuthall et al (1994) obtained a figure of 77.5% for the same statistic. Similar studies in other countries provide like conclusions (e.g. Batte et al (1990)) found 83% believed their computer was useful). On the other hand, Lively et al (1983) found the majority of farmers were only prepared to pay NZ$200/annum or less for a general videotex service.

Clearly, the data is mixed, and this would be expected. Despite the studies, farmers will continue to make their own assessments. This is how it should be as it is impossible for research to cover all situations. It is important to note, however, that time is an important component of value as the build up of historic data on any one farm enhances the value of the resultant information. Also, there are economies of size as the overheads of a particular system are spread, and the ability to use data is strongly correlated with education, as it is with the farming system flexibility available (long term contracts, for example, may constrain). Investment in information provision must be compared with alternative investments of labour hours (the major cost) and money (equi-marginal returns), and factors such as the use of insurance, contracts and futures markets in providing valuable information - that is, knowledge of prices and costs (diversification can have a similar affect) must all be allowed for.

8. Conclusions

The complexity of primary production and the uncertain world in which it operates means it is difficult to assess the value of specific information systems (either computer or pencil and paper based). Furthermore as each farm, and farmer, is unique; and as the interrelationships between information systems are complex, isolating the value of a specific system is difficult. Consequently it must be the farmers that control and dictate what systems are developed and maintained.

Pluske et al (1995) found that farmers correctly valued wool price-risk information and it is suggested they can similarly value information in other areas too. It is immaterial, however, whether or not they are successful as they are the consumers and their demands will dominate. It is obvious, therefore, that farmers should be intimately involved in the selection and development of systems. It is also interesting to note that ex-post studies have always found the information system to be profitable. That is, if farmers have in fact used an information system it has always proved to be profitable, thus re-inforcing the point that farmers do tend to be rational.

Unfortunately, most evidence to date suggests that many of the computer systems available are not meeting either farmers' or consultants' total requirements (Davis et al (1994), and Hockman et al, (1994)) indicating there is a long way to go in developing suitable and integrated packages - this will be a continuous process as computers, developers, and farmers 'mature'.

The dominance of the farmer does not mean ex-post studies of the value of systems should not continue as they will help both the producer and developer improve their discriminatory skills. Nor does it mean the principles of resource allocation should be ignored as they provide a framework on which to review packages. Equally worth noting is that prototype systems have value in exposing farmers to the possibilities as until they have some idea of

the opportunities their judgment will be less than conclusive. This is where arguments for initial subsidisation become relevant.

To date farmers have overwhelmingly voted that they require financial information systems (both historic (tax to) and forward looking (budgeting)). Surveys give high usage percentages in this area (e.g. Nuthall (1994) - 53%, Putler et al (1988) - 76%). However, this is predictable as financial aspects and related tax matters dominate thinking and involve farmer minds on a day to day basis. As farmers gain familiarity with computer and automated systems they will look for additional, but integrated, packages. They must be allowed to control and dictate these next major developments, particularly as the computer uptake figures indicate the enormous potential that exists.

If family farms are to maintain their dominance farmers must continue to exert their influence in directing information system developers. Inevitably the market will tend to ensure this through the systems farmers select and use. However, they must also positively direct the developers to encourage the production of useful systems that are not currently available.

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OBTAINING DAIRY FARM OWNERSHIP THROUGH SHAREFARMING IN GIPPSLAND, VICTORIA.

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ABSTRACT

Sharefarming plays an important role in the Australian dairy industry by providing a path for individuals with restricted access to capital to gain entry to dairy farming. Recent increases in land prices and costs of production, and herd and farm size in both countries have led to a larger capital requirement for both herd and farm purchase, and raised concerns about the future of sharefarming. To confirm the reality of these concerns and assess the present situation of sharefarmers in Victoria, a mail questionnaire was sent to 150 owner-operators and 150 sharefarmers in the Gippsland region of Victoria. The mean age of sharefarmers and dairy farm owners was 36 and 55 years, respectively. Half of the sharefarmers considered that entry into sharefarming over the last 5 years had become more difficult, while the majority (86%) of sharefarmers agreed that it was more challenging for a sharefarmer to buy a farm now than 5 years ago; to do so, they would need to progress to larger herds. Dairy farm ownership remained the main goal of sharefarmers and most of them agreed that sharefarming was still a primary means of acquiring a dairy farm in Gippsland.

Keywords: Sharefarming, dairy industry, Australia, dairy farm ownership.

INTRODUCTION

Many young people start their quest for farm ownership through sharemilking and sharefarming in New Zealand and Australia, respectively. Approximately 35% of New Zealand dairy farms (LIC, 1996a) and 16% of Victorian dairy farms (VDIA, 1996) are run by sharemilkers and sharefarmers, respectively, under a wide range of share agreements. In both countries, sharemilking and sharefarming play an important role in providing a training ground for gaining management experience and a career path for individuals with restricted access to capital to enter dairy farming.

There is growing concern about the future of the New Zealand sharemilking system. Land prices in New Zealand have effectively doubled over the last four to five years while prices for dairy cattle have remained more or less static, making farm ownership increasingly difficult for sharemilkers.

Other barriers to farm ownership are the need to purchase dairy company shares and the industry trend towards larger herds and farms. Sharemilkers must therefore sharemilk for longer and accumulate larger herds in order to generate sufficient equity to purchase a viable dairy farm and, in the long-term, this will increase the average age of farmers (Rauniyar and Parker, 1996).

The Australian dairy farm industry has experienced similar dramatic changes in industry structure, intensity, personnel and technology over the past 20 years. Like their New Zealand counterparts, Victorian farmers have had to increase farm size and productivity in order to remain competitive and economically viable, and this has increased the amount of capital required for farm ownership in Victoria. In addition, the influx of New Zealanders and others into dairying and local industry growth has increased the demand for land suitable for dairying and created more competition for sharefarming positions. This paper examines the situation of sharefarmers in Gippsland, Victoria; it complements the Manawatu sharemilking study by Rauniyar & Parker (1996).

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BACKGROUND ON SHAREFARMING IN VICTORIA

History

The evolution of sharefarming in Victoria is not well documented. It is thought that sharefarming evolved from family contractual arrangements where sons or daughters received a share of the farm's proceedings with the intention of eventually transferring ownership to the son/daughter (Sillcock, 1955). During the mid 1950s, many dairy farmers received conflicting advice about the best agreement to use. Some owners had very detailed sharefarming agreements while others had operated successfully over the years with nothing more than verbal arrangements with their sharefarmers (Sillcock, 1955). Model share agreements were prepared by the Department of Agriculture during 1955 to offer farmers assistance when drafting written sharefarming agreements. One of these agreements was best suited to selling milk or cream for processing, while the other applied to farmers supplying milk to the retail trade.

Sillcock (1963) identified two common types of sharefarming arrangements. In the first type, the owner supplied the land, equipment and stock and the sharefarmer contributed mainly labour and managerial skill. The owner commonly received three fifths and the sharefarmer two fifths of the proceeds, after deduction of fertiliser and feed costs. The second type of sharefarming agreement required the sharefarmer to supply the herd and the milking machines with between 40 and 60% of the proceeds allocated to the sharefarmer. Half shares were equitable on some farms, while on others the sharefarmer received two thirds of three fifths of the proceeds.

Two groups of sharefarmers have evolved in the Australian dairy industry. One group are professional sharefarmers who are prepared to sharefarm all their lives. These individuals do not want the worry of debt incurred as a result of purchasing a farm and see their primary goal as wealth generation through investments, including those made off-farm. The second type are young couples who use sharefarming as a stepping stone towards farm ownership. The high cost of land and stock in the 1990s has made it increasingly difficult for young couples without family support to achieve this goal (Green, 1997: pers comm).

Unlike New Zealand, Victoria has never had a standard or statutory sharefarming agreement. In order to assist dairy farm owners and sharefarmers to arrive at a mutually acceptable agreement, the United Dairyfarmers of Victoria (UDV) produced a share dairy farming manual in 1982 (currently under review). This was the first formal promotion of sharefarming as a profession and lifestyle. The UDV established (at the same time) the Share Dairyfarmer Committee' whose role was to offer advisory support to owner operators and sharefarmers.

Forms of Sharefarm Agreements

The main objective of all Victorian sharefarming agreements is to ensure that:

- the owner receives a reasonable return for his/her capital investment, labour and management, and
- the sharefarmer receives a reasonable return for labour and management which reflects his/her level of responsibility in the enterprise and any capital invested in the enterprise.

Under normal circumstances, an agreement covers seasonal variation, together with movements in income and expenditure and states when the agreement commences and ceases, and the length of formal notice required for termination. The most common agreements in Victoria are contract milking and 33.3, 40 and 50% sharefarming agreements, but other arrangements may be tailored to the needs of an individual enterprise.

The contract milking agreement is popular with owners of large herds. Under this agreement, the land owner usually owns the cows and the mobile plant. The contract milker provides only minimal input into farm decision making and the farm owner is mostly involved in all of the management decisions. The amount of labour to be provided, the number of cows to be milked and the type of facilities in the milking shed are all factors which affect the distribution of income. A contract milker receives a variable share of the milk sales; most percentages vary from 16 to 25% (UDV, 1990).

Under the 33.3 and 40% agreements, the sharefarmer provides management and labour to milk the herd and manage the farm, while the farm owner provides the milking herd and some management input. As the level of management and responsibility increases for the sharefarmer, so does his/her share of income from sale proceeds. For the 33.3% (40%) agreement, the sharefarmer usually shares 33.3% (40%) of shed, concentrates and bought-in feed costs.

A 50% sharefarmer owns the cows and usually some mobile plant and provides day-to-day management. The owner retains some control and makes the long-term decisions on farm policy and development with some consultation with the sharefarmer. Essentially, a Victorian 50% sharefarming agreement is similar to that used in New Zealand. The sharefarmer receives 50% of income from milk sales and 100% of stock sales, and usually pays 100% of shed and herd costs and 50% of all farm costs.

Operating structures
The operating structures on Victorian dairy farms are similar to those in New Zealand (Table 1). During 1994/95, about 43% of farms were owner-operated while about 4% of farms were operated by sharefarmers. Sharefarmers were involved in the management of about 18% of farms during the 1994/95 season.

Table 1. Types of management and operating structures of Victorian dairy farms.

Operating Structure	1994-95 (%)
Owner	42.5
Sharefarmer	4.2
Lessee	2.6
Owner + sharefarmer	10.8
Owner + employees	30.8
Sharefarmer + employees	3.3
Other	5.8
Total	100

Source: VDIA, 1996.

SURVEY METHOD

A mail questionnaire was designed to collect data on the personal opinions of sharefarmers and owner operators about sharefarming and dairy farm ownership in Gippsland Victoria. Farm and household data were also collected. The Gippsland region of Victoria was selected for the study because it is an important dairying region in Victoria and has many features similar to New Zealand dairy farming. The region produced 20.2% of Australia's milk production in 1993/94. As in New Zealand, pasture production peaks in spring (October to November) and most dairy farmers calve their herds in a concentrated pattern during this period to take full advantage of pasture growth. Milk production costs and the ownership structure of dairy farms are similar to those in New Zealand. The region is experiencing the trend toward fewer farms, larger herds and improved productivity, and hence many of the issues that affect Gippsland sharefarmers are the same as those that are presently affecting their New Zealand counterparts. Gippsland has three main dairying districts: East Gippsland, South Gippsland and West Gippsland.

The sharemilker and owner-operator mail questionnaires used for the Manawatu region by Rauniyar and Parker (1996) were slightly modified to suit the Victorian dairy industry. Several questions in the Manawatu survey were repeated in the Gippsland study to enable a direct comparison between the two dairying regions. Complete lists of sharefarmers and owner-operators were obtained from Murray Goulburn and Bonlac Foods milk companies in order to draw a random sample for the region. Three hundred sharefarmers and owner-operators were randomly selected from these lists (n=150/group) by selecting every eighth owner-operator and sharefarmer from the company lists. The survey instrument was pre-tested on two Gippsland suppliers and was administered after minor modification on 1 June 1996. Responses were mailed to a collection box in Yarram, Victoria. Farmers who had not responded by 15 June 1996 were reminded by telephone whilst one of the researchers (KA) was in Australia. The response rate for both the owner-operator and sharefarmer surveys' was 33 and 34%, respectively. Data were subjected to standard descriptive statistics using the SAS programme.

RESULTS AND DISCUSSION

Characteristics of sharefarmers and owner-operators in Gippsland
The mean age of sharefarmers and dairy farm owner-operators was 36 and 55 years, respectively. Almost half of the sharefarmers surveyed were under 30 years of age, while 56% of dairy farm owner-operators were over 45 years. The age structure is comparable to that reported from the ABARE (1996) survey of the Australian broadacre and dairy industries in which the average age of farmers was over 50 years. In broad terms, the mean age of Gippsland dairy farmers is similar to their Manawatu (New Zealand) counterparts, where the average age of sharemilkers and dairy farmers was 37 and 51, respectively (Rauniyar and Parker, 1996). Somewhat inconsistent results to those of the present study were reported from a survey conducted by the VDIA (1995) in Victoria which suggested that the average age of sharefarmers and owner-operators lay within the 30-35 and 41-50 year age brackets, respectively.

Most sharefarmers and owner-operators attended secondary school beyond Form 4 (Table 2). Owner-operators tended to complete their education at high school with no respondents obtaining a trade related qualification and very few (11%) obtaining a tertiary qualification. The broadacre and dairy industry survey also indicated that very few people in owner-operator households had completed a trade apprenticeship or a technical or vocational education (8%; ABARE, 1996). These results highlight the relatively low level of formal education of Gippsland dairy farmers. In contrast, 32% of the sharefarmers surveyed had obtained a trade related or tertiary certificate. In New Zealand, Rauniyar and Parker (1996) also reported that proportionately more sharemilkers had obtained a trade-related education compared to owner-operators. Partners for both groups had a higher level of qualification on average than the sharefarmers and owner-operators.

Sixty five percent of the owner-operators employed a sharefarmer and, of these, over half had a sharefarming agreement of 50% or better. Proportionately less sharefarmers had a 50% or better agreement, supporting the perception that the most common agreements in Victoria are 33.3, 40 and 50% (UDV, 1990). Almost all dairy farms operated by sharefarmers were over 60 ha in size. Farms operated by sharefarmers were, on average, 19 ha larger than dairy farms operated by owner-operators (128 and 109 ha, respectively). The effective farm area information suggests that there are four times as many smaller farms (60 ha or less) operated by owner-operators than by sharefarmers. Rauniyar and Parker (1996) also made this observation amongst Manawatu dairy farmers and suggested that these farms were more likely to disappear first as they become unprofitable. Owners of small (< 150 cows) dairy farms have insufficient scale to support a sharemilker to substitute for their farm labour as they get older and must take the decision to expand the size of their farm business if they wish to do so.

Mean herd size was also larger on farms operated by sharefarmers than owner-operators being 209 and 183 cows, respectively. The trend in herd size is comparable to New Zealand (Rauniyar and Parker, 1996). The most common herd size for both sharefarmers and owner-operators was up to 150 cows, followed by the 151-200 cows category. This pattern was close to the 155 cow average herd size in Victoria during the 1995/896 season (VDA, 1996). The mean milksolids production (1994/95 season) of sharefarmers was 73,571 kg MS (352 kg MS/cow or 575 kg MS/ha). The herd average production in Victoria for 1994/95 (343 kg MS/cow and 488 kg MS/ha) and the levels reported in the VDIA (1996) survey (338 kg MS/cow and 544 kg MS/ha) are similar.

Table 2 Personal and physical characteristics of sharefarmers and dairy farm owners and their farms in Gippsland (1996).

Characteristic	Sharefarmer		Owner-Operator	
	N	%	N	%
Personal Characteristics:				
Age (mean ± years):	48	36 ± 8	47	55 ± 5
(% of respondents):				
Up to 30 years		30		2
31 to 45 years		56		21
over 45 years		14		77
Age Partner (mean ± years):	41	36 ± 9	42	51
(% of respondents):				
Up to 30 years		48		15
31 to 45 years		40		29
over 45 years		12		56
Gender:	47		48	
Male		94		90
Female		6		10
Education level of respondents:	50		46	
(% of respondents):				
Secondary School (Level 1-3)		18		28
Secondary School (Level 4-6)		50		61
Trade related		18		0
Tertiary		14		11
Partner's level education:	42		41	
(% of respondents):				
Secondary School (Level 1-3)		19		17
Secondary School (Level 4-6)		57		66
Trade related		2		0
Tertiary		22		17
Physical Characteristics:				
Sharefarming status:				
Farmers sharefarming or employing a sharefarmer for owners	50	100	48	65
Sharefarming agreement type				
Less than 50% agreement	44	88	13	43
50% agreement	5	10	16	53
Better than 50% agreement	1	2	1	4
Effective Farm size (mean ± hectares):	50	128 ± 67	48	109 ± 75
(% of respondents):				
Up to 60 ha		6		23
61 to 80 ha		12		27
81 to 100 ha		26		15
over 100 ha		56		35
Herd size (mean ± cows):	50	209 ± 99	45	183 ± 117
(% of respondents):				
Up to 150 cows		34		54
151 to 200 cows		28		15
201 to 250 cows		18		17
over 250 cows		20		14
Milksolids production (mean kg MS):	45	73,571 ± 42,789		n.a.
(% of respondents):				
Up to 40,000 kg MS		20		n.a.
40,001 to 60,000 kg MS		30		n.a.
60,001 to 80,000 kg MS		24		n.a.
80,0001 to 100,000 kg MS		12		n.a.
over 100,000 kg MS		14		n.a.

Source: Survey of sharefarmers and dairy farm owner-operators in Gippsland region, 1996.
Note: n.a. denotes that information was not available.

Dairy farm ownership and the future of sharefarming.
Sharefarmers and dairy farm owner-operators response to a list of selected statements about their dairy farm businesses are presented in Tables 3 and 4. Table 3 summarises opinions of sharefarmers and owner-operators on similar issues while Table 4 indicates opinions on ownership specific issues.

The overwhelming majority of dairy farm owner-operators (94%) agreed that information about sharefarming agreements was readily available. In contrast, less than half (47%) of sharefarmers agreed with this statement and this is consistent with the fact that, until 1982, very little information was available for sharefarmers on the preparation of share agreements (see discussion in History of sharefarming).

Table 3 Opinions of sharefarmers (n=51) and owners (n=49) in Gippsland (1996).

Statement	Disagree (%)[1]		Neutral (%)		Agree (%)	
	Sfarmer[2]	Owner	Sfarmer	Owner	Sfarmer	Owner
Information about sharefarming agreements is readily available.	25	6	29	0	47	94
The 50/50 sharefarming agreement favours the sharefarmer financially.	49	15	43	32	8	53
Technology to improve cow productivity is readily available.	2	0	2	7	96	94
Keeping up with technological changes in dairy farming is difficult.	40	21	6	15	54	64
The farm apprenticeship scheme is a good way to train future dairy farmers.	4	2	12	11	84	87
High feed costs (other than pasture) are a major problem in dairy farming.	4	7	10	15	86	78
Dairy farming is a more risky business now than five years ago.	22	48	22	22	45	30
Larger herds have made dairy farming more stressful.	8	9	16	11	76	80
Good farm labour is difficult to find.	10	17	10	17	80	65
The lifestyle of dairy farming is just as important as the financial rewards.	8	7	2	15	90	78
Children raised on dairy farms are interested in a dairy farming career.	36	49	42	32	22	19

Source: Survey of sharefarmers and dairy farm owner-operators in Gippsland region, 1996.

[1] Original scale: 1 = strongly disagree, 5 = strongly agree.
Disagree = scores of 1 and 2, Neutral = scores of 3, and Agree = scores of 4 and 5.

[2] Sfarmer = Sharefarmer.

Almost all sharefarmers (96%) and owner-operators (94%) agreed that technology to improve per cow production was readily available. They also agreed that the farm apprenticeship scheme was a good way to train future dairy farmers. The majority of the respondents agreed that high feed costs (other than pasture) are a major problem in dairy farming. The general consensus was that larger herds have made dairy farming more stressful and that good farm labour was difficult to find. Despite this, almost all sharefarmers (90%) and dairy farm operators (78%) agreed that the lifestyle of dairy farming was just as important as the financial rewards. Over half the dairy farm owner-operators considered that 50/50 sharefarming agreements favoured the sharefarmer financially, while sharefarmers mostly disagreed or were undecided about this issue. As in New Zealand (Rauniyar and Parker, 1996), only one fifth of the respondents (22% of sharefarmers and 19% owner-operators) agreed that children raised on dairy farms were interested in dairy farming as a career. This clearly demonstrates a need for future dairy farm workers and owners to be recruited from outside the family structure.

Table 4 contains additional statements that were of importance to both sharefarmers and dairy farm owner-operators. Half of the sharefarmers (vs 32% of the owners) considered that entry into sharefarming over the last five years had become more difficult. This contrasts with 90% amongst Manawatu sharemilkers (Rauniyar and Parker, 1996). More than half of the respondents thought that sharefarmers should not manage herds on two or more farms because this prevents young people from entering the industry. The majority of sharefarmers agreed that it was

more difficult for a sharefarmer to buy a farm now than five years ago but also agreed that sharefarming provided the only realistic means to farm ownership other than an inheritance. Most (80%) owners thought the future for sharefarming was excellent. Only 10% of the dairy farm owner-operators in the sample were women but interestingly almost half of the respondents agreed that women sharefarmers were as capable as their male counterparts. Two thirds of the respondents considered that high land prices were making dairy farm expansion more difficult now than five years ago.

Table 4 Opinions of sharefarmers and dairy farm owner-operators on other relevant issues in Gippsland (1996). (See Table 3 for definition of the opinion scale).

Opinion Statement	Disagree[1]	Neutral	Agree
Sharefarmers:			
Over the last five years, entry into sharefarming has become more difficult.	20	35	45
Sharefarmers should not manage herds on two or more farms.	26	20	54
It is more difficult for a sharefarmer to buy a farm now than five years ago.	6	8	86
Sharefarmers now need to progress to larger and larger herds, in order to purchase a farm.	2	0	98
Sharefarming agreements favour farm owners financially.	18	29	53
Other than inheritance, sharefarming provides the only realistic means to farm ownership.	4	6	90
Sharefarmers managing two or more herds prevent young people from entering dairying.	26	26	48
Opportunities for women to become sharefarmers are less than those for men.	20	18	61
Uncertain butterfat prices makes financial planning difficult.	10	16	74
Owner-operators:			
A sharefarming agreement is easier to set up and manage than employing a farm manager.	6	21	72
Sharefarming provides a realistic path to farm ownership.	4	69	89
It is easier to obtain a sharefarming position now than five years ago.	26	43	32
Good sharefarmers are readily available.	51	26	23
More women are sharefarmers now than five years ago.	17	59	24
Women sharefarmers are as capable as their male counterparts.	20	33	47
The future of sharefarming is excellent.	9	11	80
Sharefarmers have unrealistic expectations for financial returns from dairy farming.	16	42	42
High land prices make dairy farm expansion more difficult now than five years ago.	26	7	67
Compared to other types of farming, dairy farming provides a good way of life for a family.	15	11	74
Financial constraints don't permit full exploitation of available technology for farming.	9	13	79

Future dairy farm ownership by sharefarmers in Gippsland.
Over half (54%) of the sharefarmers planned to purchase their farm (Table 5). Another 6% of respondents expected to inherit a farm, while 20% expected to purchase the family farm. On average, the respondents expected to achieve their goal of farm ownership in six years. The mean farm size that sharefarmers intended to purchase was 142 ha. The statistics on dairy farms in Gippsland indicate that the average farm size for the 1994/95 season was 95 ha (VDIA, 1996). The mean herd size sharefarmers intended to milk was 232 cows, however one third of respondents intended to milk less than 150 cows which is consistent with the Gippsland district average herd size (140 cows) for the 1994/95 season (VDIA, 1996).

Table 5 Details of future dairy farm ownership by sharefarmers in Gippsland, Victoria.

Details	Sharefarmer Response % of positive responses
Future Farm Ownership: (n=50)	
Inherit a farm	6
Buy the family farm	20
Buy a farm	54
Not specified	20
Future Farm Details:	
Farm size (mean ha): (n=30)	142 ± 88
Up to 60 ha	44
61 to 80 ha	12
81 to 100 ha	10
Over 100 ha	34
Herd size (mean number of cows): (n=33)	232 ± 146
Up to 150 cows	34
151 to 200 cows	28
201 to 250 cows	18
251 or more cows	20
Finance for Farm Purchase:	
Own equity: (n=26)	
Less than 25%	60
25% to 50%	28
Over 50%	12
Commercial banks: (n=24)	
Less than 25%	54
25% to 50%	22
Over 50%	24
Options other than Dairy Farm Ownership:	
Continue sharefarming: (n=25)	84
Purchase non dairy farm: (n=19)	47
Save income for retirement: (n=21)	71
Invest in off-farm assets: (n=23)	74
Use income for other purposes: (n=14)	50

Source: Survey of sharefarmers and dairy farm owner-operators in Gippsland region, 1996.

Most (60%) sharefarmers intended to finance farm purchase with less than 25% of their own equity while 28% thought they could provide 25 to 50% of the equity required. Farm ownership is likely to be unattainable for these farmers, as most rural lenders require a minimum equity equivalent to at least 60% of the total in-going costs for farm ownership. The inconsistency between funds provided from their own assets versus those sourced from banks suggests many of the sharefarmers did not understand the requirements for financing the purchase of a farm. The expectations for farm ownership can be related to sharefarmers net worth at the time of the survey and farm purchase prices ($A20-30/kg MF in the Gippsland region in 1994). Forty four percent of sharefarmers had a net worth of up to A$100,000, while almost half (48%) had a net worth of between A$100,000 and A$500,000, at the time of the survey. The 8% of sharefarmers who had a net worth of over $500,000 are likely to be closest to attaining the goal of farm ownership. Of the sharefarmers who did not aspire to own a dairy farm, 84% intended to continue sharefarming while 47% wished to purchase a non-dairy farm.

Involvement of partners and off-farm employment.
The on-farm involvement of, and off-farm employment opportunities for, partners of sharefarmers and dairy farm owner-operators are summarised in Table 6. The majority (65%) of the partners of dairy farm owner-operators did not work on the dairy farm, while most (78%) partners of sharefarmer partners did. Off-farm income amounted to less than $10,000 per annum for 84% of sharefarmers and, in this respect, does not appear to be a significant means of equity accumulation.

Table 6 Details of partner and worker involvement on farm and of off-farm employment opportunities in the Gippsland region, Victoria. (Note: Missing values or a 'no' response apply where percentages within columns do not add to 100).

Details	Sharefarmer (n=50)	Owner-Operators (n=48)
Involvement of Partner:		
Partner work on dairy farm:		
No	22	65
Part-time	28	21
Full-time	44	15
Workers Employed:		
Full-time	22	n.a.
Regular part-time	32	n.a.
Seasonal	10	n.a.
Off-farm Employment:		
You	12	21
Spouse	24	25
Income earned from off-farm work:		
Up to $10,000	84	n.a.
$10,000 to $20,000	8	n.a.
Over $20,000	8	n.a.

Source: Survey of sharefarmers and dairy farm owner-operators in Gippsland region, 1996.

CONCLUSIONS

Sharefarmers in Gippsland believe that it has become more difficult to attain their goal of dairy farm ownership in the last five years. Despite this, farm ownership remains their main goal. A more extensive study is now required to establish a framework for generalisation of the results from the Gippsland survey to the rest of Victoria. The current results provide an understanding of sharefarming in a region of Victoria and highlights some of the challenges confronting the sharefarming system in the Australian dairy industry. The preliminary findings indicate it is important that appropriate steps be taken by policy makers and industry leaders to ensure that sharefarming continues to fulfill its role in the Australian Dairy Industry of providing an entry path for young people, with limited experience and capital, to become dairy farmers.

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What Really Matters in Research Evaluation*

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Abstract
There is an increasing clamour from politicians and organisations that fund research for research and development agencies to demonstrate a return on the R&D dollar. This clamour is fuelled by those whose taxes and levies are being channelled into research. These tax and levy payers feel they have little or no control over the research they are funding. In the modern user/beneficiary pays environment, this is no longer acceptable. Beneficiaries must be clearly identified and research funds raised and allocated accordingly. In response to this situation, agricultural economists both in New Zealand and Australia have tended to focus on developing computer models to provide a consistent approach to deriving rates of return. This paper places stress on the estimation of future benefits as the critical component of research evaluation - an area which has received comparatively little attention to date.

Key Words: Research evaluation, benefit estimation, risk, uncertainty

Beneficiaries Want More Accountability

Over the last few years the debate about the most appropriate way to evaluate research proposals has hotted up. As the economy has moved to more of a user pays approach, the funding of research has become much more directly of concern to the beneficiaries. This means that decision makers from politicians down through to farmer organisations and indeed farmers, have been asking the difficult questions about the rate of return on money spent in research and development. Within our own profession a group has been formed to look specifically at this aspect. This is the Research Evaluation Group for Agricultural Economists (Regae). Regae was set up in February 1996 at the Australian Agricultural and Resource Economic Society annual conference in Melbourne. Since then it has been regularly sending out newsletters the last two of which contain articles which question the increasing use of benefit cost analysis as the major decision tool for evaluating research.

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Questioning the BCA Tool

David Pannell writing in the seventh Regae Newsletter advocates the removal of the compulsory use of benefit cost analysis with research proposals (Pannell, 1996). His reasons for removing the compulsion element are as follows:

- for some types of research, Benefit Cost Analyses (BCAs) are not appropriate;
- even where appropriate, the BCAs are generally of low quality;
- scientists recognise the quality problems and become cynical about BCAs;
- funding panels make little or no direct use of BCA results presented to them;
- double counting occurs when individual projects are aggregated to determine the total benefit; and
- that scientists, while they should be asked to provide the input to a BCA, are not competent to undertake the full BCA themselves.

In our view these are excuses and none are a sound reason for rejecting BCA:

- We recognise that some types of research are difficult to evaluate, but the alternative methodologies are even less satisfactory.
- BCS's may be of low quality, which is why they must be improved. It is not an argument for dispensing with them.
- Scientists have a conflict in evaluating their own research, we do not believe they are the appropriate people to evaluate research. Their cynicism arises not only because of the poor quality, but because they know a conflict exists when they evaluate their own research.
- Funding panels make little use of BCA's because of the poor quality of the analysis. This creates a catch 22 situation where the low level of reliance on BCA erodes commitment to developing and improving the process.
- Aggregation of projects can be undertaken without double counting if the evaluation of projects is carried out on an industry basis. We see no reason why double counting cannot be avoided where more than one project contributes to a particular benefit.
- We agree that scientists should not be asked to undertake a full BCA, however, it is not a question as to whether scientists are competent, it is more that they do not have the information. Just as scientists are not economists, neither are they marketers, so they are not the appropriate people to estimate the benefits that are to be derived in the marketplace.

While Pannell makes the case for withdrawing the compulsory element he also says that this is not to say that BCAs should be discouraged. "High quality analyses presented voluntarily by researchers in their proposals ought to count very favourably in the funding decisions of corporations". To us this seems like having a bob each way. In our view, because of funding limitations, research proposals must be compared with each other and with other investment opportunities. This requires a credible, consistent methodology. There must be a standard that all must meet. That standard, at least until something better is devised, is BCA.

The Nimmo~Bell Approach

At Nimmo-Bell we have recently completed the development of a methodology for a major export oriented industry. The demand for the research and development group to demonstrate the rate of return on projects and programmes came from the Board of the organisation itself. Our approach was to highlight the deficiencies with the current miss-mash of tools and criteria and boil them down to a single methodology for decisions makers. They could then focus on this with the knowledge that a consistent approach had been put in place to evaluate and rank the alternatives.

Evaluation and ranking are necessary because there are insufficient funds to ensure all projects can be funded. Also research competes for funds with other investment opportunities and management need to know the relative returns from different types of investment opportunities. The primary ranking criteria we used is the internal rate of return which is based on a quantification of costs and benefits over time. An important component of the analysis is the use of probability distributions to better describe the risks and uncertainty associated with R&D investment.

Why High Quality Analysis Is Not Being Achieved

The key complaints about cost benefit analysis are that the scientists fiddle the numbers that go into the analysis and that the economists just find the process too hard particularly for the marginal projects. Why is this so? We found the following to be the main reasons given as to why high quality analysis is not being achieved:

- there is often a high level of uncertainty particularly about the future benefits of research
- the information required to undertake an evaluation is not available;
- the process of evaluation does not involve the right people;
- research organisations are not prepared to commit the time and money required;
- there are other ways to produce a better answer or at least a less biased answer;

- in some cases it is an attempt to measure the unmeasurable;
- the methodology fails to capture unexpected alternative benefits; and
- is doesn't capture downstream developments that compound out of an initial idea.

Inferior Alternatives are Adopted

Because people find it is too hard to carry out a high quality analysis, a number of inferior alternatives have been adopted including:

- the black box approach with more and more complicated models;
- a reliance on qualitative judgements;
- undertaking the analysis but not relying on it i.e. making it non compulsory;
- do bits of the analysis like setting out the assumptions but not undertaking the analysis itself;
- taking a shotgun approach by adopting a number of methodologies, but this leads to double and triple counting; and
- casting around for new qualitative theories such as new age economics which discuss but do not quantify the outcomes of research.

Funding is Under Threat

All this leads to inferior decision making. In our view BCA is clearly the best of the bunch even when it is difficult to apply. Alternative tools are even less satisfactory; the same old problems remain unresolved; these problems are swept under the carpet; with no development of the metholology; and our profession continues to fail in delivering an improving product.

Rather than complaining about the deficiencies we believe this profession should get behind BCA and keep trying to improve it. The alternative is that BCA will stay a second rate tool, discredited by some people, but still the best of the bunch.

We predict that in the not too distant future, R&D proposals which are not supported by good quality BCA will not be funded. The reality is that R&D competes with other investment opportunities. The days of segmented funds for R&D are numbered. Even in the difficult area of promotion expenditure sales are monitored very closely particularly their impact on the bottom line. Businesses look very closely at the before and after performance of promotion activities.

Dealing with Objections

In our view the complaints about benefit cost analysis can be dealt with. It is not something that we can just opt out of. When we looked at the reasons why good quality analysis was not being done we developed the following responses.

- Uncertainty is dealt with by explicitly quantifying the risks and uncertainties and incorporating them into a risk analysis using risk simulation software. Risks and uncertainty that should be incorporated include the research and development costs, likelihood that the science outcome will be achieved (a function of the quality of the science and the track record of the scientists), adoption rates, level of adoption, commercialisation costs and market sales profiles.

- The lack of information is overcome by setting up standard data bases. The 80/20 rule comes into play here. Most of the information required for analyses within a certain area such as sheep research or dairy research is common to all projects. Ensuring all project evaluations use the same future price regimes (and most importantly marginal prices) is the crucial starting point. These prices should be based on an industry consensus, and not be determined by scientists alone.

- Scientists are not the best placed to undertake analysis. It's just not their bag. They shouldn't be doing it because they don't have the skills and they are biased. Even the science peer group is biased. They all have a vested interest in increasing the amount of funding to science. Estimating benefits is the key to good BCA. The people who should be providing the information on the benefits, which is the most contentious area, are the marketing and strategic people within the industry.

- Organisations are not prepared to commit the time and money because the results lack credibility - a Catch 22. But, if the analysis is founded on high quality market research then it becomes much more difficult to fiddle the numbers and the credibility of the results will increase.

- With a credible benefit cost analysis which lacks the bias inherent in most scientist based analysis the alternatives methodologies can be shown to be inferior.

- Double counting problems are overcome by taking an industry approach to evaluation. All projects, including ongoing ones, must be evaluated together.

- The criticism that analysts are trying to measure the unmeasurable is just not tenable. Lord Kelvin, Physicist, 1824-1907 said this about quantifying information *"when you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind"*. It seems ironic to us that MoRST quoted this in its paper of research evaluation methodologies (MoRST, 1996), and then proceeded to do everything but attempt to quantify the benefits and costs.

- The failure to capture unexpected alternative benefits and downstream developments that compound out of an initial idea, assume that analysis is a one-off event. This should not be so. Analysis of projects particularly on-going ones should be undertaken at the same time as new proposals are evaluated to ensure that the net benefit from the whole programme is maximised. At each major decision point the whole programme should be re-evaluated. At this point unexpected benefits can be incorporated. Conversely if initial forecasts appear too optimistic then they can be reduced accordingly.

- All the economic information should be captured in the rate of return calculation including factors such as the quality of the science and track record of the scientists. The need for additional qualitative information for decision making can be restricted to portfolio type issues. These may include: balancing long and short term research; the mix of research types from production to processing to marketing research; high and low risk projects; maintaining core competencies; and the scale of research. Rate of return must be the primary ranking criterion, and the dries among us would say the only criterion. There must be good reason to alter this ranking on the basis of portfolio issues. A high quality BCA will highlight the cost of adopting lower ranking projects on the basis of non-economic grounds.

Who Should Estimate the Benefits?

The role of the scientist is to describe the research and the likely outcomes. They can also estimate the physical resources needed to undertake the research, the timeframes for the research and the likely generation of outcomes. It is not their role to estimate the benefits - marketing and strategic people with help from the economists (marginal pricing) and accountants (costing) should do this.

It is a cop-out not to try and bring everything to a common denominator. Money has been the common denominator for determining value since the first coin was used as a medium of exchange for dissimilar things. Why was money invented? - It was invented because it becomes much more difficult to trade without it.

The economist's role is to make sure that the big picture is kept in mind and to develop new measurement techniques. For example, quantifying environmental benefits using willingness to pay and comparing outcomes and costings with alternatives that people can relate to.

Let's Get on with the Job

Our theme is that we must stop complaining that it is too hard and get on with the job of estimating benefits. To date the focus of benefit measurement in agribusiness has been largely on the farm. This misses the major point that it is in the market that wealth is generated not when the goods are presented at the farm gate. It is thus very important that the pricing signals are clear and measure the marginal returns from the market. Getting this wrong can mean the difference between a relevant research programme and a costly irrelevant programme.

For example, research that increases the amount of milk produced may be seen as good from an individual farmers view point, but from the industry view point it may be exactly the wrong way to go. Farmers are paid average prices for each litre of milk produced. They respond to this price signal. In the market, the industry value is from the marginal dollar on the extra milk product sold. If the market can only absorb a 3 percent increase in volume through sales of high value consumer based products then producing 10 percent extra milk a year means that the bulk of the product is sold in low price commodity markets where the marginal value may be negative. Basing research benefits on average prices can therefore give a completely erroneous result from an industry perspective compared to using marginal prices, even although individual farmers may benefit.

Those who fail to convincingly demonstrate the rate of return on research will find the funds will disappear. The credibility of science is under the microscope. BSE and more recently questions over the white tussock moth spraying programme and the total disagreement between New Zealand and Australian scientists about fire blight, detract from the credibility of science. The process of evaluation must be open and transparent. Current practice is to keep it held tightly within the science area. Unless the assumptions are made explicit and debated widely, it is likely that funds will continue to become more constrained and could eventually dry up.

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Organisational Models for Management of Research and Extension

By

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Summary

In the last decade public agricultural research and extension have been reorganised. The reorganisation has been driven by fiscal austerity and efficiency goals as part of a wider reform of government services. In this reform process there has been a concentration on greater accountability, financial probity, principal/agent relationships, divided responsibility, and privatisation (in some cases). In the agricultural science sector the former state departments have been replaced by a new structure dividing the functions of funders, purchasers and providers into separate entities, while extension services have been transferred successively from a state department (Agriculture) to a stand-alone bureau, and then sold to a private company. This paper reviews and analyses the previous government structures that were found to be unacceptable for both agricultural science and extension, the structures that were put in their place, and the organisational models that were explicitly or implicitly employed in deriving the new structures.

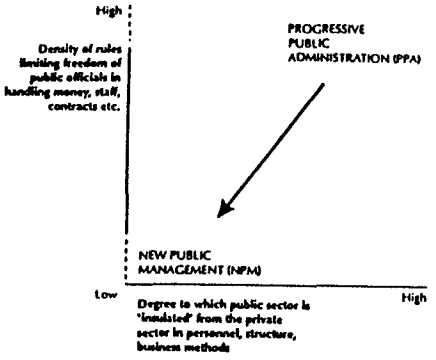
Introduction

Reform of government institutions has been part of a world-wide movement toward greater efficiency in government. The science sector has been part of the NZ reform and according to one authority, the science reforms are an excellent example of the application of the functional model (Boston *et al* 1996). This particularly concerns the separation of the purchaser and provider functions. The world wide trend in organisational reform has been described as the New Public Management (Dunleavy and Hood 1994).

The New Public Management is regarded as a way of re-organising public sector bodies to bring their management, reporting, and accounting approaches closer to business methods (Dunleavy and Hood, p.9). 'It involves a shift in the two basic design coordinates of the public sector organisation, moving it 'down grid' and 'down-group' in social science jargon'. Going'down-group' means making the public sector less distinctive as a unit from the private sector (in personnel, reward structure, methods of doing business). Going 'down-grid' means reducing the extent to which discretionary power (particularly over staff, contracts and money) is limited by uniform and general rules of procedure. By contrast traditional public administration .... was built on the idea of a highly distinct public sector 'group' and of a dense 'grid' of general procedural rules governing the conduct of business. Figure 1 shows the trends Dunleavy and Hood describe.

These trends or shifts have resulted in major changes in the structure of public organisations where they have been adopted. Dunleavy and Hood identify five areas where organisational change will take place:

Figure 1. From traditional or progressive public administration to new public management.



Reworking budgets to be transparent in accounting terms, with cost attributed to outputs, not inputs, and outputs measured by quantitative performance indicators.

Viewing organisations as a chain of low-trust principal/agent relationships (rather than fiduciary or trustee-beneficiary ones), a network of contracts linking incentives to performance.

Disaggregating separable functions into quasi-contractual or quasi-market forms, particularly by introducing purchaser/provider distinctions, replacing previously unified functional planning-and-provision structures.

Opening up provider roles to competition between agencies or between public agencies, firms and not-for-profit bodies.

Deconcentrating provider roles to the minimum feasible sized agency, allowing users more scope to 'exit' from one provider to another, rather than relying on 'voice' options to influence how public service provision affects them.

Reforms in the science sector as a whole began in 1985 with instructions to MAF and DSIR to introduce charges for science and extension services and to achieve 2% savings per year in government funding for the next five years. The aim was to encourage alternative funding ('commercial revenue targets') (MRST 1992a). In 1989, it was decided to create a Ministry of Research, Science and Technology (MRST) to take over science policy functions, and a Foundation for Research, Science and Technology (FRST) to select and fund research projects which deserved public support (science purchasers). The operation of science remained in the old departments temporarily but the existing administrative funding was divided between the new policy Ministry and the Foundation. Finally on 1 July 1992, it was decided to reform the operational or provider side of science as well, and sector research institutes were established to

take over these functions from the former departments (science providers). Ten research institutes (CRIs) were created from the previous departments' activities with some emphasis on subject matter groupings. The FRST was to administer the funds previously going to departments and the CRIs were to seek alternative funding where possible. With some acknowledgement to the discipline of economics, these funds were christened the public good science fund (PGSF) and specific criteria were developed for identifying projects worth funding in the national interest.

Old Organisational Models

The departmental system of science organisation was characterised by public control, departmental bureaucracy, large scale and multi-purpose functions, vertically integrated control systems and dispersed chains of command (Boston *et al* 1996). Research associations, jointly-funded post harvest entities were, by contrast, self-contained, specialised and self-governing, and substantially privately funded.

There was a degree of duplication between the two largest departmental organisations, staff were dominated by the public service ethic of working hours, holidays, and retirement provisions, and the results of their efforts were not sufficiently publicly visible. Departments were funded on a cash flow and annual appropriation basis with weak reporting systems to central government (Upton 1995). Accounting systems emphasised the cost of inputs (wages, salaries and overheads), and not the cost of results or outputs. Objectives were blurred between private good and public good science and success was often measured on the appropriable private good side. Operational research (support for a department's objectives) was not separately funded or identified from proper public good research [non-appropriable research rather than fundamental or basic research] and policy advice functions were delivered to government from within the bureaucracy that provided the science and extension services (provider capture).

Departments and agencies made their own priority-setting decisions independently of each other (MRST 1992a, p.9). There was no detailed and common framework for reporting science activity and expenditure, though NRAC had commenced such coordination work from 1964. A common framework was only introduced in 1990-91 when all the individual science budgets were amalgamated. Within departments and agencies, peer review systems and publication incentives were said to work well.

From a public choice viewpoint, the science departments, in common with other departments, were considered to be beset by self-interest philosophies particularly with regard to selection of projects, working conditions, and lack of public accountability. They also suffered, in common with others, from long control hierarchies, and specific to science and extension, dispersed units of service provision. The long hierarchy generated high overhead costs to all science provider activities which technically made the science service more expensive than it need be. Finally, the public service system of financial management (based on cash flows alone) lead to poor understanding of relevant costs and benefits of different activities.

The Philosophy of Reform

Public service reform was part of a general plan to reduce the involvement of government in commerce, and to introduce market driven methods for the provision of government services (Schwartz 1996, p.1). Some departments with large trading enterprises lent themselves to privatisation. Other departments were subject to separation of policy and delivery services, while others were given less resources to achieve the objectives laid down by Ministers. All departments were subject to financial reform (Public Finance Act 1989) which mimicked private enterprise disciplines through accrual accounting methods and demands for positive rates of return on capital. All departments were also put on arms-length terms with their Ministers by the imposition of formal contracts between Minister and Chief Executives (CEs), and between CEs and departments (State Sector Act 1988). Short term contracts were introduced for CEs.

From a political economy point of view, the reforms can be seen as endorsing a conservative political agenda (minimising the role of the state, selling the state's commercial assets, curbing the functions of government agencies, and maximising liberty-understood in the limited sense of freedom from state coercion)(Boston *et al* 1996, p.18). Further, because politicians can be expected to abuse their power, it is argued that they should be prevented, if necessary by constitutional changes, from running budget deficits or imposing taxes beyond a certain level (Brennan and Buchanan 1985). Similarly, because departments have a vested interest in their own survival, they should not tender advice and implement policy (Treasury 1987, p.75). Otherwise, their advice will be biased and bureaucratic capture might occur. Finally all services provided by the state should be made as contestable as possible (Boston *et al* 1996, p.18).

The problem of improving performance in a public service is central to the reforms. The route taken was to introduce contractual obligations between Minister and CEs that could be monitored and indeed enforced on occasion. CEs were employed on limited period contracts subject to review. This can be seen as an application of agency theory where the interests of principal and agent are bound to conflict. Although originally applied to problems arising from the separation of ownership and control in firms, it has been much more widely applied. Boston quotes Jensen and Meckling (1976, p. 309) as follows:

> The problem of inducing an agent to behave as if he [or she] were maximising the principal's welfare is quite general. It exists in all organisations and in all cooperative efforts-at every level of management infirms, in universities, in mutual companies, in cooperatives, in governmental authorities and bureaus, and in relationships normally classified as agency relationships such as are common in the performing arts and the market for real estate.

In the political realm voters can be regarded as principals who contract with politicians (their agents) to undertake a range of tasks and activities on their behalf (Boston *et al*, p.19)(Moe 1984, p.765):

> ..the whole of politics can be seen as a chain of principal-agent relationships, from citizen to politician to bureaucratic superior to bureaucratic subordinate and on down the hierarchy of government to the lowest level bureaucrats who actually deliver services

directly to citizens. Aside from the ultimate principal and the ultimate agent, each actor in the hierarchy occupies a dual role in which he [or she] serves both as principal and agent.

Agency theory explains why organisations have difficulty in meeting their obligations in the real world. Where agents are prone to shirking, deception, cheating and collusion, obligations are not met and efficiency is reduced. In bureaucracies, organisations are slow to respond to political change, as well as having a tendency to pursue individual agendas. As is well known, adverse selection describes the case where the principal does not have sufficient information about an agent before agreement is reached. Moral hazard is the case where the agent's behaviour after agreement cannot be monitored or anticipated. These deficiencies lead to incomplete information in a relationship, asymmetrical holding of information and greater uncertainty between the parties. The application to bureaucracy lies in better specification of what is to be achieved, output-based reward systems, more direct incentives and better monitoring systems (Boston *et al* 1996, p.19). Financial management must assist in costing and monitoring outputs and not inputs.

A related problem concerns the comparative costs of planning, adapting and monitoring task completion under alternative governance structures (Williamson 1985, p.2). Rational agents should select governance structures that minimise their aggregate production and transaction costs. Bureaucratic structures prevent the search taking place. They also prevent consideration of contracting out, for example. External contracting is best when behavioural uncertainty is low, and the risks of adverse selection are minimised; when the quantity of the desired goods and services can be easily measured and thus monitored; and when the number of potential suppliers is large (Boston *et al* 1996, p.24). In other circumstances, central control has to be preserved.

An organisational theory that pertains more to science organisations is the administrative doctrine concerning inclusive versus divided responsibility. Inclusive or 'single roof' organisations favour horizontal and/or vertical integration of activities so as to facilitate unified political responsibility, better policy coordination, and lower transaction costs. Divided responsibility organisations minimise conflicts of interest, minimise bureaucratic capture, reduce the concentration of power, enhance the clarity of the organisational mission and facilitate contestable provision (Boston *et al* 1996, p.75). Divided units are more likely to communicate with each other compared with so-called integrated units (Irene Taylor, pers.com.).

The new managerialism (Hood 1990, Aucoin 1990) embraces the ideas that the public sector can be managed like the private sector; that results are more important than the process; that the disaggregation of large bureaucratic structures into quasi-autonomous agencies improves accountability and efficiency; that public services should be contracted out more often; that tightly specified contracts and time scales produce better results; and that the use of private sector management practices such as strategic plans, performance agreements, mission statements, performance-linked remuneration systems, and corporate management information systems are preferable. The exception to the new managerialism is the provision of policy advice. This appears to be best organised on a centralised, specialist, and non-contestable basis. Although initially floated by Treasury in 1984, no new developments have occurred in this area. The Canadians have been looking at this possibility.

Science Reform

The objective of provider reform was increased accountability, fiscal savings, and better outcomes for society. This was to be achieved by privatisation (extension), or by organisational forms that avoided bureaucratic capture and set tighter goals for performance (agricultural science). Performance could be enhanced by contestability for public good science contracts, tighter organisational structures, tighter remuneration systems, and removal of the vast load of bureaucratic overheads including layers of administrators.

As crown-owned enterprises, research institutes became subject to private sector financial disciplines including returning a dividend to their owners. The rules of corporate behaviour, debt management, and risk management have changed the whole perspective of provider efficiency. Fiscal savings were also seen as an incentive to gain greater private investment in research. This objective was aided by stricter monitoring of public good spending through FRST criteria for selection of public good projects and programmes, as well as control over total funding..

One observer has stated that science management reform represents the strictest application of the functional model in all the reforms (Boston *et al* 1996, p.83). There is a formal split between the roles of funder, purchaser, and provider; MRST is essentially a single purpose policy ministry; FRST purchases scientific research via a competitive bidding process from a series of CRIs, tertiary institutions, and private providers and monitors the performance of providers; the monitoring of the Crown's ownership interest in the CRIs is carried out by the Crown Company Monitoring Advisory Unit (CCMAU); and only FRST has a dual policy advice[limited], purchasing and monitoring role. Strictly speaking, FRST allocates a fixed annual fund on public good science to science providers; departments must organise their own in-house research needs (operational research), and CRIs must maximise their share of both sources and private sector sponsorship (King 1996).

Resources

Funding: Compared with the without position in 1986, science expenditure under reform has not expanded as fast as GDP (Table 1). Measurement systems have improved since 1986 hence the two data sets are not strictly comparable. This applies particularly to the University sector. As fas as can be understood in the data, private sector expenditure on science barely increased in nominal terms and public expenditure only increased by 22% in 7 years (Table 1). Public funding for agricultural and processing research increased by 27%.

Crowding Out: One of the aims of the reforms was to get greater commitment from the private sector. However, the involvement of the private sector is not uniform. The public/private funding split varies widely across output classes (Table 2). Private funding is dominant in primary product processing [the research associations], materials and engineering, and infrastructural areas. The Universities dominate social science, health and fundamental research; and the public sector dominates primary production and the environment. These allocations reflect the teaching and training role of the universities and the particular output classes where public funding is

Table 1: Estimated Trends in Total Science Expenditure by Major Sectors

$NZm	1986-87	%	1993-94	%
Private Industry	230	40	248	30
Universities	70	12	234*	28
Pub Funding:Agriculture	100	17	127	16
Other	180	31	216	26
Total	580	100	825	100
% of GDP	1.09		1.02	

*** figure enlarged by a change in methodology compared with 1986.**

Source: MRST 1996; NZ Yearbook 1989.

needed because appropriability is lower. They also reflect the dominance of public funding in agriculture and agriculture's dependence on budget decisions, government parsimony, and uncertainty in government decision making. As a corollary, agricultural producers are not good sponsors of science despite their undoubted benefits from its application. But, contrariwise, farmers' organisations contribute handsomely to research in primary product processing.

Table 2: Science Expenditure 1993-94 by Major Output Classes and Major Providers (%)

		Private	University	Public	Total
Agriculture, forestry, fisheries		12	12	76	100
Primary products processing		68	6	26	100
Materials, engineering		54	16	29	100
Construction, transport, energy & information services		66	19	14	100
Social sciences		4	65	30	100
Environment and resources		5	17	78	100
Fundamental res., health, defence		9	78	13	100
Total	%	30	28	42	100
Total Expenditure	$m	248	234	343	825
	%GDP	0.31	0.29	0.42	1.02
Funding (PGSF)	%	5	16	61	32

Source: MRST 1996, p.41.

The main implication of the tables is that overall private sector funding had not increased to the extent that the reforms desired in the period covered. There appears to be no greater involvement

of business in research funding and therefore rather less support for theories of 'crowding out' by excessive public involvement (MRST 1992b, p.15). In terms of GDP growth, total funding levels have fallen behind, and in real terms there was an absolute decline in resources made available. These trends appear to confirm the long term decline in support for science activities noted in one public report (MRST 1992a, p.9).

The Role of the CRIs

As Dunleavy and Hood point out, government reform is characterised by separating out functions, greater transparency in accounting terms, and opening up provider roles to competition. In the New Zealand science reforms, this goal was reached by introducing a corporate structure for the provider agencies - the CRIs. The CRIs were established and empowered under the CRI Act 1992, the Companies Act 1955, and the Public Finance Act 1989. All CRIs are registered under the Companies Act.

Section 5(2) of the CRI Act states that every CRI shall, in fulfilling its purpose, operate in a financially responsible manner so that it maintains its financial viability. This is defined such that, regardless of whether or not a CRI is required to pay dividends to the Crown, the activities of the CRI generate, on the basis of generally accepted accounting principles, an adequate rate of return on shareholders' funds, and the CRI is operating as a successful going concern (Section 5(3))(CCMAU 1996).

It is therefore possible to examine the *financial performance* of the provider institutions in a way that was never possible before. Such a management discipline is intended to improve efficiencies in the organisation as well as encouraging appropriate pricing of outputs (eg bids for FRST support). These systems also raise questions about appropriate levels of debt financing, attitudes to financial risk, and the cost of borrowing (Johnson 1992). To carry out this task, a wide range of financial indicators would be required. Both within institutions and between institutions, such indicators will give guidance to optimal levels of debt and equity funding, as well as tax advantages of gearing and investment planning.

In the 1995-96 financial year, total revenue of the CRIs was $390m (Table 3), of which 63% was publicly funded. Earnings before interest and tax (EBIT) amounted to $22m, and net profit before tax $8.9m. Over the 9 remaining CRIs, the return on assets varied from 2.1% to 14.4%, and the return on shareholders' equity from -17% to +12%. Two CRIs were not earning enough to cover costs of servicing debt and tax.

The financial position of the CRIs is shown in Table 4. Assets employed were $308m with total shareholders funds at $216m. CRIs were established with a conservative level of debt provided by the Crown (CCMAU 1996 p.7) and use of outside valuations to establish some sort of opportunity cost of the capital employed. Total financial debt is currently $29m. Measures of financial performance show fairly uniform current ratios, equity ratios, and gearing, but rather wider variation in interest cover (Table 4). CRIs have not been required to pay dividends, but allowed to re-invest their surpluses to date (CCMAU, p.6).

Table 3: Estimated Financial Performance of CRIs 1995-96

CRI	Total Revenue $m	EBIT $m	Net Profit $m	PGSF Ratio %	Return on Assets %	Return on Equity %
Ag Res	90.2	4.4	1.4	63	5.7	2.3
Crop	27.0	0.3	0.4	-	1.7	3.3
Environment	27.0	0.3	0.3	6	2.1	2.9
FRI	37.4	2.4	1.4	-	8.7	6.8
Hort	48.7	5.6	3.9	70	14.4	11.9
Geological	26.4	0.5	(1.4)	70	3.8	-17.5
Industrial	41.5	0.7	(2.0)	69	2.1	-10.9
Land	32.4	1.5	1.3	60	8.0	8.3
Water	59.8	6.3	3.6	47	12.1	11.2
Totals	390.4	22.0	8.9	63	n/a	n/a

Definition of terms:
EBIT: earnings before interest and tax
Totals: include inter CRI transactions ($8.9m).
Return on assets: earnings before interest/ave total assets
Return on equity: Net profit after tax/shareholders funds

Source: CCMAU 1996

Table 4: Estimated Financial Position of CRIs 1995-96

CRI	Total Assets	Shareholder Funds $m	Financial Debt	Current Ratio	Equity Ratio	Gearing	Interest Cover
AgRes	82.6	61.0	4.9	1.7	74	7	4.6
Crop	18.3	12.4	-	0.6	68	n/a	8.0
Environment	18.7	11.7	2.1	1.1	62	15	1.8
FRI	29.5	21.1	3.7	2.0	72	15	7.5
Hort	44.0	34.7	3.7	1.6	79	10	13.9
Geological	12.9	7.3	1.6	0.8	56	18	3.3
Industrial	30.5	17.7	6.1	0.6	61	26	1.1
Land	22.4	16.3	-	0.9	73	n/a	27.3
Water	49.7	33.9	7.2	0.9	68	18	8.2
Total/Ave	308.6	216.1	29.3	1.1	68	n/a	8.4

Definition of terms:
Shareholders funds: paid up capital plus retained profits
Financial debt: Crown debt
Current ratio: current assets/current liabilities
Equity ratio: shareholders funds/total assets
Gearing: debt/debt + equity
Interest cover: EBIT/interest expense

Source: CCMAU 1996

While the CCMAU is interested in *monitoring* the crown corporates on behalf of the Minister shareholders, the disciplines of corporate finance put strong pressures on senior managers of CRIs. Individual projects have to be managed, priced, and financed under fairly strict criteria. A general rule is that additional projects should not be adopted if they do not improve the required rate of return on equity. The required rate of return on equity should itself be risk adjusted to match comparable risks elsewhere in the economy. The required rate of return on equity will rise with increased gearing to cover the extra risk involved. Ernst and Young are developing criteria for the application of the capital asset pricing model for monitoring CRIs and determining appropriate risk exposure (CCMAU 1996, p.18).

A related question is whether CRIs should manage their debt more actively? In a risk framework, debt may be cheaper than equity, hence substituting debt for equity could lower the average cost of capital employed. Debt servicing is tax deductible, hence more debt can, up to a point, lower tax charges and raise the return to equity holders (but also remembering that Government is both the shareholder and the tax agency in the case of CRIs). Corporate managers would have more regard for their equity holders than the tax man. Ernst and Young have reported to CCMAU (p.21) that most CRIs could manage a higher gearing ratio (up to 30% noting that IRL already had a ratio of 23% at the time) and still attract commercial debt funding at reasonable rates. From the point of view of management, higher debt could give greater flexibility in seeking contracts, tide CRIs over from one contract to another, allow development of new unfunded projects, and enhance search for research support.

Assessing the Reforms

The assessment of reform must seek to identify improving changes from the past. Essentially, is society getting a better return on its investment in science? There is a scarcity of data and analysis in this area which suggests that this investigation has not yet been undertaken because of the difficulties in carrying it out.

There is agreement that the new system has provided better focus for the whole science system (Upton 1995, Devine 1995). 'The science reforms have encouraged a cultural change among scientists and end-users. The highly mission-oriented business culture of the 1990s, coupled with growing end-user focus of the research community, have given research a significant role in underpinning international competitiveness' (Devine 1995).

The public good emphasis has given a better understanding of where the public interest lies. 'Clear, well thought out policy guide-lines are needed...relevance only has meaning within the ideas of public returns to New Zealand...higher priority should be given to programmes which, as presented, and at envisaged funding levels, are expected to give the best marginal return measured in appropriate social, environmental or economic value systems' (Devine 1995).

The pastoral CRI reported modest profits in 1995, but noted that its investment of $48m in freehold land and buildings was substantially greater than is appropriate for a technology based organisation (AgResearch 1995). Most CRIs had the advantage of shedding layers of head office staff and offices located in urban real estate areas. Some could making savings from the removal of low quality and ill-directed projects which did not suit their new missions (Devine). Savings

were not achieved in the transfer of priority setting from a departmental basis to a funder/purchaser/provider basis. The *transaction costs* of these activities have actually increased particularly with regard to providers' (scientists) time and energy (Upton 1995, p.4)(King 1996).

Some change would be desirable in the way such bidding costs are shared (Pearce 1995). He suggests a more equitable sharing between purchaser and provider. Reconsideration of the process could reduce transaction costs. 'An integrated package of process changes is needed to move the science purchasing and delivery system from what can be thought of as a quality control mode to a quality management mode'.

Maintaining Autonomy: In anticipation of transition problems, and in recognition of the need to give CRIs some autonomy in funding, Government arranged for some of the previous public funding [about 10%] to be allocated to the CRIs *outside* the PGSF system (CRI report, ch. 22). This is called non-specific output funding (NSOF). This would allow a CRI to work independently of the priorities set by FRST and could include preparatory research to establish the viability of an idea, support for research teams without public funding provision, and fellowships and the like.

This can be seen as an exception to the purchaser/provider model and recognises the uncertain nature of the scientific process and mind (Upton 1995, p.4). 'In the absence of large alternative research funders...[like philanthropic trusts] it seemed to me prudent to leave some funding in the hands of research providers as an insurance policy against purchaser/government failure'. Another special fund was established to provide research opportunities to extremely capable scientists whose retention was in the national interest but whose interests did not fit in with any established funding category [the Marsden Fund]. As the Minister states 'it is a response to the particular nature of the process of scientific enquiry rather than an *application of institutional theory*'! The universities particularly welcomed this development (McCutcheon 1995, p.19).

These funds also give the CRIs more flexibility in managing their debt. They can be used to support projects over their early stages and other activities mentioned earlier.

The Role of the Universities: The universities are an important part of the science sector (Table 1). They dominate basic research and social science research expenditure (Table 2). Initially they were left out of the PGSF discussions because of disagreement over the share of funds they would have to give up out of Vote:Education, their main source of funding. University research is funded implicitly by a component of the Vote:Education block grant, by grants and contracts obtained from government departments, funding agencies and industry, by commercial activities and by scholarships awarded to research students (CRI report, ch. 28).

A small contribution to the PGSF was agreed in 1993, and this opened access to public good funding for university research. Nevertheless, one writer says that this only represents 10% of research funding in *his* university (McCutcheon 1995, p.18). There are problems for universities in this kind of organisation of research. If research is undertaken for the primary purpose of completing a degree, it is seen as teaching-related research which should be funded out of Vote:Education; if the primary purpose of the research is to produce a public good science output then it is classified as public good research or non-teaching research with consequent access to

PGSF (McCutcheon, p.18). The latter is an obvious source of support for PhD candidates if they can survive the bidding process! Since public good funding covers professional time, university staff awarded contracts find themselves in conflict with their employers who think that they are paid to teach. If the best researchers concentrate on research, the burden of teaching falls on less qualified staff and so on. Further, some support for research in universities is on a direct cost basis, with the University covering the overheads; the PGSF system undermines these donors. McCutcheon believes that user pays system is inimical to true university research objectives based on intellectual curiosity, training and disciplinary research (ibid, p.19).

The Interface between Agricultural Research and Extension: The extension activity was always the responsibility of the Department of Agriculture. There was no sharing with the universities as in other countries. In 1987, the Ministry (as it then was) amalgamated the research and extension bureaus, both to save costs and overheads *and* to seek possible synergies (Ritchie 1995, p.3). Then in 1991, the two were separated again: research services to be split among the CRIs, and extension services to be formed into a publicly-owned trading enterprise. In 1995, this enterprise was sold to Wright Stephenson. On the 4-year synergy experiment, Ritchie says 'strong regional autonomy helped establish local initiatives early in the commercialisation process, but at the time prevented the development of a national business ethic ...the culture of a research organisation is different from a truly commercial organisation...research culture is driven by innovation and product development while the consultancy culture is market driven and one of client service' (ibid, p.3).

On the commercialisation issue, the government took the view (under Treasury advice) that extension services were *not* public goods at all, and government has no need to *support* such a service. This is a debatable issue especially where the public good content of information services, field demonstrations and policy servicing are concerned. As Ritchie reports, his commercial organisation has had to down-size and concentrate its activities on one-to-one extension advice, sub-contracting to the science providers, training services and advice to agribusiness (Ritchie, p.5). Sub-contracting to the science providers involves field experimentation and technology transfer. This kind of interaction has considerable potential (King). The new divided responsibilities for technology transfer have left a gap compared with the old public service system. New ideas and organisational skills are needed in this area (King 1996, Ritchie 1995). The status of technology transfer could be enhanced by identifying it as a separate outcome in the PGSF, instead of disguising it as part of an individual output (King).

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AN *EX POST* ECONOMIC ANALYSIS OF RESEARCH, DEVELOPMENT AND EXTENSION OF COVER COMB SHEARING TECHNOLOGY

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ABSTRACT

Organisations involved in agricultural research or research funding are becoming increasingly interested in ways to effectively evaluate potential research projects in order to optimise the benefits from their research funds. This includes demonstrating the returns to on-farm agricultural research in order to justify further investment of limited funds in this sector. This paper describes a cost-benefit analysis model for the evaluation of a technology that was researched and developed mostly in the period 1989 to 1992. The cover comb[1] is a discrete, relatively simple technology. The development, research evaluation and extension of the cover comb have been reasonably well documented. The cover comb generates financial advantages to end-users by reducing sheep losses, particularly for late winter-spring shearings, and possibly by conserving pasture when feed reserves are low. A model was developed to 0complete an *ex post* cost-benefit analysis of cover comb shearing technology and this also provided a basis for developing a more generalised *ex ante* cost-benefit model of on-farm research and development. Sensitivity analyses were conducted for two adoption rates (increases of 9.5% and 12.9% of all adult sheep in New Zealand being shorn by cover comb between 1989 and 2000), two benefit levels based on reductions in sheep losses of 0.5% and 1%, and discount rates of 5% and 10%. The internal rates of return ranged from 485% to 1330%, and the net present values from $12.30 million to $49.22 million.

Keywords: research evaluation, cover comb, cost-benefit analysis, model.

INTRODUCTION

Reduced Government spending on agricultural research in New Zealand in recent years, policy initiatives to increase private sector funding, and reduced expenditure on farm production research in favour of food processing or added value research, have all encouraged organisations involved in agricultural research or its funding to focus more closely on ways to maximise industry benefits from the allocation of limited research funds. An *ex ante* evaluation of potential research projects can be undertaken in order to devise the optimum portfolio of research funds; an *ex post* evaluation demonstrates the returns to on-farm agricultural research and can possibly be used to justify further investment in the sector concerned.

The objectives of this research were: first, to quantify the costs and the benefits associated with the development, evaluation and extension of cover comb technology and, second, to calculate the return on this investment. The cover comb is a relatively simple technology, whose development, research evaluation and extension are well-documented. Initial design (1970 - 1973) and development costs were incurred by Sunbeam Corporation Ltd (a supplier of shearing equipment), and some of the subsequent research (1989 - 1995) and extension costs were funded by an industry organisation (Wools of New Zealand; WONZ). The cover comb leaves 3 to 5 mm greater depth of wool on the sheep than a standard comb, providing sheep with greater protection from adverse weather after shearing. Production benefits from using the technology include reduced feed intake or live weight loss, and fewer sheep losses following shearing in winter and early spring when the weather can change rapidly (Holmes *et al.*, 1992; Dabiri *et al.*, 1995). The model developed for the *ex post* cost-benefit analysis of cover comb shearing technology is described in this paper, and its adaptation to a more generalised *ex ante* cost-benefit model of on-farm research and development to assist in future decision making is discussed.

[1] The term "cover comb" is a brand name for the Sunbeam cover comb. The Heiniger high country comb and the Chinese John Hand comb have more recently come onto the market. The generic term "winter comb" refers to the Sunbeam, Heiniger and John Hand combs which leave additional wool on the sheep and are similar to the Sunbeam cover comb in terms of design. At the time of the trials the Sunbeam cover comb was the only "winter" comb available, and therefore the trials were conducted using this cover comb. For the purposes of this study the term "cover comb" includes all three comb types unless specifically referred to as the Sunbeam cover comb.

METHODS

The study comprised several components: quantification of production responses in order to identify the benefits of cover comb shearing; costing and timing of research, extension and development; identification of the population the technology applied to; estimation of the adoption rate for the technology; and the development of a cost-benefit model to apply benefits and costs on an industry-wide basis for different cover comb adoption rates and sheep production responses. All costs and benefits were expressed in 1996 New Zealand dollars.

Research, Extension and Development Costs

Six cover comb trials were conducted at Massey University between 1989 and 1995, and the research costs were derived from these trials using the Public Good Science Fund (PGSF) model to calculate research costs. This spreadsheet model is used by Massey University to cost proposed research for submission to the PGSF. Expenditure is broken down into personnel costs (including ACC and superannuation), overheads (100% of salaries), general operating costs, premises costs for laboratory-intensive research, equipment depreciation and extraordinary costs. Costs for the six trials were based on the budgets submitted in the research proposals and the "Materials and Methods" sections of related publications (Holmes *et al.*, 1992; Dabiri, 1994; Burnham *et al.*, 1996; Husain, 1996). These costs were adjusted to reflect the full cost of research, and are shown in Table 1. Extension costs were based on the time spent by WONZ Wool Production Officers (WPOs) on cover comb-related extension, and the annual cost to WONZ of a WPO. The time spent on cover comb-related activities was identified through a survey of WPOs. Cover comb extension was estimated at $10,000/annum, from 1991 to 1996. Development costs were provided by Agrisales NZ Ltd, distributor of the Sunbeam cover comb.

Table 1: Research costs for the six cover comb trials (NZ$ 1996, GST exclusive).

Year	1989	1990	1992	1994	1995	Total
Cost	28,122	39,883	104,916	54,614	76,596	304,131

Technology Uptake

The overall benefit to cover comb technology was derived from the benefits per sheep shorn, and the estimated difference in adoption levels (i.e. the number of sheep cover comb-shorn) with and without the research and extension. Adoption rates were determined by the pattern of cover comb sales (Sunbeam cover comb and Heiniger high country comb), and by a survey of sixteen shearing contractors who shore over 10% of the national flock in the 1995/96 season. Because of the difficulty in predicting the uptake of technology without the research and extension, and the variability of the results between contractors, two uptake levels were applied in a sensitivity analysis. These were an increase of 12.9% for the high adoption rate (HAR) and 9.5% for the low adoption rate (LAR) of all adult sheep in New Zealand being shorn by cover comb between 1989 and 2000. It was assumed from the flat pattern of cover comb sales, that a ceiling level of cover comb adoption without research had been reached prior to the research and extension. An increase in uptake between 1989 and 1995 of 5% to 10% of ewes shorn was allowed for because of bad weather in the 1992/1993 season. From 2000 onward the level of adoption was assumed to be constant (27.4% of all adult sheep in New Zealand being shorn with a cover comb).

Benefits of Cover Comb Shearing

The measurable benefits associated with cover comb shearing came from three areas: a reduction in sheep losses due to the use of cover combs for shearing rather than conventional combs; a reduction in costs from using cover combs for shearing instead of blades; and net benefits from changes in shearing policies due to the availability of the cover comb. Policy changes were likely to be from conventional full wool shearing to pre-lamb or eight month shearing policies, or from second shearing to eight month shearing. Differences in income due to a change in shearing policy were calculated using a partial budget approach. These differences were sensitive to wool prices, yield differences and shearing costs, and are likely to vary between years. Average benefits from all shearing policy changes were assumed to be zero in the first year and $1.00/ewe for subsequent years. The benefit from a change to cover comb shearing from blade shearing was based on an extra $0.73 per sheep for blade shearing compared to conventional comb shearing (Lincoln University, 1996).

The benefits mostly related to a reduction in sheep losses due to shearing with a cover comb rather than a conventional comb, although this was difficult to determine exactly. Dabiri *et al.* (1995) recorded losses of 14% in conventional comb shorn-sheep; in comparison losses in cover comb-shorn sheep and unshorn sheep were similar at 3%. Results from studies measuring post shearing losses have been highly variable (0 to 75%) (Everitt, 1961; Geytenbeek, 1962; Hutchinson, 1968; Hutchinson and McRae, 1969; Sumner and Scott, 1990; Dabiri,

1994). For the purpose of the cost-benefit analysis conservative losses of 1% (higher benefit level; HBL) and 0.5% (lower benefit level; LBL) were assumed. Lamb losses were assumed to remain at 0.5% as lambs are not shorn in the winter or early spring months. Prices received and production data were based on an average of five years data (NZMWBES, 1991-1995; NZWB, 1991-1993; Wools of NZ, 1994-1996). In calculating benefits from a reduction in ewe losses lambing percent calculated was a function the number of cover comb-shorn ewes likely to be in lamb at shearing and the expected number of lambs born per ewe; this was estimated at 100%. Benefits from a reduction in losses were $0.52, $0.36 and $0.16 at the HBL and $0.26, $0.18 and $0.16 at the LBL for ewes, hoggets and lambs, respectively.

The net benefit per ewe as a result of a reduction in losses, a change from blade shearing, and a policy change for the first and subsequent years was then weighted by the proportion of ewes affected by each change, to calculate the overall net benefit per ewe. From 1993 onwards the proportional allocation of benefits from cover comb shearing to ewes from a reduction in losses, a change from blade shearing and a change in shearing policy was 92%, 3% and 5%, respectively. Benefits per ewe from 1993 onward came to $0.55 per ewe at the HBL and $0.31 per ewe at the LBL. Benefits for hoggets, other sheep (estimated be the same as hoggets) and lambs were assumed to be from losses only. An extra $0.08 per sheep for cover comb shearing rather than conventional comb shearing was deducted to calculate the net benefit. Feed savings were ignored in the analysis as these were not able to be accurately quantified, but were noted in anecdotal farmer evidence.

Discount Rate

Costs and benefits were discounted over time using discount rates (DR) of 5% and 10%. The difference between inflation and interest rates (90 day bills and 5 year government stock) has ranged between 4.0% and 6.7% over recent years (Statistics NZ, 1991 - 1996).

Model Development

A spreadsheet model was developed to provide an *ex post* cost-benefit analysis of cover comb shearing technology research and extension for the period 1989 to 2020. The model included a sub-model of regional populations by stock class to estimate the number of sheep shorn by cover comb, and a cost-benefit sub-model that used numbers shorn, net benefits per sheep, and research and extension costs over time to calculate the returns. Numbers shorn with a cover comb, both with and without the research, were calculated for years in which it was believed the rate of technology uptake was changing i.e. 1989, 1992, 1995 and 2000. Values for the remaining years were extrapolated from these points. The numbers shorn for each year were based on opening sheep numbers for the national flock. The proportions of sheep shorn, and within the different sheep classes, were used to calculate the numbers of sheep shorn by stock class. These proportions used were based on NZMWBES data (NZMWBES, 1991-1995). These calculations can be done on either a regional or a national basis.

The cost-benefit sub-model calculated the returns to the cover comb research and extension for the 1989 to 2000, 2005, 2010 and 2020 periods as net present values (NPV), internal rates of return (IRR) and benefit-cost ratios (BCR). The difference in sheep shorn with, and without the research and extension for each class and year was first calculated. Equations 1 to 6 provide a mathematical description of the calculation of returns to research and extension.

$$PVB_{ky} = \frac{(B_{ky} \times NS_{ky}) - (C_{ky} \times NS_{ky})}{(1+i)^y} \qquad \text{(Equation 1)}$$

where:

PVB_{ky} = present value (net) of the benefits in class k and year y;
k = 1 = two-tooth and mixed age ewes;
k = 2 = ewe hoggets;
k = 3 = wether hoggets, wethers and rams;
k = 4 = lambs;
NS_{ky} = difference in number of sheep cover comb-shorn with and without the research and extension in class k and year y;
B_{ky} = benefit per sheep cover comb-shorn in class k and year y;
C_{ky} = cost per sheep cover comb-shorn in class k and year y (i.e. $0.08 per sheep);
i = discount rate;
y = year number (i.e. relative to 1996. 1996 = 0).

$$PVB_y = \sum_{k=1}^{4} PVB_{ky} \qquad \text{(Equation 2)}$$

where:

PVB_Y = present value of the benefits in year y.

$$PVC_y = \frac{R_y + E_y}{(1+i)^y} \qquad \text{(Equation 3)}$$

where:

PVC_y = present value of the costs in year y;
R_y = research costs in year y;
Ey = extension costs in year y.

$$PV_y = PVB_y - PVC_y \qquad \text{(Equation 4)}$$

where:

PVy = present value in year y.

The net present value (NPV), internal rate of return (IRR) and benefit-cost ratio (BCR) have been calculated for the years up to, and including 2000, 2005, 2010 and 2020 as described in Equations 5 and 6 (for years 1989 to 2020). Year -7 equals 1989 and year 24 equals 2020, relative to the 1996 base year. The internal rate of return is the discount rate at which the net present value is 0.

$$NPV_{2020} = \sum_{y=-7}^{24} PV_y \qquad \text{(Equation 5)}$$

$$BCR_{2020} = \frac{\sum_{y=-7}^{24} PVB_y}{\sum_{y=-7}^{24} PVC_y} \qquad \text{(Equation 6)}$$

Sensitivity and scenario analysis

A sensitivity analysis was also conducted for different rates of technology uptake for ewes. Benefits accrued from a reduction in losses only. Adoption of cover combs due to the research and extension was assumed to start in 1990 and increase at a rate of 2% per year until the ceiling adoption rate (1%, 2% 5% and 10% of ewes) was reached. Results applied to the period 1989 to 2020.

In calculating the return to development, research and extension, benefits were attributed to all sheep which were cover comb-shorn; that is, the "without" scenario was for no sheep to be cover comb-shorn, because without development the cover comb would not exist. Results were determined for the 1972 to 2020 period at a 5% discount rate. The adoption rate used from 1989 onwards was that for the HAR. Prior to 1989, uptake was assumed to have been low until the early 1980's (2.9% of sheep shorn in 1981). The main uptake was assumed

to have occurred in the South Island in the early 1980's after the cover comb had been trialled at Nokomai Station. An estimated 9.9% of sheep, mainly in the South Island, were cover comb-shorn in 1988.

RESULTS

The results of the estimated model comparing the returns for two levels of cover comb adoption, two benefit levels and discount rates of 5% and 10% are presented in Table 2.

A 0.5% reduction in sheep losses, with all other variables held constant, generated a 128% difference in the IRR, a 113% to 122% difference in the NPV and a similar difference in the BCR (Table 2). A delay of three years in the uptake of the technology would have reduced the IRR from 1330% to 108% (HBL, HAR). The NPV and BCR at the 5% discount rate for the 1989 to 2020 period would be reduced from $52.22m and 116:1 to $39.54m and 93:1 respectively.

Table 2: The returns to research and extension for cover comb technology (DR = discount rate; H or LBL = high or low benefit level).

	High Adoption Rate				Low Adoption Rate			
Return[1]	DR = 5%		DR = 10%		DR = 5%		DR = 10%	
	HBL	LBL	HBL	LBL	HBL	LBL	HBL	LBL
IRR (%)	1330.5	584.2	1330.5	584.2	1099.8	484.6	1099.8	484.6
NPV to 2000	21.98	10.14	22.55	10.34	15.61	7.03	16.11	7.22
NPV to 2005	31.45	14.63	29.43	13.61	22.32	10.14	20.99	9.48
NPV to 2010	38.86	18.15	33.70	15.64	27.57	12.58	24.02	10.88
NPV to 2020	49.22	23.07	38.00	17.68	34.92	15.99	27.06	12.30
BCR to 2000	52.22	24.61	45.52	21.42	37.37	17.37	32.81	15.24
BCR to 2005	74.27	35.09	59.10	27.87	53.00	24.63	42.44	19.71
BCR to 2010	91.54	43.29	67.53	31.88	65.25	30.32	48.41	22.49
BCR to 2020	115.69	54.76	76.02	35.91	82.36	38.26	54.43	25.28

[1] Returns are presented as an internal rate of return (IRR) (%), a net present value (NPV) ($millions) and a benefit-cost ratio (BCR).

The effect of an increase in research costs was also assessed at a discount rate of 5% at the HAR. At the HBL and with research costs seventy times greater, the IRR, NPV and BCR for the period 1989 to 2020 were 13.8%, $24.30 million and 1.96:1, respectively. At the LBL and with research costs thirty times greater, the IRR, NPV and BCR were 15.5%, $12.56 million and 2.16:1, respectively. However, in both of these cases, the returns for the period 1989 to 2000 were very low, reflected by the IRR of less than 5%.

The returns to research and extension were capitalised to infinity at the HAR, for both a 10% and a 5% discount rate, and a HBL and a LBL. The NPV and the BCR increased approximately 32% at the 5% discount rate, and approximately 6.4% at the 10% discount rate.

The model estimated a 82.5% IRR, a $147.86 million NPV and a 90.1:1 return to development, research and extension at the HBL. At the LBL the IRR, NPV and BCR were 47.2%, $58.98 million and 36.54:1, respectively.

The results of the sensitivity analysis comparing the effects of different technology uptake levels for ewes, based on a reduction in losses only, are presented in Table 3.

Table 3: The returns to research and extension on cover comb shearing of ewes at four adoption rates.

	High Benefit Level		Low Benefit Level	
Return[1]	DR = 5%	DR = 10%	DR = 5%	DR = 10%
1% Adoption Rate				
IRR (%)	468	468	90	90
NPV ($m)	2.77	2.23	0.88	0.61
BCR	7.46	5.40	3.04	2.20
2% Adoption Rate				
IRR (%)	1072	1072	356	356
NPV ($m)	5.97	4.97	2.18	1.73
BCR	14.92	10.80	6.09	4.41
5% Adoption Rate				
IRR (%)	1167	1167	450	450
NPV ($m)	14.69	12.00	5.74	4.60
BCR	35.22	24.70	14.37	10.08
10% Adoption Rate				
IRR (%)	1171	1171	458	458
NPV ($m)	27.42	21.56	10.94	8.50
BCR	64.89	43.57	26.48	17.78

[1] Returns are presented as an internal rate of return (IRR) (%), a net present value (NPV) ($millions) and a benefit-cost ratio (BCR). Results are for the 1989 to 2020 period.

DISCUSSION

The very high internal rates of return on the investment in cover comb shearing technology were largely a reflection of the timing of the costs and benefits; in this study the high returns were achieved because large benefits were obtained in the years immediately following the year that costs were incurred. Net benefits from later years, once discounting had occurred, were negligible. As a result the IRR for all time periods was the same (i.e. had been discounted to a negligible level by 2000). When development costs were included (i.e. 1972 - 2020) returns remained very favourable but were lower than for the 1989 to 2020 research and extension because of the timing and size of costs and the slower rate of cover comb adoption until 1990.

The returns to research and extension in this study were particularly sensitive to the reduction in sheep losses. The overall national reduction in sheep losses due to the use of the cover comb is likely to be low and is not able to be estimated with a high degree of accuracy. Furthermore, post-shearing losses can be variable between regions, years or farms. The true value of the reduction in losses due to cover comb-shearing possibly falls between the two levels, and accordingly the returns to research and extension can be estimated by interpolation using the LBL and HBL results in Table 2.

Returns were only calculated up to 2020, allowing for uncertainty and possible research depreciation. Returns would have been greater, particularly at the 5% discount rate, if no depreciation on research had occurred.

Rapid technology uptake was one reason for the high returns found in this study; delaying the uptake by three years significantly reduced returns. This emphasises the importance of effective technology transfer to minimise time lag effects on research benefits. The large sheep population that the research applied to, relative to the research investment, was also a major factor in explaining the high returns. Only a small increase in uptake by farmers and shearing contractors was needed to make the research worthwhile (Table 3).

The investment results are conservative because the reduction in losses due to the greater protection from inclement weather after shearing with a cover comb was the only advantage included in the cost-benefit analysis. Other advantages may include feed savings, a better spread of labour, a reduction in time spent moving sheep to shelter in adverse climatic conditions post-shearing, management flexibility, peace of mind, animal welfare and sales advantages (Parker *et al.*, 1995). If a financial value had been attributed to these benefits, and they had been included in the analysis, the returns would have been greater.

Off-farm benefits due to the cover comb are unlikely to be significant, unless large numbers of farmers use cover comb technology to change shearing policies to eight month or pre-lamb shearing. This would affect the types of wool available (e.g. whiter and stronger fibres) and the timing of wool sales, and possibly their relative prices.

The cost-benefit model should prove useful in *ex ante* research evaluation. While a specific return is unlikely to be able to be calculated because of the uncertainty of some variables, sensitivity analysis could be used to identify whether the proposed research is likely to be worthwhile under different sets of conditions, and to identify the variables which are likely to have the greatest impact on returns to the investment in research and extension. In this respect the model output will aid decisions on how and where research funds should be allocated. The information gathering process for the cost-benefit analysis, by itself, will benefit decision-makers in allocating research funding.

This study demonstrated that even *ex post*, the net returns to research cannot be predicted with complete certainty, as some data may remain unknown and are not able to be incorporated in a cost-benefit analysis framework, or are not foreseen (e.g. sales advantages). Cost-benefit analysis should therefore be used in association with other methods, such as scoring (MoRST, 1996), when allocating research funds.

The returns to research expenditure estimated in this study are very high in comparison to many of the returns cited in past studies (Marsden *et al.*, 1980; Scobie and Eveleens, 1986; Echeverria, 1990; Bezar, 1993; Ralph, 1993; FoRST, 1997). These earlier studies have primarily derived aggregate returns to research or returns to plant breeding research and in general, the IRR has been between 30 and 50%. For example, Scobie and Eveleens (1986) calculated a 30% return to aggregate research in New Zealand.

The high returns to cover comb technology research and extension are a reflection of the low cost of the research and extension relative to the benefits obtained, the rapid uptake of the technology and the size of the industry the technology applies to. The characteristics of the cover comb (i.e. it is a is simple, risk-reducing, easily adopted and applicable to a large agricultural industry) contributed to these returns (Marsden *et al.*, 1980; Johnston *et al.*, 1992; Reid *et al.*, 1996). It follows that returns from other research with greater front-end costs, a smaller end-user clientele and more complex (and hence slower) adoption may generate low or even negative returns.

CONCLUSION

The main purpose of this study was to calculate the returns to research and extension using WONZ and Massey University's investment in cover comb research and extension as an example, and in doing so to develop a framework for a model that could be adapted for future evaluation of on-farm research in the wool industry. These outcomes were achieved. The returns from the investment in research and extension in cover comb shearing were shown to be very high, even when conservative estimates of the benefits to the technology were applied. The results clearly demonstrate the investment in on-farm research can still be very profitable and that care should be exercised when reallocating funds in a research portfolio between on- and off-farm activities.

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FARMER PERCEPTIONS OF SUSTAINABLE PRACTICES FOR NEW ZEALAND PASTORAL AGRICULTURE

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ABSTRACT

The implementation of sustainable agricultural production systems has become a driving force for management change on New Zealand farms in the 1990s. As part of a study to identify technologies, a nationwide mail survey was conducted. A questionnaire was mailed, after pre-testing with 15 farmers, in June 1996 to 2000 rural addresses selected at random from the New Zealand Rural Post mailing list. A total of 942 questionnaires were returned and of these 313 (23% effective response rate) contained a complete dataset. These were classified into four farm 'classes': dairy farms (> 60 milking cows); larger sheep/beef/deer units (> 500 stock units (su)); small units (50-500 su) and hobby farms (< 50 su). This resulted in 71, 72, 86 and 86 farms in each class, respectively. Results from the parts of the survey that focused on farmer perceptions of sustainable practices, sources of information on new technology, and farm and household characteristics are presented.

Respondents were generally supportive of measures to maintain and enhance a 'clean and green' image for agriculture, providing these measures could be implemented profitably. However, they were generally opposed to fencing-off all waterways from livestock and the notion of restricting weed control to only non-chemical methods. The Occupational Health and Safety Act was viewed as an unnecessarily complicated and bureaucratic imposition on farmers. In broad terms, the economic viability of pastoral farming is regarded by farmers as the dominant factor determining the sustainability of their livestock farming businesses, and this is a fundamental condition for the widespread adoption of technologies and management practices that will help to achieve the goal of sustainable agriculture. Many farmers indicated that they currently face a significant financial constraint and mechanisms to improve market returns and provide more accurate information to direct investment decisions for production are required, if environmentally friendly practices are to be adopted.

Keywords: sustainable agriculture, national survey, farmer opinion, financial viability.

INTRODUCTION

Pastoral agriculture is a vital component of the New Zealand economy and accounted for 40% of the total value of New Zealand exports and approximately 49% of total land use for the year ending June 1995 (NZMPB 1993; NZMWBES 1996). It is largely dominated by sheep and beef cattle, dairy and deer farms. In 1995, New Zealand had 17,700 sheep and beef cattle, 14,600 dairy and 2,100 deer commercial units and 36,000 part-time farm units (NZMWBES 1996). In broad terms, New Zealand pastoral agriculture is internationally competitive on three grounds: (a) low cost pasture-based production, (b) a 'clean and green' image, and (c) relatively young and innovative farmers. In recent years, the agricultural sector has been subjected to pressure from low returns for farm produce, particularly in the sheep and beef cattle sectors, and the imposition of policies and rules through the Resource Management Act, 1991. Both factors have impacted on the technologies and management practices that farmers can adopt. The implementation of sustainable agricultural production systems (MAF 1993) has become a major driving force for New Zealand farmers in the 1990s and it is expected to remain a dominant influence on the way they manage their resources into the 21st Century.

The future performance of pastoral agriculture in New Zealand will therefore reflect farmer perceptions and the level of adoption of sustainable practices at the farm level. This paper focuses on farmer perceptions of sustainable practices for dairy, sheep, beef cattle and deer farms. It constitutes part of a larger study on the adoption of sustainable technologies for New Zealand pastoral agriculture (Rauniyar & Parker, 1997).

CONCEPTUAL FRAMEWORK

The attainment of sustainable systems for agricultural production requires farmer attitudes and perceptions to be understood and modified, if necessary. It also requires complementarity between farmer attitudes and perceptions, and the intervention measures proposed. Farmer attitudes and perceptions are reflected in their current farming practice, and these may need to be changed if practices or technologies which are significantly different to current practices are to be adopted. Many of the attitudes and perceptions of land-users, and thus their farming practices, are governed by the social, economic, cultural, biophysical and institutional environment which surrounds them (Allen *et al.* 1991).

METHODOLOGY

A Farmer-Scientist/Policy-advisor Exchange Forum was organised to identify parameters related to the adoption of sustainable farming practices and technologies. Outputs from the Forum and information from an informal consultative process with policy advisors and farmers were incorporated in the design of a mail questionnaire for a national survey of the practices adopted by dairy, sheep and beef cattle, and deer farmers. The survey instrument was pre-tested on 15 farmers (different to those who participated in the Forum). Comments from the pre-test farmers on question wording, layout and missing elements were used in preparing the final questionnaire. In addition to descriptive information about each farm and details on the use of farming practices, farmers were asked to express their views on 14 issues concerning the sustainability of farm businesses. They were asked to reveal their preferences at one of five levels (strongly disagree, disagree, neutral, agree and strongly agree). The term "sustainability" was worded as "long-term viability" to minimise antagonism toward the former term. Long-term viability is implicit to farmers being able to afford to comply with, and implement practices for, the RMA, and is a term which farmers are used to relating to. Viability is a more encompassing term than "profitability" because while the latter may be positive, it does not necessarily reflect the asset or cashflow position of the firm. In contrast, it is axiomatic that if a farm is viable, it must also be profitable.

An unbiased list of farmers was sought for the national mail survey. Despite problems with the validity of rural addresses, and constraints imposed by the Privacy Act, the rural delivery mailing list of New Zealand Post was deemed to be the most appropriate source of farmer's names and addresses. Given the problems of accurately identifying farm households a target of about 400 completed questionnaires from a list containing 2,000 random rural addresses (20% return) was set. The address list was purchased from New Zealand Post. The final questionnaire was mailed to all 2,000 rural addresses. Total effective survey returns reached about 15% two weeks after mailing. A reminder postcard was then sent to each rural address which had not responded. This increased the effective returns to 23%, but of these, 626 were returned from rural households not involved in pastoral farming. This meant that information from 316 questionnaires was able to be used in the analysis. All except three of these had complete information. The respondents represented New Zealand agricultural regions well, covering from Kaitaia and Manganui in the Northland to Gore and Invercargill in the South Island. The respondents included commercial dairy, sheep and beef cattle, and deer farmers as well as small and hobby farmers. The good geographical representation of the farming areas and variation across farming sectors (by type and size of operation) provided an appropriate basis for a nationally representative study.

The completed survey questionnaires were edited for clarity and codes prior to data entry. Data entry was completed using the EXCEL software, and statistically analysed with the SAS package. In order to make meaningful comparisons, non-dairy farms were classified on the basis of total stock units so that comparisons could be made amongst dairy, large non-dairy, small non-dairy and hobby farms. Farms were classified into four categories: (a) dairy farms (with more than 60 cows); (b) larger sheep, beef and/or deer farms with more than 500 stock units; (c) smaller sheep, beef and/or deer farms with total stock units between 50 and 500; and (d) hobby farms (total stock units less than 50). Each dairy cow, breeding cow, other cattle, breeding ewe, other sheep and deer was assigned as 8.0, 6.0, 4.0, 1.0, 0.8 and 1.5 stock units (su), respectively. The distribution of farms in the four classes appears in Table 1. The survey sample contained 23% dairy, 23% larger units (sheep, beef and/or deer), 27% smaller units (sheep, beef and/or deer) and 28% hobby farms. The hobby farm category also contained farms with no livestock in 1996. For presentation purposes, the five response categories for issues concerning the sustainability of farm businesses were reduced to three (strongly disagree/disagree, neutral, agree/strongly agree). The chi-square statistics were computed to test independence between farmer opinion and farm classes.

RESULTS AND DISCUSSION

Farmer, Household and Farm Characteristics

General farmland household characteristics of the respondents are summarised in Tables 1 and 2. An average farmer was 44 years old, with little variation across different farm types. Hobby farmers were the youngest of the farm classes (43.8 years) while those from the larger units were the oldest group (45.5 years). Nearly one-fourth of the sample respondents were women. Gender composition across farm class was statistically significant ($P < 0.001$). The major reason for this was that the dairy farm group had more women respondents (36%), while the hobby farms group had only 14% women respondents. This result confirms the increasing role of women in dairy farming. Farmer experience on the current farm ranged from four (hobby farms) to nine years (larger units) across the farm types.

Nearly two fifths of the respondents had an educational qualification up to the fifth form, while 28% had higher school certificate and 27% had post-high school qualifications. Respondents from all four farm classes had achieved a similar educational attainment. The educational qualification of the partners of respondents was marginally higher than theirs, but also fairly similar across farm classes, except the partners of dairy farm respondents, who had a lower level of educational attainment. This may be associated with the fact that 36% of the dairy respondents were women.

The average farm size by farm type was 114, 463, 34 and 23 ha for dairy, larger units, smaller units and hobby farms, respectively ($P < 0.001$). Almost 91% of hobby farms and 85% of the smaller units were less than 50 ha. On the other hand, 47% of the dairy farms were between 50 and 100 ha, and another 21% were between 100 to 150 ha. Twenty-one percent of dairy farms and 73% of the larger units exceeded 150 ha. Effective farm area was 90, 71, 83 and 70% of the total area for the dairy, larger units, smaller units and hobby farms, respectively. The lower proportion of effective area on non-dairy properties was expected, as these properties usually have greater proportion of steeper topography not suitable for grazing.

Views held by farmers on sustainability issues

The response for all farms on 14 issues concerning farm business sustainability are summarised in Table 3. Ten of the 14 statements reflecting farmer views were statistically different across the four farm classes. Farmers agreed, or strongly agreed, to statements positively related to farm profitability. Caring for a better environment was clearly reflected in their views, particularly when such actions could be related to increased farm profitability. For example, 82% of the farmers revealed that they were willing to change management practices in order to control soil erosion; 86% thought that the long-term economic well-being of the farm businesses was just as important as protecting the environment; 92% of the farmers expressed support for practices to improve water and soil quality if these were profitable; and 74% indicated that they were unlikely to become members of a Landcare group, or similar, community group for managing natural resources if farming is unprofitable.

In general, clear disagreement/strong disagreement was found with respect to 4 of the 14 statements. Nearly 62% of the farmers did not think that weeds should only be controlled by biological means, which is consistent with the fact that most of the farmers indicated elsewhere in the questionnaire that they used chemical sprays to control weeds on their farms. More than half (53%) of the farmers did not agree with the statement that all continuously running waterways should be fenced off from livestock. This reflects the high cost, and in many cases impracticability, of fencing off small water ways in particular, from livestock. Almost half of the farmers (49%) disagreed with the statement that reliable market information to guide long-term farm management decisions was readily available to farmers. Similarly, 44% of the farmers disagreed that given time the RMA would help to improve the profitability of farm businesses. Sixty-nine percent of the farmers held the view that growth promotants should be discouraged for beef production and 62% of the farmers considered animal welfare on New Zealand farms to be very good. Seven of the 14 statements on sustainability issues are discussed next by farm class.

Weed control only by biological means
Dairy farmers were most opposed to the statement that "weeds should only be controlled by biological means" (76%). Even two-fifths of the hobby farmers disagreed with this statement (Table 4). The farmers' view is a reflection of the importance of weed control; weeds need to be contained effectively and within a short period of time. The farmers' response indicates that they do not have confidence in (or perhaps are unaware) of non-chemical means of weed control.

The Role of the RMA
Only 15% of the farmers agreed that "given time the RMA will improve the profitability of farm businesses", while 44% disagreed with the statement and 42% were neutral (Table 5). The proportion of farmers expressing a neutral opinion suggests that either it is too early to assess the long-term effect of the RMA or that there is confusion regarding the economic and financial impacts of the RMA on individual farms. This result has implications for Councils and other agencies responsible for establishing standards and overseeing the implementation of the RMA. The "bottom-line" for the vast majority of farmers is that the cost of changes to farming practice need to be more carefully linked with long-term farm business viability.

Fencing off all running waterways from livestock
Larger sheep, beef and/or deer farms were most opposed (71%) to the statement that "all continuous running waterways should be fenced off from livestock", compared to 40% of the hobby farmers, 45% of the dairy farmers, and 59% of those on smaller units (Table 6). On the other hand, 45% of the hobby and 38% of the dairy farmers agreed with the statement. Strong opposition to fencing off all continuous running water from larger units stems from the fact that fencing costs are likely to be prohibitive, particularly on hill country. In addition, such fences are likely to compromise livestock movement and farm access.

Greatly restricted use of agricultural chemicals
About 44% of the dairy farmers disagreed that farmers would support greatly restricted use of agricultural chemicals in order to enhance the 'clean and green' image of New Zealand agriculture, while 20% were neutral and only 36% agreed with the statement (Table 7). Farmer opposition to the statement should be interpreted in the light of need to effectively control pests, diseases and weeds on farms within a short period of time (e.g. while ragwort can be controlled biologically this takes considerable time and the effectiveness of control is related to increases and subsequent rapid falls in the population of the control agent).

Protecting water quality
Two-fifths of the farmers on dairy and large units did not agree with the statement that "protecting water quality is more important than using fertiliser to maintain soil fertility" (Table 8). Overall, 45% of the respondents agreed with this statement. Farmers considered that the application of fertiliser was equally important to the maintenance of pasture productivity. Nearly two-thirds of the hobby farmers agreed with the statement, and this may have been motivated by their greater concern for water quality, than the amount of pasture grown.

Future generation in farming career
Less than half of the farmers in any farm class agreed that children from farm families continue to be interested in taking up a career in farming (Table 9). Changing lifestyle, low returns from farming, greater capital requirements for future farm operations and limited prospects for further career enhancement are likely to have shaped farmers' views on the 'desirability of their children pursuing a farming career' statement. Some 44% of dairy, as well as hobby farmers, expressed neutrality to the statement. Thus, there appears to be quite a high level of uncertainty or ambiguity amongst the farmers about the feasibility (or desirability) of the inter-generational transfer of farm property.

Occupational Health and Safety Act
The Occupational Health and Safety Act was certainly not popular amongst the farming community (Table 10). Overall 51% of the farmers perceived the Act to be complicated and 19% thought that the Act was restrictive and hindered their farming operation.

Reliable market information to guide long-term farm management decisions
An overwhelming majority of the respondents from the larger sheep and beef cattle/deer farms (73%) disagreed with the statement that "reliable market information to guide long-term farm management decisions is readily available" (Table 11). Interestingly, 44% of the dairy farmers also disagreed with the statement. The farmers' view on this matter was also reflected in comments to a later question in the survey on the lack of transparency in market organisations, the prohibitive cost of acquiring market information independently, and the inadequacy of market information systems to provide a reasonable indication of the longer-term outlook for specific pastoral farming products. Sheep and beef cattle farmer views on markets, in particular, are likely to have been influenced to some extent by low product prices at the time of the survey.

Satisfaction with current marketing arrangements
Less than half (48%) of the farmers surveyed were satisfied with current marketing arrangements for their produce (Table 12). Dissatisfaction was highest amongst the sheep, beef and/or deer farmers (41%) and the smaller unit farmers (58%). Their response is very likely to be associated with the recent low returns for farm produce. Even 32% of the dairy farmers reported that they were not satisfied with current marketing arrangements.

Farmers suggested four areas of change in marketing arrangements (Table 12): altering the pricing structure (38%), improving market organisation (35%), increasing market promotion (19%) and expanding market information and research (8%). The hobby farmers dominated the suggestion for market promotion, while dairy farmers dominated the response for more market information and research. The pricing structure suggestions were mainly made by smaller unit farmers, and these included payment of a premium for quality, less price fixing and creating more stable returns. The list of changes suggested for market organisation included: collective marketing; integration of farmers, marketing organisations and processors; ensuring payment for stock in receivership situations; and an independent review of the beef industry. Ideas for market promotion included: sound marketing strategies and expansion of export markets, diversification of existing markets, and promotion of beef as a "natural alternative" in the US and Japanese markets. Finally, the list of suggestions for market information and research included: development of new markets, market information from the end-users, and developing processing possibilities for beef and lamb prior to its export.

Essential factors for long-term viability of farm businesses

Economic factors
Among all the factors specified as affecting the long-term viability of farm business, economic or financial factors stood out as the major concern for the overwhelming majority of farmers (Table 13). Reference was made to farm profitability in terms of favourable market interest rates and exchange rates for the New Zealand dollar, stable government agricultural policies, diversified opportunities and incentives for on- and off-farm investment, less capitalisation of farm land values, a stable local community economy and access to farm credit.

Social and community factors
Social factors were rated as the second most important issue for the long-term sustainability of farm businesses. Nearly half of the dairy and larger unit farmers, and more than one-fifth of other farmers sought attention in this area (Table 13). The health status of farmers and their families, rural lifestyle, less regulation of community activities, fewer "kids" on farm, and better rural services (education, health, childcare, fire protection and policing) were reported by many of the farmers as social concerns.

Productivity factors
Farmers expressed concern about means to attain higher productivity from their livestock. One-third of the farmers thought that farm productivity per hectare of land and per unit labour could further be enhanced (Table 13). They realised it would be possible only through technological breakthroughs and effective research output. Effective measures for better drainage and weed control, enhancing the reliability of water and energy supply, TB control, a higher standard of breeding stock (improved genetics), residue-free farm production and quality control were seen as key productivity issues for the long-term sustainability of farm businesses.

Marketing factors
One in five farmers had concerns about the marketing of farm produce (Table 13). Issues such as a collective export market for primary products, innovative market research to identify and develop niche markets, transparency in the activities of middlemen and processors, and the direct linkage of farmers with processors, export market diversification away from a single market dependency, a fair reward for premium quality, and effective but reliable market forecasting were highlighted by the farmers as issues that required attention in relation to marketing.

Environmental factors
Most of the farmers thought that they were already farming sustainably and providing due care for the environment. Concern for the environment was largely expressed by the smaller unit and hobby farmers (Table 13). They emphasised aspects such as the "clean and green" image of New Zealand farm produce, the protection of water quality, soil erosion control, and organic/Biodynamic farming practices as some areas that needed further attention.

SUMMARY AND CONCLUSIONS

This paper constitutes part of a larger study which was conducted to identify constraints faced by New Zealand pastoral farmers in adopting sustainable technologies and management practices. In general, farmers' opinion of a set of 14 statements related to sustainable farming practices reflected their current farming practices. Their opinion was largely driven by economic and financial factors. Hobby farmers held a somewhat different set of opinions from the other farmers. Farmers indicated they were willing to change their farming practices if these could be proven to be profitable. Thus, economic incentives are preconditions for their participation in Landcare or similar groups in managing natural resources. Farmer opinion on the future economic benefits resulting from their compliance with the Resource Management Act was mixed.

Strong opposition was voiced to fencing off of all continuous running waterways by all farmers and although they accept the notion that the "clean and green" image of New Zealand agriculture is important, only 36% of the farmers agreed to greatly reduced use of farm chemicals to help reserve the image. Farmers believed that protecting water quality and maintaining soil fertility through fertiliser use were both important, but not at the expense of each other. Inter-generational transfer of farms was considered relatively less important now than in the past due to: changing lifestyles, low returns from farming and a reduced desire of the next generation to take up a farming career. More than two-thirds of the farmers claimed that reliable market information was a major problem to them. The Occupational Health and Safety Act was not well received by the farmers. Most thought it was a complicated bureaucratic requirement and one in five farmers believed the Act restricted and hindered their farming operations.

The economic viability of pastoral farming will dominate the sustainability of farm businesses in New Zealand. In this respect farmers will continue to seek ways to enhance farm productivity, but will require effective marketing arrangements to be put in place to compensate for declining real returns for agricultural commodities and on-going research focused on farm production and management practices that improves the efficiency of resource use and reduces the unit cost of production. The study affirms the view that most farmers will attempt to farm sustainably and adopt environment friendly practices, as long as it is profitable for them to do so.

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Table 1: Demographic characteristics of New Zealand farmers.

Characteristics	Farm type				Overall
	Dairy	Sheep, beef, deer larger units su > 500	Sheep, beef, deer smaller units su 50-500	Hobby su < 50	
Age (Years)	**n=46**	**n=63**	**n=74**	**n=76**	**n=266**
- Mean	44.5	45.0	44.3	43.8	
- Std. dev.	10.6	10.0	10.7	11.3	
- Median	45.5	45.0	44.0	42.5	
Gender					
- Male %	64	79	81	86	76
- Female %	36	21	19	14	24
Chi-square					10.4 (3) ***
Educational qualifications of the partners	**n=59**	**n=60**	**n=64**	**n=72**	**n=255**
A. Primary or less	6.7	8.3	7.8	1.4	5.9
B. Secondary	35.6	33.3	35.9	31.9	34.1
C. Trade Certificate, Tech Correspondence	3.4	3.3	6.3	6.9	5.1
D. Higher School Certificate	25.4	28.3	23.4	31.9	27.5
E. Post High School	28.8	26.7	26.6	27.8	27.4
Chi-square					6.2 (12) NS
Educational qualifications of respondents	**n=63**	**n=68**	**n=77**	**n=81**	**n=289**
A. Primary or less	6.4	8.8	5.2	2.5	5.5
B. Secondary	36.5	35.3	31.2	30.9	33.2
C. Trade/Vocational	12.7	5.9	10.4	3.7	8.0
D. Higher School Certificate	9.1	23.5	18.2	27.2	22.2
E. Post High School	25.4	26.5	35.1	35.8	31.1
Chi-square					11.8 (12) NS

Source: ADOPTECH Survey 1996.

Note: ***, ** and * refer to statistical significance a the 1, 5 and 10% level based on the chi-square statistical testing the independence between farmer views (agree, neutral, disagree) and type of farm (dairy, commercial sheep-beef-deer, smaller livestock units and hobby farms).

Table 2: Effective area of New Zealand farms.

(Percent farmers responding)

Characteristics	Farm type				Overall
	Dairy n=71	Sheep, beef, deer larger units su > 500 n=73	Sheep, beef, deer smaller units su 50-500 n=85	Hobby su < 50 n=89	
Effective farm area (ha)					
A. < 50 ha	14.1	9.6	88.2	91.7	54.0
B. 50-100 ha	50.7	20.6	5.9	3.4	18.6
C. 100-150 ha	16.9	9.6	3.5	2.4	7.7
D. 150-250 ha	15.5	26.0	2.4	2.4	10.9
E. > 250 ha	2.8	34.3	-	-	8.6
Chi-square					258.7 (12) ***
Mean effective area (ha)	103.4	328.8	27.8	15.9	
Std. dev.	74.3	472.2	37.6	31.1	
Land contour (mean %)	**n=71**	**n=73**	**n=83**	**n=84**	**n=301**
Flat (%)	61.7	29.1	54.6	61.9	
Rolling/easy hill (%)	32.3	50.2	33.3	27.5	
Steep hill (%)	6.2	21.4	11.5	10.5	
Cropped area for feed (ha)	**n=70**	**n=70**	**n=84**	**n=77**	**n=301**
Mean	3.6	5.7	0.9	0.4	
Std. dev.	5.1	9.8	2.5	1.4	

Source: ADOPTECH Survey 1996.

Nearly 62% of the dairy and hobby farms comprised flat land, while half of the larger units were rolling/easy hill country. Twenty-one percent of the larger units had steep hill land. The higher proportion of farms with steep hill contour was consistent with the 71% effective area for grazing. One-third of the dairy and smaller units had rolling/easy hill topography.

Table 3: Farmer views on issues related to the long-term viability of farm business in 1996.

(Percent farmers responding)

Statement reflecting farmer views	n	Disagree/ Strongly Disagree	Neutral	Agree/ Strongly Agree	Significant Variation by type of farm
1 The long-term economic well-being of farm businesses is just as important as protecting the environment.	313	6.4	7.4	86.2	(**)
2 Children from farm families continue to be interested in taking up a career in farming.	314	25.5	38.5	36.0	(**)
3 Farmers are willing to change management practices in order to control soil erosion.	314	4.8	13.4	81.9	(***)
4 Farmers would support greatly restricted use of agricultural chemicals in order to enhance the "clean and green" image of New Zealand agriculture.	313	31.3	23.6	45.1	(*)
5 Weeds should only be controlled by biological means.	315	61.9	17.8	20.3	(***)
6 The local Regional Council standards for monitoring the quality of the environment are acceptable to farmers.	312	31.8	41.7	27.5	NS
7 Given time the Resource Management Act will improve the profitability of farm business.	311	43.7	41.5	14.8	(**)
8 Protecting water quality is more important than using fertiliser to maintain soil fertility.	313	29.4	26.5	44.1	(***)
9 All continuously running waterways (eg. Streams, rivers) should be fenced off from livestock.	315	53.3	13.0	33.7	(***)
10 Animal welfare on New Zealand farms is very good.	314	17.5	20.7	61.8	NS
11 Growth promotants should be discouraged for beef production in New Zealand.	313	14.7	16.0	69.3	NS
12 Farmers will adopt practices to improve water and soil quality if they are profitable.	315	3.2	5.1	91.8	NS
13 Farmers are unlikely to become members of a Landcare, or similar, community group for managing natural resources if farming is unprofitable.	315	12.7	3.7	73.6	(**)
14 Reliable market information to guide long-term farm management decisions is readily available to farmers.	312	48.7	22.8	28.5	(***)

Source: ADOPTECH Survey 1996

Note: ***, ** and * refers to statistical significance at the 1, 5 and 10% level, respectively, based on the chi square statistic testing the independence between farmers views (agree, neutral, disagree) and type of farm (dairy, commercial sheep-beef-deer, smaller livestock units and hobby farms).

Table 4: Farmer views on the statement "Weeds should only be controlled by biological means" by farm type.

(Percent farmers responding)

Farm type	n	Farmer views on the statement		
		Disagree/ strongly disagree	Neutral	Agree/ strongly agree
A. Dairy farms	71	76	15	9
B. Sheep, beef &/or deer farms				
a. larger units: > 500 su	73	64	22	14
b. smaller units: 50-500 su	85	68	15	17
C. Hobby farms	86	42	19	40
Total/Overall	315	62	18	20

Chi-square (6 d.f.) = 32.5 (P < .01).

Source: ADOPTECH Survey 1996.

Table 5: Farmer views on the statement "Given time the Resource Management Act will improve the profitability of farm businesses".

(Percent farmers responding)

Farm Type	n	Farmer views on the statement		
		Disagree/ strongly disagree	Neutral	Agree/ strongly agree
A. Dairy farms	70	50	41	9
B. Sheep, beef &/or deer farms				
a. larger units: > 500 su	70	53	37	10
b. smaller units: 50-500 su	85	43	44	13
C. Hobby farms	86	31	43	26
Total/Overall	311	44	42	15

Chi-square (6 d.f.)=15.32 (P <.05).

Source: ADOPTECH Survey 1996.

Table 6: Farmer views on the statement "All continuous running waterways (e.g. streams, rivers) should be fenced off from livestock".

(Percent farmers responding)

Farm type	n	Farmer views on the statement		
		Disagree/ strongly disagree	Neutral	Agree/ strongly agree
A. Dairy farms	71	45	17	38
B. Sheep, beef &/or deer farms				
a. larger units: > 500 su	73	71	8	21
b. smaller units: 50-500 su	85	59	2	29
C. Hobby farms	86	40	15	45
Total/Overall	315	53	13	34

Chi-square (6 d.f) = 19.4 (P < .01).

Source: ADOPTECH Survey 1996.

Table 7: Farmer views on the statement "Farmers would support greatly restricted use of agricultural chemicals in order to enhance the clean and green image of New Zealand agriculture".

(Percent farmers responding)

Farm type	n	Farmer views on the statement		
		Disagree/ strongly disagree	Neutral	Agree/ strongly agree
A. Dairy farms	71	44	20	36
B. Sheep, beef &/or deer farms				
a larger units: > 500 su	71	24	30	46
b smaller units: 50-500 su	85	26	28	46
C. Hobby farms	86	33	17	50
Total/Overall	313	31	24	45

Chi-square (6 d.f.) = 10.8 (P < 0.1).
Source: ADOPTECH Survey 1996.

Table 8: Farmer views on the statement "Protecting water quality is more important than using fertiliser to maintain soil fertility".

(Percent farmers responding)

Farm type	Farmer views on the statement		
	Disagree/ strongly disagree	Neutral	Agree/ strongly agree
A. Dairy farms	44	31	25
B. Sheep, beef &/or deer farms			
a. larger units: > 500 su	40	26	33
b. smaller units: 50-500 su	29	22	49
C. Hobby farms	9	27	64
Total/Overall	29	27	44

Chi-square (6 d.f.) = 36.3 (P < 0.000).

Source: ADOPTECH Survey 1996.

Table 9: Farmer views on the statement "Children from farm families continue to be interested in taking up a career in farming".

(Percent farmers responding)

Farm type	n	Farmer views		
		Disagree/ strongly disagree	Neutral	Agree/ strongly agree
A. Dairy farms	71	12	44	44
B. Sheep, beef &/or deer farms				
a. larger units: > 500 su	72	33	26	41
b. smaller units: 50-500 su	84	32	39	29
C. Hobby farms	86	24	44	32
Total/Overall	313	25	39	36

Chi-square (6 d.f.) = 16.0 (P < 0.05).

Source: ADOPTECH Survey 1996.

Table 10: Problems perceived by survey farmers with respect to the Occupational Safety and Health Act. (The first and second comments are shown).

(Percent farmers responding)

Perceived problems	Farm type				Overall
	Dairy	Sheep, beef, deer larger units su > 50	Sheep, beef, deer smaller units su 50-500	Hobby su < 50	
First response	**n=55**	**n=63**	**n=52**	**n=50**	**n=220**
None	22	14	37	40	27
Complicated	53	57	48	46	51
Restrictive	20	29	15	10	19
Usage problem	5	-	-	4	2
Chi-square (d.f.)					21.2 (9) **
Second response	**n=9**	**n=16**	**n=8**	**n=5**	**n=38**
None	33	38	50	60	42
Complicated	67	50	50	40	53
Restrictive	-	13	-	-	-
Usage problem	-	-	-	-	-
Chi-square (d.f.)					4.0 (6) NS

Source: ADOPTECH Survey 1996.

Table 11: Farmer views on the statement "Reliable market information to guide long-term farm management decisions is readily available".

(Percent farmers responding)

Farm type	n	Farmer views on the statement		
		Disagree/ strongly disagree	Neutral	Agree/ strongly agree
A. Dairy farms	70	44	23	33
B. Sheep, beef &/or deer farms				
a. larger units: > 500 su	73	73	7	21
b. smaller units: 50-500 su	85	47	25	28
C. Hobby farms	84	33	35	32
Total/Overall	312	49	23	28

Chi-square (6 d.f.) = 28.8 (P < 0.000).
Source: ADOPTECH Survey 1996.

Table 12: Farm financial conditions and satisfaction with current marketing arrangements experienced by the survey farmers.

(Percent farmers responding)

Indicator	Farm type				Overall	Chi-square Statistic (d.f.)
	Dairy	Sheep, beef, deer su > 50	Sheep, beef, deer su 50-500	Hobby su < 50		
Over the past 5 years farmers have been able to maintain their property	n=69 70	n=74 57	n=82 72	n=76 75	n=301 68	6.7 (3) *
Farmers had to reschedule their financial obligations during the past 5 years	n=65 51	n=74 58	n=75 40	n=75 51	n=289 50	5.0 (3) NS
Farmers have been able to repay their mortgage on time	n=65 98	n=67 82	n=69 94	n=67 94	n=268 90	7.2 (3) *
Farmers are satisfied with current marketing arrangements	n=69 68	n=73 26	n=80 41	n=67 58	n=289 48	29.6 (3) ***
Areas of change	**n=22**	**n=48**	**n=38**	**n=18**	**n=126**	
A. Pricing structure	36	38	47	22	38	
B. Market organisation	36	38	34	28	35	
C. Market promotion	9	17	18	39	19	
D. Market info/research	18	8	-	11	8	
Chi-square						13.6 (9) NS

Source: ADOPTECH Survey 1996.

Table 13: Essential factors identified by the survey farmers for the long-term viability of farm business.

(Percent farmers responding)

Issues	Farm type				Overall	Chi-square d.f.=3
	Dairy	Sheep, beef, deer larger units > 500 su	Sheep, beef, deer smaller units 50-500 su	Hobby < 50 su		
A. Economic/Financial	82	88	65	51	70	31.6 ***
B. Social	48	50	22	30	37	18.5 ***
C. Environmental	1	3	11	14	8	12.4 ***
D. Productivity	30	30	36	41	34	3.1 (NS)
E. Marketing	21	22	22	14	20	2.4 (NS)

Paper for 1997 NZARES Conference

Impact of Dairy Farm Conversions in Taupo District

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Introduction

Over the last 20 years there has been a significant change in land use in New Zealand out of sheep and beef and into (in particular) forestry and dairying and it is likely that this trend will continue into the foreseeable future (MAF 1996). At the local district level this has impacts and implications at an environmental, social and economic level for landowners, local communities, agribusiness, and local government. This paper discusses the impact of large scale dairy farm conversions that have occurred in the Taupo District, and follows on from a similar study into the impact of large scale forestry plantings in Wairoa District (Krausse and King, 1997).

The paper is based on a project commissioned by MAF Policy, and carried out by a consortium led by Agriculture New Zealand Ltd. Unfortunately, the project was not complete at the time of writing this paper, but a complete report will be published by MAF Policy, as a Technical Paper before the end of the year (MAF 1997).

Taupo District[1] is situated in the central area of the North Island, and covers an area of 6,970 square kilometres. Dominant features of the landscape are the volcanic cones to the south of the district, and Lake Taupo which covers an area of 616 square kilometres. The topography of the district is generally hilly to rolling land, with the soils being volcanic ash overlaying pumice. These soils are infertile in their natural state, free draining, and prone to erosion. Water quality in the district is currently judged to be high, with Lake Taupo supporting a significant tourism based industry related to fresh water recreational pursuits.

Of the land used in primary industry, 207,302 hectares (48%) is made up of plantation forestry and 140,169 hectares (33%) in pastoral agriculture. Most of the pastoral land had been "broken in" from its natural state by the Department of Lands and Survey, and settled as sheep and beef farms by ballot. Over the last 6 years the number of dairy farms has increased from 40 in 1991 to 75 in 1996, with dairy cow numbers doubling from 15,800 in 1991 to 32,000 in 1996. These conversions have largely been driven by the much higher profitability of dairying compared to sheep and beef.

As a more intensive and profitable form of pastoral farming, an increase in dairying in Taupo District has the potential to have a major effect on the environment, at a social level, and in increasing the level of economic activity. The thrust of the study was to try an quantify these effects.

[1] Taupo "District" refers to the local government area.

Methodology

The terms of reference for the project called for a survey of existing sheep and beef properties to determine differences in environmental impacts, financial returns, and social aspects. A total of 30 properties were surveyed; 15 of each of sheep and beef and dairying. Five of each farm type was intensively interviewed face to face, with the remaining 10 interviewed by phone. The consultants also discussed a wide range of factors with other organisations such as the District and Regional Councils, servicing industries, and utilities. An input/output analysis was done to determine multiplier effects at the district level. Statistical information was also gathered from a variety of local and central Government agencies, and organisations.

Environmental Impacts

1. Effluent Disposal

Dairying has been shown to have significant impacts on water quality (MAF 1993), mainly via the impact of disposal of dairy shed effluent, as well as accelerated nutrient run off and leaching (Robertson Ryder and Associates, 1993, 1995). Currently, the water quality in the Taupo streams and lake are regarded as high (Edgar, pers comm, NIWA,1994) and Environment Waikato is currently extending its monitoring programme to cover more sites both within the lake, and inflowing streams. Little information is known about ground water quality and the inflow of ground water into Lake Taupo.

The study showed that the vast majority (14 of the 15 surveyed) of the dairy farmers were disposing of dairy shed effluent via a spray irrigation system back onto pastures. This is perhaps a direct reflection of Environment Waikato rules, given that spray irrigation is a permitted activity, while the two pond, or other, system(s) are a discretionary activity. The regional rules also stipulate a maximum nitrogen loading of 150kg/ha/yr in irrigated areas. This relates to a recommended *minimum* irrigateable area of 4ha/100 cows (DEC 1996), or, as a rule of thumb, 12-15% of the effective area of the farm. The average area irrigated from the survey dairy farms was 23 ha, or 10.8% of effective area. At the average NPKS rating of dairy effluent, this would give an equivalent application of: 124kg/ha N, 15 kg/ha P, 111kg/ha K, and 62 kg/ha S.

While the nitrogen loading is below the maximum, there is significant potential for nutrient leaching, particularly of nitrogen and potassium, into the ground water aquifers, as well as nutrient run off to surface waters. Environmental impact studies in Southland and Otago (Robertson, Ryder & Associates, 1993, 1995) concluded that conversion of sheep & beef farms to dairying would result in significant increased losses of nitrogen, oxygen demanding substances and faecal bacteria to ground and surface waters. The Otago study concluded that diffuse source pollution from dairy farms (leaching and runoff) far outweighed the contributions from dairy shed effluent discharges.

2. Fertiliser

Average fertiliser input is shown in Table 1, based on data from Bay of Plenty Fertiliser Company, for the Taupo district for the 1996/97season.

Table 1 : Average Nutrient Applied as Fertiliser in the Taupo District (1996/97) (kg/ha)

	Nitrogen	*Phosphate*	*Potassium*	*Sulphur*
Dairy	51	45	52	53
Beef	7	19	18	24
Sheep	4	10	9	14

Source: BoP Fertiliser Ltd

Data from the five intensively surveyed farms show slightly higher average rates for the sheep & beef properties, at 8kg N/ha, and 27kg P/Ha, while the dairy farms showed much higher rates, at 95kg N/ha, and 90kg P/ha. Much of this could be attributed to capital applications to increase base soil fertility to get the dairy farms "up and running" as quickly as possible. The BoP Fertiliser data was also run through the AgResearch/MAF Policy "Overseer" nutrient budgeting model. The balances from this model are shown in Table 2;

Table 2 : Overseer Nutrient Balance Results (Nutrient balance in kg/ha)

	Nitrogen	*Phosphate*	*Potassium*	*Sulphur*
Dairy	19	-3	51	0
Sheep & Beef	6	-19	-3	-2

From this it would appear that the dairy farms are roughly in balance as regards P and S, but are applying excess N (remembering that the bulk of N comes from atmospheric N fixed by pasture legumes) and K. As could be expected given the current economic state of the sheep & beef industry, the balance on these farms shows a significant lack of P, and a rough balance (slightly on the deficit side) of K and S, and (slightly on the surplus side) of N. The higher applications from the survey dairy farms would mean a significant surplus of P and N, with resultant likelihood of nutrient leaching to ground water. The average applications of NPKS in effluent, as discussed earlier, would also result in a significant surplus balance, and therefore potential for leaching and/or run off.

3. Water Usage

The surveyed sheep & beef farms used on average 14,000 litres/day (4.2 *l*/stock unit or 53 *l*/ha), 50% of farms abstracted water from streams, while 50% abstracted their water from underground aquifers. Dairy farms used an average of 83,000 litres/day (17.7 *l*/SU or 344 *l*/ha), with the bulk of dairy farms taking water from underground aquifers. There is no data on the extent of these aquifers, or the impact of water abstraction.

4. Stocking Rate

Average stocking rate on the sheep & beef farms was 12.5 su/ha, compared with 18.8 su/ha on the dairy farms. While obviously the potential for pugging damage is greater under the dairying regime, the soils are very free draining, and experience in the Reporoa district, which is a long established dairy district on the same soil type, would indicate that while some localised pugging can occur over the winter, it tends to be a relatively short lived effect.

5. Erosion

The soils, being pumice based, can be very prone to erosion, such as tunnel gullying. While 40% of both sheep & beef and dairy farmers noted erosion as an issue, neither of the groups indicated that they had much serious erosion, with "pumice wash" from farm tracks following heavy rain being the most mentioned.

6. Riparian Management

Two thirds of the sheep & beef farmers noted that they allowed stock access to waterways, as opposed to only 14% of the dairy farms. However, against this, 73% of the sheep & beef farms reported that they had carried out some plantings of riparian strips, as compared to 40 % of the dairy farms.

Social

Perhaps the most significant social difference between the 2 groups was the higher population associated with the dairy farms surveyed. This is illustrated in Table 3.

Table 3 : Survey Population

		Dairying	*Sheep & Beef*
Average area		213 ha	285 ha
Adults:	Owners	30	30
	Employees	45	6
Total		*75*	*36*
Children:	Owners	32	19
	Employees	18	1
Total		*50*	*20*

Larger populations impact on local retail and servicing firms. These are largely centred on Taupo. Retail and service firms contacted noted an increase in demand, and were satisfied that they would have the capacity to meet any further increase in demand. Primary schooling was undertaken locally, with no reported problems with the increased number of children.

A number of farmers noted that they also occasionally sought services from centres outside of Taupo district, namely Rotorua, Tokoroa, and Taumaranui.

The dairy farmers tended to use more contractors, particularly for conserving supplementary feed (hay & silage). These were largely sourced from within the district. There was also a considerable demand on contractors during the initial set-up phase, with out-of-district contractors mainly used for the construction of the dairy sheds, but mostly within-district contractors used for such things as construction of races, water supplies, and fencing.

Farmers surveyed felt that there was a good community spirit in the local districts, with dairy farmers slightly more positive that sheep & beef farmers. All were happy with the idea of dairy conversions.

Consultation with Iwi groups showed that while they had a concern for the environmental effects of the conversions, they were also interested in converting some of their land to dairying. Ngati Tuwharetoa are significant landowners, and current projections to the year 2000 indicate they could be milking 6,600 cows by then, with potential for more large conversions.

Infrastructure

The majority of the roads in Taupo district are sealed (500km out of 650km). Taupo District Council has a policy to seal an average of 10km per year, with actual sealing in recent years varying between 8 and 28km. Because of the geological nature of the country (mainly pumice) and the lack of a convenient supply of good roading metal, unsealed roads are prone to erosion and general deterioration. For reasons of cost, roads sealed by Taupo District Council are not designed for prolonged use by heavy vehicles, and Council officers anticipate that if dairy conversions continue, the sealed roads will be inadequate for continual use by milk tankers, and maintenance problems will increase. Council also considers that milk tanker turning movements into driveways will break up the pavement edges and hence farmers may have to seal the entrances to tanker tracks.

Electricity is supplied to the District by three supply companies; Trustpower, King Country Energy, and Waitomo Energy Services. The bulk of the reticulation system is 2 phase, which is inadequate for dairying, and hence upgrades to 3 phase is necessary. While there is no technical problem in supplying 3 phase power, there are a number of legal issues, such as easements and financial liability the upgrade. Costs can obviously be reduced if adjoining properties, or a number of properties in close proximity, are upgraded at the same time.

All other general retail and service firms such as veterinary services, mechanical repair, farm supplies, etc, are readily available in nearby urban centres such as Taupo, Rotorua, or Tokoroa.

All major processing sites are outside of Taupo District; milk is processed at the New Zealand Dairy Group (NZDG) factory at Lichfield (north of Tokoroa), while most livestock is slaughtered at a number of meat works, again outside of the district.

Economic

1. On-farm

The economic activity associated with dairy farming is at a higher level than sheep & beef farming. Gross farm revenue is much higher, as is farm working expenditure and the associated cash farm surplus. Table 4 summarises the financial details from the surveyed farms;

Table 4 : Farm Revenue and Expenditure

	Sheep & Beef ($/ha)	*Dairy ($/ha)*
Gross Farm Revenue	522	2,229
Farm Working Expenses	342	1,293
Cash Farm Surplus	180	936

Disposable profit at $9.53/ha is not large on the sheep & beef properties, compared with $95.72/ha on the dairy farms. Despite substantially higher revenues on the dairy farms, this was offset by much higher costs, debt servicing and drawings. Average drawings on the dairy farms was 2.25 times higher than the sheep & beef farm drawings.

Main areas where expenditure on dairy farms was higher relative to the sheep & beef farms were (on a per hectare basis):

wages	369%	higher
animal health	400 %	higher
feed	886%	higher
fertiliser	457%	higher
vehicles	310%	higher
repairs and maintenance	384 %	higher
electricity	733%	higher

Capital requirements for conversion are substantial, with typical costs of around $3,500/hectare. For the average 213ha property this gives a total requirement, excluding purchase of the land itself, of $745,000. Often the purchase and set up costs involve significant debt. While no figures were collected as to debt levels, the average interest cost of $105,000 would indicate, after allowing for some seasonal finance servicing, a typical debt of $1 million. At the average debt servicing/gross farm revenue ratio of 27% for the conversion farms, any significant downturn in the dairy payout would put considerable financial pressures on these farms.

Farm valuations showed a significant jump following conversion to dairying, as shown in table 5;

Table 5 : Valuation Comparisons (1996)		
	Sheep & Beef ($/ha)	*Dairy ($/ha)*
Land	3,844	8,931
Buildings	1,080	2,541
Total	4,924	11,472

Average rates on the sheep & beef properties were $3,000, compared to $8,000 for the dairy properties, indicating an increased income to the District Council, which in turn will help in meeting increased costs such as roading.

2. District Impact

Input/output analysis was used to determine the multiplier effect of the conversions within the Taupo District boundaries. The decision to use the district boundaries is important because, as noted earlier, all processing of agricultural products is carried out outside the district. Hence the gain from processing increased milk is captured elsewhere, while the impact of fewer stock being processed through meat works also falls elsewhere.

Currently there are 75 dairy farms in Taupo district, milking 32,000 cows, up from 41 and 15,800 respectively in 1991. The expectation is for 111 farms milking 47,600 cows by the year 2000. The input/out analysis assumed 3 different scenarios;

(i) Current impact of the conversions - 35 extra farms on 6,400ha producing 3.9 million kg milksolids (MS).

(ii) Current impact plus slow growth to 2000 - 52 extra farms on 9,500ha producing 5.8 million kgMS.

(iii) Current impact plus high growth to 2000 - 70 extra farms on 12,800ha producing 7.8 million kgMS.

A regional input-output table was developed using the GRIT method (Butcher 1985) and converted to an IO7 format. The only variation made to the table was that whereas the SLQ for wholesale and retail trade suggested that only 54% of household spending was done in the district, survey work suggested a level of at least 75%, and hence the wholesale and retail trade coefficient for the household sector was changed.

Multiplier tables for output, value added, income, and employment were calculated. All of these are shown in the report on the project (MAF 1997), while the output and employment multipliers are shown in the following tables;

Table 6 : Total Output Ratios for Taupo District						
	Initial	*First Round*	*Industrial Support*	*Consumption Induced*	*Total*	*Flow-on*
Sheep & Beef	1.0	0.22	0.07	0.19	1.48	0.48
Dairy	1.0	0.22	0.07	0.16	1.45	0.45

Table 6 shows that for every $1 in output from a dairy farm, there is a flow-on effect of an increase in output of 45 cents in the Taupo District economy. Of this, 29 cents is due to economic activity stimulated by the inputs into the farm and 16 cents is due to the impact of consumption stimulated by salaries/wages paid on the farm and in the sectors involved in supplying inputs to the farm. The first round of effects are the effects on those sectors that supply inputs in the dairy farm sector, the industrial support effects are those that occur in the sectors that are stimulated by greater economic activity in the first round of impacts, and consumption induced effects are those effects that occur due to personal consumption activities occurring as a result of the initial, first round, and subsequent industrial support effects.

Table 7 : Total Employment Ratio (per $m output) in Taupo District						
	Initial	*First Round*	*Industrial Support*	*Consumption Induced*	*Total*	*Flow-on*
Sheep & Beef	8.48	3.15	0.53	1.74	13.89	5.41
Dairy	6.97	3.16	0.53	1.40	12.06	5.09

Table 7 shows that for every $1 million of output from dairy farming there are 6.97 jobs on dairy farms, and a further 5.09 jobs created elsewhere through the flow-on effects of economic activity.

Table 8 : Output Impact of Dairy Conversions (1996/97 $m)					
	Initial	*Production Induced Impact*	*Consumption Induced Impact*	*Total Impact*	*Flow-on*
Scenario 1	15.43	3.48	1.92	20.83	5.40
Scenario 2	22.92	2.17	2.85	30.94	8.02
Scenario 3	30.86	6.97	3.85	41.68	10.82

Table 8 shows that for scenario (1), for example, there is an initial $15.43m of output on the conversion farms, and a further $5.4m output in the rest of the district economy.

Table 9 : Employment Impacts of Dairy Conversions (1996/97 $m)					
	Initial	*Production Induced Impact*	*Consumption Induced Impact*	*Total Impact*	*Flow-on*
Scenario 1	74	39.22	14.88	128.20	54.20
Scenario 2	110	58.26	22.10	190.42	80
Scenario 3	148	78.49	29.78	256.51	108

Table 9 shows that for scenario (1), there are 74 jobs created on the conversion farms, and a further 54 jobs created elsewhere in the district due to the flow-on effects.

Similar tables were calculated for the sheep & beef sector, and then deducted from the dairying figures to give a nett effect of the conversions. Output and employment effects for scenario (1) are summarised in Tables 10 and 11;

Table 10 : Output Impacts (1996/97 $m)			
	Dairy	*Sheep & Beef*	*Difference*
Initial Effect	15.43	3.92	11.51
Total Effect	20.83	5.71	15.13
Flow-on Effect	5.4	2.4	3.0

Table 11 : Employment Impacts (1996/97 $m)			
	Dairy	*Sheep & Beef*	*Difference*
Initial Effect	97	34	63
Total Effect	168	56	112
Flow-on Effect	71	22	49

In summary, scenario 1 (of converting 6,400 ha from sheep & beef to dairying in Taupo District) has the nett impact of:

$11.5 million in output on the conversion farms
$3.0 million in output in the rest of the district economy

$3.41 million in added value on the conversion farms
$1.84 million in added value in the rest of the economy

$1.09 million in gross district income on the conversion farms
$1.21 million in gross district income in the rest of the economy

63 jobs on conversion farms
49 jobs elsewhere in the district

The impacts on output and employment for all three scenarios are shown in Table 12:

Table 12 : Summary of Output and Employment Effects			
Scenario	1	2	3
Land Area Converted (ha)	6,400	9,500	12,800
Farm Output ($m) Flow-on Output ($m)	11.5 3.0	17.12 4.46	23.02 7.23
On-Farm Employment (jobs) Off-Farm Employment (jobs)	63 49	93 74	127 97

The size of the Taupo economy was not calculated, and therefore the impact of the above increases in output can not be compared. However, the increase in employment is significant, with the above figures representing a 1.0% (scenario 1) to 1.7% (scenario 3) increase in total employment in the Taupo District, or 8.5% (scenario 1) to 17.5 % (scenario 3) increase in employment in agriculturally related work.

3. Dairy Company Share Issue

In 1996 NZDG amended their rules to require an increased share holding by farmers in the company, and increased the value of those shares. This followed on from two main factors. Firstly the advent of the Dairy Board Amendment Bill which clarified the ownership structure of the Dairy Board and whose shares were now held by the Dairy Companies. Secondly a combination of the large number of dairy conversions that were taking place, plus increased cow numbers on existing dairy farms, resulting in a significant increase in milk flow and hence capital investment needed to handle this. The new share structure was therefore introduced to reflect both the share holding NZDG has in the Dairy Board, and to impose a large part of the capital cost of expansion of processing facilities on those farms increasing milk production. The cost of the Dairy Board shares are also in part to reflect increased Dairy Board costs due to increased milk production. The end result is that conversion farms are required to take out a share holding in NZDG of shares worth $2 per kg of milksolids (to be) supplied. Future increases in production also require further purchase of shares at the rate of $2/kgMS. For the average surveyed dairy farm in the report, producing 130,000 kgMS, this would require an up-front cost of $260,000. Such large up-front capital costs, combined with the general downturn in dairy payouts for the 1996/97 and 1997/98 seasons has seen a marked drop off in the rate of conversions both within Taupo and through out the Waikato. While further conversions are expected to take place, the rate is now unlikely to match those used in the input/output scenarios 2 and 3 used above.

Conclusions

The impact of dairy conversions in Taupo District have seen a significant impact on the district's agricultural economy, and is likely to impact further when more conversions take place. The increase in economic activity as a result of the conversions has directly strengthened servicing firms in the district as well as the indirect flow-on effects including consumption induced effects. Given that forestry and tourism are the major industries within the district, the overall economic impact of dairy conversion is likely to be overshadowed. Never-the-less, the district economy as a whole would be strengthened.

Socially, within the local areas where the conversions are taking place, there has been a significant increase in the population, increased numbers of children attending local schools, and corresponding increased patronage of servicing firms, including medical and retail outlets.

There is a looming issue with respect to infrastructure, especially roading. Given that current roads do not have the capacity to stand up to regular heavy milk tanker traffic, it is highly likely that the Taupo District Council will face increased costs for road maintenance, and for further road sealing. The costs associated with this will no doubt add fuel to the discussions on who funds roading, and the role Central Government plays in this.

Possibly the major potential impact of the dairy conversions lies in their environmental impact, particularly on water quality. At this stage little is known of the water ecology of the Taupo district, particularly ground water. Dairying has a significant potential to impact on both ground and surface water by both diffuse and point source discharges. The figures presented in this paper indicate a major increase in nutrient loadings going onto the land, and therefore there is a high likelihood that this will adversely impact on the water systems. Given that a significant part of the Taupo economy is based around fresh water recreational pursuits, there is a need for the Regional and District Council to monitor water quality closely, and consider the impacts land use change may have .

While a greater degree of monitoring is necessary, it in itself will not necessarily predict or indicate the future consequences of further dairy farm conversions. Catchment modelling, as is being developed by NIWA (Rodda, pers com), will be necessary to try and predict these future impacts, which in turn may require changes in farm management practices and in farmer education.

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Instability in the New Zealand Meat Processing Industry An Economic Analysis[1]

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Abstract

The New Zealand meat processing industry has experienced a period of industry instability over the last fifteen years. There have been a continual process of plant closures, mergers and acquisitions, and new entrants entering, and in some cases exiting, the industry. Despite these apparent problems, there has been very little rigorous economic analysis of the industry. This research evaluates industry instability in the meat processing industry. The economic model that appeared appropriate to use in doing this was the theory of empty core markets. Empirical observations seemed to confirm that the New Zealand meat processing industry is operating in an empty core market. The principal results of this are twofold. Firstly, the current instability in the meat processing industry may not be the result of a short term market environment or mismanagement. Secondly, without the implementation of some form of industry cooperation or the advent of some merger or acquisition activity, the current instability in the meat processing industry may be destined to continue.

Keywords: meat processing industry, industry instability, empty core markets

1.0 Introduction

The New Zealand meat processing industry has exhibited a history of financial instability over the past decade, with a number of plant closures (Grimes, 1994). Since the early 1970s the industry has been the subject of continual rationalisation. During the late 1980s the rationalisation was probably at its most intense. A number of plant closures, mergers, entry and exit of firms, and near collapses were seen. Capacity rationalisation appeared to begin in the 1980s with the closure of Whakatu in the Hawkes Bay. Britton et.al (1992) believes that the second major restructuring move was in 1988, when Waitaki International, Alliance Group Ltd and Primary Producers' Co-operative Ltd (PPCS), agreed to a merger and rationalisation package. The pattern of industry closures has continued during the 1990s, with the most recent high profile closures being the receivership of both Fortex and Weddel.

Profitability within the meat processing industry has been an issue in recent times. Three recent reports have highlighted the current lack of profitability. Southpac Corporation (1994) showed that for the three year period through to 1992/93, earnings had been insufficient to cover interest payments in two of those years. At the time of writing the preliminary analysis of the 1993/94 season showed earnings would again be insufficient to cover interest payments. McWilliams (1994) concluded that over the previous eight years the New Zealand meat processing industry had gone from being a stable profitable industry to an unstable possibly unbankable industry. A report prepared by the Boston Consulting Group (1994) showed that meat processors earned a very small after tax return on equity after extraordinary items in 1989 and 1990, a substantial loss in 1991, a positive return in 1992, substantial losses in 1993, and substantial projected losses for 1994.

While it could be argued that such on-going rationalisation is part of any dynamic industry, the recent severe lack of profitability suggests that the industry may be suffering from more than just a readjustment problem. Lynch (1995) argues that relentlessly slim margins have left little to spare for investment in plant and equipment, in research and development, or to expand in-market distribution networks. He showed how the industry had struggled to cover the cost of capital for a decade, and in only one of those years (1992) could companies claim to have achieved satisfactory financial returns. In the 1993/94 processing season, total industry net profit was barely $100 million on an overall operating revenue of $5 billion.

The length of this rationalisation process presents the need for a greater understanding of the industry; it would be difficult to identify another industry where rationalisation has continued for a similar length of time. The continual nature of the rationalisation suggests there may be some underlying reason for the apparent continued industry instability.

The aim of this research is to offer some explanation for the unstable situation observed in the meat processing industry, thereby adding insight to the debate on potential industry direction.

In section 2, an appropriate economic model which can be used to evaluate instability in the industry is identified and discussed. Propositions which would need to be satisfied for the theory to be valid are also isolated. Section 3 outlines appropriate methods of providing evidence to support the propositions developed in section 2. Section 4 provides evidence to support the propositions. The results are discussed in section 5, while the conclusions are outlined in section 6.

This paper relates to what has been traditionally referred to in New Zealand as the meat processing industry, which includes the processing of lambs, sheep, cattle, and bobby calves and all their associated by-products. The research also concentrates on the input side of the industry only, thus ignoring the marketing, sales and distribution side of the industry.

[1] This paper reports thesis research completed as part of Brent Casey's Masters of Commerce and Management. The paper was presented at the Annual Conference of the New Zealand Agricultural and Resource Economics Society, July 1997.

2.0 Empty Core Markets

Four theories were considered which predicted industry instability. Three of these theories, namely natural monopoly, destructive competition, and Viner Industries were discounted, and the theory of empty core markets was selected as the most appropriate theory to use to assess the meat processing industry[2].

Empty core markets theory has its origins in cooperative game theory. The theory of empty core markets is an extension of a theory known as core theory. However, with an empty core market there is no competitive equilibrium

Telser (1971) argues that the core of a market is basically where buyers and sellers trade in a market until the goods and services are in the hands of those who value them the most. This process results in an efficient outcome, where there are no opportunities for improvement. At this point, the market has reached a competitive equilibrium.

In an empty core market there is no competitive equilibrium. A market has an empty core when (for a final set of transactions that is acceptable to all buyers and sellers) there is an alternative set of transactions that promises higher returns to buyers and sellers than the current set of transactions. Pirrong (1992) explains that with an empty core market, individual demands for surplus are larger than the maximum amount that can be created.

The theory of empty core markets has been used to show that competition in an industry characterised by quite feasible demand and cost conditions may result in a lack of profitability leading to industry instability. These conditions are demand uncertainty and a high proportion of costs that are fixed in the short term.

The notion of an empty core market is best illustrated by an example. From this, the general conditions that are consistent with an empty core market can be further explained.

The following example is a hypothetical example which could occur in the meat processing industry. It numerically illustrates an empty core market game and clearly shows how industry instability may eventuate[3].

[2] For an indepth discussion on the various theories and the reasons for the theory of empty core markets being the most appropriate theory to use in this research see Casey (1997).

[3] This example was provided on a confidential basis from the Chief Executive of one of New Zealand's largest meat processing companies. While the costs do not relate to this particular company, the apportioning of costs between fixed and variable costs are considered representative of the industry.

Table 1 shows this hypothetical case representing three equally efficient or inefficient plants. The equal efficiency is shown by the per unit variable costs being equal for each plant.

Table 1
Total Costs of Hypothetical Meat Processing Plants

	Plant A Capacity 20,000 per week	Plant B Capacity 60,000 per week	Plant C Capacity 120,000 per week	Total Cost To Farmer
Per Week Fixed Costs $000	125	357	500	982
Per Unit Variable Costs ($)	10	10	10	10
Variable Costs @ Capacity $000	200	600	1,200	2,000
Total Costs @ Capacity $000	325	957	1,700	2,982
Total Per Unit Costs @ Capacity ($)	16.25	15.95	14.16	14.91
Total Stock Available 120,000	20,000	50,000	50,000	120,000
Total Cost $000	325	857	1000	2182
Per Unit Cost ($)	16.25	17.14	20.00	18.18

Assuming a market price paid per unit processed of $17.25, the following profits for each processing plant can be calculated.

At Peak

Profit of Plant A	$1.00/lamb	$20,000/week
Profit of Plant B	$1.30/lamb	$78,000/week
Profit of Plant C	$3.09/lamb	$370,800/week

Off Peak

Profit of Plant A	$1.00/lamb	$20,000/week
Profit of Plant B	$0.11/lamb	$5,500/week
Profit of Plant C	($2.75)/lamb	($137,500/week)

The example shows that it is in the best interest of all plants to be operating at full capacity. When operating at capacity, all plants make a substantial profit. However, when demand is uncertain, it is conceivable that plants could be operating for a period of time below capacity. In the above example it is shown that operating below capacity has a significant effect on the profitability of both plants B and C. In the case of plant B, operating 17 percent below capacity reduces it's profits by 93 percent, from $78,000/week to $5,500/week. In the case of plant C, operating 58 percent below capacity reduces it's profits by 137 percent, from a profit of $370,800/week to a loss of $137,500/week.

Now consider the effect on both plants A and C if plant B successfully bids for a further 10,000 lambs which increases plant B's throughput back to full capacity. The manager of plant B knows that sourcing an additional 10,000 lambs will restore plant B's profit to $78,000 per week at a processing margin of $1.30 per lamb. If the manager paid an additional $3.00 per lamb for the additional 10,000 lambs on top of the original 50,000 (i.e. purchased them above the market value), plant B would make the following profit.

Extra expense			
10,000 lambs @ $3.00	=	($30,000)	
Profit improvement			
$5,500 to $78,000	=	$72,500	
Net Gain	=	$42,500	per week

Plant B is able to spend an additional $30,000 to restore its profit to $72,500, resulting in a net gain of $42,500 per week.

It is also worth calculating what it would cost the other plants to let plant B have the additional 10,000 lambs. In other words, what would it cost each plant to ignore a price war?

Plant A has its numbers reduced from 20,000 to 10,000 lambs for the week.

Fixed Costs	=	125,000	
Variable Costs	=	100,000	
Total Costs	=	$225,000	/ 10,000 lambs
	=	$22.50 per lamb	

Market Price remains at $17.25		
Loss per lamb	=	($5.25)
Loss per week	=	($52,500)
Versus a profit of	=	$20,000

Plant C has its numbers reduced from 50,000 to 40,000 lambs for the week.

Fixed Costs	=	500,000	
Variable Costs	=	400,000	
Total Costs	=	$900,000	/ 40,000 lambs
	=	$22.50 per lamb	

Market Price remains at $17.25		
Loss per lamb	=	($5.25)
Loss per week	=	($210,000)
Versus a loss of	=	($137,500)

Clearly, neither plants A or C can allow plant B to secure the additional lambs. If plant A allows plant B to secure the additional 10,000 lambs, it moves from a weekly profit of $20,000 to a loss of $52,500. If plant C allows plant B to secure the additional 10,000 lambs, it moves from a weekly loss of $137,500 to a loss of $210,000. All three plants therefore enter into a price war. The resultant cutthroat competition is rational and legal, but clearly not in the best interests of any of the three plants.

The theory of empty core markets has been used to explain instability in a number of industries including the ocean shipping industry (Sjostrom, 1989; Pirrong, 1992), the cast iron pipe industry (Telser, 1978; Bittlingmayer, 1982), the airline industry (Smith, 1995; Telser, 1978), the railroad industry (Telser, 1978), and the electricity generation industry (Telser, 1978).

The instability in an empty core market occurs when firms engage in bitter price competition during periods when there is excess capacity. With excess capacity, supply is greater than demand. This results in a reduction in prices. Because of the presence of high levels of fixed costs, competition is intense as companies try to operate at or near full capacity in order to absorb their high fixed costs. Such intense competition among incumbent firms leads to sub-normal profits during the periods of excess capacity. These sub-normal profits are clear in the above example. Eventually the lack of profits leads firms to exit the industry. These firms are generally replaced by other companies who believe they have the cost structure and demand certainty to operate efficiently in the industry. If demand is such that all firms are able to operate at or near full capacity, then all firms in the industry are able to survive. However, once demand decreases again, the same cycle of sub-normal profits resumes, resulting in firms exiting the industry and being subsequently replaced when demand again increases.

Given the above discussion and example, the theory of empty core markets was considered the most appropriate theory to use in this research. However, the theory needs to be evaluated more rigorously in terms of its applicability to the meat processing industry. Therefore, the following formal propositions were developed.

P_1: *demand for processing space in the New Zealand meat processing industry displays demand uncertainty.*

P_2: *the cost conditions in the New Zealand meat processing industry are consistent with short run decreasing average costs.*

3.0 Evaluating Market Characteristics

Demand uncertainty and short run decreasing average cost have traditionally been measured in empty core market studies by the coefficient of variation and econometric cost curve estimation respectively (Bittlingmayer, 1982; Pirrong 1992).

In this study the coefficient of variation was used to measure the degree to which the demand for processing space in the meat processing industry is uncertain. In addition, other measures were used where it was believed that these measures could illuminate the coefficient of variation.

Although the econometric cost curve estimation technique has been widely used in the empty core markets literature to measure short run decreasing average (Bittlingmayer, 1982; Pirrong 1992), it is likely to obscure the effect that the semi-fixed costs have on the meat processing industry[4]. Also, this technique has been criticised for its inability to measure various components of cost such as normal profits and the cost of capital. For these reasons it was considered inappropriate in this research.

Another technique which can be used to measure short run decreasing average costs is to calculate correlation coefficients between some unit of output and the various cost categories to determine the extent to which each cost category is fixed or variable. However, very few studies have relied solely on correlation coefficient results to determine the existence of decreasing average costs. (Pirrong, 1992). In addition, it does not plot the shape of the short run average cost curve, but merely assumes short run decreasing average costs exist because of the presence of high levels of fixed costs.

The engineering approach is a popular method used to determine the existence of decreasing average costs and appears to have been used extensively in the literature (Chenery 1949; Bower, 1964; Pratten, 1971; Boylan, 1975; Tarr, 1977, 1984). Using the engineering approach to establish the shape of the short run average cost curve would also allow the kinks to be identified that are likely to result from the semi-fixed costs that are evident in the meat processing industry.

This approach also makes it easier to model the games being played between competing firms. For these reasons, the engineering approach was used in this study.

[4] For a discussion on semi-fixed costs see pages 8 and 9.

4.0 Empirical Evidence

4.1 Demand Uncertainty

In order to make meaningful comparisons between the different classes of livestock processed, the throughput figures needed to be converted to a common unit. All throughput figures were converted to lamb equivalents (LEs) using export carcase weights. This conversion method is the same method used by Clemes (1984). Conversions used are shown in the appendix.

Because this study concentrates on the input side of the meat processing industry, demand uncertainty relates to the demand for processing space.

To accurately measure demand uncertainty, detailed meat processing industry throughput figures were required. The information was made available on an aggregated basis. Monthly throughput figures for the entire country were provided by the New Zealand Meat and Wool Boards' Economic Service. The information provided covered an 11 year period, from the 1985/86 processing season through to the 1995/96 processing season. The information was provided for lambs, sheep, beef, and bobby calves.

Table 2 shows the coefficient of variation results for all categories of livestock processed. They illustrate the cyclical demand uncertainty within a processing season for the different categories of livestock processed.

Table 2
Cyclical Demand Uncertainty Within a Processing Season
Coefficient of Variation Results
1985/86 - 1995/96

	Total Lamb	Total Sheep	Total Cattle	Total Bobby Calf[1]
1985/86	0.82	0.81	0.52	
1986/87	0.60	0.57	0.30	
1987/88	0.59	0.71	0.30	
1988/89	0.55	0.54	0.35	
1989/90	0.76	0.67	0.39	
1990/91	0.51	0.67	0.31	
1991/92	0.64	0.64	0.36	
1992/93	0.69	0.68	0.34	
1993/94	0.62	0.69	0.46	
1994/95	0.60	0.57	0.36	1.91
1995/96	0.58	0.64	0.39	1.77

1. Bobby Calf figures only available from 1994/95 season.

Source: New Zealand Meat and Wool Boards' Economic Service

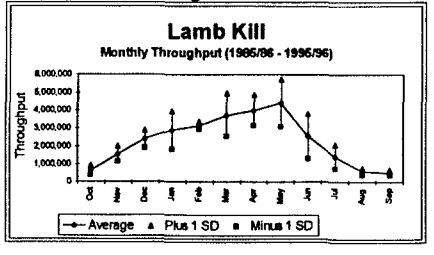
Pirrong (1992), when calculating coefficients of variation to measure demand uncertainty for monthly shipping, concluded that monthly shipments varied significantly in the different markets studied when the coefficient of variation ranged between 0.15 and 0.28. The results above reveal much higher coefficients of variation than these, hence it seems safe to imply that the results presented in this research suggest that the demand for processing space in the New Zealand meat processing industry displays within season demand uncertainty.

This demand uncertainty occurs for all categories of livestock processed. However, it is obvious that the demand uncertainty is less severe for cattle than it is for the other categories of livestock processed, with all but two seasons having the coefficient of variation results below 40.

The seasonality of the processing season can be graphically seen in figures 1A to 1C. These figures show the mean throughput by month, expressed in LEs, over the eleven year period. In addition to showing the mean, the figures also show the throughput demand uncertainty within a month over the eleven year period by plotting one standard deviation either side of the monthly means. These standard deviation figures imply that given the data used, 68 percent of the time monthly throughput will be between the range presented in the figures. It is obvious from figures 1A to 1C that in some months demand in more uncertain than in other months.

Figures 1A to 1C show that on average, the number of lambs processed peaked in May each year. Similarly, the number of sheep processed peaked in January and the number of cattle processed peaked in May. The figures clearly show the cyclical nature of the industry, with all classes of livestock processed showing the increase and subsequent fall in livestock processed on a monthly basis as the processing season advances.

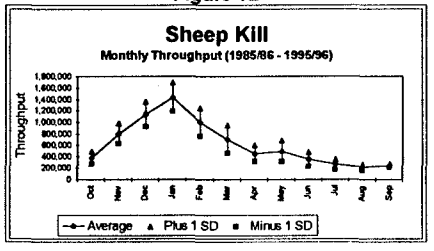
Figure 1A



In terms of total lambs processed, the monthly demand uncertainty, measured as one standard

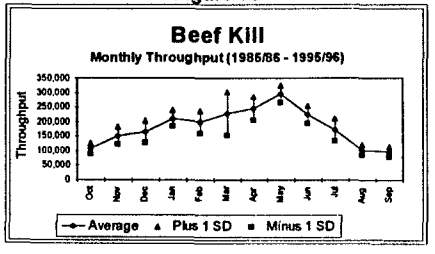
low between July and December. This period is generally considered the off peak period of the processing season. The monthly demand uncertainty shown in figure 1A between January and June (peak and shoulder period of the processing season) is higher than during the off peak period of the processing season. The exception to this is February which for some reason appears to have had limited variability over the eleven year period measured. There is no obvious reason for this, however the variability is only based on eleven observations which in not statistically considered a large number.

Figure 1B



The monthly demand uncertainty in sheep processing appears to be similar to that of lamb processing in that the period where the majority of the sheep were processed (November to May) has higher variability than the period when less sheep were processed (June to October).

Figure 1C



The pattern of low throughput months (August to October) corresponding with low variability is also evident in beef processing. The exception to the pattern is March which showed significantly higher throughput uncertainty than any other month. Again, there is no obvious reason for this.

It should not be too surprising to expect that throughput is uncertain within the processing season due to the nature of New Zealand's grass-fed production systems, particularly with lamb production. For example, lambs are timed to be born in the spring when the weather is settled and adequate feed is available. This results in farmers demanding that processing be which results in the industry collectively running at full capacity during only part of the season. Bollard et al (1995) comments that livestock producers are accustomed to an industry with sufficient capacity to slaughter on demand even at the peak of the season.

In addition to the grass-fed production systems, New Zealand's differing weather patterns are also likely to have an impact on the timing of the processing season. For example, it could be that in one season total throughput is more uniform than another season, where because of drought, there has been increased throughput in one or two months leading to throughput falling in subsequent months.

4.2 Decreasing Average Costs

4.2.1 Collection of Cost Data

Accessing detailed cost data was a difficult process because of the confidential nature of this information. All meat processing companies in New Zealand were approached either directly of indirectly about the prospect of providing financial information to complete this research, with emphasis being put on confidentiality and anonymity. Detailed financial information was made available from some companies on this confidential basis. Some of the financial data provided related to single chain, single plant companies while other financial data related to multi chain, multi plant companies. The information provided for this research was obtained on the basis that the information was commercially sensitive and on the understanding that it could not be identified or disclosed to any other party.

Having access to this information allowed detailed short-run average cost curves to be calculated with a high degree of accuracy. Having a number of companies provide financial information allowed comparisons between companies to be made and the research was not forced to draw conclusions having used only one company or plant that was assumed to be representative of the entire industry.

Some companies provided information on plants that processed beef only, some sheep only, and others a combination of sheep and beef. In order to calculate average costs per unit of throughput, the throughput figures were converted to lamb equivalents using the conversion factors detailed in section 4.1.

Where a company was involved in further processing, the further processing figures were split out and not included in the average cost

individual processing plants. The direct costs and revenue from further processing were easy to separate; however the overheads relating to further processing were not as easily separated. Therefore, processing revenue as a percentage of total revenue for each plant was calculated, and this ratio was then applied to total overheads to give a proportion of overheads attributable to further processing.

4.2.2 Average Cost Curve of Model Plant

Independent advice was sought to help identify a typical industry plant (model plant). The people approached had industry knowledge, although were not directly involved. Obviously there is a degree of subjectivity involved in their opinions, but by including a number of people in the discussions it was hoped that this subjectivity would be limited. It would have been preferable to include company representatives in the discussions but this would have meant breaching the confidentiality of the information provided so was not considered an option.

The information used to determine the shape of the short run average cost curve of the model plant was the annual accounts of the selected plant, broken down on a monthly basis. To begin with, monthly throughput was converted to lamb equivalents. The assumption was then made that the month where lamb equivalents was highest represented full capacity for the plant. Total annual capacity for the plant was calculated by multiplying the month where LE throughput was highest by twelve (months). Total annual capacity for the plant was calculated to be 1.2m LEs. The model plant used was a two chain plant. It was assumed that each chain in the model plant was equally efficient.

Having converted the throughput to LEs and calculated the total capacity of the plant, the various cost categories were divided into fixed, semi-fixed, and variable costs. This was done by using industry knowledge on various costings. The rationale for assigning the costs to the different categories was discussed with various industry people. This was the only possible approach given the commercially sensitive nature of the information provided.

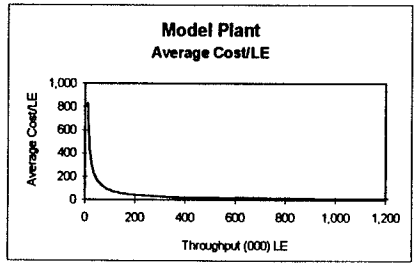
The semi-fixed costs were costs within the plant that at the beginning of a season are typically classified as variable, however when a chain opens they become fixed. For the purpose of determining the shape of the average cost curve in this section, it was assumed that all the wages costs relating to the model plant were semi-fixed. This may not be the case for any individual plant and will accentuate the affect of the semi-fixed costs on the shape of the average cost curve. However, the general objective of this section is to establish the shape of the model plant average cost curve, and this assumption is unlikely to alter the shape.

Examples of costs included under fixed costs include insurance, repairs and maintenance, salaries, and administration. Variable costs included materials and transport costs. All wages costs were treated as semi-fixed costs.

Having split the individual costs into their different categories, the average cost at each level of throughput was able to be calculated. To begin with, the fixed costs remained the same over the entire range of throughput. This meant that as throughput increased, the average fixed cost per unit decreased. Semi-fixed costs were also fixed once the decision had been made to open a chain, meaning that as throughput increased the average semi-fixed cost also decreased. This was up to the point where the second new chain was opened. Here, total semi-fixed costs increased to take account of the new staff. From this point, the average semi-fixed costs decreased again as throughput increased. Variable costs were calculated at a fixed rate per unit of throughput, meaning that as throughput increased, total variable costs also increased. The average cost per unit of output was obtained by adding together the total fixed, semi-fixed, and variable costs at a particular level of throughput and dividing the total cost figure by the level of throughput.

The following figure shows the average cost curve of the plant considered to represent the model plant.

Figure 2



It is obvious from figure 2 that the average cost curve of the model plant decrease very rapidly during the processing of the first 100,000 LEs and then smooths out. However, the scale of the average cost axis means that the cost curve is dominated by the dramatic initial fall in average costs which obscures the subtlety of movements in costs at higher levels of output. The following figure shows the shape of the short run average cost curve of the model plant at a selected throughput range. This range was selected so that the 'jagged edge' phenomenon that results from the introduction of a new chain could best be illustrated.

Figure 3

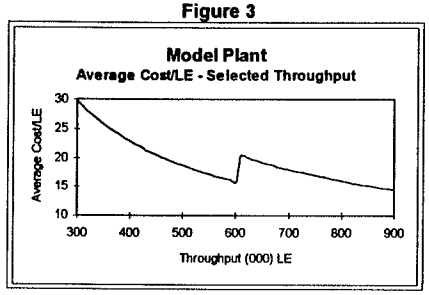


Figure 3 clearly shows that the average cost curve continues to decrease over higher levels of output. The average cost curve decreases in the above graph up to 600,000 lamb equivalents. It is also important to notice the 'jagged-edge' appear on the figure at 600,000 lamb equivalents. This represents the start up of the second chain within the model plant. The reason for this 'jagged-edge' appearance is the presence of semi-fixed costs when the second chain is bought into operation.

This represents the upper estimate of the 'jagged edge' because the assumption was made that all wages were semi-fixed costs. In reality it is likely that the 'jagged edge' is somewhat less, however it would still appear as long as some of the wages or other costs associated with operating a chain were classified as semi-fixed.

4.2.3 Evidence of Decreasing Average Costs in the Meat Processing Industry

The previous section showed the short run average cost curve of the model plant. It was noted that the average cost curve appears to rapidly decline at the beginning, then continues to decline at less of a rate. This decreasing average cost phenomenon is punctuated by a 'jagged edge' that reflects the introduction of a new chain.

The objective of this section is to determine the degree to which the decreasing short run average cost curve calculated for the model plant represents the actual short run average cost curves of a number of plants in the industry. The short run average cost curves of five plants were calculated using actual cost data.

In order to plot the short run average cost curve of an individual plant, the average cost at various throughput levels was calculated, in a similar way to Bower (1964) and Pratten (1971). The quality of the information provided meant the average cost figures were able to be calculated on a monthly basis, given the throughput for that particular month. Information was provided that covered one calendar year. The monthly average cost figures were calculated by totalling the costs of a plant for the given month and dividing these total costs by the total lamb equivalents processed for the month. Because of the demand uncertainty discussed in section 4.1, plants process differing amounts of throughput each month. The monthly relationships between throughput and average cost were plotted on a chart and the points were joined to determine the shape of the short run average cost curve of each plant. In some cases there were twelve observations calculated and plotted. However, some plants did not operate for twelve months in a year. In these instances only the months the plants operated were used to determine the shape of the average cost curve. Figures 4A to 4E show the short run average cost curves for five meat processing plants.

Figure 4A

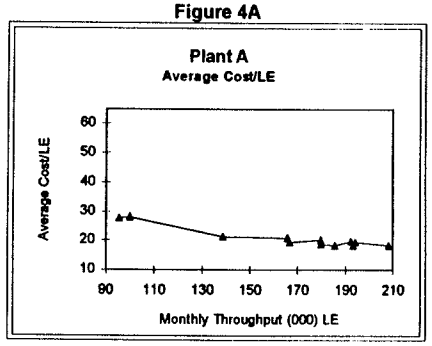


Figure 4B

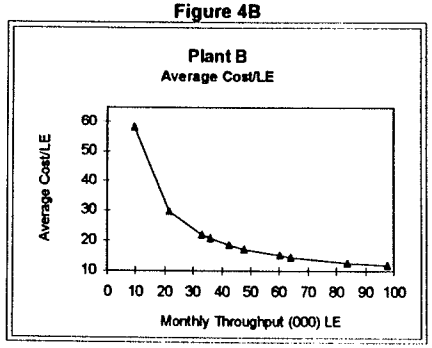


Figure 4C

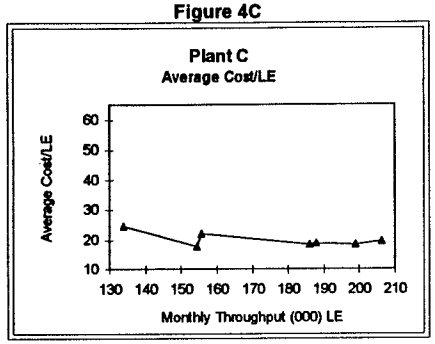


Figure 4D

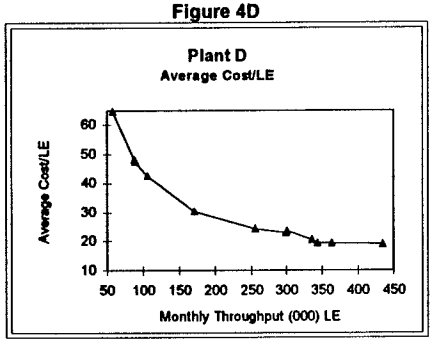
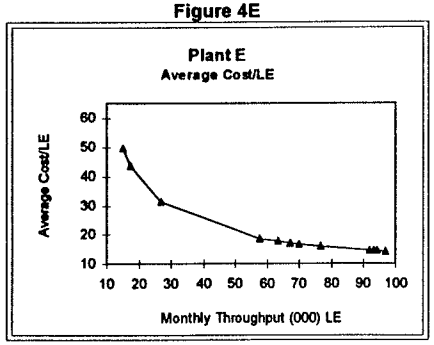


Figure 4E



All five plants graphed exhibit some degree of decreasing average costs over the range of throughput graphed. The most noticeable are plants B, D, and E. The average cost curves of plants A and C do not appear to decrease to the same extent as the other plants, but financial data was not available that allowed the average cost to be calculated at lower levels of throughput. Hence only the ranges 90,000 to 210,000 LEs were shown for plant A, while the range for plant C is 130,000 to 210,000 LEs.

It is clear in figure 4C that costs decrease and then increase before decreasing again. This may support the 'jagged edge' phenomenon. The most obvious 'jagged-edge' is at around 155,000 lamb equivalents processed. However, no actual data exists to confirm whether or not this level is the actual level at which the new chain opened in Plant C or whether some other factor would explain the kink.

It is difficult to deduce jagged edges from plants A, B, D, and E. It could be that there is no influence on the average cost curve because they are single chain plants. However, this is unlikely to be the case for plants A and D due to the large capacity of these plants. It may simply be that the jagged edge is not as pronounced as it is with plant C, or that the jagged edge does not show up under the assumptions used to determine the shape of the short run average cost curves.

The reason for the decreasing average cost curves depicted in graphs 4A to 4E is likely to be due to the make up of the costs of the five plants. Table 3 separates the fixed and variable costs of each plant at the beginning of the year. This data was taken directly from the monthly accounts of the individual plants. Obviously, a portion of the variable cost will become fixed as chains are opened, with this portion representing the semi-fixed costs as already discussed. While recognising that accountants may use arbitrary methods to categorise fixed and variable costs, the table does give an indication of the degree to which fixed costs dominate the total costs of each plant.

Table 3
Percentage of Fixed and Variable Costs
Plants A - E

	Fixed	Variable
Plant A	47	53
Plant B	60	40
Plant C	55	45
Plant D	48	52
Plant E	56	44

The high levels of fixed costs shown in table 3 result in short run decreasing average costs over the entire throughput range. As throughput increases, these fixed costs are spread further, resulting in the average cost per unit processed falling. Providing the average variable cost does not increase as throughput increases, decreasing average fixed costs will results in a short run decreasing total average cost curve.

The shape of the cost curves presented in figures 4A to 4E appear consistent with the shape of the

the model plant. All short run cost curves indicate a degree of decreasing average costs over the entire range of output with the exception of the 'jagged edge' caused by the possible introduction of a new chain in Plant C and the subsequent inclusion of the semi-fixed costs.

4.2.4 Discussion of Results - Decreasing Average Costs

The results presented in section 4.2.3 showing the shape of the average cost curves of individual meat processing plants are supported by previous studies that have discussed the cost structure of the industry.

McWilliams (1994) states that the meat processing industry is characterised by high fixed costs and the Southpac Corporation (1994) gave some indication of the level of fixed costs in the industry, revealing that between 55 and 60 percent of meat industry costs are either fixed of semi-fixed.

Clemes (1984) provided a very detailed analysis of factor costs in the New Zealand meat processing industry. The results of this research are significant, particularly with regard to the high level of fixed costs. Clemes (1984) found strong evidence to support the 'jagged-edge' phenomenon. He found that the proportion of fixed and variable costs at the start of the season remain constant only until the first chain is opened. At this time, the manning standards (variable labour costs) required for that chains operation become fixed and remain fixed until that chain closes, as do the labour costs associated with each successive chain.

Hence, the derived short run average cost curves of the model plant and the five actual plants provide evidence of the existence of short run decreasing average costs in the meat processing industry.

5.0 Discussion

The conditions that are consistent with an empty core market are demand uncertainty and short run decreasing average costs. Evidence has been provided that these conditions are found in the meat processing industry. It has been argued that, under empty core markets conditions, forcing competition in such an industry will result in cutthroat competition. This cutthroat competition leads to industry instability.

The meat processing industry is characterised by demand uncertainty because of the seasonal nature of New Zealand's grass-fed animal processing space is heavy, all processing plants are able to operate at or near full capacity (assuming no overall excess capacity in the industry) and thus operate at their minimum average cost. During these times the majority of firms in the industry are likely to be profitable because in most cases the demand for processing space is matched by the supply of livestock. Budgeted margins are obtained, and profitability maintained.

However, during the shoulder and off peak periods of the processing season, individual firms may be unprofitable. This is because plant managers may be unable to secure enough livestock to keep their plants operating at or near full capacity. The outcome of this is that plants operate at less than full capacity which results in an increase in their average cost per unit processed.

In order to increase their throughput and decrease their average cost per unit processed, each plant must secure additional livestock. To achieve this, prices paid for livestock are likely to rise as the demand for livestock by individual processing plants is greater than the supply. As all plants are attempting to secure additional livestock, it is likely that they will engage in cutthroat price competition during these periods of excess capacity. The increase in prices paid for livestock reduces the margins of each processing plant. These margins are likely to be reduced to an unprofitable level due to the nature of the cost structure of individual plants.

Because fixed costs dominate the cost structure of the meat processing industry, each plant has a portion of costs that exist whether of not the plant produces for a given month or not. For example, a plant could have fixed costs of $2 million per month. Because they are fixed costs, the plant must pay these costs whether or not the plant processes that month. The result of this is that the plant is better off to process during the month and sustain a loss of $1.9m than to not process and suffer a loss of $2m (total fixed costs for the month). It is likely that all firms will behave in this manner.

Margins are therefore able to be squeezed to an unprofitable level. Assuming that margins are greater than variable costs, plants will be better off processing minimal amounts of throughput and cover some of their fixed costs than not processing at all.

In some cases plants will remain open all year and continue processing over the entire season. These plants will absorb any losses sustained during low throughput periods of the processing season and offset them against the profits made

other cases, the effect on profitability due to variations in throughput will be cushioned by opening and closing chains within a plant during the season. However, plants are relatively inflexible, with capacity (via chains) being added and removed in relatively large increments. In addition to absorbing fluctuating throughput numbers by opening and closing chains, some plants will close completely and reopen when throughput numbers increase to a financially viable level. These plants will close when plant processing margins are less than their variable costs, because the losses sustained will be greater than the fixed cost portion of their total costs.

The profitability of a plant for a particular season therefore depends of two distinct parts of the processing season. A plant will be profitable if the profits made during the peak of the processing season are enough to compensate the losses sustained during the shoulder and off peak periods of the processing season.

If at the end of the season the losses sustained during the shoulder and off peak periods of the processing season are greater than the profits made during the peak of the season, the game then becomes one of survival. Those with a strong balance sheet can sustain the losses longer than those that are in a relatively weaker position. Banks also play a major role in the game and their decision to continue financing the losses is likely to have a profound impact on the final outcome.

Therefore, in an empty core market situation, firms can be driven into bankruptcy by their losses (Scherer, 1970). However, these bankrupt firms will not necessarily be the less efficient producers, but those which are weakest financially. These may be the newer and smaller organisations without well developed banking connections. However, capacity is not necessarily lost following bankruptcy. The plants are normally acquired at bargain prices by another solvent firm, which sooner or later restores them to operation, burdened by much lower capital charges.

The exit of a firm from the meat processing industry is likely to leave excess capacity during the peak of future processing seasons. This in turn is likely to eventually bring new entrants to the industry to take up this slack capacity. This may not happen immediately, and it is more likely that it will happen over a number of processing seasons. However, when the demand for processing space falls again during the shoulder or off-peak period of the processing season the same pattern of losses being sustained is likely to transpire.

6.0 Implications and Conclusion

This research has used the theory of empty core markets to explain the current instability within the meat processing industry. The results have shown that the observed industry instability can be explained by the theory and is consistent with the prediction that an industry operating in a competitive environment that is characterised by short run decreasing average costs and demand uncertainty will be unstable.

The theory of empty core markets suggests that the current industry instability is not the result of bad policy, bad management, or bad luck. By contrast, the theory argues that the identified industry instability is due to the nature of the business. Without implementing some cooperative solution, or partaking in some merger of acquisition activity, it is argued that the meat processing industry is destined for continued instability. It therefore appears that the industry has three courses of action.

1. leave the industry as it is and continue to operate in an unstable environment.

2. implement some form of cooperation designed to reduce the industry instability.

3. partake in some form of merger or acquisition activity.

The first course of action involving leaving the industry as it is and continuing to operate in an unstable environment is likely to result in owners of the processing plants suffering continued losses. In the case of cooperative ownership, these losses would have to be absorbed by the on-farm profits of farmers. In the case of backward vertical integration, the losses sustained in the processing industry would have to be absorbed by the profits of the marketing company or the wholesaler. Where direct ownership in terms of investment is involved, it is likely that these investors will continue to suffer losses due the continued unstable nature of the processing industry.

These continued losses are likely to be unsustainable in the long run, particularly to those whose direct ownership is for investment purposes. Eventually, some plants or firms are likely to exit the industry and in time will be replaced by other firms who believe that they have the demand certainty and cost structure to operate efficiently and successfully in the meat processing industry.

The second course of action involving some form of cooperation designed to reduce the industry instability is observed in traditional empty core markets. In the meat processing industry, any degree of cooperation is likely to have the effect of reducing the competition that leads to the cutthroat competition during the shoulder and off peak periods of the processing season. However, it is debatable whether any form of cooperation would be allowed given New Zealand's current policy environment and the nature of the Commerce Act which specifically prevents cooperation in an industry unless it can be proven that such cooperation is beneficial to all those with an interest in the industry.

The third course of action involving some form of merger or acquisition activity is also suggested by the literature as a way of reducing instability in an industry characterised as an empty core market. Like any form of cooperation, a process of mergers and acquisitions would have the effect of reducing the competition that leads to the cutthroat competition during the shoulder and off peak periods of the season. Again it is uncertain the extent to which merger and acquisition activity would be supported by legislators and regulators, and particularly the Commerce Commission.

The principal results of this research are twofold. Firstly, the current instability in the meat processing industry is not the result of a short term market environment or mismanagement. It has been shown that this behaviour is consistent with that expected in an empty core market. Secondly, without the implementation of some form of industry cooperation or the advent of some merger or acquisition activity, the current instability in the meat processing industry is destined to continue.

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Appendix A

1	lamb	=	1	lamb
1	sheep	=	1.42	lambs
1	bobby calf	=	1.19	lambs
1	cattle	=	17.61	lambs

The figures used to calculate these conversion factors were sourced from the Ministry of Agriculture and the New Zealand Meat and Wool Boards' Economic Service. These figures were discussed with industry participants and were considered reasonable conversion factors to use. All statistics quoted in this section are based on lamb equivalents (LEs).

DETERMINING THE OPTIMAL RESERVATION PRICE OF FOREST STANDS

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ABSTRACT

Pastoral farmers who grow a forest crop as part of a farm-forestry farming system can choose to harvest before or after the accepted 'maturity' period. The decision to harvest trees depends on wood yield and price, and the returns from other enterprises. Because timber and farm product prices are stochastic, the farmer is likely to maximise net returns if the area of forest harvested reflects the variability in prices. The aim of this project is to develop a prototype decision model which can be used by farmers to determine a reservation price for forest stands. It will indicate to the farmer the price above which the stand should be sold to maximise profits.

The reservation price is affected by the probability distribution of log prices, the annual yield increment of timber, interest rate and the value of bare land. A dynamic programming technique written in Microsoft Excel and Visual Basic is used to develop the model. The change in wood yield with age (and other forest management treatments) was modelled using Forest Research Institute's stand modelling system, STANDPAK. The benefits of using the model to value immature forests under fluctuating stumpage prices are explored in this paper.

INTRODUCTION

Domestic log prices in New Zealand have fluctuated over the past 4 years in response to overseas demand for wood. In 1993 log prices were particularly volatile reaching a high of about \$370 /m³ for pruned *Pinus radiata* logs (Massey University, 1997). Prices have since fallen and pruned logs currently sell for about \$150 m³ (Edmond, 1996). A grower may choose to sell a stand of trees at the current market price or wait for a higher price in the future. If the value of the forest crop at the offered price is higher that the expected future value then the grower should sell.

For a distribution of log prices and rate of wood volume increase, an optimal reservation price for a forest stand can be calculated (Brazee and Mendelsohn, 1988; Lohmander, 1988). The grower should sell the forest stand if only the offered price is higher than the optimal reservation price to maximise the value of forest. This paper presents the results of a study undertaken to calculate the reservation price of a *Pinus radiata* forest stand and indicates how the value of a young forest stand can be calculated when log price is stochastic.

METHODOLOGY

The forest manager's objective is to maximize the value of a forest stand. This value can be affected by silvicultural treatments and the expected price of grades of logs recoverable from the forest stand. Following Lohmander, 1988, the problem can be stated as:

$$\text{Max } W(t) = (Wt)^* = \int_0^{P^*(t)} W^*(t+1)F'(P)dP + \int_{P^*}^{\infty} e^{-rt}[PV(t)+L]F'(P)dP \qquad (1)$$

where

P	price of standing volume of wood;
W(t)	expected present value at time t just before P_t has been observed and the forest has not yet been harvested;
P*	the optimal reservation price;
L	expected present value of land after the forest has been harvested;
F(P)	the probability density function of P;
r	the discount rate;
V(t)	the volume of the stand as a function of time.

The first term of Equation (1) is the expected value of the forest stand if the offered price is below the optimal reservation price. In this case the forest is not harvested in the current year. The second term is the expected present value if the offered price is equal to or exceeds the reservation price at a given discount rate. (The opportunity cost of land is included in the calculation).

The objective is to find a price P* so that the Equation (1) is maximized. If W*(t+1), the value of the standing forest, is known then the reservation price in time t can be determined. The value of the standing forest also depends on what happens to the forest in the future. The forest may be harvested if the offered future price exceeds the reservation price, or left unsold. A problem can be solved by working backwards from an age which exceeds the accepted rotation age of the stand of forest At this age a minimal value can be assigned to the forest.

MODEL SPECIFICATION AND DATA SOURCES

The reservation price model is applied to a stand of *Pinus radiata* forest planted on Massey University's hill country farm near Palmerston North. The growth of the stand was modelled using Forest Research Institute's STANDPAK package for two regimes designed to produce pruned and unpruned saw logs for the domestic market. The characteristics of the site and schedule of treatments used in STANDPAK are summarised in Table 1 and Appendix 1. The pruned stand regime is pruned three times and thinned once to final stocking of 300 stems /ha. The unpruned stand is thinned once at age 12.6 years to a final stocking of 400 stems /ha.

Table 1 **Tending operations used to simulate Radiata pine growth in STANDPAK (Site data and growth models used in the simulation are shown in Appendix 1).**

A 'Pruned'

Schedule of tending operations used for the production of pruned sawlogs

PRUNED (DOS) 330 stems/ha to leave 2.0 m. of crown at age 4.7 years
PRUNED (DOS) 300 stems/ha to leave 2.2 m. of crown at age 6.5 years
PRUNED (DOS) 300 stems/ha to 6.0 m at age 9.2 years
THINNED stand (least prnd) to waste leaving 300 stems/ha at age 9.2 years
SWITCHED to later model set from G23 H26 V22 M6 at age 15.9
END Rotation at age 40 years

B. 'Unpruned'

Schedule of tending operations used for the production of unpruned sawlogs

THINNED stand (least prnd) to waste leaving 400 stems/ha at age 12.6 years
SWITCHED to later model set from G23 H26 V22 M6 at 15.9 years
END Rotation at age 40 years

The estimated growth is shown in Figure 1. The unpruned sawlog regime produces a higher volume of timber and has a higher mean annual increment (MAI) that than the pruned regime. In both regimes the peak MAI falls between ages 30 and 37 years. It is therefore likely that harvest will take place before the stand reaches 37 years.

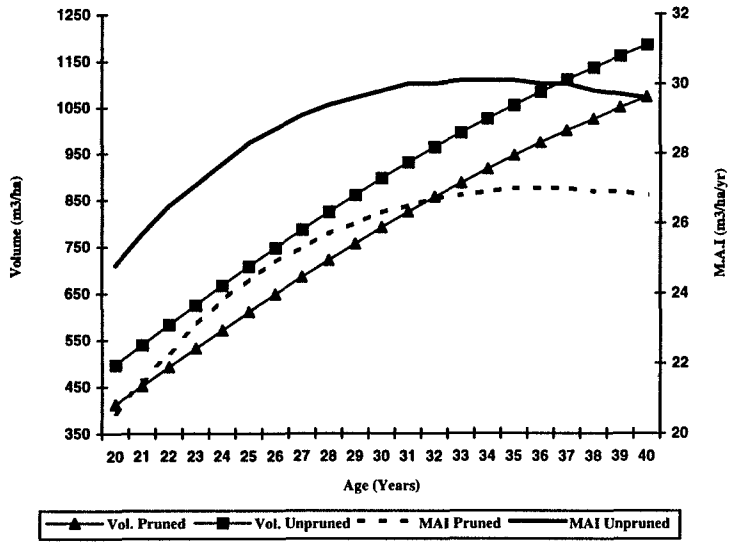

Figure 1 **Standing volume and mean annual increment (M.A.I) of Radiata pine - site index 23.**

The value of logs recovered from the stand is higher for the pruned sawlog regime. This is shown in Tables 2 and 3 at age 30 years for the minimum and maximum prices record between 1993 and 1997 (Edmonds, 1996; Massey University, 1997;). At age 30 years the stumpage consistent with log grade prices, and felling, transport and roading costs range from $37/m3 to $158/m3 for the pruned sawlog regime, and $12/m3 to $94/m3 for the unprunned sawlog regime.

Table 2 **Log grade recoveries at clearfell age of 30 years**

Log grade	Minimum log price for NZ domestic grades at wharf gate or mill door ($/m³)	Maximum log price for NZ domestic grades at wharf gate or mill door ($/m³)	Pruned		Unpruned	
			Volume (m3)	Outturn (%)	Volume (m3)	Outturn (%)
P1	148	370	223.9	31.7	0	0.0
P2	111	370	41.6	5.9	0	0.0
S1	90	200	2.6	0.4	72.5	8.5
S2	70	170	5.3	0.8	74.9	8.7
S3/L3	58	130	69.4	9.8	130.7	15.3
L1/L2	56	150	282.4	40.0	479.3	56.0
PULP	35	75	80.0	11.3	99.2	11.6
Totals :			705.2	100	856.6	100

Table 3 **Stumpage at clearfell age of 30 years of Radiata pine (using log grade recoveries and prices shown in Table 1).**

	Pruned		Unpruned	
	Minimum	Maximum	Minimum	Maximum
Standing Volume(m³)	791	791	896	896
Revenue at wharf gate or mill door($)	61,002.6	157,041.6	49,660.5	123,557.1
Cost -felling, roading and transport ($)	32,138.7	32,138.7	38,946.2	38,946.2
Net revenue ($)	28,863.9	124,902.9	10,714.0	84,610.9
Stumpage ($/m³)	36.5	157.9	12.0	94.4

The minimum and maximum stumpage used in this study are:

Pruned regime: $35/m3 - $160/m3
Unpruned regime: $10/m3 - $ 95/m3

The future probability distribution of stumpage is unknown. A uniform distribution will be assumed for the purposes of this study using the above ranges.

Two discounts rates, 7% and 10% real, are used in this study.

An opportunity cost of $2000 /ha is assumed for land, which is approximately equal to the current selling price for a hill country sheep and beef farm. (This is obviously a simplification since the opportunity of cost land that is to be replanted into forestry may be different from the value of bare land in pastoral production)

The model is solved backward from age 40 years which exceeds the age of maximum mean annual increment (See Figure 1). It is assumed that at this age the stand will sell at any price on offer. In this case the minimum stumpage is the optimal reservation price.

The model is programmed in Microsoft Excel and Visual Basic, and the optimal price in Equation (1) is solved numerically and backward in time from age 40 years to age 20 years.

RESULTS

The optimal reservation price is shown in Figure 1 for the pruned and unpruned saw log regimes, and for 7% and 10% discount rates. As expected the optimal reservation price (stumpage) decreases with age, and it is higher for the pruned saw log regime. The reservation price reduces as discount rate is increased.

The reservation price is fairly constant between age 26 years to 34 years (about 130/m³ for the pruned sawlog regime). This indicates a high probability that the forest stand will be harvested between these ages.

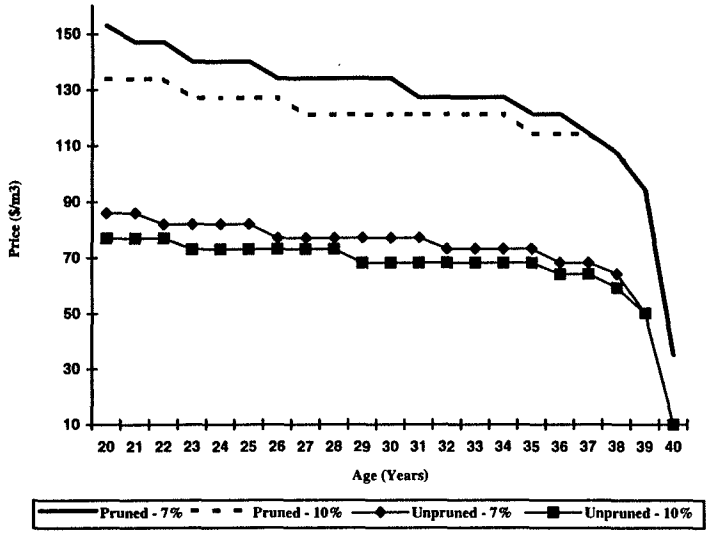

Figure 2 **The optimal reservation price (stumpage) at 7% and 10% discount rate of Radiata pine**

The optimal present value of the forest stand is shown in Figure 2. As expected the present value of the forest decreases with age, and increases with discount rate. At the 7% discount it is best to prune, and leave unpruned if a 10% real discount rate is anticipated.

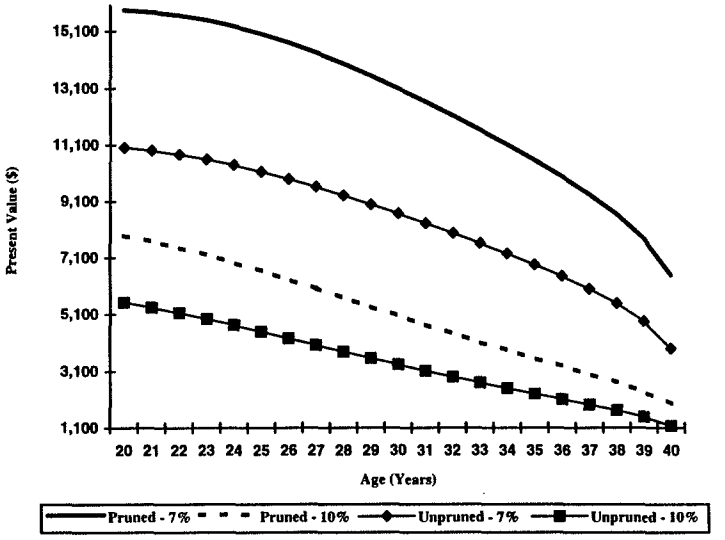

Figure 3 **The optimal expected present value at 7% and 10% discount rate of Radiata pine.**

CONCLUSION

An advantage of forestry over other cropping or pastoral farming systems is that the forest need not be harvested at any given age if the price on offer is too low. The forest should not be harvested unless the offered price exceeds the optimal reservation price for that age class. The reservation price depend on the distribution of prices and the he growth of the forest. It has been shown in this study that optimal rotation length depend on the offered price and the optimal reservation price of logs. This approach also provides a rational for valuing young forest stands, and to compare different silvicultural treatments when price is stochastic.

ACKNOWLEDGMENT

The regimes used for this study were developed by James Millner and Jason Blair, Plant Science Department, Massey University. Their assistance is gratefully acknowledged.

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Appendix 1 Stand treatments used in Stand Growth Module of StandPak

```
+-------------------------------------------------------+
|        S T A N D   G R O W T H                        |
|   Stand Treatment and Growth Simulation               |
|            Version 6.10                               |
|            New Zealand                                |
|     Forest Research Institute Limited                 |
+-------------------------------------------------------+
Massey University                    Wed Jun 18 11:53:08 1997
TUAPRUN1                                      #075-57CC
=========================================================================
```

Growth Model	: 23 EARLY
DOS fn.	: Standard
Basal area fn.	: High
Crown fn.	: Beekhuis
Basal area adj.	: 20.0%
DOS adj.	: 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 cm
Height Model	: 26
Site Index	: 23.0 m
Stand Volume fn.	: 22
Start Date	: 1994 JUL (4.1)
Monthly Growth fn.	: 6
Mean Top Height	: 3.3 m
Growth Model	: 9 NAPIRAD
GF rating	: 7
Height Model	: 26
Site Index	: 23.0 m
Stand Volume fn.	: 22
Start Date	: 1994 JUL (4.1)
Monthly Growth fn.	: 6
Mean Top Height	: 3.3 m
Stocking at start	: 1000 stems/ha

<u>Schedule of tending operations used for the production of pruned sawlogs</u>

PRUNED (DOS) 330 stems/ha to leave 2.0 m. of crown at age 4.7 years
PRUNED (DOS) 300 stems/ha to leave 2.2 m. of crown at age 6.5 years
PRUNED (DOS) 300 stems/ha to 6.0 m at age 9.2 years
THINNED stand (least prnd) to waste leaving 300 stems/ha at age 9.2 years
SWITCHED to later model set from G23 H26 V22 M6 at age 15.9 years
END Rotation at age 40 years

<u>Schedule of tending operations used for the production of unpruned sawogs</u>

THINNED stand (least prnd) to waste leaving 400 stems/ha at age 12.6 years
SWITCHED to later model set from G23 H26 V22 M6 at 15.9 years
END Rotation at age 40 years

THE ECONOMICS OF IRRIGATING DAIRY FARMS UNDER CLIMATIC RISK

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ABSTRACT

In recent years many dairy farmers, particularly in Northland, have expressed an interest in investing in irrigation. The potential benefits of such an investment, in terms of the security of production over the summer months, and the consequent reduction in stress on farmers, animals, and pasture, are obvious but, because of uncertainty about the weather and farm prices, the assessment of the economic benefits is not so straightforward. A methodology was therefore developed to evaluate the economic benefits of an investment in dairy farm irrigation. Modelling techniques were used, in conjunction with historic data, to simulate pasture growth rates and derive farm gross margins, for both a dryland and an irrigated system, over 37 seasons for a Waikato case farm at Rukuhia. This allowed climatic variations during the summer to be accounted for and the effects of changes in economic variables to be assessed. A Monte Carlo style simulation was then used to estimate the probability distribution of the time taken to pay back an investment in irrigation. At 1995/6 prices a $325,000 investment in irrigation at Rukuhia was estimated to take between three and ten years to repay its cost, with a 97% probability that payback would occur within four to seven seasons. The economic variable with the largest effect on the probability distribution of the time to payback was the milksolids price; interest rates and the capital investment cost were relatively less important.

Keywords: Irrigation, dairy farm, risk, model, time to payback.

INTRODUCTION

In autumn 1992 the Northland dairy company began fostering the local use of an irrigation system developed in Tasmania by Gerard Van Den Bosch. As reported by Bird (1993), more than 280 inquiries were received from farmers the following year, and this included expressions of interest from outside of the Northland region. One major benefit of an irrigation system, such as the Bosch Long Lateral System, is increased security of production over the summer months, and an associated reduction in stress on farmers, animals and pasture. The profitability of such an investment however is also of concern to the dairy farmer. A dairy farmer operating a non-irrigated system is subject to risk in that variations in summer pasture growth rates may have major implications on milksolids production and/or production costs, and hence the farm's gross margin. Obviously the more prone an area is to drought or dry summer conditions the more profitable investment in irrigation is likely to be. The relative profitability of investment in irrigation therefore depends on the weather that occurs across seasons and the economic conditions that prevail.

This paper reports on the development of a method to obtain the probability distribution of the time taken to pay back an investment in irrigation on a case study dairy farm, based at Rukuhia in the Waikato. The Waikato, while less subject to droughts than Northland, is an area that is also suffers from extreme summer conditions (During et al. 1970), and has been a centre of irrigation research for more than forty years.

CASE STUDY METHOD

A method was developed to account for variation in summer weather patterns and estimate the economic benefits of investment in irrigation on a dairy farm under climatic risk. A systems approach was taken to obtain the probability distribution of the time taken to pay back an investment in irrigation. The system components included: a model of pasture growth that uses meteorological data to predict pasture growth rates and irrigation requirements for different seasonal conditions; a dairy farm model to estimate the gross margins associated with both an irrigated and a non-irrigated system for each set of pasture growth rates; and a simulation model which, by generating random sequences of possible seasons, uses the derived returns to irrigation to estimate the probability distribution of the time to payback.

The case study analysis was based on the findings of an 11 year irrigation trial conducted at the Rukuhia Soil Research Station between 1953 and 1964 as reported by McAneney et al. (1982). Statistical methods were used to estimate pasture growth rates and irrigation requirements using the trial data (W. Weeda pers. comm.) and rainfall data (NIWA unpublished data) for 37 seasons. These pasture growth data were used as input to a linear programming (LP) model of a dairy production system (McCall et al. 1997; Stachurski 1996) to obtain gross margins for both dryland and irrigated systems in each of the 37 seasons. The estimated returns to irrigation were then used to calculate the payback period associated with each of a large number of randomly generated sequences of the 37 seasons under consideration, thereby obtaining the probability distribution of the time taken to pay back an investment in irrigation at Rukuhia.

Pasture Growth Model

The major conclusions from the Rukuhia irrigation trial were that irrigation resulted in increased pasture production and also significantly reduced the variation that occurs in pasture growth rates from October to April (McAneney et al. 1982). The monthly pasture growth rates recorded on irrigated pasture during the years of the trial were relatively constant, with the associated coefficients of variation (CV) ranging between 8% and 17% during the irrigation period and reaching a maximum of 28% in July. Thus, the pasture growth rate in each month on optimally irrigated pasture was assumed not to vary significantly between seasons and was estimated from the average rate of growth recorded during the Rukuhia trial.

The total amounts of rainfall plus irrigation applied in each month between October and March were also relatively constant over the seasons of the trial (CVs of between 16% and 33%). Whilst seasonal variation in factors such as temperature and wind run, are likely to have some impact, it seems not unreasonable that the amount of water required to maximise pasture growth in each of these months would be relatively invariant between seasons. Accordingly, the optimal water requirement for each of these months was estimated from the total amount of water applied on average during the month. A relatively high CV of 46%, however, meant that no conclusion could be drawn for April. The irrigation requirements between October and March were estimated from the shortfall between the total monthly rainfall and the optimal water requirement for that month. An allowance of 30 mm was made for April, this being approximately the amount of irrigation applied during the Rukuhia trial. Monthly rainfall data measured at the Rukuhia Meteorological Station immediately adjacent to the irrigation trial site were available from 1946 to 1984 (NIWA unpublished) and total irrigation requirements for the 37 seasons were calculated as the sum of the estimated monthly irrigation requirements. A comparison of the calculated irrigation requirement and the actual amount of irrigation applied in each of the seasons of the Rukuhia trial indicated that the predicted irrigation requirements were either overestimates (up to 43%) or very close to the actual amounts applied.

In the case of dryland pasture the monthly growth rates outside the irrigation period were estimated from the average rates of growth recorded during the Rukuhia trial. The associated CVs ranged from 13% to 25%. During the early months of irrigation (Oct - Dec) pasture growth was relatively constant, with CVs of between 23% and 30%, however pasture growth exhibited considerable variation (44% to 99%) during the late summer/autumn period.

In order to explain the effects on dryland pasture production when soil moisture levels fall below the optimum range for growth a non-irrigated pasture growth model was proposed:

$$Gr_t/Gr_t^* = k_0 + k_1(R_{t-1} - W_{t-1})/W_{t-1} + k_2(R_t - W_t)/W_t \qquad \text{Eqn 1.}$$

where:

- t is a month in the irrigation period;
- Gr_t is the non-irrigated growth rate in month t (kgDM/ha/month);
- Gr_t^* is the potential or irrigated growth rate in month t;
- R_t is total rainfall in month t (mm);
- W_t is the optimal water requirement in month t (mm); and
- k_0, k_1, k_2 are constants.

That is, the ratio of actual growth to potential growth depends on the water deficit, expressed as a percentage, in both the previous and the current month. The constant k_0 is expected to equal one (i.e. actual growth = potential growth in the absence any moisture stress). Also k_1+k_2 is anticipated to be greater than or equal to one (i.e. negative or zero growth rates may occur in prolonged dry periods).

The data from the Rukuhia irrigation trial were used to estimate the above model for each month individually. The regression statistics indicated a lack of fit in the earlier months of irrigation (Oct - Dec) and also in April. Accordingly, the model was rejected for these months and the average rates of growth recorded during the Rukuhia

trial were instead taken to be the best estimates of expected pasture growth rates on non-irrigated pasture. The lack of fit in April was not surprising given the high coefficient of variation associated with the "optimal" water requirement. However, good fits were found in February and March, and a moderate fit in January. Data for these three months were pooled and the model estimated (Table 1).

Table 1. The regression statistics - Fit of the Rukuhia dryland pasture growth data (January to March) to Eqn 1.

Coefficient	Value	Standard Error	t-statistic
k_0	0.9891	0.0553	17.8874
k_1	0.5021	0.0609	8.2405
k_2	0.6423	0.0799	8.0436

with $R^2 = 0.83$ and Adjusted $R^2 = 0.82$.

The postulated model explained 82% of the variation in pasture growth rates on non-irrigated pasture between January and March. All coefficients were significant at the one percent level (27 degrees of freedom) and the hypothesis that $k_0 = 1$, with a t-statistic of 0.1979, could not be rejected. Whilst a test statistic was not derived, k_1+k_2 was greater than one as expected. The model was therefore used to estimate the pasture growth rates expected to occur between January and March, on dryland pasture, in each of the 37 seasons under consideration.

Gross Margins

The gross margin was defined as the return from milksolids less the variable costs of production in a given season. It was assumed that the case study dairy farmer aimed to maximise the gross margin, and that the case study dairy production system was based only on grazed pasture and pasture conserved as silage.

The dairy LP model (McCall et al. 1997; Stachurski 1996) was initially used to obtain the optimal "base strategies" for both a dryland and a fully irrigated production system. The base strategy related to the farmer's plan for the coming season and determined: the stocking rate and pasture cover at the start of the season, the production targets for the season, and a management plan to achieve these targets. This management plan, based on the pasture growth rates that s/he expects to occur during the season, determined the grazing management strategy, the amount and timing of silage harvesting, and when silage would be fed during the season. It was assumed that the anticipated pasture growth rates from January and March for dryland pasture equalled the mean values of the predicted growth rates.

The strategies that maximised the expected gross margin, for a milksolids payout of $3.55 per kilogram and at 1995/6 production costs, were obtained for both irrigated and non-irrigated production systems (Table 2). The optimal grazing management strategy on non-irrigated pasture involved the transfer of feed, in the form of silage and saved pasture, from the surplus period (Sep - Dec) into the late summer/autumn deficit period. Autumn saved pasture was used to combat the deficit that arose in early lactation. On the irrigated system, a later calving date reduced the demand for feed in late July/August but led to a deficit in late lactation. The optimal grazing management strategy in this case was to transfer feed, in the form of late summer/autumn saved pasture and silage, from the irrigation period into the winter where the higher stocking rate resulted in deficit.

Table 2. The base strategies for the case farm with and without irrigation during the October to April period.

PRODUCTION SYSTEM	Irrigated	Dryland
Gross Margin ($/ha)	3912	2963
Pasture Cover at 1st of July (kgDM/ha)	1998	2314
Pasture Cover at Start of Calving (kgDM/ha)	2062	2235
Area Cut for Silage (% of farm size)	72.9	28.5
Silage Fed to Cows (kgDM/ha)	1387	5101
Pasture Fed to Cows (kgDM/ha)	15680	12855
Milksolids Produced (kg/ha)	1315.2	998.2
Stocking Rate (cows/ha)	3.08	2.79
Start of Calving	29-Jul	15-Jul
Cows Culled after 180 day Lactation (%)	-	20
Cows Culled after 240 day Lactation (%)	20	-
Average Production per Cow over 180 day Lactation (kg MS/cow)	-	261
Average Production per Cow over 240 day Lactation (kg MS/cow)	364	-
Average Production per Cow over 300 day Lactation (kg MS/cow)	443	382

It was assumed that the base strategy would be implemented at the start of each season and that it would proceed according to plan through the winter and spring.

For the optimal irrigated system, pasture production was "constant" between seasons. Thus, there was no variation in the final outcome and the management plan and milksolids production target were always realised. The only variable factor was the amount of irrigation required in each season, and hence the gross margins for the 37 seasons were obtained by adjusting the base strategy gross margin for the annual cost of irrigating pasture per season. Costs, including those for electricity to pump water, maintenance of the irrigation system, and extra fertiliser (250 kg superphosphate/ha) required for increased pasture growth under irrigation, were estimated for the Bosch Long Lateral Irrigation System (Bosch Irrigation Ltd. undated). This irrigation system requires minimal maintenance, and is designed for overnight operation to take advantage of off-peak electricity rates.

For the non-irrigated system, differences from the expected, or base strategy, gross margin occurred as a result of variations in pasture growth between January and March. Discrepancies between actual and anticipated pasture growth rates can have a major impact on milk production and the management plan for the rest of the season. The LP model was used to estimate the highest gross margin that could be achieved in each of the 37 seasons based on the estimated values of the actual pasture growth rates in each season and the initial base strategy. The LP model was constrained so that initial and final pasture covers, the stocking rate, and the amount and times of silage harvesting, were the same as in the base strategy. While the same number of cows as in the base strategy had to be calved and milked through to mid-January in each season, the LP model could choose the lactation length and culling date for each season. All or part of the herd could be dried off, and up to a total of 20% of the herd culled, at 30 day intervals once a 180 day lactation had been completed. Harvested silage could be fed at any time and surplus silage could be stockpiled. The feeding of purchased supplements was permitted only to allow the herd to complete a 180 day lactation and obtain a feasible LP model solution. Surplus pasture could be topped after grazing to conform with pasture cover constraints and ensure that pasture quality was maintained. Topping costs were not included in the gross margins.

Probability Distribution of the Time to Payback

The payback period is defined as the number of years required for the investment in irrigation to generate sufficient returns to cover the initial capital costs and all subsequent interest payments. That is, the time to payback is the year in which the net present value of the investment first becomes positive. It was assumed that the seasons between 1946/7 and 1983/4 comprised a random sample of the population of possible seasons, in terms of rainfall during the irrigation period, and that each season had an equal probability of occurrence. It was also assumed that the first return to irrigation

occurred at the end of the season in which the irrigation system, installed in year 0, was first used i.e. in year 1. A Monte-Carlo style simulation approach was then used to generate random sequences of seasons and the time to payback was calculated for each sequence in the following manner. For the sequence of randomly generated numbers: $r_1, r_2, \ldots$, the time to payback was given by the smallest value of t that satisfied:

$$- \mathbf{CAPCOST} + \sum_t \mathbf{RETIRR}[r_t] / (1 + i)^t > 0 \qquad \textbf{Eqn 2.}$$

where:

CAPCOST = the capital investment cost of the irrigation system;
r_t = a randomly generated number between 1 and 37;
RETIRR$[r_t]$ = the estimated return to irrigation in the r_t^{th} season of the 37 possible seasons;
i = the relevant interest rate.

When a sufficiently large number of sequences of seasons were simulated, the frequency distribution of the time to payback values obtained from the simulation provided an approximation of the probability distribution for the payback period.

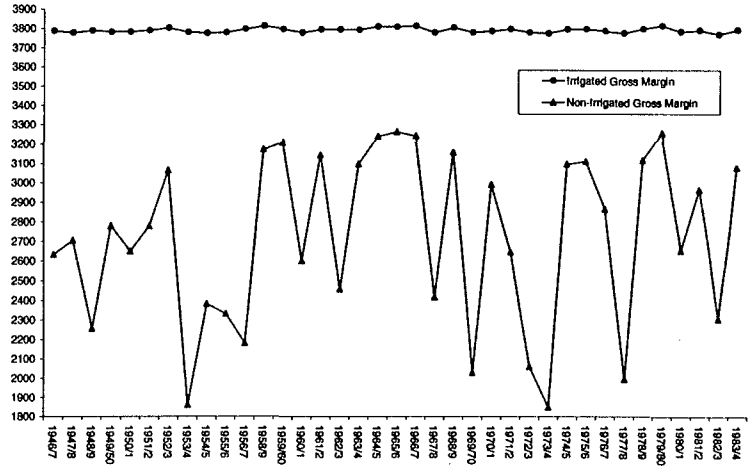
Bosch Irrigation estimated the capital cost of installing their long lateral system at between $2,700 and $3,800 per hectare. For the purposes of this study a capital cost of $3,000 per hectare was used. An allowance of $25,000 was made to cover the costs of installing a power supply and obtaining resource consent, giving a total capital cost of $325,000 to install the irrigation system on a case study farm of 100 hectares. The return to irrigation in each of the 37 seasons was estimated from the difference between the dryland and the irrigated gross margin, thus yielding the distribution of returns to irrigation that are likely to be achieved in the Waikato (based on a milksolids payout of $3.55 and 1995/6 production costs). It was assumed that the investment in irrigation was financed entirely by borrowing, therefore the relevant discount rate was the market rate of interest for rural loans. The rural lending rates offered by the National Bank on 26 April 1996 were 10.5% for a fixed term of up to three years, or 10.7% at floating rates. The fixed rate of 10.5% was chosen as the discount rate for the initial analysis.

Using the values described above a simulation involving the random generation of 10,000 possible sequences of seasons was performed. Initially, 100 random numbers were generated and each of these was then used as the seed, or starting point, for the generation of random numbers for 100 sequences of seasons.

RESULTS

The gross margins associated with both an irrigated and a dryland dairy production system, for each of the 37 seasons between 1946 and 1984, are presented in Figure 1.

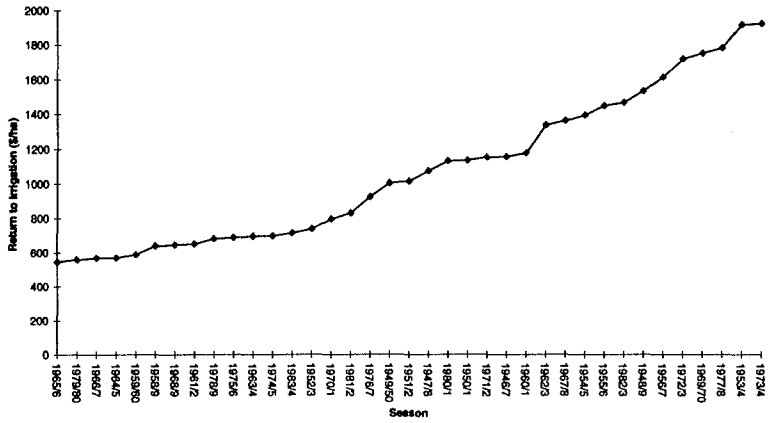
Figure 1. Irrigated and non-irrigated gross margins ($/ha) across 37 different seasons.



The gross margins associated with the non-irrigated system exhibited considerably more variation than those for the irrigated system (Figure 1). Whilst the CV for the gross margins for the dryland system was quite low at 16%, a CV of just 0.3% was obtained for the irrigated system, indicating an almost total lack of risk. Significant returns to irrigation were achieved even in seasons when dryland pasture growth rates were well above average and minimal irrigation was required (e.g. the 1965/6 and 1979/80 seasons in Figure 1).

Figure 2 shows the estimated returns to irrigation per hectare in the Waikato (based on a milksolids payout of $3.55 per kilogram and 1995/6 production costs), presented in order of increasing returns, over the 37 seasons. The mean return to irrigation over the 37 seasons was $1070.36 per hectare and varied between $546.55 in 1973/4 and $1923.90 in the 1965/6 season (CV=40%).

Figure 2. The expected returns to irrigation ($/ha) in order of increasing value across 37 different seasons.



Results of the simulation of the time taken to pay back an investment in irrigation on the case dairy farm are presented in Table 3. The time to payback varied between three and ten years, with a 97% chance that the investment in irrigation would repay its costs sometime in the next four to seven years (Table 3). There was nearly an 85% probability that the time to payback would be no more than six years.

Table 3. Results of the simulation of the time to payback.

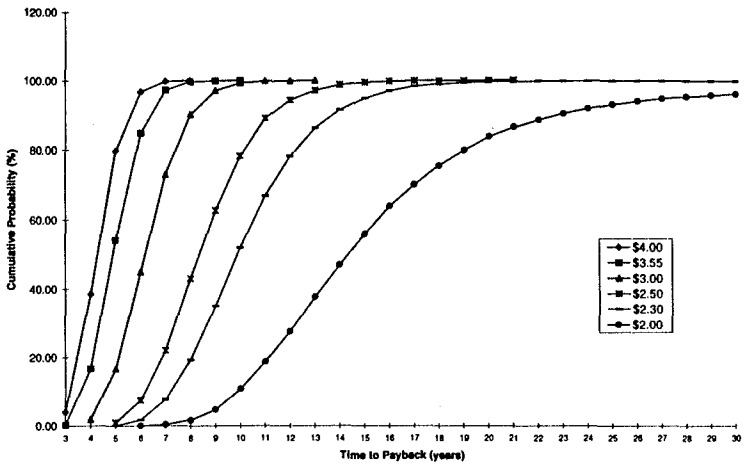
Time to Payback (yrs)	Frequency	Probability (%)	Cumulative Probability (%)
3	29	0.29	0.29
4	1644	16.44	16.73
5	3757	37.57	54.30
6	3054	30.54	84.84
7	1244	12.44	97.28
8	243	2.43	99.71
9	28	0.28	99.99
10	1	0.01	100.00
Total	10000	100.00	

Sensitivity Analysis

Milksolids Price

Over the last ten years the average milksolids payout has varied between $2.00 and $4.00 per kilogram. Under the assumption that the same base strategies were implemented, so that changes in the gross margins of both systems arose only as a result of the change in the milksolids price, the probability distributions of the time to payback were obtained for a milksolids price of $4.00, $3.00, $2.50, $2.30, and $2.00 (assuming capital costs of $325,000 and an interest rate of 10.5%). Results are summarised in Figure 3.

Figure 3. Probability distributions of the time to payback for varying milksolids prices.



The milksolids payout had a significant impact on the expected time to payback. If the milksolids price ranged between $2.30 and $4.00 per kilogram then there was more than a 99% probability of payback occurring within 20 years, given a constant interest rate of 10.5% and an initial capital investment of $325,000. However, at a milksolids price of $2.00 per kilogram, the chances of payback within 20 years were only 83%, and in fact there was a 1.3% probability that payback would not be achieved within 50 years.

Interest Rates

Rural lending rates between 19991 and 1996 have ranged between 8% and 15%, ignoring the high interest rates at the beginning of this period which almost certainly still reflected the uncertainty involved in the deregulation of the financial sector. Cumulative probability distributions of the time to payback were estimated for interest rates of 8% and 15% (assuming a milksolids payout of $3.55 per kilogram and a capital investment cost of $325,000). The impact of variations in interest rates on the time to payback were shown to be relatively insignificant when compared to the effect of variations in the price of milksolids. Under the stated assumptions there was a 99% probability that payback would occur within nine seasons regardless of the actual level of the interest rate (so long as it did not rise above 15%).

Capital Investment Cost

The cost of installing the Bosch long lateral system varies between $2,700 to $3,800 per hectare. Allowing a further $10,000 to $40,000 to cover resource consent and power supply, the capital cost of an investment in irrigation on the 100 hectare case study farm was assumed to range from $280,000 to $420,000. Probability distributions of the time to payback were derived for capital investment costs of $280,000, $375,000, and $420,000 (assuming a milksolids payout of $3.55 per kilogram and an interest rate of 10.5%). The effects of differing capital investment costs on the probability distribution of the time to payback were also relatively insignificant when compared to the effect of changes in the milksolids payout. In this case there was a 99% probability that payback would occur within 10 seasons regardless of the capital cost of the investment, assuming that the milksolids payout and rural lending rates remained at 1995/6 levels.

DISCUSSION

Top producers on dryland pasture in the Waikato are members of the "600 Club" i.e. farmers producing more than 600 kilograms of milkfat, or 1044 kilograms of milksolids, per hectare. The base strategy production level of 998 kilograms of milksolids per hectare fell a little short of this. This is likely to be, at least in part, due to the limitations and restrictions imposed by the use of the dairy LP model. On the other hand, an expected production of 1315 kg MS/ha for the irrigated system is significantly higher than the best production levels presently achieved on dryland pasture. If the LP model were allowed more flexibility it is possible that strategies that result in higher returns and/or milksolids

production might be identified. The base strategies obtained, however, do not seem unreasonable relative to current levels of dairy farm performance in the Waikato.

On non-irrigated pasture, optimal management involved the conservation of silage in late spring for feeding out during the summer months which is in line with current management practices. On irrigated pasture, an increased stocking rate and a higher individual milksolids production per cow was achieved through later calving and the feeding of supplements during the winter. This optimal management strategy conforms to that suggested by Bosch Irrigation for the management of an irrigated dairy system (Bosch Irrigation undated).

The gross margins achievable in practice on dryland pasture in each of the 37 seasons are likely to have been underestimated by the analysis. The dairy LP model assumes perfect knowledge of all pasture growth rates in each season hence the gross margins obtained for non-irrigated pasture relate to the best possible outcome subject to the constraints of the model. Whilst sub-optimal decisions may in fact be made when pasture growth rates diverge from anticipated levels, the farmer has more flexibility than is allowed by the LP model, and thus is likely to be in a position to achieve a higher production than the model suggested.

Variations in climatic factors other than rainfall during the irrigation period, and in the factors that influence pasture growth at other times of the year, will impact on the gross margins of both systems. Any such variation in climatic conditions can be expected to cause the gross margins for both systems to move in the same direction, although these changes are unlikely to be of the same magnitude.

The cost of the labour involved in irrigating pasture was not included in the analysis. The value a farmer places on his or her time depends on their individual circumstances, however, the time to payback will obviously increase if labour costs are explicitly taken into account. Other costs or benefits may also not have been accounted for. For example, pasture "topping" costs, a tax on water use, capital investment required over and above the installation of the irrigation system, tax deductions and/or payment incentives for shoulder milk production. These factors could easily be incorporated into the analysis should they be relevant to the particular farmer's circumstances.

Finally, the assumption that the farm was in a *status quo*, or equilibrium, situation, so that the same base strategy could be implemented every season, is perhaps unrealistic. In general, most farmers are in the process of further developing their farm, such as through pasture renewal or fertiliser treatments, and have medium to long term goals aimed at increasing productive capacity.

CONCLUSION

The modelling results obtained from the Rukuhia case study of irrigation are encouraging. At 1995/6 prices a $325,000 investment in irrigation at Rukuhia would take between three and ten years to repay its cost, with a 97% probability that payback would occur in within four to seven seasons. Sensitivity analysis indicated that, whilst interest rates and capital costs are important, the milksolids payout is the most significant factor in determining the likely time to payback for an investment in irrigation. New Zealand's natural competitive advantage is in pasture, and it is therefore recommended that a farmer considering a higher-input/higher-output dairy production system should at least investigate the benefits of irrigation as a possible option. The model presented in this paper provides a rigorous framework for completing this task.

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The Impact of Consumer Trends in the United Kingdom and United States on New Zealand's Red Meat Industry

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Abstract

Over the past decade, social demographic and economic developments have had a dramatic impact on eating habits and consumer behaviour. The world food industries are now driven by rapidly changing consumer demands. Understanding these changes in the markets and responding to them is key to the future success of New Zealand's food producers, processors and exporters. Factors such as convenience, health, and food safety are of paramount importance. This paper analyses literature and recent market studies, and describes how changing trends in the United Kingdom and the United States will impact on the New Zealand red meat industry.

Introduction

The United Kingdom and the United States are two of the New Zealand meat industry's most important export markets.

The UK is New Zealand's largest export lamb market. In the year ended September 1996, 29 percent of total lamb exports, or 94,636 tonnes were exported to the UK at a value of $351 million (FOB). Exports to the UK form part of New Zealand's quota market access to the EU of 226,700 tonnes. New Zealand accounts for around 89 percent of UK sheepmeat imports. Traditionally lamb exports have been frozen carcase, but this is gradually changing. In 1996, 9.4 percent of lamb was chilled with the balance frozen – 42.7 percent frozen carcase form and 47.9 percent frozen lamb cuts and boneless product. Most New Zealand product is sold at retail.

The UK is also New Zealand's largest export mutton market.

The US is New Zealand's largest export beef market. In the year ended September 1996, 51 percent of total beef and veal exports, or 168,739 tonnes were exported to the US, at a value of $406.8 million (FOB). New Zealand has quota access to the US of 213,402 tonnes per year. Although export volume has fallen in recent years, New Zealand holds around 20 percent market share of US beef imports. The majority of beef and veal exported to the US is lean beef for mixing with fatty trimmings produced from cattle from their own feedlots, specifically for the ground beef market. The ground beef market is very significant in the US comprising 41.3 percent of total beef consumption.

Lamb export volumes to the US have grown along with unit value. For the year ended September 1996, 10,798 tonnes of lamb were exported to the US, at a value of $72 million (FOB). The US is a small but expanding market for New Zealand lamb.

The USDA (1997) describes the average UK consumer as being closer to the typical US consumer than any other European country. Both consumers are relatively affluent with growing sophistication. Both the UK and the US have a high proportion of working women, an increasing number of smaller households, and an ageing population. The result is a complex food market, where purchasing decisions are a combination of price, quality, health and other considerations. Within the individual markets, consumers rank these purchasing decisions differently, the UK being price sensitive and the US ranking taste and nutrition above price.

Consumption

Both the UK and the US have shown rapid changes in meat consumption over the past decade. A combination of economic, demographic and social factors have impacted on consumption. Consumers now prefer processed meat products, which has led to decline in traditional roasting joints.

United Kingdom
UK consumers have traditionally been moderate meat eaters, with total per capita consumption of meat nearly 30 percent below the average for the European Community.

Pig meat is the most popular meat, however the decline in cooked breakfasts at home has lowered consumption in recent years due to reduced bacon consumption. Per capita consumption of beef has declined, with a marked decreased in consumption following the 1996 BSE scare. Sheepmeat consumption has also declined, but consumption of domestic sheepmeat has increased while imports of New Zealand lamb have declined. In the 1970's New Zealand imports accounted for over 50 percent of total UK consumption, falling to 27.5 percent in 1991 when UK lamb production and consumption reached record levels. Kilkenny (1993) cites the main reason for the decline in imported frozen lamb as being the decrease in consumer demand for frozen carcase meat. Following the 1996 BSE scare there was higher consumer interest in lamb. Poultry consumption has increased rapidly, compensating for the decline in consumption of the other meat options.

United States
The US is a very large market for beef, pork and poultry. Beef is the most popular meat, with consumption trending down over the last decade, but increasing slightly in the past two years. Per capita consumption of pork, lamb and fish have remained relatively steady during the past decade. Consumption of poultry has increased rapidly displacing beef as a meal option through innovative consumer ready products, lower prices, and high quality and consistency.

Economic Growth

A slow down in economic growth and recession in the UK in recent years, has affected consumer spending. Economic growth was healthy in 1994 at 4.0 percent per annum. However growth dropped to 2.5 percent during 1995 and 2.3 percent in 1996. Economic growth is forecast to be 3.2 percent in 1997, with consumer expenditure expected to recover. (USDA, 1997)

US economic growth has increased in recent years, from 2.0 percent per annum in 1995 to 2.4 percent in 1996. Economic growth in 1997 is forecast to be 3.3 percent. (Doyle *et al*, 1997)

Population

The UK and the US populations are both ageing. Bruhn (1996) says these demographics suggest the needs and preferences of the older generation will play an increased role in the marketplace.

UK population was estimated at 58.8 million in 1995, with 89.3 percent urban. Around 6.7 percent were over the age of 75 years, and this is forecast to rise to around 10.6 percent by 2030. Kilkenny (1993) says meat consumption is highest among the 45 to 65 year age group, and those in the 25 and under age group purchase and consume less meat. There is a concern that as the 25 and under population ages, they will consume less meat than the 45 to 65 year group currently do.

US population is currently 263.4 million and is forecast to increase by 129 million by the year 2050, an average of just under one percent annual growth. The US also has an ageing population.

Changing ethnic composition in both markets has inspired new taste experiences. The spicy character of Asian and Hispanic foods is becoming an increasingly important item in American cuisine. UK consumers have become more adventurous in their eating habits, with increased cultural and travel experiences.

Expenditure on Food

UK food expenditure as a percentage of total household expenditure is relatively low compared with the rest of Europe. Food's share of household expenditure in the UK has fallen from 15.1 percent in 1980 to 1985, to 12.0 percent in 1991. Meat's share of total household food expenditure fell during the same period, from 27.0 percent to 22.5 percent in 1991. Kilkenny (1993) says that income impacts on meat consumption, but measurement is not clear, as food prices from 1985 to 1992 rose less than the rate of inflation. However as meat comprises a substantial share of the total household food budget, economies can be applied when there is pressure on income.

Kilkenny (1993) says there is some evidence in the UK that consumers are trading down to cheaper cuts of meat as a result of the slow down in economic growth. MLC (1996) report a long term trend towards an increased market for beef mince has developed, strengthened by the trade down to lower value cuts and widespread use in ethnic foods.

US expenditure on food is 15.0 percent of total income, with meat's share being 17 percent of total food expenditure. The portion of total food expenditure outside the home has increased in the past two decades. US consumers eat out twice as much as UK consumers, however they spend less on each meal because of snacking.

Product Prices

UK consumers are price sensitive. Kilkenny (1993) says price promotion in the UK is a major determining factor on consumer's choice of meat. In a survey of supermarket shoppers, 97.6 percent rated price as very important. UK retailers therefore consider price promotion one of their most effective promotional activities. There is however, no evidence that promotion increases meat consumption, as it merely facilitates the substitution of meat

options. The reduction in consumption of both beef and lamb in recent years is due to their prices having risen relatively more than pork and poultry.

The value of New Zealand lamb exports to the UK is much lower than the rest of Europe (UK $4.15 per kg, Germany $ 5.92 per kg, France $5.94 per kg). UK consumers are traditional, conservative, and price conscious. Over the years a significant portion of New Zealand lamb has been commodity frozen carcase. Kilkenny (1993) says consumers perceive lamb as old-fashioned meat, inclined to fat, difficult to cook, not versatile or convenient. This is compounded by the negative image of frozen lamb, in a market where consumer preference is for fresh and chilled meat.

US consumers are less price sensitive. Taste is recognised by Bruhn (1996) as the most important factor in food selection, followed by nutrition and price. Bruhn (1996) says the relative importance of these factors is consistent across age groups and income groups within the US.

The value of New Zealand beef exports to the US has fallen from $908 million in 1992 ($4.59 per kilogram) to $406.8 million in 1996 ($2.41 per kilogram). The US is the world's largest beef producer and has a major impact on world prices. New Zealand beef is positioned at the commodity end of the US market and is therefore very sensitive to supply and demand fluctuations.

Women in the Workforce

There are an increased number of women in the US and UK labour forces. These dual earning households have increased affluence, with consumers more willing to pay for convenience. Convenience is an important consideration as there is less time available for shopping and meal preparation.

Kilkenny (1993) reports that 80 percent of UK housewives are in part or full time employment outside the home.

In the US women in paid employment rose from 35 percent in 1960 to over 60 percent in 1996.

Healthy Living

Nutrition and healthy eating are important considerations in both markets. Consumers recognise a strong relationship between diet and health. This has led to a growth in healthy food products, which are low in sugar, salt and fat.

UK research suggests that health concerns have affected eating habits, with 69 percent of consumers changing their diets to healthier foods. This survey also reported that 54 percent of consumers eat less red meat than they used to. Bruhn (1996) believes US consumers view beef as a high fat choice product. Poultry consumption in both markets has increased, one reason is the consumer perception that poultry meat is lower in fat.

A more recent development in the health food market is the development of functional food. These are food and drink products with added vitamins and minerals that confer specific health benefits to consumers. (Sadler, 1993)

Vegetarianism appears to be increasing in both markets. Bruhn (1996) reports that the increase in vegetarianism is due to a lower calorie and fat diet and pressure from animal rights groups. The USDA Foreign Agricultural Service reports that in 1995, 4.5 percent of the UK population were classed as strict vegetarians. Both markets show slow growth in vegetarianism with the proportion of vegetarians in each market being small. Nevertheless consumers in both markets are showing a reduction in meat consumption, and vegetarian options at meal times are increasing. (USDA, 1997)

Food Safety

Food safety in both markets is an increasingly important issue. Specific health scares, such as BSE, have severely affected demand. Kilkenny (1993) says the impact of these health scares has tended to be relative to the duration of media attention (this was before the latest outbreak).

US consumer food safety focuses on microbiological safety. Research shows that microbiological safety is described as a serious hazard by 77 percent of consumers, exceeding pesticide residue considered a serious hazard by 66 percent of those consumers surveyed. (Bruhn, 1996)

Animal Welfare and Environmental Concerns

Animal welfare is a major concern in the UK. Kilkenny (1993) says consumers perceive food safety concerns as being linked to unnatural feeding and factory farming practices. Consumers have a growing interest in how meat is produced.

US consumers are concerned about the environment, however the level of concern appears to have reduced in recent years. In the Food Marketing Institute's 1996 annual survey, fewer consumers refuse to buy products because of disagreement with company policy, ethical treatment of animals, or unrecyclable or unnecessary packaging. Bruhn (1996) says that these results could reflect either a shift in consumer attitudes or a response by the food production and processing industries to mitigate these issues.

Changes in UK Retail Trading

UK imports of New Zealand lamb are primarily for retail trade. Constraints on time, a direct result of the increase in working women, has caused dramatic changes in food retailing. Supermarkets have a growing dominance in food retail trade, as consumers prefer one stop shopping. Supermarkets in the UK increased from 4,220 in 1988 to nearly 5,000 in 1995, with two thirds of supermarkets belonging to the five main supermarket chains. The increased dominance of supermarkets has attracted trade away from the traditional butcher. (MLC, 1996)

Increased meat trade in supermarkets presents challenges, as it places meat in an environment in direct competition to other food alternatives. Kilkenny (1993) says challenges lie in the presentation and promotion of meat to compete effectively against other food alternatives that are often more effectively branded, packaged and marketed. Meat did not face this competition in the traditional butcher's shop.

The future of retailing is largely dependent on the growth of discount stores and superstores. Superstores provide a large number of product lines and many additional services, whereas discount stores have limited product lines and services but provide competitive pricing. UK superstores are forecast to grow 25 percent over the next five years, after growing 49 percent between 1990 and 1995. (MLC, 1996)

The growth in one stop shopping does not necessarily mean the complete demise of the traditional butchers, as butchers take advantage of their strength in service standards and advice. UK Meat and Livestock Commission (MLC) says many modern consumers are less familiar with cooking preparation, so butchers provide in-store recipe cards and cooking instructions.

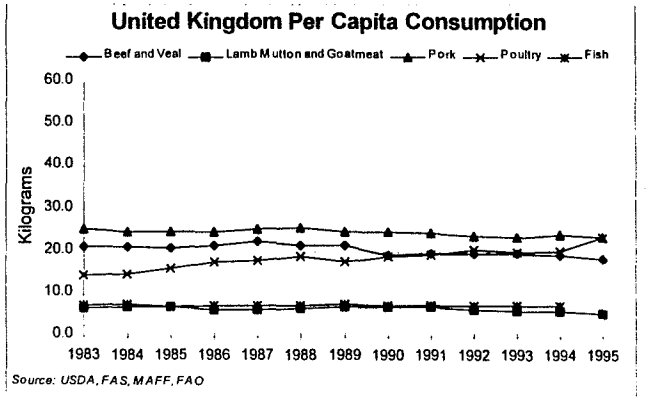
Changes in US Food Service Sales

US imports of New Zealand beef are primarily for the ground beef industry. Bruhn (1996) notes the entire food service industry has experienced growth, with the greatest growth being in fast food, increasing 119 percent from 1984 to 1994. During the same period restaurant sales grew 74 percent, cafeteria sales grew 33 percent and caterers sales grew 18 percent.

US consumers are eating out at an increased rate. In 1970 away from home food spending was 33 percent, in 1996 this had risen to 43 percent. Bruhn (1996) says consumers eat out mainly due to constraints on time with not enough time to prepare and cook meals.

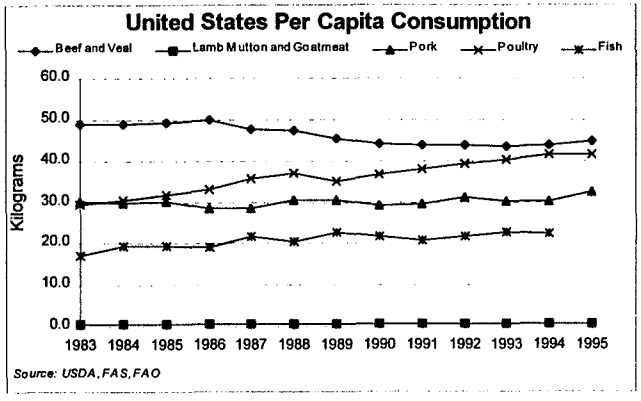
Consumption Trends

Combined economic, demographic and social factors outlined have had the following affect on meat consumption over the past decade.



- Pig meat is the most popular meat with per capita consumption steady at 23.4 kilograms.
- Poultry consumption has grown rapidly, increasing by 16 percent since 1990. Per capita consumption is just below pig meat at 23.0 kilograms.

- Beef is the third most popular meat with per capita consumption at 17.8 kilograms. Consumption has declined from 22.5 kilograms in 1987. The 1996 BSE scare saw a marked decrease in consumption, followed by a slow recovery that has not quite reached previous consumption levels.
- Sheepmeat consumption has declined slightly to 5.6 kilograms per capita.
- Fish consumption has remained steady at 7.5 kilograms per capita.



- Beef is the most popular meat with per capita consumption at 44.6 kilograms. Consumption has steadily declined from 49.8 kilograms in 1986. Statistics from the USDA show consumption has increased slightly in the last two years, due to increased production and lower prices.
- Poultry consumption has increased rapidly. Per capita consumption is 41.5 kilograms, up from 31.9 kilograms in 1985.
- Pig meat is the third most popular meat, with per capita consumption at 32.3 kilograms.
- Sheepmeat consumption has remained relatively steady at 0.6 kilograms per capita.
- Fish[1] consumption has remained steady, with per capita consumption at 22.5 kilograms. Consumption has declined slightly in recent years due to increased prices.

[1] Fish consumption includes fish and seafood products

Implications for New Zealand's Red Meat Industry

Increase in Working Women
The increase in women in paid employment has led to an increase in dual earning households and increased affluence. The change in lifestyle means consumers are more willing to pay for convenience. Bruhn (1996) says consumers are exchanging money for time saving restaurant dining, takeout meals and convenient food preparation. This means continual development of processed and convenient products, and marketing these as part of a complete meal solution.

Lack of Food Skills
The increase in working women is impacting upon cooking skills. In a dual earning household, parents are often not at home preparing meals. Food skills, such as food preparation, cooking and general nutrition, are not being passed down to younger people. Food skills that were second nature to previous generations, are often lacking in the younger consumer. These consumers seek help and information in meal planning and preparation. This requires different labelling, increased levels of service, and information such as recipes, preparation and cooking instructions.

The combination of increased affluence, lack of time, and limited food skills has led to a marketing approach which combines good taste, convenience, information and service at an affordable price.

Decrease in Average Household Size
The decrease in the average size of households means consumers seek smaller portion size meals. This means marketing on a per portion basis, rather than on a weight basis and has implications for cuts and packaging.

Ageing Populations
Ageing populations means the older generation will become increasingly important in the marketplace. This also means marketing on a per portion basis.

Food Safety
Food safety is a major issue. MAF Regulatory Authority reports the signing of the GATT Sanitary and Phytosanitary Measures and Technical Barriers to Trade agreements means that while signatory countries can insist upon higher food safety standards than existing international standards, the requirements must be implemented uniformly and applied consistently to both domestic production and imports. Countries must also accept food safety standards, procedures and systems that give equivalent outcomes, rather than insisting on replication of their own national requirements. New Zealand must promote, maintain and improve market access and have internationally accepted, scientifically justified and cost effective food safety programmes such as hazard analysis critical control point (HACCP) and ISO 9000 Series standards.

Traceability
Traceability back to farm of origin or even individual animals may become a requirement, driven by major customers, as a crucial part of the marketing programme. The UK and the US are currently developing national identification systems. These systems are primarily being developed for food safety, but could extend to verification for marketing programmes, and the provision of production data to improve quality and consistency. The New Zealand red meat industry needs to prepare for traceability. Any traceability scheme must be cost effective - traceability may not attract any price premium and in fact a lack of traceability may eventually attract a price discount.

Healthy Living
Healthy living is increasingly important. New Zealand beef product attributes are lean, safe, healthy, and low in cholesterol. New Zealand lamb product attributes are low fat, high quality, healthy, and convenient. Marketing programmes should build on these. For both beef and lamb, the healthy aspect of low fat requires a production focus on lean breeds and higher weights. The development of convenient products requires more boneless cuts. From a production aspect this means larger heavier lambs in the 15.0 to 17.5 kilogram range.

Changes in Retail Trading
Increasing dominance of supermarkets means meat competes against other meal options, that are better presented and more effectively promoted. Meat promotion must focus on meal solutions. This has implications for packaging and promotion. Promotion can include complimentary products, such as spices and cook-in-sauces, towards a complete meal solution.

A primary focus for New Zealand exporters is to develop long-term supply strategies with key customers. These supply strategies must be customer driven and will require continuous development and improvement of existing products.

There is discussion on all year round lamb production. While New Zealand's production season can be extended, this adds costs and undermines our competitive advantage in production efficiency. All year round production is primarily for the chilled lamb trade, which is growing steadily from a low base in the EU and North America.

Implications Specific to the UK Market

The UK is New Zealand's largest export lamb market, taking 29 percent of export volume in the year ended September 1996.

New Zealand has preferential access to the UK market, which gives a competitive advantage. This preferential position must be used to develop and strengthen long-term relationships with key customers, to promote New Zealand lamb as a high quality consumer product.

Lamb exports to the UK are lower unit value compared with Germany, France and Switzerland. New Zealand was traditionally known as a low cost supplier of frozen sheepmeat to the UK. Increasing returns means lamb must be repositioned out of the commodity end of the market, to the premium end, through the development of new consumer products. This means moving lamb up the value chain from frozen carcase, to primal frozen cuts, to cuts and boneless cuts which are frozen, and to chilled products.

UK consumers have an increased preference for fresh and chilled meat. Frozen meat is perceived to be cheaper than fresh, and therefore suffers in terms of image and aspiration appeal. New Zealand must improve the perception of frozen meat by developing new consumer cuts, incorporating smaller portions of boneless product.

Implications Specific to the US Market

The US is New Zealand's largest export beef market, taking 51 percent of export volume in the year ended September 1996.

New Zealand has traditionally been a supplier of commodity lean beef for the ground beef trade. New Zealand's dependence on the US market has reduced over the last five years, as prime beef has been diverted to Asian markets. New Zealand exporters should continue to develop markets for prime grass-fed beef to avoid the commodity price risk associated with supply and demand fluctuations in the US market for manufacturing grade beef.

However the US market will remain extremely important, as New Zealand requires a large manufacturing market for cull dairy cows and manufacturing grade cow and bull, particularly as the national cattle herd continues to move toward greater dependence on the dairy herd. New Zealand exporters must also undertake research and development into manufacturing products for the food service sector, to attain the objective of achieving higher unit value.

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AN EXPLORATORY STUDY OF URBAN ATTITUDES AND PERCEPTIONS ABOUT RURAL LAND USE IN NEW ZEALAND

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ABSTRACT

Urban peoples' perceptions and opinions regarding rural land use are important in defining the acceptability of agricultural, horticultural and forestry systems. Overseas data suggest that there are differences in opinions and attitudes between urban and rural people, and that concerns about rural land practices vary between countries. However, little is known about how New Zealand urbanites perceive rural land-use activities, or what issues they regard as important. The objectives of this study are to gain an understanding of urban peoples' perspectives about rural land use, and to identify issues and practices associated with rural land use that are of concern to urban people. Twenty semi-structured interviews were conducted in Palmerston North, allowing respondents to identify issues and practices associated with rural land use that are of concern to them. Participants were selected from diverse backgrounds so that a wide range of attitudes and opinions were identified. Important concerns that were identified included pollution of water and land, soil erosion in hill country, deforestation, and productivity of rural areas. The results suggest that at least some respondents recognise that issues are interrelated. The concern for productivity suggests that urban people in New Zealand place importance on the continued productivity of agricultural and horticultural lands, though not necessarily at the expense of the environment. The relative importance placed on productivity and environmental concerns is important for policy considerations, and needs further investigation. It was also found that younger people tended to be less aware of and less concerned about rural land use practices, perhaps because they generally have less direct ties with rural areas. As the population becomes more urbanised and land use intensity increases, these findings could have important rural policy implications.

Keywords: Urban, attitudes, perceptions, rural land use, semi-structured interviews.

INTRODUCTION

The Resource Management Act (1991) encourages more public participation in deciding how New Zealand's natural resources are managed. Because of this, opinions held by urban people are becoming more important in defining the acceptability of rural land management practices. Public concerns about rural land use vary from country to country (Hodge 1990), and while overseas studies about urban perceptions of rural land indicate issues that may be important in New Zealand, a better understanding can only be gained through research in New Zealand. Previous studies in New Zealand have focussed on attitudes towards forestry (Swaffield 1994; Kilvert 1996), but little work has been done on urban attitudes and perceptions towards agriculture, horticulture, and rural land use in general. This paper reports on an exploratory study that begins to identify these perspectives.

URBAN ATTITUDES TOWARDS RURAL LAND USE ISSUES

A number of overseas studies have focussed on public attitudes toward rural or agricultural issues (Molnar and Duffy 1987; Hodge 1990; Catchpole and Davis 1992; Weber, Hoban, Kendall, and Bull 1995; Willits and Luloff 1995). Issues covered in these studies include attitudes towards pesticide use, the role and treatment of animals in agricultural production, groundwater contamination, pollution from livestock effluent, soil erosion, and beliefs about the role of farming in society.

Regular monitoring by the British Agrochemical Association (BAA) found that the most important environmental issues for the general public were largely related to broad pollution issues and the effect on the ozone layer from atmospheric pollution (Catchpole and Davis, 1992). Concerns about pesticides and crop spraying were only cited by 10% of the population spontaneously. When asked specifically about farming practices which pose a threat to the countryside, two thirds perceived problems with farming activities involving the use of herbicides, insecticides and fungicides. Only three percent of the public considered the use of pesticides to be necessary and desirable, whereas 48% perceived pesticides to be both unnecessary and undesirable. Aerial spraying of crops was even more widely criticised.

Concerns about animal welfare issues were also identified in the literature. Hodge (1990) reports on a 1987 British survey where 92% of respondents felt that animals should be humanely stunned before slaughter, 84% objected to live export of animals for slaughter, 86% felt close confinement of sows should be made illegal, and 67% felt that battery egg production should be banned. Weber et al (1995) believe that society want to develop a "new contract" with agriculture, that includes animal welfare or the rights of animals used in food production, food safety and quality, environmental impacts of agricultural production, and the role of animal products in a healthy diet.

In New Zealand, a 1984 study investigated key aspects of visual landscape appreciation in Rodney County (Brown 1984, cited in Park 1987). Visual landscape values considered important by residents included indigenous vegetation (the more continuous the better), general vegetation and diversity in the landscape. The public did not like landscapes containing exotic vegetation and horticulture, little vegetation (trees) or elements reflecting "poor management" or disharmony.

More recently, in a study of public opinions about logging and plantation forests, Kilvert (1996) identified that approximately one third of the New Zealand public regard plantation forests as barren and untidy. They were also concerned about the impact of logging on soil stability, were uncertain as to if and when logged areas would be replanted, and were of the opinion that adverse visual aspects of logging were long term or even permanent. Forty eight percent of respondents were either concerned or very concerned about post harvest visual amenity. However, the majority of respondents recognised plantation forests as a fast growing renewable crop with a temporary short term period of negative visual impacts. Kilvert also identified variation between regions in New Zealand with regard to approval and disapproval of clear felling of pine forests. Wall and Cocklin (1996) reported important differences in opinion between urban and rural people in their study of attitudes of East Coast people (urban and rural) toward forestry development in the region. Support for farming was strongest from rural people and Pakeha, while support for forestry was strongest from urban people, and Maori.

Research also has suggested that urban people are more concerned about environmental protection while rural people focus more on the productive capability of rural areas (Buttel and Flinn, 1977; Wilson 1992). Farmers have a stronger utilitarian attitude to the natural environment than do other population groups (Wilson 1992), and are more likely to feel land should be used to produce goods that are useful to people. Given the importance of agriculture to New Zealand, however, it could be that urban New Zealanders defy this stereotype. After examining images portrayed in television advertisements with rural themes, Carter and Perry (1987) concluded that there is an underlying theme that the purpose of rural land is to provide marketable commodities, suggesting at least some support for a general utilitarian attitude towards land use in New Zealand.

METHODOLOGY

In order to begin to gain a better understanding of urban attitudes toward rural land use, twenty semi-structured interviews were conducted in Palmerston North with selected volunteers from various groups: Rotary, Lions, the Camera Club, Forest and Bird Society, and Tutahi Manawatu Maori Cultural group; and with individuals "off the street." A conscious effort was made to cover the broad range of characteristics of the urban population. Ultimately, the interviewees consisted of nine women and eleven men, representing all age groups from early twenties to late sixties, and coming from a variety of occupations and income groups. Four of the group were Maori and sixteen were Pakeha.

Qualitative methods such as in-depth interviews allow respondents to express their opinions in their own words (Antaki 1988; Potter and Wetherell 1987, cited in Swaffield 1994). Interviews also give a better understanding of the context in which the importance of words and phrases can be evaluated. The context of statements is often lost if words are aggregated into statistical analysis as in the case of quantitative methods (Silverman, 1985). The disadvantage of qualitative methods is that there are limitations on extrapolating the results to the general population. Qualitative methods typically use samples which are intended to capture the diversity of individuals that are important to the problem, but make no claim to represent a wider population (Silverman, 1985).

One particular form of qualitative research is the exploratory interview. Oppenheim (1992, p. 67) believes the purpose of an exploratory interview is

> ...to develop ideas and research hypotheses, rather than to gather facts and statistics. It is concerned with trying to understand how ordinary people think and feel about the topics of concern to the research.

An interview outline consisting of a series of open questions was developed to guide the interview process in this research. This process was structured such that respondents were given the opportunity to cite their own concerns without prompting before responding to more specific leading questions. Practice interviews were conducted with a preliminary interview outline. After practice interviews were completed, appropriate changes were made to the interview outline. Furthermore, the interview structure continued to be refined during the course of the interviews as understanding of the issues improved.

All interviews were tape recorded to preserve accuracy. After each interview, notes were made of points that came up in casual conversation after the recorded interview was completed. General impressions about how the interview went and the approximate age of the respondent were also noted.

Qualitative data were analysed by developing categories to allow identification of comparisons and differences between data bits (Dey 1993). Some data were placed in more than one category since the idea or concept generated applied to a number of areas of the analysis (Tollich and Davidson 1996). The outline that was developed to guide the interview also provided the initial set of categories for analysis.

RESULTS

The amount of contact that respondents had with rural areas or rural people varied. Six people had lived on farms when they were children, one of whom currently is a shareholder in a Maori Trust Farm. Two people had contact with rural areas through their work, and one person had recently purchased a 'ten-acre' block. Eleven respondents had little or no contact with rural people or rural areas.

Over half of the respondents, including some of those who had lived on farms, indicated they had little knowledge about current agricultural, horticultural or forestry practices. Rural matters had no direct impact on most peoples' lives, but many acknowledged that rural matters indirectly affected them. Over fifty percent of respondents gave little thought to rural issues; those who did were involved with rural land through work, had lived on a farm, or were members of Forest and Bird Society. However, most people still identified issues or practices that were of concern to them. Four people felt it was important for urban people to have contact with rural areas, and thought it was important for urban people, especially children, to become more familiar with methods of food production.

The predominant attitude among respondents was that land users were production orientated, either in terms of productivity or profitability. In some cases this was seen as a recent change (10 - 15 years), often in response to external economic pressures. Some respondents thought this production-orientated attitude was at the expense of the environment. Others felt that although there was an emphasis on production, land users were becoming more aware of environmental considerations. All respondents felt that collectively, agriculture, horticulture and forestry were important to New Zealand's economy, primarily as a source of overseas income. Some people indicated the importance was declining as urban activities became more predominant.

Respondents were asked to identify any positive aspects of rural land use as well as identifying concerns they had. Increasing awareness of environmental considerations by farmers and government was identified by three people as positive. The recent introduction of the Resource Management Act was mentioned as either having a positive influence, or having the possibility of having a positive influence on rural land management practices. Specific practices that were considered positive were increased planting of trees, either to protect hill country or generally to improve visual amenity of rural land.

CONCERNS IDENTIFIED BY RESPONDENTS

Respondents were given the opportunity to express concerns that were important to them without any prompting on specific topics. Most people raised one or two issues; the greatest number of issues raised by one person was six; while at the other end of the scale, six people didn't report any concerns. The following are issues that were raised by respondents without prompting. The range of issues suggest a number of rural land use practices are important to urban people, though it is difficult to assess their relative importance to the respondents.

Productivity of Land: Half of the respondents brought up issues that are related to the productivity of land. Six people raised specific issues as concerns; two others made general references that land should be used productively, and two mentioned the loss of productive land as a catalyst for thinking about rural land use issues,

although neither of them indicated that they thought the loss of productive land was bad. Examples cited as causes of loss of productivity include the flooding of land behind the Clutha dam, damage from Cyclone Bola, the closing of Applefields' orchards, the loss of plantation forests to fire, and the spread of cities into rural areas.

Four people were concerned about the loss of productive agricultural land to other uses, eg, the spread of cities and the increasing number of lifestyle blocks. Lifestyle blocks were seen as unproductive because the people moving onto them didn't have the necessary skills to make productive use of the land.

One person was concerned about returning land to Maori because she believed it was not being used for productive purposes after it was returned. Another person thought about rural land issues in relation to the viability of agricultural enterprises, and was concerned about sheep and beef farmers not producing a high enough return in relation to the value of the land. He later suggested forestry as an alternative form of production that would return more, and also be better for the environment.

One person indicated that the loss of productivity associated with erosion was the basis for his concern. Erosion in general was mentioned by a number of people as a concern, and is discussed in more detail below. Intensive cropping methods were also identified as affecting the soil's ability to be productive.

Pollution: Seven people mentioned polluting effects of primary industries as either a concern, a practice they would not like to happen, or something having a negative effect on the environment. People identified production units, industries associated with primary production, and an increase in small holdings as causes of pollution. Respondents were concerned with pollution affecting rivers, streams, ground water, land, air, and as a potential hazard for rural land users. Specific types of pollution that concerned people were dairy effluent, fertiliser runoff, nitrates, runoff from sprays, and lead pollution. The pollution of water, especially by dairy shed effluent and fertiliser runoff, was mentioned most frequently.

Effects on Soil: Nine people were concerned about the impact of rural land use on soils. The most frequently raised concern was erosion, particularly highly visible erosion such as slips or landslides. Wind erosion and other less noticeable forms of erosion were also identified, as were soil compaction and soil-polluting practices.

Many people felt that the erosion problem was quite severe. Erosion was seen as a consequence of inappropriate land use, in particular the deforestation of hill country to farm sheep and cattle. The visual impact of soil slips, and the impact from Cyclone Bola were the predominant ways that urban people identified erosion as a concern.

Impacts on Rural People: Three people indicated concern about impacts on rural communities and rural people. Their concerns were: activities that would have a negative impact on rural people, the ability to maintain adequate levels of income for rural people, the effect on the users of biocides, and rural depopulation. Two explanations were given for why rural depopulation was not desirable; it would allow large businesses to become more established in the agricultural sector, and the continuing urbanisation of New Zealand would detract from an important part of New Zealand's character. Concern about rural people's income level was linked to the potential for increased environmental damage resulting from rural people adopting less desirable practices in an attempt to remain profitable.

Chemical use: The use of chemicals (including biocides, pesticides, sprays and poisons) was a concern identified by four people. The use of chemicals tended to be associated with horticulture, but negative environmental effects on farms, where chemicals are produced, or when they are transported were also mentioned. Possible impacts on people, either people eating food produced with chemicals or the users of the chemicals, was one concern. Another concern about pesticide use was that not enough research had been done of the potential effects of chemical use. These concerns regarding agrochemicals were similar to those identified in the New Zealand National Bureau of Research survey (1990).

Forestry Issues: Harvesting of trees was a concern for six people. In particular, deforestation of native forests was seen as undesirable because of a preference for native bush over cleared land, and the positive effect native bush has for the atmosphere. Harvesting of exotic forests was also mentioned by two people. The first person was not keen on harvesting exotic forests, even though he accepted there were benefits from harvesting the trees. Another concern about harvesting exotic forests mentioned was the use of clear-felling techniques.

Other: Two people mentioned a dislike for the visual appearance of land in general that was no longer in native bush. One person specifically mentioned that he did not like the way farmland looked. He preferred native bush, but accepted production forestry as an improvement over pasture.

A particular concern for one respondent about animal welfare was a philosophical objection to the exploitation of animals. Specific aspects that this person disliked were daily dairying activities, the slaughtering process, and transportation of animals to slaughter.

The same person also expressed concern regarding the relative importance of economic and environmental issues. He felt environmental considerations were more important than economic ones, but did not believe that people using the land shared these concerns. He was concerned that recent deregulation in the agricultural industry would result in rural people adopting practices that were harmful to the environment in order to remain competitive in the international market place.

No Concerns: Six people responded that they did not have any concerns about rural land use issues. Reasons for a lack of concern varied, but included: people being unaware of negative practices or impacts associated with rural land use, people not being aware that practices they considered undesirable were occurring, the lack of importance of rural land use on people's lives, an acceptance that negative impacts were part of farming, and lack of concern even though they are aware of the negative impacts on the environment.

SPECIFIC ISSUES

In the second part of the interview, respondents were asked for their opinions about five specific issues identified from the literature: animal welfare, chemical use, erosion, the visual appearance of rural areas, and the effect of rural land use practices on water quality. Each of these issues had already been raised by at least one person without prompting.

Animal welfare: Farm animal welfare was not a concern for most people. They tended to identify sheep, beef and dairy farming as enterprises associated with rural land use. Many people recognised occasional cases of animals being mistreated (which they didn't approve of), but felt that in the vast majority of cases, farmers looked after their animals well.

After they had said general animal welfare standards were acceptable, some people raised specific practices they didn't approve of. Docking of cows' tails was one issue frequently mentioned. Some people disliked the thought of animals being slaughtered, and some opposed the intensive farming of animals, particularly battery hens and pigs. Other practices mentioned in this vein included velvetting of deer and transportation of animals. One person was prepared to accept intensive farming of animals because it kept the price of meat down, even though he thought it was mistreating the animals.

Chemical Use: Only four people independently indicated concerns about chemical use, and all of them had taken steps to purchase or grow organic products. Two other people verbally supported farming without chemicals, though did not indicate that they purchased organic products. However when people were asked about chemical use, almost everyone indicated either concern or uncertainty about the effects of chemical use. These were similar to those raised by people who had independently mentioned concerns about chemical use.

Four people felt that practices associated with chemical use were improving, in particular, with users following instructions better, and being more aware of potential negative impacts of chemical use. Some respondents questioned the cost of producing food without using chemicals and whether enough food could be produced without chemical use. Three people accepted the use of chemicals, pesticides and sprays as necessary, although they had previously raised concerns about the use of chemicals and sprays. Conditional acceptance of chemical use was also mentioned by other people.

Two people were not concerned about the use of chemicals based on the fact that the industry was regulated and because watch-dog groups presumably kept an eye on safety issues. For one person, this was connected to an assumption that land users were best qualified to determine appropriate practices. He did suggest that the misuse of chemicals was a potential concern. Two people were not concerned about the use of chemicals or pesticides. One person was not concerned because she was not in an area being sprayed, though she also indicated that if she had children she would be more concerned. Only one person was unreservedly unconcerned about the current use of chemicals.

Erosion : Erosion had already been raised and discussed by a number of people. Three people who hadn't mentioned it as a concern previously, indicated they had some degree of concern when specifically asked about it. Seven people did not consider erosion a problem in New Zealand. These seven people appeared to have little knowledge about the extent of erosion in New Zealand, either saying they knew very little, stating that it wasn't a problem or that farmers wouldn't let it happen. This lack of knowledge was predominant amongst younger respondents who had minimal contact with rural areas. All seven were estimated to be under thirty five.

Visual Aspects of Rural Landscape : The most common attitude was that trees, either in the form of native bush, scattered in farmland or production forestry, were desirable and enhanced the appearance of the rural landscape. A couple of people indicated a dislike for large tracts of Pinus radiata, but similar numbers stated they thought pine forests were attractive. One respondent indicated that she did not like monocultural practices, preferring to see a variety of land uses. Several people stated a strong dislike of the appearance of farms because they found them boring, or in some cases untidy. In these cases the respondents felt that tidy fences improved the appearance of farms. Other people indicated that the visual amenity of farms could be improved with the planting of more trees, with one person suggesting that this could be likened to a business investing a portion of profits to improve the working environment. A few people liked the agricultural landscape in its present state. One person liked gravel roads as they contributed to a feeling of 'ruralness,' though he did indicate that rural people may not share his sentiments due to a sense of isolation.

Water Quality : People had previously identified concern for negative impacts on water quality from rural landuse practices. These were predominantly the pollution of waterways from dairy effluent and fertiliser run-off. One respondent showed concern about dairy effluent being pumped onto land, which could result in pollution of groundwater after rain. Three people raised an additional issue of deforestation in hill country causing greater sediment loading of rivers, and increased runoff into rivers after storms.

Two people suggested that farmers should be monitored concerning negative impacts on waterways, with one person suggesting that polluters should be fined more heavily than they are now. Two people felt that non-farm water issues were more important than farm impacts. These included the presence of giardia and urban use of water. One respondent indicated the importance of water quality to Maori and explained that the Trust of which she was a member placed a great deal of emphasis on farming with practices that protected water quality.

DISCUSSION

Urban attitudes and perceptions of rural land use issues vary widely. Levels of awareness and concern about rural land use tended to be related to the amount of contact that people had with rural areas, either presently or in the past.

More than half of the respondents gave little thought to rural issues. This may be because rural matters have little direct impact on urban people, who therefore give little attention to rural matters because of other priorities. However, most of these people did identify one or more specific concerns. Although few respondents indicated that they would take the opportunity to participate in discussions about appropriate forms of rural land use, most felt that it was important for urban people to have that opportunity. A small group indicated that they would like to participate.

Most people tended to be concerned about those issues with which they have had direct contact and experience, although some people did have an holistic approach to the place of agriculture, horticulture and forestry in society. Important concerns were pollution of water and land, productivity of rural land, erosion and deforestation. The last two were concerns particularly associated with hill country areas. Other concerns that were identified less frequently were the use of agrochemicals, animal welfare issues, and the visual appearance of the rural landscape.

Although this study did not attempt to find out the level of knowledge that urban people have about rural practices, there was strong evidence to suggest that the level of understanding that some people have about rural practices is very limited or mistaken. Many people acknowledged that they were not familiar with rural practices. This was especially evident in respondents aged thirty or less, many of whom had little or no contact with rural areas or rural people. For example, three of the four respondents who showed the least knowledge about water quality impacts were under thirty and had little contact with rural land. Other examples of limited or incorrect knowledge include one person not being concerned about erosion because he wondered if it was a practice that

farmers allowed to happen for a purpose; and another person (from a farming background) stating that recycling animal fertilisers was sufficient to replace nutrients removed from production systems because plants make nutrients from sunlight. This lack of knowledge about specific practices could contribute to lack of concern about rural matters. There were cases where people indicated that their lack of concern about a particular issue or activity was simply due to lack of awareness.

A distinction should be made between a lack of concern about rural land use issues due to a lack of awareness or knowledge of rural land use practices and their associated impacts, and a lack of concern when people are fully aware of practices and their impacts. The policy implications in each case may be different. In the first instance, an education-based policy is probably appropriate, whereas in the second case, another policy instrument might be required.

All respondents had an opinion on the visual appearance of the landscape. Driving through rural areas is the way that many urban people experience rural areas (Willits and Luloff, 1995). Visual impacts of practices may be the most common way people are made aware of rural practices because they have few other opportunities to become more familiar with land use practices. This may explain why erosion and deforestation were raised by so many people, and why animal welfare concerns were minimal.

Although previous studies suggest that rural people tend to place more emphasis on the productivity of rural areas than do urban people, productivity of rural land was identified as important to many of the respondents in this study. When asked about positive aspects of rural land use, productivity and contribution to the economy were two of the factors most frequently cited.

Although a large number of people mentioned productivity issues, the majority of the concerns were about the environmental impacts of production methods. This suggests that although productivity is important, the impacts of production methods should not be overlooked. One person specifically stated that he felt rural people placed too much importance on productivity of rural land and not enough importance on environmental consequences. Understanding concerns about the relationship between productivity and environmental impacts is important, especially as many people identified a recent emphasis on the productivity of rural land that has been brought about by difficult economic conditions. The importance of environmental issues was reinforced by the number of people who felt positive about the introduction of the Resource Management Act and the increasing concern among rural land users about environmental impacts.

Concern about chemical use is difficult to assess. On the basis of the literature (Catchpole and Davis 1992; Maskill and Harre 1994) agrochemical use was expected to be a major issue. Roughly a quarter of respondents raised the chemical issue independently, though when directly questioned about chemical use, all but one respondent indicated some form of apprehension about chemical use. Only one person stated that she had absolutely no worries about chemical use in rural land. Catchpole and Davis (1992) also report that a lot more people mentioned concerns about chemicals when directly asked about them, compared to raising the concerns independently. Purchasing organic products was one of the few ways that some people acted on their concern; however, there were people who said they were concerned about chemical use but did not buy organic produce.

Although concerns about animal welfare were widely reported in the literature, the majority of respondents in this study were fairly happy about the way farm animals were treated in New Zealand. Docking cows' tails, and intensive farming of hens and pigs raised the most concern. However, only one quarter of the people interviewed indicated concern about intensive production, either without prompting or when asked about animal welfare concerns. This is far lower than the levels of concern reported by Hodge (1991) in England, where 86% of people disliked close confinement of sows, and 67% disliked of the battery farming of hens. The fact that New Zealand's agricultural systems are predominantly pastoral rather than intensive confinement systems may explain the lack of concern about animal welfare on farms here. Minimal knowledge of farm practices may also be a contributing factor.

CONCLUSIONS

The main purpose of this exploratory study was to identify attitudes and perceptions that urban people in New Zealand have about rural land use, and concerns they have about rural land use practices. A wide range of concerns were identified, though it is difficult to assess their relative importance to New Zealand urbanites. Few people indicated that they would take part in discussions about appropriate land use, and even fewer were motivated enough to take some action against concerns they have. A common sentiment was that many urban

people would not have sufficient knowledge to offer an informed opinion to discussions, and that better decisions could be made by people more involved in rural land issues. However, people believed that the opportunity should be there to allow informed urban opinion. Buying organic produce as a reaction against chemical use, and not eating meat because of animal welfare concerns were the only actions mentioned. However, the number and diversity of issues raised shows that there are issues about the way rural land is managed that urban people are concerned about.

People's background appeared to have a large influence on their attitudes and perceptions regarding rural land use. More people over thirty had previously lived on a farm, or had greater contact with rural areas. Those who had lived on farms indicated a desire for urban people to be more aware of rural practices, and because of their previous contact, appeared to be more interested in rural matters than people who had less of a background with agriculture, horticulture or forestry. As New Zealand's population becomes more urbanised, a possible consequence is that interest and concern about rural land use issues may decrease. However, there is also the possibility that because they are less knowledgable about rural land use practices, urban people may become more concerned and take more action when eventually they are made aware of what is happening.

Education about rural land use practices—what is done and why—may bridge this knowledge gap. There appeared to be a significant portion of urban people interested in rural land use issues, yet they did not want to force an uninformed urban perspective on rural land users. A more knowledgable and informed urban population would mean that constraints imposed by society on rural land use are more realistic and acceptable to rural land managers.

There was a feeling that rural land users were placing more emphasis on productivity than they had in the past. In some cases, this was thought to create negative effects on the environment. Investigation of the relative importance that urban people place on productivity and protecting the environment is an area that should be explored in more detail. It appeared that many people wanted a rural sector that was productive without polluting or destroying the resources. If more effort was made to publicise steps that rural land users take to minimise or eliminate negative impacts on the environment, the public could be made more aware that increases in productivity do not necessarily result in greater environmental impacts. Conversely, if rural land users are made aware of negative impacts that are unacceptable to society, production methods can be adapted to accommodate these concerns.

A number of the concerns raised in this study are interrelated. Erosion was identified as a separate concern, but the reason for the concern for some people was that it reduced productivity. On the other hand, erosion could also be a concern because it affected visual amenity. One negative aspect of chemical use was environmental contamination, so chemical use and pollution are linked. People liked to see trees in the rural landscape because they improve the visual appearance, but they also decrease erosion on hill country which then improved water quality and provided shelter to stock. Because concerns are interrelated, targeting changes in specific practices could address a number of concerns at once.

Further research is needed to understand the extent of the viewpoints held by urban people. A more quantitative study, such as a survey, could make a start to answering these questions. A nationwide survey would also give an indication as to whether opinions vary between regions within New Zealand. In addition, further in-depth studies to determine the reasoning behind some of these concerns and the potential impact that they might have on land use policies would also be useful.

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An Econometric Model for Forecasting New Zealand FOB Prices for Dairy Products and the Farmgate Payout for Milk

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ABSTRACT

Dairy farming output accounts for over thirty percent of New Zealand's gross farm revenue and nineteen per cent of total New Zealand merchandise exports. Accurate forecasting of dairy farming revenue is, therefore, important when forecasting national income.

More than ninety percent of New Zealand dairy industry output is exported, a large proportion of which is traded in an undifferentiated form at commodity prices. Hence, international dairy product prices have a significant influence on New Zealand FOB prices for dairy products and what farmers receive for their milk at the farmgate.

World dairy trade, of which New Zealand's share is at around twenty five percent, is dominated by the European Union with forty seven percent of the trade (excluding intra-EU trade). European Union export subsidies and other dairy policies have a significant influence on international prices. The GATT Uruguay Round agreement will constrain few of the distortions created by EU export subsidies. These and other determinants of international dairy product prices are explored in this paper.

In this paper, econometric equations derived for forecasting FOB prices for butter, cheese, and skimmilk and wholemilk powders are reported. The forecasts obtained from these equations are then used to forecast the New Zealand farmgate payout for milk.

BACKGROUND

Dairying is the largest farming industry in New Zealand, contributing 32 percent of New Zealand's gross output from agriculture, amounting to $10,271 million in the year to March 1997. Exports of dairy products contributed 34 percent of the total value of agricultural based

[1] Views expressed in this paper are those of the authors and not necessarily those of the Ministry of Agriculture. This paper has utilised preliminary work undertaken by Kerry Nitz, formally of MAF Policy, to further develop the forecasting framework. His modelling suggestions and comments on an earlier draft and comments of colleagues at MAF Policy are acknowledged. The errors and omissions remain the responsibility of the authors.

exports or 19 percent of total New Zealand merchandise exports.

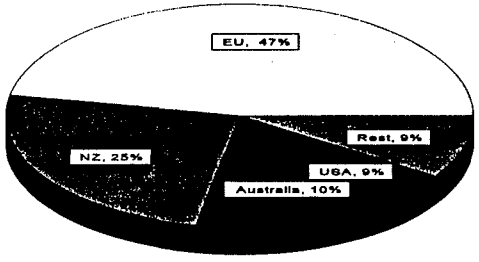
Forecasts of dairy export revenue and farmgate payouts are of importance to policy makers particularly for the Government's budget management activity, which requires estimating their contributions to the gross agricultural sector revenue. Since around 90 percent of all dairy products manufactured in New Zealand are sold overseas, international prices for dairy products strongly influence prices paid to New Zealand dairy farmers. Forecasting international dairy product prices, which are determined in a complex world dairy market, is a much more difficult task than forecasting milk production which is influenced mainly by climatic conditions and changes to dairy cow numbers.

Three times a year, the Ministry of Agriculture undertakes a detailed exercise in forecasting agricultural sector income. This paper reports on an econometric model being developed by MAF Policy for forecasting international prices for four of the five principal dairy products that New Zealand exports, butter, cheese, skim milk powder and whole milk powder.

International Dairy Products Trade

Only around 5% of global milk production is traded internationally in the form of dairy products and is concentrated among four main exporters, the EU (47%), New Zealand (25%), Australia (10%) and the US (9%) (AgraEurope, 1996). Together they account for over 90% of the world dairy trade (figure 1). Note that this excludes intra-EU trade.

Figure 1: World Dairy Trade 1996
Around 5 % traded internationally



While the above four are the major international traders of dairy products, the top four milk producers in the world are the EU, the US, India (including milk from buffalos) and the Russian Federation (FAO, 1997).

Blank (1983) describes the structure of the world dairy industry to be oligopolistic on both the supply (export) side and the demand (import) side; a few nations control a majority of the total trade. He concludes that this type of market structure leads to economic warfare, which, in the absence of collusion, promotes neither price stability nor long-term equilibrium.

Ten year comparisons in percentage share of the volume of trade provided in table 1 suggest that New Zealand and Australia's share of trade for all four principal dairy products has increased significantly, while that of the EU has declined in general, the exception being EU-SMP trade. In 1993/94 the EU, New Zealand, Australia and the US were still the four main exporters of dairy products, while the principal importers varied for the different products. The Former Soviet Union was the main butter importer, Japan the main cheese importer, Algeria the main WMP importer and Mexico the main SMP importer. In 1993/94, New Zealand was the world's leading butter exporter, as shown in table 1 (IDA 1996). The EU was the leading exporter of cheese and milk powders and a significant exporter of butter.

Table 1: Major International Exporters and Importers of Key Dairy Products

Exports of Butter (% of Global exports)			**Imports of Butter (% of Global imports)**		
	1983/84	1993/94		1983/84	1993/94
EU-12	53.6	27.1	Former SU	15.7	17.8
US	6.4	15.3	EU	15.1	12.0
Australia	3.6	13.2	Egypt	5.2	7.6
New Zealand	29.4	38.7	Mexico	2.5	6.6
Exports of Cheese (% of Global exports)			**Imports of Cheese (% of Global imports)**		
	1983/84	1993/94		1983/84	1993/94
EU-12	57.7	57.0	Japan	9.9	15.3
US	2.3	2.0	US	15.0	13.6
Australia	6.9	10.8	EU	13.2	10.9
New Zealand	11.4	15.2	Saudi Arabia	5.5	6.1
Exports of SMP (% of Global exports)			**Imports of SMP (% of Global imports)**		
	1983/84	1993/94		1983/84	1993/94
EU-12	29.5	34.8	Mexico	11.3	20.5
US	29.6	10.0	Malaysia	3.6	10.3
Australia	7.1	26.6	Philippines	5.8	10.0
New Zealand	19.2	20.9	Algeria	5.4	6.4
Exports of WMP (% of Global exports)			**Imports of WMP (% of Global imports)**		
	1983/84	1993/94		1983/84	1993/94
EU-12	65.2	58.2	Algeria	5.6	12.4
US	2.4	3.3	Saudi Arabia	7.2	6.3
Australia	6.2	8.4	Malaysia	5.8	5.8
New Zealand	17.4	29.3	Taiwan	4.8	5.6

Source: IDA, 1996

Likely Influences on International Dairy Product Prices

While domestic support and trade policies of individual countries are usually the most significant determinants of prices paid for milk by consumers, international dairy product prices are more likely to be influenced by the factors listed below.

Supply factors

- Climatic conditions in the major trading nations which affect export supplies available have significant influence on what New Zealand farmers receive for their milk. For instance, the drought conditions in Victoria, Australia at the start of the 1997 calendar year and storms and floods in the US around the same time are likely to influence their supply levels during 1997/98.
- Expansion of unsubsidised export supply from sources such as Australia and New Zealand where commitments on export subsidies will not be constraints to exports.
- Relative performance of competing land based agricultural activities, such as sheep and beef as well as arable farming.

Demand factors

- Oil prices are likely to influence the levels of imports by oil exporting countries in North Africa, the Middle East and Latin America.
- Economic and political stability in major importing countries like Venezuela, Algeria, Iran, Mexico and Russia.
- Import levels in some developing countries are likely to be influenced by the previous season's prices for dairy products.
- Asian countries are also significant markets for dairy products, mainly from Australia and New Zealand. The major influences there seem to be income and population growth, and the increasing familiarity with dairy products, which in many cases are non-traditional food items for them.

Government policy influences

- Levels of stocks in the major exporting countries, particularly the EU and the US, which in previous years have been flooded onto the world market at lower prices with assistance from government export subsidies.
- Trade policies of major exporting and consuming nations.
- The implementation of the GATT Uruguay Round phased reduction commitments in

export subsidies, in particular for cheese, which has constrained government's trade policies and the investment decisions of dairy industries around the world.

- Continuing (although decreasing) subsidised exports from major dairy producers.

Table 2 : International Dairy Product Prices (US$) and New Zealand Farmgate Payout (NZ$)

Year Ended May*	Butter $/t FOB Nominal	Cheese $/t FOB Nominal	WMP $/t FOB Nominal	SMP $/t FOB Nominal	Ave Farmgate Payout, $/kg MS	
					Nominal	Inflation Adjusted, 1996
1980	1228	1438	935	719	1.22	3.88
1981	1854	1610	1397	1098	1.52	4.18
1982	2295	1777	1494	1085	1.95	4.59
1983	2244	1794	1425	972	2.11	4.58
1984	1734	1425	1079	754	2.09	4.34
1985	1500	1350	1012	712	2.33	4.16
1986	1104	1169	987	753	2.29	3.69
1987	1050	1108	975	842	2.03	2.76
1988	1068	1402	1242	1140	2.34	2.98
1989	1579	1999	1915	1911	3.28	4.00
1990	1721	2000	1779	1779	3.59	4.08
1991	1386	1575	1437	1460	2.42	2.67
1992	1456	1656	1571	1519	3.34	3.66
1993	1373	1856	1779	1815	3.66	3.95
1994	1313	1877	1513	1554	3.32	3.54
1995	1468	2004	1734	1802	3.40	3.47
1996	1917	2063	2116	2095	3.99	3.99
1997	1473	2145	1859	1843	3.60**	3.53**

Sources: NZDB and Dairy Statistics 1995-96 (Livestock Improvement Corporation)
Note * **New Zealand prices given above are for year ended May, while those used in the model are for calendar years.**
** Estimate only

"As the small number of exporters, listed earlier, take greater control of the supplies to the world market, prices could become more volatile, ie prices could become more sensitive to supply and demand on the world market" (AgraEurope, Dairy Industry Review, 1996).

Apart from the fluctuating international prices, the farmgate payout for milk in New Zealand

over the years has been strongly influenced by the volume of milk produced within New Zealand. The additional volume of manufactured output is usually sold as undifferentiated products in the lower returning markets, and this drives the average final milk payout down.

While the returns to New Zealand farmers in recent years have been further eroded by the appreciation of the New Zealand dollar, the extent of this was mitigated to a certain degree by the Dairy Board's forward cover of the exchange rate.

Dairy Policies in Selected Countries

In the US, Federal dairy price supports and milk marketing orders, import restitutions, export subsidies, domestic and international food aid programs and state milk market regulations all play a role in the production, pricing and marketing of milk and dairy products (OECD, 1996). According to the OECD, the Dairy Price Support Programme in the US has resulted in excess milk production of 6-8 percent annually since the 1980s.

At the time of accession of UK to the EEC in 1973, special access rights for continuing exports of New Zealand butter and cheese to the UK were established. The UK is covered by the EU's Common Agricultural Policy, which offers price support through a system of purchasing product surpluses at established floor prices. Intervention purchases are then disposed of most importantly through subsidised export sales to non-EU countries. The intervention price effectively provides a floor to the market. A system of variable levies have essentially excluded imports of dairy products, except where special concessions have been negotiated, eg in the case of New Zealand butter exports. In 1984, the EU introduced quotas on milk production in response to market surpluses and the rising cost of sustaining the Common Agricultural Policy (OECD, 1996). The Common Agricultural Policy is also applicable to other EU member countries.

GATT Impacts

The implementation of the GATT Uruguay Round commitments will gradually reduce the volume of dairy products that can be exported, with the aid of subsidies, over the remainder of the decade. However, the volume of subsidised products available for sale on world markets will remain large.

The Uruguay Round (UR) agreement introduces a new period of policy adjustment which will eventually lead to reduced levels of support, and probably more competition. According to the OECD (1996), the main impact of the UR agreement on the dairy industry over the implementation period will be from reductions in export subsidies and some increases in market access for imports through the current minimum access provisions. The OECD (1996) adds that as the implementation of the Agreement is to be phased-in over a 6 year period and further lags in adjustment of production, consumption, and trade are likely to occur, the full effects are not expected to be felt until well into the next decade. Table 3 shows the maximum volumes of subsidised EU exports allowed to the year 2001. The immediate impact on SMP trade is minimal, but subsidised cheese exports from the EU would be more severely constrained relative to current levels. Butter exports are unlikely to be affected at all.

Table 3: GATT: Maximum Annual Subsidised Exports from the EU ('000 tonnes)						
	1995/96 (actual)	1996/97	1997/98	1998/99	1999/2000	2000/2001
Butter	487.8 (145.1)	470.1	452.4	434.7	417.0	399.3
SMP	335.0 (241.0)	322.5	310.0	297.5	285.0	272.5
Cheese	426.5 (420.5)	405.4	384.4	363.3	342.3	321.3
Other Dairy	1185.4 (1133)	1140.0	1094.5	1049.0	1003.6	958.1
Source: AgraEurope, Dairy Industry Review, Nov 1996						

In response to the new GATT commitments on reduced export subsidies, the EU dairy exports will have to be cut back by 2.5 million tonnes in milk equivalents over the next six years unless, a) there is a shift in production from cheese to butter and SMP, b) new markets for exports without refunds are developed or c) there is significant growth in internal markets (OECD, 1996). The EU, under the UR Agreement, can further increase its subsidised exports of butter and SMP as its current export levels are lower than allowed. For cheese, the EU's current level of subsidised exports are well above the base and must be further reduced.

As part of the GATT Uruguay Round outcome, New Zealand obtained an increase in its country-specific tariff quota for butter to the EU from 51,830 tonnes in 1994 to 64,249 tonnes in 1995, and 76,667 tonnes annually thereafter. New Zealand also maintained its country-specific cheese access to the EU of 9,500 tonnes. As part of the compensation for the accession of Austria, Finland and Sweden to the EU, New Zealand's country-specific cheese access was increased by 16% to 11,000 tonnes from 1996. New Zealand is now also able to compete for the EU's annual tariff quotas for SMP and various types of cheese, which were opened to all GATT/WTO member countries from 1 July 1995.

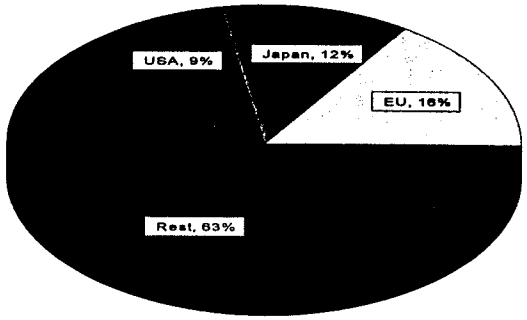
Exports of New Zealand Dairy Products

New Zealand's largest dairy markets by value are the EU, Japan and the US (figure 2), although during 1996/97 Russia displaced Japan as the second largest market for New Zealand dairy products. The EU, Japan and the US have protected dairy industries, with domestic prices much higher than world prices. The high prices obtained from tariff quotas in these markets insulate New Zealand to a small extent from the volatility of world prices for dairy products obtained from sales to other markets.

In 1995/96, the UK was New Zealand's main butter market, taking 34% of total butter exports by volume. In the same year, Japan was New Zealand's main cheese market, importing 28% of total cheese exports by volume, and the US took 42% of casein exports by volume to remain New Zealand's main market for casein. The main milk powder market for New Zealand in 1995/96 was Malaysia, taking 15% of milk powder exports by volume (SNZ and NZDB).

Figure 2: Dairy Exports from NZ

Value by destination, Yr Ended June 1996



$3,792 m
Source: NZDB

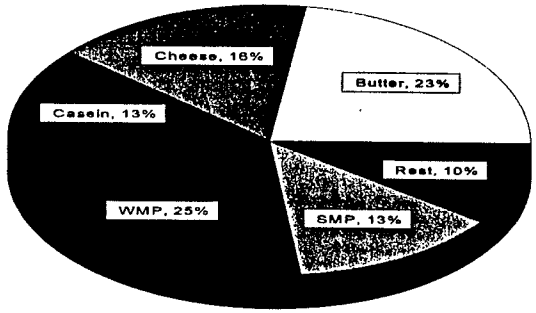
Besides Japan, the most important markets for New Zealand dairy products in the Asian region for the year to June 1996 were: Malaysia, Taiwan, the Philippines, Thailand, and Indonesia. Importance of these markets is as our main export destination for milk powders.

In 1995/96, Mexico was New Zealand's eighth largest market by value, taking mainly milk powders. Other important markets that year were: Algeria, where economic instability led to a fall in imports of New Zealand dairy products, in particular WMP; Venezuela, which mainly imported WMP (Venezuela faced a foreign exchange crisis during 1995/96 and as a result the government prohibited imports for about 3 months); Saudi Arabia; and Iran (SONZA, 1997).

While WMP and butter are the two dominant export products, cheese, SMP and casein are also of considerable importance (figure 3). Appendix A contains details of different dairy products manufactured in New Zealand, and volumes exported in more recent years.

Figure 3: Dairy Exports from NZ

Value by Product Group, Yr Ended June 1996



CONCEPTUAL FRAMEWORK OF THE INTERNATIONAL DAIRY MARKET MODEL

Export supplies of dairy products and prices in New Zealand are influenced by developments in the international dairy market and world prices. One of the problems faced in studying world dairy markets is the absence of a clear definition of what constitutes a 'world price' (Blank, 1983). Various price series have been used elsewhere as representative of the world price. FOB prices are representative of the 'actual' quoted prices at which products are traded in world markets and hence are used in this study.

The main objective in this study was to describe and measure the effects of major factors influencing FOB prices for four of the main dairy products at the international level and hence at the New Zealand level, so that the New Zealand milk solids or milk fat prices can be forecast. International FOB prices are those recorded for Northern Europe by the OECD and are reported in US$ per cwt. The FOB prices at the New Zealand level are those reported by the New Zealand Dairy Board in its "International Market Update" published monthly and considered relevant for determining the New Zealand farmgate payout for milk.

Lack of comparability of many international data series, however, was quite prevalent. Most of the data used in this study are based on the OECD-AGLINK data base which is mainly on a calendar year basis. Some data for Australia and the US, as well as the cheese trade from the EU, was obtained from the Commodity Statistical Bulletin (ABARE, 1996). International data on exchange rates and inflation rates were obtained from the various issues of the International Financial Statistics (IMF).

The conceptual approach adopted in developing the econometric model of International Dairy Markets can be summarised in the form of figure 4. The dairy products included in this International Dairy Market model are butter (B), cheese (C), skim-milk powder or SMP (S) and whole-milk powder or WMP (W). A high-value dairy product of significance to New Zealand, casein, was not included due to the unavailability of relevant overseas data.

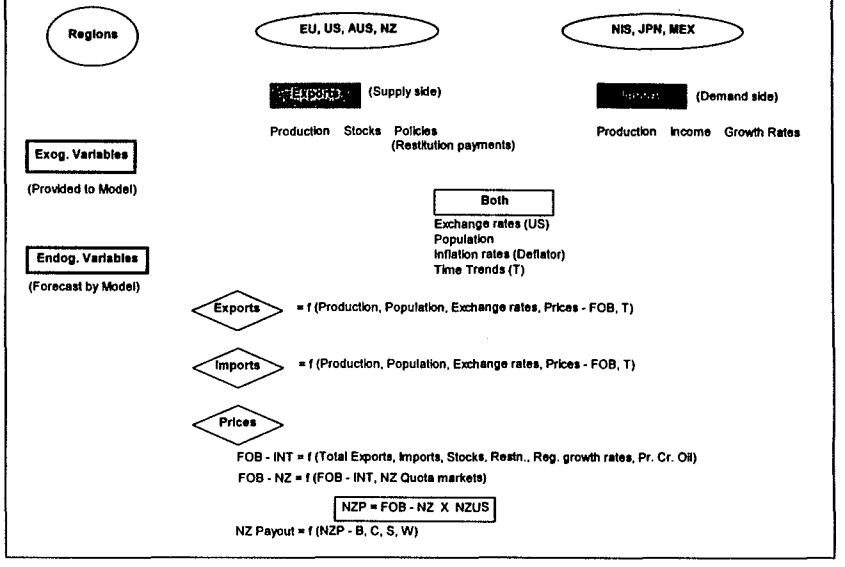
The *exporting regions* covered in this study are the European Union (EU), the United States (US), Australia (AUS) and New Zealand (NZ) which are the main exporters of the dairy products in the world. The *main importers* of butter, cheese and skim-milk powder in general, are the Newly Independent States (NIS), Japan (JPN) and Mexico (MEX), respectively, and are hence included in this model. Another important import market for milk powders, Malaysia, was not included due to the unavailability of adequate country specific data.

The model has *endogenised* international FOB prices (in US$) and trade (both exports and imports) for the above exporting and importing regions and with respect to the four dairy products studied. The *exogenous factors* not modelled and hence provided for in the model on the *export (supply) side* are production levels and stock carry overs for the dairy products as well as country related policies, such as export restitution payments, particularly for the EU. On the *import (demand) side* domestic population, income levels, economic growth rates and also production levels were exogenous to the model. Exchange rates, inflation rates (CPIs as deflators) and time trends (T) were used on both sides of the model as appropriate.

Both exports and imports were modelled as a function of *production levels, domestic population, exchange rates, international prices at the FOB level and some trend factors*. The expected signs of regression co-efficients in the export equations will be opposite of those in the import equations for the same variables.

Figure 4: Conceptual Framework of the International Dairy Market Model

[Dairy Products Covered: Butter (B), Cheese (C), SMP(S), WMP(W)]



FOB price equations, at the international level (in US$), are represented as a function of total exports from all exporting countries, stocks held by those countries and export policies (eg export restitution payments) of one of the main exporters (the EU), imports to an important representative market as well as *regional economic growth rates* (eg, East Asia) and *crude oil prices* as appropriate. Equations for FOB prices at the New Zealand level (also in US$), which are more relevant for determining New Zealand farmgate payout, are modelled as a function of FOB prices at the International level as well as the size of the New Zealand quota markets for products such as butter.

The New Zealand FOB prices in US$ for all four dairy products studied are then converted to NZ$ values using the New Zealand:US market exchange rate (NZUS), measured as NZ$ per one US$, even though the use of forward cover exchange rates by the New Zealand Dairy Board were applicable to some of the years. New Zealand farmgate payout is modelled as a function of NZ$ butter price, cheese price and aggregated (skim and whole) milk powder price, as the latter two prices are highly correlated.

MODEL ESTIMATION

The estimated model is reported in Appendix B as tables 1 (Price equations at the New Zealand and international level), 2 (Export markets for butter, cheese, SMP and WMP) and 3 (Major representative import markets).

Price Equations - New Zealand

Price equations are *estimated in real terms*, where the international and New Zealand based FOB prices measured in US$ are deflated by the US CPI, a proxy for Industrial World CPI (Bain, 1983), and the New Zealand farmgate payout is deflated by the New Zealand CPI.

Average *New Zealand Farmgate Payouts* equation exhibits a reasonably high explanatory power with an adjusted Coefficient of Determination (R^2) value of 0.873 and an F-value of 28.6, significant at the 5% level of confidence (Appendix B: table 1). The Durbin-Watson statistic of 2.46 suggests no autocorrelation problems in the estimated equation. The coefficients on NZ$ FOB prices for butter, cheese and a combined milk powder price were all positive as expected, even though the t-values were not significant. A positive time trend was also observed. The size of the coefficients suggest that cheese FOB price has the greatest impact on New Zealand farmgate payouts followed by the butter and milk powder prices.

The equations linking the *FOB prices at the New Zealand level* to that at the International level all had reasonable explanatory power with R^2 values ranging from 0.720 (Cheese), 0.858 (Butter), 0.918 (WMP) to 0.964 (SMP). The regression coefficients on International FOB prices were all positive and significant at the 5% level of confidence. The size of the coefficients varied between 9 and 11 with a value of 10 suggesting a near perfect relationship between the two prices since the International FOB prices are measured as US$ per cwt and the New Zealand FOB prices are measured as US$ per tonne.

Price Equations - International

The International FOB prices for dairy products were modelled on the supply side, as a function of total exports from the four key exporters studied (ie, EU, US, AUS and NZ), combined stocks held by the two main producers (ie, EU, US) and the export restitution policies of the EU, the dominant exporter. On the demand side, imports by one of the main importers of the respective dairy product, economic growth rates of the East Asian countries (a region of current and growing demand for milk powders), and the price of crude oil were included in the international price equations. Some of the largest importers of dairy products are the oil exporting countries of North Africa (eg, Algeria), the Middle East (eg, Iran, Saudi Arabia) and Latin America (eg, Venezuela).

The overall explanatory power of variables included in these equations (Appendix B: table 1) were 0.637 (WMP), 0.805 (Cheese), 0.818 (Butter), and 0.894 (SMP). The F-values were significant at the 5% level of significance, except for the WMP equation, significant only at the 10% level. The WMP equation did not include the imports by the overall main importer of WMP, Malaysia, due to the lack of relevant data, affecting its explanatory power.

The main variable which was consistently statistically significant and having a negative impact on the international price of dairy products was the *level of export restitutions by the EU* over the years studied. The extent of the negative impact on dairy product prices, measured in terms of the size of the coefficients was very similar for cheese, SMP and WMP, but somewhat smaller for butter. Consumption subsidies are important in the EU, in addition to export subsidies.

The size of the *combined stocks held by the EU and the US* also had a negative impact on international cheese and SMP prices, but was statistically significant only for SMP. The stock levels did not appear to be significant and were not included in the final butter equation and the WMP stock data was not available for the main exporters studied.

The *total export volumes* of the main exporters did not have the expected negative impact on the international price, except in the case of the cheese equation, where this coefficient was statistically significant at the 5% level of confidence. The coefficients in the other three equations were relatively small, even though positive. The volume of imports by the main importers had a positive sign on international prices, as anticipated, but only the Japanese imports in the cheese equation were statistically significant, while NIS imports in the butter equation and Mexican imports in the SMP equation were not.

On the demand side, *crude oil prices* had a positive sign in the butter price equation, but were not statistically significant. *East Asian economic growth rates* were positive, as anticipated, and were significant at the 5% level of significance in both the milk powder equations. The size of the coefficient for East Asian economic growth rates was marginally higher in the WMP equation than for the SMP equation. The countries included in the composite East Asian weighted average economic growth rates were Hong Kong, Indonesia, South Korea, Malaysia, Singapore, Taiwan, Thailand and the Philippines, weighted by GDP shares.

Export Market Equations

The export equations covered the four dairy products studied (butter, cheese, SMP and WMP) and included the modelling of exports from the four main exporters, Australia, the US, the EU and New Zealand. The explanatory variables in these equations included the *volume of respective dairy products produced in each of the countries, the real FOB prices at the international level (lagged one period), the domestic population, the exchange rate and a time trend*, where appropriate.

Butter:

The explanatory power of the butter export equations were not exceptionally good (R^2 values of about 0.550 to 0.600) , with the exception of the Australian butter export equation which had an R^2 value of 0.747. All the F-values were, however, significant at the 5% level of confidence. Durbin-Watson statistic was also within the acceptable range of 1.5 to 2.5 (Appendix B: table 2).

In all the butter export equations, *the butter production variable* had the expected positive

impact on exports and the coefficients were also significant at the 5% level of confidence, except for in the New Zealand butter export equation. The respective *domestic population* also had the expected negative impact on exports, but only the coefficient for Australian population was significant at the 5% level of confidence. Again the exception was the US equation, where the sign on the coefficient was positive and also significant.

The *lagged FOB butter price at the international level* also exhibited the anticipated positive impact on exports in the US, Australia and New Zealand, even though not statistically significant. The exception to this was the EU export equation where the lagged FOB price variable had a negative sign and was significant. The respective *currency exchange rates* in relation to the US$, in which currency the international FOB prices are reported, was negative in the EU and New Zealand butter export equations contrary to expectations, but was significant only in the EU equation. It was positive and significant in the Australian equation.

A *time trend variable* was used in the New Zealand equation only and was positive and statistically significant. As the equations have been estimated over a very long period of over 20 years (1972-1995), some of the trends have been non-linear and do not hold for the entire period.

Cheese:

The explanatory power of the cheese export equations were much better than the Butter export equations with R^2 values ranging from 0.719 for the US, 0.735 for New Zealand, 0.813 for Australia and 0.957 for the EU. All the F-values were also significant at the 5% level and the D-W statistic in the acceptable range, except for the US equation (Appendix B: table 2).

In all but one of the cheese export equations, *the cheese production variable* had the expected positive impact on exports, the exception being the EU equation. The coefficients were also significant at the 5% level of confidence. The respective *domestic population* had the expected negative impact on exports only in the Australian equation, but the coefficient was not significant. The coefficient was significant in the EU equation, even though it had a positive impact on exports.

The *lagged FOB cheese price at the international level* did not exhibit the anticipated positive impact on exports in the Australian, the EU and the New Zealand equations, and was statistically significant in the latter two. The respective *currency exchange rates* in relation to the US$, in which currency the International FOB prices are reported, had a positive sign in the EU cheese export equation as expected and was significant. The sign was negative in the Australian and New Zealand equations, but significant only in the New Zealand equation.

A *time trend* variable was used only in the New Zealand equation. It was positive and statistically significant. As the equations have been estimated over a very long period of over 20 years (1972-1995), some of the trends have been non-linear and do not hold for the entire period.

SMP:

The explanatory power of the SMP Export equations were not exceptionally good (R^2 values mainly between 0.450 and 0.550) , with the exception of the Australian SMP export equation which had an R^2 value of 0.753 (Appendix B: table 2). The F-values were, however, significant at the 5% level of confidence in the Australian and the US equation and at the 10% level in the EU equation. The Durbin-Watson statistic was within the acceptable range of 1.5 to 2.5 for the US and New Zealand equations, but slightly lower (1.38 to 1.47) for the Australian and the EU equations.

In all but one of the SMP Export equations, *the SMP production variable* had the expected positive impact on exports, the exception being the EU equation. EU subsidies for SMP for bakeries and animal feed to absorb extra production could explain this. The coefficients were also significant at the 5% level of confidence in the Australian and the US equations, but not in the New Zealand equation. The respective *domestic population or real GDP* also had the expected negative impact on exports in the Australian equation, but was not statistically significant. Again the exception was the New Zealand equation, where the sign on the coefficient was positive, but not significant.

The *lagged FOB SMP price at the international level* did not exhibit the anticipated positive impact on exports in any of the SMP export equations, and was statistically significant in the US and the EU equations, but not in the Australian and New Zealand equations. The respective *currency exchange rates* in relation to the US$, in which currency the international FOB prices are reported, had a negative sign in all the SMP export equations contrary to expectations, and was significant in the Australian and the EU equations.

A *time trend* variable was used in the US, and the EU equations and was positive in both of them, but was not statistically significant. As the equations have been estimated over a very long period of over 20 years (1972-1995), some of the trends have been non-linear and do not hold for the entire period.

WMP:

The explanatory power of the WMP Export equations were much better than the SMP Export equations with R^2 values of 0.600 for the EU, 0.778 for the US, 0.936 for Australia and 0.957 for New Zealand. All the F-values were also significant at the 5% level of confidence and the D-W statistic, within the acceptable range (Appendix B: table 2).

In all but one of the WMP export equations, *the WMP production variable* had the expected positive impact on exports, the exception being the US equation. The coefficients were also significant at the 5% level of confidence, in the Australian and the New Zealand equations and at the 10% level in the EU equation. It was not significant in the US WMP export equation. The respective *domestic populations* were not used in any of the WMP export equations. Domestic markets of these countries are not important consumers of WMP and hence WMP exports are less dependent on the size of the domestic population.

The *lagged FOB price at the international level for WMP* exhibited the anticipated positive impact on exports in all but the Australian equation, but was statistically significant only in the New Zealand equation. The respective *currency exchange rates* in relation to the US$, in which currency the international FOB prices are reported, had the expected positive sign only in the New Zealand equation, even though not significant.

A *time trend* variable was used in all of the equations and in the case of the US and the EU equations also in the quadratic form. This reflected an initial decline and a subsequent increase in exports in the US and the EU, with both the linear and quadratic trend variables being significant in the US equation only. A linear trend variable alone was used in the Australian and the New Zealand equations. Trend was positive but statistically not significant for Australia and negative and statistically significant for New Zealand.

Import Market Equations

It was possible to estimate only three import market equations, owing to data limitations. The Newly Independent States (NIS) of the former Soviet Union, the main importers of butter, Japan a key importer of cheese and Mexico the major importer of SMP are the three markets for which the equations were estimated.

The explanatory power of the equations varied from an R^2 value of about 0.584 for Mexican SMP imports, 0.723 for Butter imports by the NIS and 0.969 for Japanese Cheese imports. The F-values were significant at least at the 10% level of confidence and the Durbin-Watson values were also within the acceptable range (Appendix B: table 3).

The *volume of dairy product* produced locally had an anticipated negative sign in all the equations, but was statistically significant only in the Japanese cheese equation. Recent decline in both production and imports in the NIS, following the break up of the former Soviet Union in 1992, was taken into account in the form of a dummy variable and a negative sign statistically significant was found.

The *population level* had the anticipated sign on imports in the NIS and was statistically significant while for Mexico it was represented as *per capita GDP* and was positive, but not significant. In Japan, the population variable had a negative sign which was also significant.

The *lagged FOB price at the international level* also had an unanticipated positive sign in all three import equations, even though significant only in the NIS butter import equation. This result suggests that factors besides International prices determine the purchase decisions of the mainly state purchasing agencies, particularly in the NIS and Mexico.

The respective *currency exchange rates* in relation to the US$, in which currency the international FOB prices are reported and the trade most often takes place, had the expected negative sign on imports only in the Japanese cheese import equation with the coefficient also significant. It was positive, but not significant in the Mexican SMP import equation and was not used in the NIS butter import equation as the respective currency has not been used in international currency exchange in recent years.

The *time trend* variable used in the three import equations was statistically significant at least at the 10% level of confidence. The coefficient was negative in the NIS butter import equation, while being positive in the Japanese cheese and Mexican SMP equations. This is consistent with the historical developments of imports in these three markets.

MODEL VALIDATION

In this section, the endogenous variables which are estimated and intended to be forecast within the International Dairy Market model are evaluated using an ACTFIT procedure available within the Time Series Processor (TSP) econometric package. In this evaluation, the fitted values of the endogenous variables using the estimated equations discussed in the previous section are compared with their actual historical values. The *Correlation Coefficients*, the *Regression Coefficients* of the actual on fitted values and the *Error due to Bias* arising from consistent over or under estimation which comprise this assessment are reported in table 4.

Prices

The ultimate objective of this model development is to forecast the New Zealand average farmgate payout for milk. In order to do this, the FOB prices at the New Zealand level have to be forecast first. The model validation results reported in table 4 suggest that the actual and fitted values of *New Zealand farmgate payout* have a correlation of 0.897 and a regression coefficient of 0.938, both of which are quite close to a value of 1.0 which is the most desired result. The bias level in this equation is close to being negligible at 0.00006, suggesting no consistent over or under estimation of the actual values by the fitted estimates.

The correlation coefficients between the actual and fitted values of *FOB prices at the New Zealand level* range from 0.594 for WMP to 0.873 for Butter, with Cheese and SMP falling in between. The corresponding correlation coefficients between the actual and fitted values of *FOB prices at the International level* range from 0.651 for WMP to about 0.898 for SMP, with Cheese and Butter within this range.

The limited explanatory power of the FOB price equation for WMP relates to the lack of data for the major import markets which precluded them from being used in estimating the equation. The regression coefficients of actual on fitted values of FOB prices, both at the New Zealand and the international level, also suggest values which are somewhat divergent from the preferred value of one. The values over one for butter and WMP indicate general under estimation of these prices and in contrast, the values under one for cheese and SMP suggest a general over estimation of these prices.

The level of bias in the FOB price equations are much higher than in the New Zealand payout equation, with butter FOB prices being the highest at about 0.05 at the New Zealand level and at 0.03 at the international level. The lowest bias was reported for SMP FOB prices in New Zealand, with a value of 0.01, and a value of 0.005 for WMP FOB prices at the international level.

Table 4: International Dairy Model Validation
(Results of the ACTFIT Procedure)

Endogenous Variable	Variable Code	Correlation	Regression	Bias
I. PRICES				
A. New Zealand				
- Average Payout	RNZPay	0.897	0.938	0.00006
- Butter FOB	RBFOBNZ	0.873	1.432	0.05294
- Cheese FOB	RCFOBNZ	0.764	0.753	0.04964
- SMP FOB	RSFOBNZ	0.841	0.864	0.00956
- WMP FOB	RWFOBNZ	0.594	1.144	0.01365
B. International				
- Butter FOB	RBFOB	0.888	1.279	0.03121
- Cheese FOB	RCFOB	0.724	0.691	0.00535
- SMP FOB	RSFOB	0.898	0.896	0.00780
- WMP FOB	RWFOB	0.651	1.177	0.00492
II. EXPORT MARKETS				
A. Butter				
- Australia	AUSBX	0.961	1.024	0.02413
- United States	USBX	0.604	0.924	0.00035
- European Union	EUBX	0.758	0.907	0.01773
- New Zealand	NZBX	0.453	0.557	0.00980
B. Cheese				
- Australia	AUSCX	0.927	1.230	0.01036
- United States	USCX	0.589	0.703	0.01306
- European Union	EUCX	0.895	0.789	0.00455
- New Zealand	NZCX	0.896	0.949	0.00002
C. SMP				
- Australia	AUSSX	0.963	1.119	0.12567
- United States	USSX	0.741	1.337	0.00763
- European Union	EUSX	0.330	0.697	0.00956
- New Zealand	NZSX	0.297	0.716	0.00016

Endogenous Variable	Variable Code	Correlation	Regression	Bias
D. WMP				
- Australia	AUSWX	0.976	1.006	0.00031
- United States	USWX	0.899	0.989	0.00022
- European Union	EUWX	0.875	0.986	0.00002
- New Zealand	NZWX	0.981	0.980	0.00073
III IMPORT MARKETS				
- Butter: Newly Independent States	NISBM	0.781	0.741	0.04375
- Cheese: Japan	JAPCM	0.980	1.049	0.02209
- SMP: Mexico	MEXSM	0.472	0.788	0.00388

Export Markets

Among the export markets, the *Australian exports* of dairy products had the highest correlation between the actual and fitted values with values of 0.927 or higher and the regression coefficients were above one, but only ranged between 1.006 (WMP) and 1.230 (cheese).

For the *US market* the correlation ranged from 0.589 for cheese to 0.899 for WMP, with butter at 0.604 and SMP at 0.741. In the case of the *EU market*, the correlation values were around 0.880 for cheese and WMP and 0.758 for butter, but was only 0.330 for SMP. The correlation for SMP exports was quite low also for *New Zealand* at 0.297, while the values for cheese (0.896) and WMP (0.981) were quite high and for butter it was 0.453. Marketing decisions of institutional nature by New Zealand tied to the EU export and stock levels not addressed by the model is a likely explanation for the low correlation observed for both the EU and New Zealand SMP export equations.

The *regression coefficients* for the US market ranged between 0.703 for cheese to 1.337 for SMP, while the values for butter and WMP were in the range of 0.924 to 0.989. The corresponding coefficients for the EU market ranged from about 0.697 for SMP to 0.986 for WMP with cheese at 0.789 and butter at 0.907. In the case of New Zealand, cheese and WMP exports were in the range of 0.949 to 0.980, while SMP was at about 0.716 and butter, the lowest at about 0.557.

The *bias* in general was the lowest in the case of the WMP export fitted values at below 0.0007 and the highest for SMP export fitted values, particularly for Australia (0.126), while for New Zealand SMP exports it was quite low at below 0.0002. The bias was still lower in the case of New Zealand cheese export fitted values at 0.00002 and for New Zealand butter exports it was somewhat higher at around 0.0098.

Import Markets

The *correlation coefficients* for the import markets varied between 0.980 for Japanese cheese and 0.472 for the Mexican SMP imports while NIS butter imports was in between at 0.781. The *regression coefficient* was also closest to one for Japanese cheese imports at 1.049 and in the range of 0.741 to 0.788 for the other two import markets. The bias was in the range of 0.004 to 0.044, which was moderate.

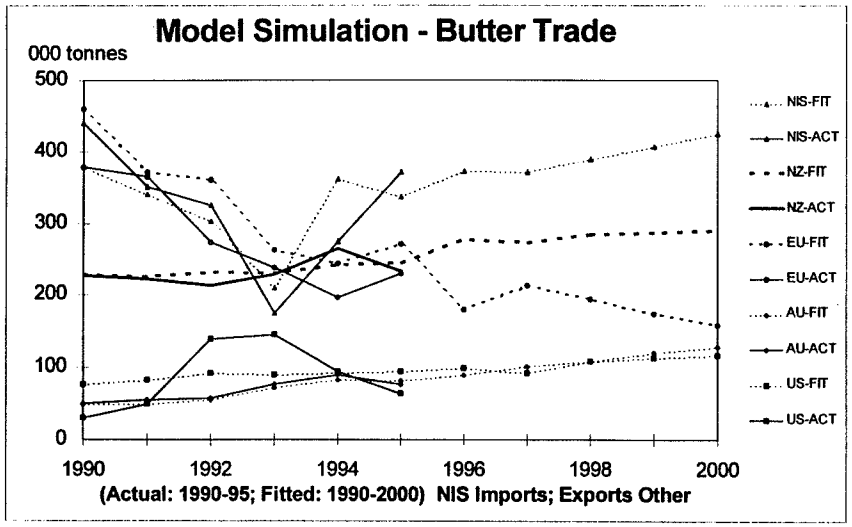
MODEL SIMULATION

The model simulation results are presented in this section in the form of figures 5-11. Each figure reports the actual values of exports or prices from 1990-95 and the fitted or simulated values for the 1990-2000 period.

Butter:

Butter trade simulation included imports by the NIS and exports by the four major dairy exporters modelled, the EU, the US, Australia and New Zealand. NIS butter imports declined from 440,000 tonnes in 1990 to 175,000 tonnes in 1993 and recovered to about 370,000 tonnes in 1995. The fitted values show the general pattern of this decline and recovery (figure 5) and forecast a steady increase in imports to around 420,000 tonnes by the year 2000. This 13% increase in imports underpins a further 10% decline in butter production in the NIS.

Figure 5:



Butter exports from the EU had declined from around 380,000 tonnes in 1990 to below

200,000 tonnes in 1994 with some recovery in 1995. The overall trend of this decline is tracked by the fitted values quite well, particularly for the last two years (figure 5). The forecast export levels suggest that during the 1996-2000 period, EU butter exports will decline further to about 160,000 tonnes. An exogenous (OECD) assumption of 5% decline in the EU production over 1996-2000, underlies this forecast.

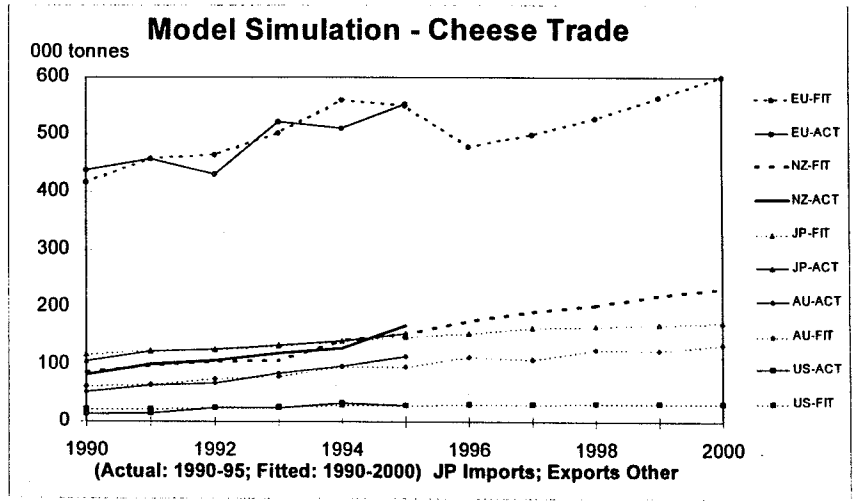
New Zealand butter exports increased from about 230,000 tonnes to over 260,000 tonnes in 1994 and declined somewhat to 230,000 tonnes in 1995. The fitted values again followed the actual values, even though some of the peaks and troughs were not captured fully. Butter exports from New Zealand are forecast to increase to about 290,000 tonnes by the year 2000, which is a 5% increase in exports associated with a 10% exogenous production increase assumed (by the OECD) over the 1996-2000 period..

Butter exports from the US and Australia have been comparatively negligible in the past at about 100,000 and 75,000 tonnes, on average, respectively. They are forecast to rise in the US (by 18%) to 120,000 tonnes, but rise significantly (by 40%) in Australia to about 130,000 tonnes in the year 2000. An exogenous assumption of 38% and 3% increase in the Australian and US production by the OECD over the 1996-2000 period, respectively, underlies this forecast export increase.

Cheese:

During the 1990-95 period, the EU was the main exporter of cheese, volumes rising from about 430,000 tonnes to 550,000 tonnes. This increase in EU cheese exports has been tracked well by the fitted values as can be seen in figure 6. This is forecast to decline to about 480,000 tonnes in 1996 and then gradually increase to about 600,000 tonnes in the year 2000.

Figure 6:



This is in spite of the GATT maximum subsidised export volumes declining from about 400,000 tonnes in 1996 to about 340,000 tonnes in 2000 (table 3). An exogenous assumption of 110,000 tonnes or 3% increase in the EU production (OECD) underlies this export increase. Only a significant growth in new EU export cheese markets without refunds can meet this. Cheese exports from New Zealand, which rose from about 80,000 tonnes in 1990 to about 170,000 tonnes in 1995 is tracked closely by the fitted values. The forecast suggest that it will increase further by about 30% to 235,000 tonnes in the year 2000 (figure 6).

Historically the US and Australia have been relatively smaller exporters of cheese. Australian exports rose from about 50,000 tonnes in 1990 to over 110,000 tonnes in 1995 and the US exports grew from a low base of 14,000 tonnes to about 30,000 tonnes during the same period. Australian exports are forecast to rise by 17% to about 135,000 tonnes in the year 2000, while the US exports increase by 6% to around 32,000 tonnes.

The main importer of cheese is Japan, whose purchases rose from about 100,000 tonnes in 1990 to about 150,000 tonnes in 1995 has been followed closely by the fitted values. This is forecast to rise further by 10%, but only gradually, to about 175,000 tonnes in the year 2000.

SMP:

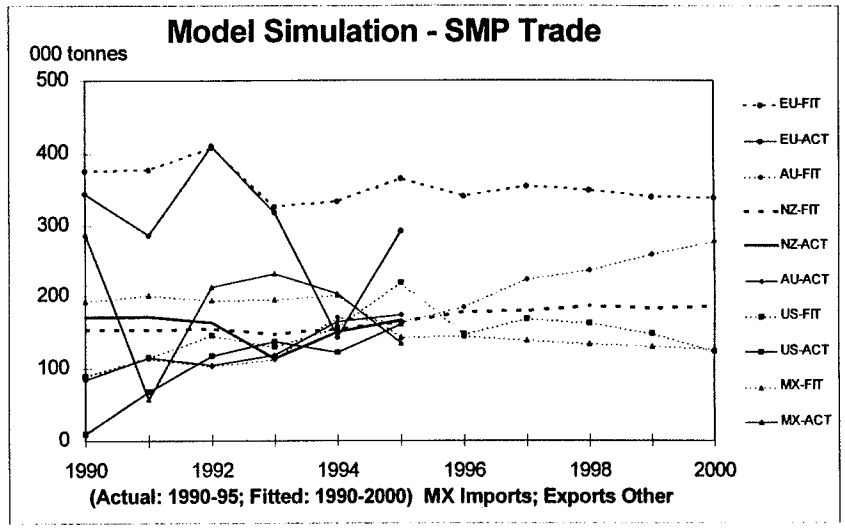
The EU has been the main exporter of SMP over the 1990-95 period, when exports fluctuated between 140,000 and 410,000 tonnes. The general trend of this volatility has been followed by the fitted values, even though the large decline in exports in 1994 was not captured fully. Over the forecast period, exports are forecast to remain in the range of 340-350,000 tonnes (figure 7), even though the GATT maximum subsidised exports decline to about 285,000 tonnes by the year 2000. New markets without export refunds have to be found for the surplus

New Zealand SMP exports declined from about 170,000 tonnes in 1990 to about 110,000 tonnes in 1993 and recovered to about 165,000 tonnes in 1995. The fitted values follow the general pattern of this variation (figure 7). They are forecast to fluctuate around 185,000 tonnes during the 1996-2000 period. A 14% decline in production is assumed by the OECD.

Australian exports of SMP which grew from 85,000 tonnes in 1990 to 175,000 tonnes in 1995 is forecast to grow further by 50% to about 275,000 tonnes by the year 2000. A 32% increase in Australian production by the OECD underlies this export growth. US exports which rose from very negligible levels to about 160,000 tonnes in 1995 is forecast to fluctuate around 150,000 tonnes but then decline to about 125,000 tonnes in the year 2000.

Mexican SMP imports declined to about 60,000 tonnes in 1991 from 290,000 tonnes in 1990 and subsequently rose to about 200,000 tonnes before dropping to 130,000 tonnes in 1995. It is forecast to increase first to 145,000 tonnes in 1996, but then decline to about 130,000 tonnes again by the year 2000. This is a 12% decrease in imports over the 1996-2000 period.

Figure 7:



WMP:

Once again the EU is the main exporter of WMP, where exports grew from about 520,000 tonnes in 1990 to about 590,000 tonnes in 1995. The fitted values have followed these changes very closely (figure 8). This rate of increase is not sustained during the forecast period, with exports rising from 540,000 tonnes in 1996 to about 560,000 tonnes in the year 2000. This is in spite of an 8% increase in production assumed by the OECD.

New Zealand is the next biggest exporter of WMP, where exports grew from about 120,000 tonnes in 1990 to about 320,000 tonnes in 1995 and the fitted values again followed the actual values very closely (figure 8). Forecasts suggest stable exports in the range of about 300-310,000 tonnes from New Zealand during the 1996-2000 period, with no further significant growth. A 15% increase in production assumed by the OECD underlies this forecast.

Historically, the US and Australia have been much less significant exporters of WMP. Australian WMP exports rose from about 30,000 tonnes to about 70,000 tonnes and the US exports increased from very negligible levels to about 60,000 tonnes during the 1990-95 period. They are forecast to remain relatively less important during the forecast period in spite of some growth to about 75,000 tonnes in Australia and to about 125,000 tonnes in the US. A 10% increase in production is assumed by the OECD, both in Australia and in the US.

Figure 8:

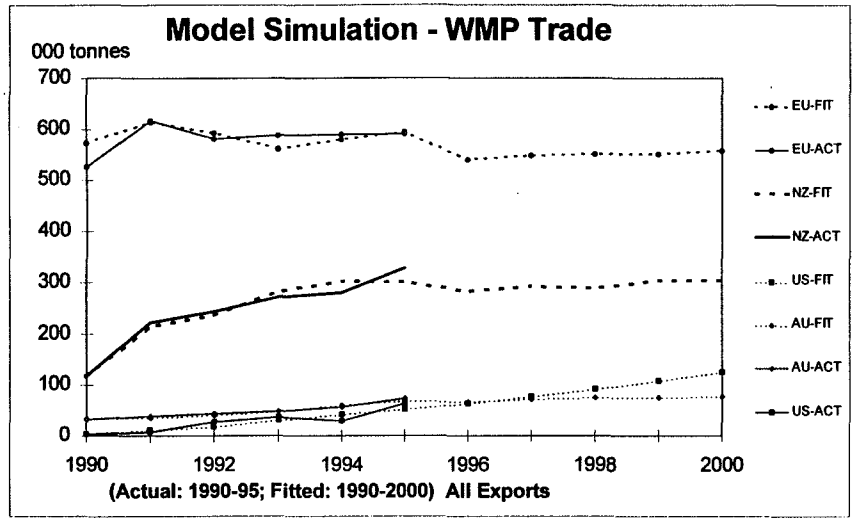
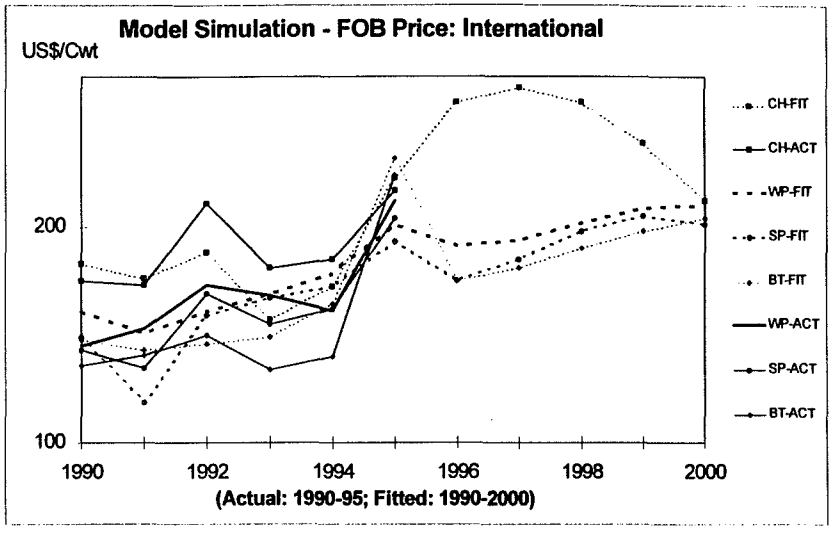


Figure 9:



FOB Prices: International

FOB prices at the international level are reported for Northern Europe in US$ per cwt by the OECD.

Cheese FOB prices at the international level fluctuated around US$170-185 per cwt before rising to US$217 in 1995 and the general pattern of this change has been followed by the fitted values, even though they were somewhat lower than actual prices during 1992-94 (figure 9). They are forecast to rise to US$265 in 1997 before declining to US$212 in the year 2000, presumably due to the extra world cheese production forecast.

FOB prices for WMP at the international level rose from about US$140 in 1990 to about US$210 in 1995, which is followed closely by the fitted values even though not coinciding (figure 9). They are forecast to rise gradually from US$190 to 210 per cwt over the forecast period 1996-2000.

FOB prices for SMP at the international level rose from about US$140 in 1990 to about US$200 in 1995, which is generally followed by the fitted values (figure 9). They are forecast to rise gradually from US$175 to 200 per cwt over the forecast period.

Butter FOB prices fluctuated around US$130-140 per cwt during 1990-94 before rising to US$224 in 1995 and the general pattern of this change is followed by the fitted values. They are forecast to rise gradually from US$175 in 1996 to about US$200 in 2000.

FOB Prices: New Zealand

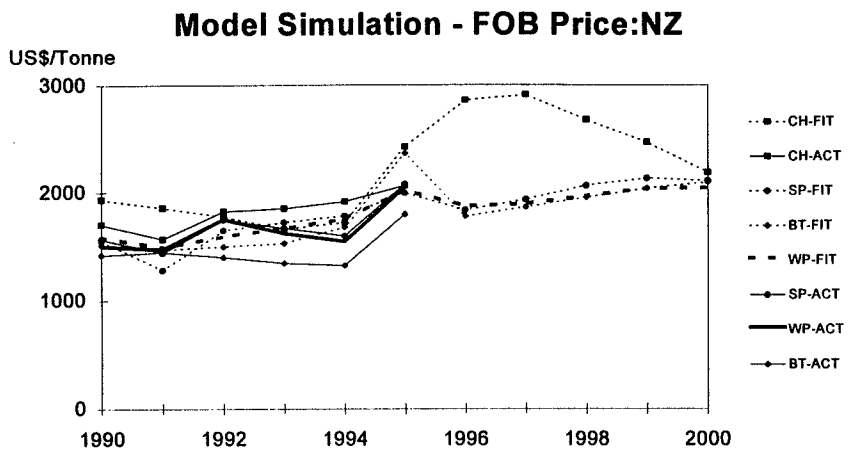
FOB prices at the New Zealand level are reported in a price band of US$ per tonne by the New Zealand Dairy Board in its "International Market Update" which is published monthly.

Cheese FOB prices at the New Zealand level fluctuated around 1700-1800 US$ per tonne before rising to US$ 2060 in 1995 and the general pattern of this change has been followed by the fitted values, even though they were lower than actual prices during 1992-94 (figure 10). They are forecast to rise to US$ 2900 in 1997 before declining to US$ 2200 in the year 2000.

FOB prices for WMP at the New Zealand level rose from about US$1500 in 1990 to about US$2000 in 1995, which is followed closely by the fitted values (figure 10). They are forecast to rise gradually from about US$1900 to around 2100 per tonne over the forecast period 1996-2000.

FOB prices for SMP at the New Zealand level rose from about US$1560 in 1990 to about US$2080 in 1995, which is generally followed by the fitted values (figure 10). They are forecast to rise gradually from US$1800 to about 2100 per tonne over the forecast period.

Figure 10:

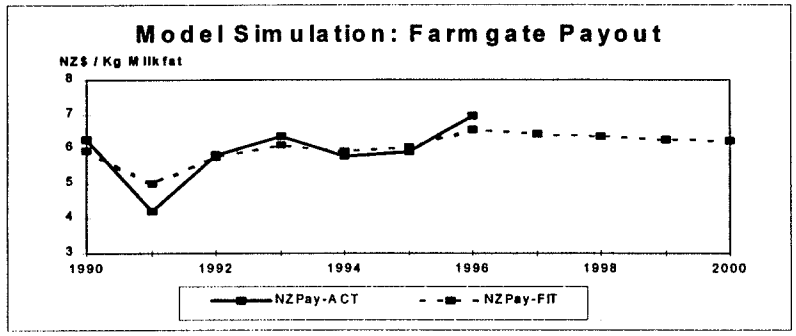


Butter FOB prices fluctuated around US$1400 per cwt during 1990-94 before rising to US$1800 in 1995 and the general pattern of this change is followed by the fitted values. They are forecast to rise gradually from US$1800 in 1996 to about US$2100 in 2000.

New Zealand Farmgate Payout (NZ$ / Kg Milkfat)

Actual farmgate payouts for 1990-96 are compared with the model simulated farmgate payouts in figure 11 and appear to closely track the actual values. The main troughs (1991) and peaks (1993) in payouts have been captured, even though not to the full extent. Forecasts for 1996-2000 suggest a gradual decline in payouts from NZ$6.55 per kg milkfat in 1996 to $6.20 in 2000.

Figure 11:



SUMMARY OF DAIRY MODELLING RESULTS AND IMPLICATIONS

Dairy products are very important export earners for New Zealand, accounting for over 30% of earnings from agricultural exports and up to 20% of overall exports in recent years. The world dairy trade consists of only 5% of global milk production.

World dairy trade, however, is dominated by four main exporters, the EU, the US, Australia and New Zealand, who together account for over 90%. The main importers vary depending on the dairy product. Countries of the Former Soviet Union (FSU) or the Newly Independent States (NIS) have been the main butter importers, while Japan is the main cheese importer and developing countries of North Africa, Central America and the South East Asian region are the main destination for milk powders.

In this study, an econometric model is developed to identify the factors important in explaining the volume of exports of the four main dairy products (butter, cheese, skim milk powder-SMP, and whole milk powder-WMP) by the above four exporters and the volume of imports of three main representative importers for butter, cheese and SMP. Due to the lack of relevant overseas production and trade data for important WMP importing countries (eg, Malaysia) and general paucity of data for all countries in the case of casein, another important high-value dairy product for New Zealand, these are not part of this model at this stage.

These trade volumes along with other relevant related variables, including dairy product stock levels, EU export policy measures, regional economic growth rates and the price of crude oil are used to forecast the international FOB price of the four main dairy products. The relevant FOB prices for New Zealand reported by the NZDB in its International Market Update in US$ per tonne, is related to the international FOB prices reported for Northern Europe in US$ per cwt by the USDA. Finally, the New Zealand FOB prices for dairy products are converted to NZ$ values using the NZ:US exchange rate and are used in a New Zealand farmgate price equation where milkfat prices are explained. The choice of milkfat price rather than the price of milk solids is because the former series is available for a longer period.

The farmgate price for milkfat forecast appear to track the actual prices quite closely, even though both FOB-New Zealand and FOB-International prices for particular dairy products were tracked less closely. This is apparently due to some over-estimation of SMP and cheese fob prices being compensated by some under-estimation of butter and WMP fob prices, for the historical period likely to have been transferred to the forecast period. These limitations in the FOB price estimation are apparently the result of problems encountered in accurately tracking exports of some dairy products from some countries. New Zealand butter and SMP exports are cases in point. Others are SMP exports from the EU and to a lesser extent cheese exports from the US, as evident in the discussion in the model validation section. Mexican SMP imports are also not tracked adequately. All WMP exports were tracked quite well but no major import markets could be studied owing to the lack of relevant production and import data.

Overall, this modelling effort has been beneficial in identifying and evaluating the influence of known major factors which influence dairy product exports and imports and hence the FOB

prices received over the years. With further refinements of individual equations assisted by more consistent data from verified sources, the forecasts from this model can be more useful.

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APPENDIX A

Table 1:

Volume of Dairy Products Manufactured in New Zealand (tonnes)			
	1991/92	1993/94	1995/96
Creamery Butter	217,972	223,513	241,537
Anhydrous Milkfat	43,562	48,904	55,832
Frozen Cream	21	8,697	8,652
Cheese	139,549	193,342	229,086
Wholemilk Powder	250,105	306,448	298,307
Nutritional Products/Infant Food	24,563	26,325	34,869
Skimmilk Powder	136,037	135,953	172,149
Buttermilk Powder	23,402	26,663	29,984
Casein Products	74,205	79,377	79,157
Lactose	25,035	29,847	20,132
Whey Products	12,289	17,826	22,414
GRAND TOTAL	966,342	1,112,577	1,232,790
Source: NZDB			

Table 2:

Total Volume ('000 tonnes) and Value ('$m) of NZ Dairy Exports (June Years)						
Product	1991/92	1991/92	1993/94	1993/94	1995/96	1995/96
	'000 tns	$m	'000 tns	$m	'000 tns	$m
SMP	138	383.1	128	362.6	127	425.7
WMP	259	784.0	306	971.1	278	942.6
Cheese	101	393.3	118	482.1	173	617.4
Casein	71	443.8	78	558.9	72	557.1
Butter	172	578.7	205	683.0	193	703.7

APPENDIX B

Table 1:

PRICE EQUATIONS

NEW ZEALAND (1979-95)															$\bar{R}^2$	F	DW
Average Payout (RNZPay)																	
RNZPay	=	-8.625	+	0.000031 (1.084)	RNZBP	+	0.0013 (1.511)	RNZCP	+	0.0000011 (1.220)	RNZSWP				0.873	28.6**	2.46
									+	0.1093 (1.441)	T						
Butter FOB Price (RBFOBNZ)																	
RBFOBNZ	=	1.405	+	9.135 (6.73**)	RBFOB	+	0.000003 (1.60)	NZUKBTQT							0.858	49.4**	1.75
Cheese FOB Price (RCFOBNZ)																	
RCFOBNZ	=	-0.058	+	10.591 (6.49**)	RCFOB										0.720	42.2**	1.65
SMP FOB Price (RSFOBNZ)																	
RSFOBNZ	=	1.789	+	9.204 (20.8**)	RSFOB										0.964	432.6**	2.42
WMP FOB Price (RWFOBNZ)																	
RWFOBNZ	=	0.827	+	9.333 (13.4**)	RWFOB										0.918	179.4**	1.80

ues in parentheses are t-statistics, with the asterixes (*) representing the level of significance at the 10% (*), 5% (**) and 1% (***) level.

[2] A variation of this farmgate price equation representing dairy product prices in a weighted average form, where export volumes were used as weights, gave better results with respect to t-values.

AMF/Ghee	41	123.2	51	150.6	44	155.6
Other	109	294.4	116	336.0	120	390.1
TOTAL	891	3,000.5	1,002	3,544.3	1,007	3,792.2

Source: NZDB

Table 3:

Key Destinations of NZ Manufactured Dairy Products, 1995/96

Butter	$m	Cheese	$m	WMP	$m	SMP	$m
UK	305	Japan	157	Malaysia	156	Japan	58
Russia	89	Australia	80	Mexico	88	Malaysia	58
Iran	77	Russia	49	Sri Lanka	79	Indonesia	47
Morocco	36	US	48	Peru	74	Taiwan	38
Egypt	16	UK	63	Venezuela	66	Philippines	31
Hong Kong	21	Philippines	25	Brazil	46	Saudi Arabia	29
Netherlands	25	Belgium	23	Thailand	60	Hong Kong	21
Taiwan	16	Chile	16	Taiwan	65	Brazil	12
Belgium	19	Mexico	13	Hong Kong	30	Kuwait	13
Australia	11	Jamaica	12	Cuba	24	United Stated	18
Others	88	Others	132	Others	257	Others	102
TOTAL	704	TOTAL	617	TOTAL	943	TOTAL	426

Source: NZDB

Table 1 (Continued):

B	INTERNATIONAL (1981-95)															$\bar{R}^2$	F	DW
1.	Butter FOB Price (RBFOB)																	
	RBFOB	=	2.05	+	0.00045 (0.614)	TBX	-	0.0087 (-1.964*)	EUBRestn	+	0.00049 (0.544)	NISBM						
							+	1.84 (1.71)	RPCROIL	+	0.65 (2.91**)	DV8182				0.818	13.6**	2.3
2.	Cheese FOB Price (RCFOB)																	
	RCFOB	=	5.30	-	0.0052 (-4.636**)	TCX	-	0.00090 (-1.043)	EUSCS	-	0.0125 (-3.892**)	EUCRestn	+	0.017 (2.99**)	JAPCM	0.805	12.6**	2.1
													+	0.24 (1.69)	DV8182			
3.	SMP FOB Price (RSFOB)																	
	RSFOB	=	1.667	+	0.0004 (1.636*)	TSX	-	0.00041 (-4.588**)	EUSSS	-	0.0113 (-5.023**)	EUSRestn	+	0.00008 (0.123)	MEXSM	0.894	24.6**	1.8
										+	0.057 (2.56**)	EASIA						
4.	WMP FOB Price (RWFOB)																	
	RWFOB	=	2.04	+	0.00023 (0.556)	TWX	+	0.175 (1.04)	DV8182	-	0.011 (-3.19**)	EUWRest				0.637	7.1*	1.7
										+	0.077 (2.13*)	EASIA						

Table 2:

II EXPORT MARKETS

A	BUTTER (1972-95)															$\bar{R}^2$	F	DW
1.	Australia (AUSBX)																	
	AUSBX	=	-209.7	+	0.578 (5.174**)	AUSBQ	-	0.011 (-2.83**)	AUSPOP	+	1.28 (0.052)	AUSUS				0.747	17.9**	2.
							+	3.16 (0.480)	RBFOB(-1)									
2.	United States (USBX)																	
	USBX	=	-630.1	+	0.324 (2.02*)	USBQ	+	0.002 (2.045*)	USPOP	+	14.2 (1.426)	RBFOB(-1)				0.593	12.1**	1.
3.	European Union (EUBX)																	
	EUBX	=	2,635	+	0.466 (2.757**)	EUBQ	-	0.007 (-0.658)	EUPOP	-	516.5 (-2.104**)	EUUS				0.523	7.5**	1.
							-	107.8 (-1.913*)	RBFOB(-1)									
4.	New Zealand (NZBX)																	
	NZBX	=	-132.5	+	0.389 (1.597)	NZBQ	+	0.669 (0.102)	RBFOB(-1)	-	12.4 (-0.656)	NZUS				0.598	9.6**	2.
										+	3.0 (2.41**)	T						

Table 2 (Contd.):

CHEESE (1972-95)												$\bar{R}^2$	F	DW
Australia (AUSCX)														
AUSCX	=	36.2	+	0.551	AUSCQ	-	0.0023	AUSPOP	-	5.9	RCFOB(-1)			
				(3.304**)			(-0.42)			(-1.20)				
									-	13.6	AUSUS	0.813	25.9**	1.71
										(-0.77)				
United States (USCX)														
USCX	=	-12.8	+	0.013	USCQ	+	0.317	USRGDP				0.719	30.5**	1.28
				(7.81**)			(0.645)							
European Union (EUCX)														
EUCX	=	-338	-	0.103	EUCQ	+	0.025	EUPOP	-	39.5	RCFOB(-1)	0.957	128.2**	1.91
				(-4.01**)			(11.6**)			(-2.65**)				
									+	101.6	EUUS			
										(2.19*)				
New Zealand (NZCX)														
NZCX	=	-68.9	+	0.519	NZCQ	-	38.9	NZUS	-	10.9	RCFOB(-1)			
				(3.380**)			(-2.85**)			(-1.77*)				
									+	2.11	T	0.735	16.9**	2.34
										(2.04*)				

Table 2 (Contd.):

SMP (1972-95)												$\bar{R}^2$	F	DW
Australia (AUSSX)														
AUSSX	=	28.9	+	1.30	AUSSQ	-	2.72	AUSRGDP	-	12.6	RSFOB(-1)			
				(5.78**)			(-1.20)			(-1.08)				
									-	69.1	AUSUS	0.753	18.6**	1.47
										(-1.82*)				
United States (USSX)														
USSX	=	-202.0	+	0.623	USSQ	+	2.23	T	-	92.2	RSFOB(-1)			
				(2.88**)			(0.826)			(-2.79**)				
												0.530	9.6**	1.88
European Union (EUSX)														
EUSX	=	663	-	0.097	EUSQ	-	133.1	RSFOB(-1)	-	389.3	EUUS			
				(1.03)			(-2.82**)			(-2.05*)				
									+	0.814	T	0.560	3.1*	1.38
										(0.14)				
New Zealand (NZSX)														
NZSX	=	3.8	+	0.178	NZSQ	+	0.063	NZPOP	-	18.8	RSFOB(-1)			
				(0.63)			(0.68)			(-1.52)				
									-	36.3	NZUS	0.460	1.8	2.08
										(-1.20)				

Table 2 (Contd.):

D	WMP (1980-95)															$\bar{R}^2$	F	DW
1.	Australia (AUSWX)																	
	AUSWX	=	4.11	+	0.687	AUSWQ	-	8.93	AUSUS	-	5.9	RWFOB(-1)						
					(9.89**)			(-0.88)			(-1.567)							
										+	0.15	T				0.936	56.2**	1
											(0.39)							
2.	United States (USWX)																	
	USWX	=	4,585	-	0.209	USWQ	-	106.7	T	+	0.275	RWFOB(-1)						
					(-0.619)			(-3.568**)			(0.03)							
										+	0.62	T^2				0.778	8.9**	2
											(3.69**)							
3.	European Union (EUWX)																	
	EUWX	=	1.666	+	0.503	EUWQ	-	99.4	EUUS	-	21.7	RWFOB(-1)						
					(1.785*)			(-0.822)			(-0.538)							
							-	25.0	T	+	0.101	T^2				0.600	5.5**	2.
								(0.192)			(0.138)							
4.	New Zealand (NZWX)																	
	NZWX	=	676.2	+	1.439	NZWQ	+	30.56	NZUS	+	35.6	RWFOB(-1)						
					(6.998**)			(1.218)			(2.15*)							
										-	10.2	T				0.957	83.8**	2.
											(-2.58*)							

Table 3:

III IMPORT MARKETS (1972-95)

																$\bar{R}^2$	F	DW
1.	BUTTER - NEWLY INDEPENDENT STATES (NISBM)																	
	NISBM	=	-9,121	-	0.079	NISBQ	+	0.087	NISPOP	+	36.1	RBFOB(-1)				0.723	13.0**	2.03
					(-0.663)			(2.346**)			(0.857)							
							-	0.167	DVSUBK	-	172.2	T						
								(-1.954*)			(-2.007*)							
2.	CHEESE - JAPAN (JAPCM)																	
	JAPCM	=	3.58	-	1.244	JAPCQ	-	0.00493	JAPPOP	+	7.5	RCFOB(-1)				0.969	144.1**	1.84
					(-1.949*)			(-3.746**)			(2.41**)							
							-	0.191	JAPUS	+	8.551	T						
								(-3.264**)			(5.033**)							
3.	SMP - MEXICO (MEXSM)																	
	MEXSM	=	-661.6	-	5.140	MEXSQ	+	17925	MGP	+	3.65	RSFOB(-1)				0.584	5.3*	2.47
					(-1.407)			(1.144)			(0.168)							
							+	3.97	MEXUS	+	9.803	T						
								(0.21)			(2.495**)							

CONTRIBUTED PAPERS:

RESOURCES

WHY PROTECT HIGH CLASS (ELITE) SOILS?

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The following are the views of the author, and not necessarily those of MAF Policy.

1. Background

Discussion rages throughout the country about the protection of soils from subdivision. It seems to lack direction and cohesion. Deep down, as fundamentally agriculturalists, most of us would probably like to fling up our arms and say "stop destroying farmland". However, as economists we may see issues of efficiency and long term benefit to the nation as being compromised by this approach.

There seems to be several components to the debate which should be recognised individually:

- why should high class (elite) soils be protected?
- Can the Resource Management Act 1991(RMA) be used to protect elite soils?
- Are the methods proposed in District and Regional Councils plans likely to achieve the community's goals, and what is the cost?

In this paper, I will focus on the first component, while raising some points relevant to the third later on. I hope some discussion will develop which will lead to some focussing of the agricultural economics profession on how best to help the communities grappling with this issue, so that the most appropriate policies can be implemented to achieve the community's goals.

2. Potential Misunderstandings

As professional researchers and facilitators, we must ensure that we not only understand the differences in terms ourselves, but that we communicate these to our audience in such a way that they can also grasp the subtle differences. This may take considerable time and effort, but is necessary if the research findings and policy options are to be effective.

A distinction needs to be made between "urbanisation" and "subdivision". Urbanisation results in (arguably) **irreversible** loss of land from primary production. Subdivision, on the other hand, can and does result in loss from primary productive uses, but not irreversibly. A change in circumstances of the owner can lead to reactivation of the land's productive capability. However, many continue to associate small blocks with permanent loss of productive soils. (Indeed, it could be argued that urbanisation still allows some primary production in the form of vegetable gardens, and therefore the only land truly lost from primary production is that covered by asphalt, buildings and infrastructure. Of course, some of these may be glasshouses...).

Further confusion arises when one extends productive use to include non-food producing activities. The utility value of houses may be higher than the productive value of the land foregone if these could be measured on an equal basis.

Recent research has confirmed that there are problems in defining what is efficient use of land. The Western Bay of Plenty study (Western Bay of Plenty and MAF Policy, 1996) concluded that, when lot size is allowed to be determined by more market-led influences, land subdivided into smaller than 2ha blocks was more likely to be taken out of primary production. However, the total production (by value) from the area subdivided into <2ha blocks actually increased by 15% following subdivision. This was due to the very intensive use of some of these blocks for flower production.

On the other hand, many traditional farms are dependent on off-farm income to provide sufficient income to meet their commitments. A survey undertaken of the 1992/93 financial year found that 50% of farms surveyed have off-farm income from off-farm work (Rhodes and Journeaux 1995). From the evidence presented in these two studies, it is becoming more difficult to define what is a lifestyle block and what is an economic unit.

3. What Are High Class (Elite) Soils?

The definition of high class (elite) soils has in itself created some debate, which I will not add to here. However, it would be generally accepted that the soils most deserving of protection from urbanisation in a particular region are those which have the widest range of food/fibre production possibilities, are the most versatile, with the least inputs required and the fewest environmental effects from intensive productive use. There is no doubt that better soils produce a wider range of food and crops more efficiently in terms of physical inputs and outputs, and also that they are a finite resource. A relatively higher proportion are likely to be close to cities and towns, since the food producing capability of the soil was usually one of the main reasons why the town was established in the area in the first place, along with access and transport considerations.

To help give an idea of the scale of the issue, "high class" or "elite" soils are defined as those which are Class I or II under the Land Use Capability (LUC) classification developed by the Ministry of Works and Development. These are soils which are suitable for continuous arable use with no (Class I) or few (Class II) limitations. There are several recognised limitations to the use of the LUC system, given changes to farming technology over recent years, and newer systems are being developed related more closely to intended use. However, as there is no other nationally based system in use, the LUC serves to illustrate the point.

There are about 1,398,000ha of Class I and II soils in NZ (5.2% of total land area, or 10.% of farmed land). Of this, 293,600ha (21%) is in Canterbury. Of this, 10,391ha (3.5% of Canterbury's Class I and II) is within the Christchurch City boundary, of which 8612ha (2.9% of Canterbury's) remains in rural uses at present.

4. Why do Some Wish to Protect Elite Soils?

From observation, it appears that the six main reasons people have for objecting to subdivision are:

- to preserve future production options;
- to preserve a finite, unique and relatively scarce resource;
- the cumulative effects of setting a precedent;
- to preserve the right of present farmers to carry out farm activities;
- to preserve wide open spaces;
- to control the infrastructural costs of urban development.

While each reason has a component related to the loss of elite soil by covering with structures and asphalt, and another component relating to the formation of smaller parcels of land, the last three reasons relate more directly to the rural/urban interface, ie spray drift, noise, odours, landscape, etc. They are not related to soil type perse. The first three reasons are the most relevant to the debate on the loss of elite soils to urbanisation, and are discussed below.

4.1 To Preserve Future Options

Some people feel that the options of future generations will be compromised if soils are irreversibly lost from use for primary production. There appear to be two components to this:

- that the world will not be able to feed its people, and so losses of land to urban use must be minimised for the sake of world food security;
- that market forces will increasingly be allowed to operate in world markets, so that our natural competitive advantage in primary production will be able to be exploited, and the relative profitability of primary production in New Zealand will improve.

Is the world going to run out of food? Some research of various publications shows a variety of views. Some say there is potentially more than enough land which could produce food to meet the demands for the foreseeable future, and that improvements in crops and management will provide the solution, as they have in the past (FAO,1995; Fischer 1997; Spedding 1996). With wheat yields averaging around 1.5t/ha in non-OECD countries, about 2-2.5t/ha in USA and Canada, and 5.5t/ha in Europe (OECD, 1996), there is considerable potential to improve yields. As well, 100 million ha of currently unused land, rainfed and suitable for cropping, have been identified in Sub-Saharan Africa and South America (Fischer 1997, quoting IFPRI estimates). Others have evidence that suggests the current systems of farming are environmentally unsustainable, especially in regard to irrigation developments (Brown, 1996; Heiler, 1996), and that the time frame in which to increase food supply is too short for demand to be met from developing countries.

NZ is a net exporter of food, and will continue to be so in the reasonably foreseeable future. Therefore, we do feed some of the world (mostly the overfed few), and can be self sufficient in food if the need arose. However, we are small players in total world production of almost all products. The worlds population continues to increase, albeit at a slower rate than over the last two decades, and is expected to reach 8 billion in 2020 (Fischer 1997, from UN projections) and 10 billion by 2050, while levels of grain stocks are at their lowest for many years. Adverse climatic events have already caused large but temporary increases in grain prices. It remains to be seen whether this will translate into rising general food prices in the medium term. On the other hand, development and acceptance of biotechnology techniques may herald another "green revolution", and the historic trend of reducing food prices may continue.

4.2 To Preserve a Finite, Unique and Relatively Scarce Resource

Some people believe that elite soils are a national resource in themselves, much like areas of native bush, and should be protected from being covered by concrete and asphalt. At what point does the soil resource cease to be a resource? When it doesn't exist, or when it can't be used for the purpose which makes it a valuable resource? It is still there, under the asphalt, and also supports botanical life in lush, well-cared for gardens which may add more to the nation's well-being than paddocks of carrots, if this could be valued on a similar basis. Perhaps setting aside an area from urban development as a reserve of elite soils would meet the community's needs.

4.3 Cumulative Loss of Elite Soils

The thought of the cumulative loss of small parcels of land to urban use becomes increasingly less palatable for some people. However, the justification for the protection of elite soils based on world food security is not altered, since NZ's food production has little effect on world food supply. Likewise, while future options may be compromised for each piece of land lost from primary production, is this likely to be significant? What is the likelihood of significant areas of elite soils being lost to subdivision in the reasonably foreseeable future when Canterbury, for example, has an area of elite soils equivalent to 12 Christchurch cities?

The Christchurch City Council (Ivan Thompson per com) estimates that 600ha of new, or "greenfield", urban development will be required in the next 20 years, based on a population increase of about 40,000. About 8300ha of elite soils (as defined by the Horticultural Versatility system class V1 and V2) are in non-urban use within the city boundary, so the loss of versatile soils is likely to be only a small percentage of the region's total supply in the foreseeable future. The rate of loss perhaps needs to be kept in perspective.

From the CCC Officer's report on the proposed city plan, if all Christchurch City's Class I and II soils were urbanised, about 3% of Canterbury's (and 0.6% of NZ's) high class soils would be lost, but 200,000 people could be housed at current population densities.

However, in relation to the other reasons for objection to subdivision, the cumulative effects on landscape values (loss of wide open spaces) and the right to continue existing farming practices are likely to be more significant. This needs to be recognised as an effect of subdivision, and needs to be addressed in a different way to the protection of elite soils.

5. Discussion of Reasons

The jury is out on whether the world can in fact supply enough to feed itself, and what will happen to food prices. In relation to protecting elite soils in New Zealand, there are two other issues which should also be taken into account.

One is that it is most likely to be profitability of the intended use (not only in dollars, but also including intangibles such as lifestyle), rather than productivity perse, that determines the use to which a piece of land will be put. Included in the profitability equation is the price of land, which appears to be influenced more by the location of the land to towns or cities than the soil type.

Also, it should be remembered that food production is "transportable", so that it will be relocated to more profitable areas, perhaps on relatively poorer soils, and will itself displace activities of lower profitability. This process is continually occurring. At present, the effect of removing land around Christchurch from horticultural production is not to reduce the production of vegetables, but for horticulture to displace traditional arable crops further out of town. In turn, traditional sheep and beef production has been replaced with cereal crops in other parts of Canterbury. A similar phenomenon has happened with dairy production relocating from areas with high land prices (Brooks, 1996).

Area in Horticulture (Ha)	1991	1994
Christchurch City	2 503	2 414
Selwyn District	3 571	3 847
Waimakariri District	754	1 254
Ashburton District	1 905	1 870
Total Canterbury Region	**11 589**	**12 047**

Given these uncertainties, how much emphasis should be given to the maintenance of intergenerational equity? Resources which are highly valued today may have little value in the future. If those who predict world food supply will continue to outstrip consumption turn out to be correct, and real food prices continue their long term downward trend, will the future generations of those who have paid the price for that protection thank our society? Of course, the reverse may be true, in which case the present generation will be thought of as visionary for protecting as much of the best soils as possible.

6. Are the Current Methods Used to Protect Elite Soils Appropriate?

Many councils have transferred the Town and Country Planning Act approach into their proposed plans, perhaps because it is easy to administer and provides some certainty and continuity during the process. In a recent survey, 15 out of 17 Councils surveyed have continued with the minimum lot size approach (Wharfe 1997).

Observation suggests than restricting subdivision through minimum areas and zones has achieved the desired protection of elite soils from **urbanisation**, but has removed them from **production**. If this is so, have these policies really achieved what people wanted? What has been the cost to NZ as a whole? A recent study looked at the effects on the inflation rate, and therefore interest and exchange rates, of the implementation of the RMA in the Auckland area, and found that :

"Had housing prices been in line with CPI then inflation would have been only about half what has been recorded and the Reserve Bank would have been comfortably within its target band, and there would have been no need to maintain such a tight monetary regime in recent months."
(McShane 1996, pg 8)

Since rises in construction costs have not been as large as house price rises would indicate, an explanation of the sharp rise in land prices is required. The report found there is no real shortage of **land** in the Auckland region, but that a regulatory environment has been introduced which has deliberately set out to create a **shortage of available building sites**. Demand factors such as immigration, speculation, or investment, coupled with restrictions in supply of building sites, leads to an increase in prices of all land and existing housing.

A study in Hawaii (Ferguson & Khan 1992)examined land use competition between agriculture and housing on the island of Oahu. *Results indicate severe trade-offs for affordable housing if all high-quality farmlands are strictly preserved.*

McShane (1996) states "It would appear that the intention of the RMA was to protect soil as a natural resource, but by a process of argument which draws on other sections of the Act regarding the efficient use of resources, (arguments which may or may not be legitimate) this need to safeguard the life supporting capacity of **soil as a resource** has been translated into a need to protect **traditional farming as a use**."

There are many papers which discuss the inefficiencies in resource allocation which result from the main methods used to protect elite soils, ie minimum lot sizes and zoning (Clough, O'Neil 1994, Musgrave 1986). These methods usually involve transfer to a greater or lesser extent of the landholders property rights (ie the right to sell land for any end use) to the community. Musgrave (1986) described the situation in New South Wales, highlighting the same concerns as NZ communities are indicating about food security, scarcity of good soils, etc, and pointing out that, while farmers may also benefit from zoning, their loss in asset values is likely to far exceed their gain.

Undistorted land markets will promote farm sizes capable of supporting efficient, sustainable production. History, he contends, shows the inability of bureaucrats to plan optimal farm size (and use), and could be blamed for the current crisis where there are a large number of uneconomic farm units, and few options. The process does not recognise sufficiently that farming is continually changing. Government (both local and national) should be promoting flexibility in all markets and helping information flow.

It appears that the Resource Management Act does provide a vehicle for the protection of elite soils. Section 32 provides the opportunity to analyse the costs and benefits in their broadest sense of proposed policies. Continued development of the principles behind the "Cascade of Effects" may provide the framework for such analyses.

7. Conclusion

There is considerable debate on the issue of the protection of soils from being permanently lost from production. The issue is made up of many components which are often mixed up and confused.

There is a need to clarify why people want to protect soils. If it turns out that the real reason's are more to do with landscape values and the right-to-farm, then perhaps there are more appropriate policy instruments than those designed to protect soils.

The challenge is to establish the facts, and to present practical methods of achieving the objectives, along with the implications of doing so. Policy makers, decision makers and the public need to be informed of and understand these implications, along with alternatives, and to debate the costs and benefits within the principles of section 32 of the RMA. The agricultural and resource economics profession has a huge role to play in this.

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Weighting A Soil and Vegetation Self Assessment Scale: Results of a Conjoint Analysis

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Abstract

Environmental management requires that people can identify and follow long term trends in resource condition on agricultural properties. It is intended that monitoring of resources will be carried out by Regional Councils as part of their RMA (1991) responsibilities, but land owners themselves would also like to be aware of resource changes. Self Assessment Resource Scales are intended to provide a means for land owners to document the state of resource condition on their own properties. The scales for soil and vegetation condition were developed to be two of these. The scales were based upon observations that many land owners already make while carrying out common farming activities. To develop the indicators three focus groups of farmers held three meetings each and used field exercises to ensure the indicators were kept practical. A total of 13-16 indicators of resource condition were made into a questionnaire to be made available to land owners. In the questionnaire the indicators were linked into an index using weightings related to socially desired norms for resource standards. The weightings were developed in a separate workshop with six people from a number of Regional Councils. Each person in the weightings workshop was asked to rate a series of cards representing different farm areas in different states of resource condition. The ratings were to represent how sustainable each of the different examples were. Following the workshop, a conjoint analysis was carried out of the results. The analysis calculated the strength of relationships between the indicator assessments and the card ratings. The conjoint analysis modelled the decision making process quite well, but the results of some indicators showed significant differences between people within the group.

The results of the conjoint analysis have been used to provide weightings in soil and vegetation scales currently being tested by a number of land owners and farming groups.

Introduction

Sustainable farming has been a popular topic for a number of years now with a wide range of definitions being used (Hannam I, 1991). Workshops have been held with farmers in 3 regions of the Waikato to develop an operational definition of "sustainable farming" (Parminter et.al., 1994). In all the workshops the concept of "sustainable farming" included concepts about achieving clean water, productive vegetation, productive soils, contented animals, and efficient animals.

In many ways sustainable farming was considered to be a continuum with no fixed end point. However farmers wanted to be able to 'take stock' and then include any future resource needs in their planning. Developing tools for monitoring the natural resource components of sustainable farming was the aim of this research study. The paper covers the productive vegetation and productive soil indexes and how a conjoint analysis was used to give weightings to indicators for then combining into an index.

To produce indicators for monitoring farm performance three focus groups of farmers were set up in different regions, Waikato, Manawatu and Canterbury. Using focus groups enabled the researchers to base their indicators upon existing farmer experience. It made sure that the terminology used was understood by farmers or new terms clearly defined. It also ensured that they would not require specialist skills or equipment, and could be completed as part of general farming activities. The groups were able to identify common indicator categories consistent to monitoring resource condition in all three regions.

The stages the groups went through were:

- Selection of indicators based upon (but not exclusive too) an extensive list with which they were provided. The list came from previous work with farmers, from a number of sources (eg Parminter et al, 1994). The indicators the farmers decided upon were those that they said they had used to assess physical resource condition on their properties. The farmers also decided how many increments they wanted to use within each indicator and the most appropriate terminology to define each increment level.
- Following this, the collated information was put into a questionnaire form for all group members to test by using on their property.
- A literature review was carried out by the researchers to provide supporting information on each indicator and a section on practical management options. At all stages the material was tested in the field by the focus groups
- Once the questionnaire had been developed, other science technical staff were asked to identify any errors or omissions, and make general suggestions. Any non-farmer changes were assessed by the farmers before they were included.
- For each resource in the study the indicators were linked together into an index using weights related to socially desired norms of resource standard. Workshops with policy agents were used to determine the weights. These workshops are documented in detail within this paper.
- At this stage the Self Assessment Scales have been supplied to land owners and farmer groups outside of the original focus group members. These people have been asked to use them and provide feedback, before final modifications are made to the Self Assessment Scales.

Background

The study of resource scales is intended to develop a means for land owners to assess resource condition by themselves whilst they are carrying out other farming activities such as moving livestock. The scales are based upon observations that many farmer land owners already make as part of their general farm management

Methods

A workshop process was used to identify respondent's preferences for various states of natural resource condition and from which component indicators could be weighted. Although the indicators being studied had been developed from common farmer practice, the farmers in the focus groups wanted their results to be consistent with the evaluation of resource condition made by regional council staff. Selected regional council staff were therefore approached to participate in the workshop.

A conjoint method was used to evaluate the results because it:

- allowed the respondents to participate as independent operators
- related components of their decisions to their overall decisions
- could handle the large number of variables involved, even with a low number of respondents

Workshop

On the 7 November 1996, a workshop was held to determine the index weights for the vegetation and soil indices. In total, there were six participants - five experienced staff from Regional Councils, in Auckland, Hawke's Bay, Otago, and Taranaki. One soil scientist previously associated with the project also attended. At the workshop, respondents were asked to score two series of cards (42 in each) based upon the Self Assessment Scales for vegetation and soil. So that they were familiar with the Self Assessment Scales, each respondent first used the scales to assess field examples before the workshop started. The cards provided at the workshop each represented different examples of soil and vegetation states. Each example was described on the cards using indicator levels from the scales. The different respondents assessed comparable card examples. They were asked to score each card based upon how sustainable the soils, or persistent the vegetation states were deduced to be under typical sheep and beef management. Respondents marked their scores on a sliding one-to-twenty scale at the top of each card. Respondents only had the information provided on each card (eleven to thirteen indicators of resource condition) as the basis for making their assessment. An example of the cards that were used is shown in Appendix A. On the cards the state of the indicators for each example is shown descriptively (as described in the Self Assessment Scales) and visually by a group of columns. The highest columns relate to that example and shows where in the range of possible indicator levels that example lies.

Conjoint analysis

Following the workshop, a conjoint analysis was carried out of the results. Conjoint analyses have been used in marketing to provide a quantitative estimate of how the features of a number of products affect people's decisions to use them (Montgomery, 1985). In the analyses the ranges of levels for all features are normalised and converted to utilities and from these a function determined that calculates likely product use. The main requirement for conjoint analyses are that the utility of the product is equal to the sum of the utilities for each of its features. A conjoint analysis would therefore not be considered suitable if there were significant interactions occurring between product features.

In this study, Bretton Clarke Conjoint Analyser© software (1992) was used. A resource assessment score (1-20) provided the equivalent of a product rating and the resource condition indicators replaced product features. Otherwise all the other program functions were kept unchanged. Results from the respondents were averaged to obtain a group utility function, and the results checked against individual utility functions to identify any aggregation errors. The group utility function was used to determine the weighting for each level in each indicator. Weightings represent the additive contribution of each level to the final resource condition assessment made by the group of respondents.

Respondents were also asked to identify the preferred order of levels within the indicator scales and the results compared to the order in the conjoint analysis results. This was intended to identify and correct any problems in ordering that might have been created by the large number of indicators that respondents were assessing.

Results

Soil Indicators

In table one are the calculated relative importance of each of the soil indicators. Relative importance was used to describe how much each of the indicators contributed to the scores of the soil cards. An average relative importance[1] of each indicator is calculated from the group's results. From the table, it is apparent that soil fertility, soil damage, compaction, depth of topsoil, and soil aggregates, contributed a lot to respondents' card scores.

Overall, the conjoint model appeared to represent the decision making process of the group quite well (Rsquare of 0.8 for soil and similarly vegetation). The relative importance of each soil indicator, for each of the respondents, was totalled and compared to the average for the group. The results of two indicators show significant differences between people within the group as identified in the table. These indicators together contributed to almost 20% of the final resource condition score. They represent important differences between people in the group over how much their resource assessments were affected by variation in these indicators.

Table 1. The Relative Importance of Soil Indicators

Number of Respondents: Six (6)
Average Adjusted Rsquare = 0.768 (Standard Error = 0.07)

Indicator	Relative Importance (%)	Within Group Differences
Soil Damage	11.8	
Depth of Top-Soil	8.2	
Colour of Sub-Soil	5.5	
Depth to Parent Material	6.5	
Size of Soil Aggregates	8.7	
Drainage	7.4	
Drought	7.2	
Compaction	9.5	
Soil Fertility	11.4	***
Plant Roots	6.9	
Earthworms	7.2	***
Organic Matter Breakdown	5.2	
Soil Pests	4.4	

*** significant differences (at the 95% level) exist between group members and the group mean for the relative importance given these indicators

In table 2 the weightings for each level of each indicator are shown. The conjoint analysis resulted in the most sustainable soils being those with: no apparent soil damage from erosion, loose uncompacted soils, and soil fertility unlimiting.

[1]The term relative importance (RI) is used in the analysis as a measure of the contribution of that indicator to the final card score. RI is dependent upon the importance of each indicator and its range. Therefore even if two indicators have the same decision making importance the one with the greatest range will have the largest RI. In this application of conjoint analysis, most of the indicators had a similar range of between 3 and 4 units, therefore the RI is mostly determined by the importance of that indicator to the final card score.

Table 2. Weightings for Each Level of the Soil Indicators

Indicator	Degree of preference: Most			Least
Soil Damage		none 39	little 36	lot 0
Depth of Top-Soil (cm)		11+ 14	6-10 13	0-5 0
Colour of Sub-Soil	black 14	brown 8	yellow 5	grey 0
Depth to Parent Material (m)		1.1+ 23	0.6-1.0 15	0-0.5 0
Size of Soil Aggregates (cm)	0.6-2 14	0-0.5 1	3-6 1	7+ 0
Drainage		well 12	imperfect 3	poor 0
Drought		rare 23	occasionally 16	usually 0
Compaction		loose 33	lumpy 27	tight 0
Soil Fertility	unlimited 42	generally sufficient 26	sometimes deficient 22	limiting 0
Plant Roots	deep and well developed 13	deep 13	shallow 8	shallow and poorly developed 0
Earthworms		11+ 14	4-10 2	0-3 0
Organic Matter Breakdown		rapid 9	slow 1	very slow 0
Soil Pests		none 10	little 5	lot 0

Vegetation Results

Table three shows the relative importance of the vegetation indicators associated with changes in the card scores. From the table it is apparent that bare ground, legumes, and high fertility grasses played large parts in the respondents' card scores.

From other calculations it is known that two (of five) respondents evaluated a number of indicators in a different way to the others. The differences in the relative importance of all three indicators appear to represent a genuine difference in the decision making process regarding those indicators, rather than a different interpretation of what the indicators might mean. The indicators concerned made a minor contribution (15%) to the card scoring, and I have used the data from all respondents in further analyses.

In table four the weightings for each level of each indicator are shown. In the analysis, the areas with the most sustainable (persistent) vegetation are those with: a lot of legumes, a lot of high

Table 3. The Relative Importance of Vegetation Indicators

Number of Respondents: Five (5)

Average Adjusted Rsquare = 0.808 (Standard Error = 0.153)

Indicator	Relative importance (%)	Differences
Pasture Height	5.1	***
Pasture Density	11.9	
Pasture Colour	7.3	
Weedyness	5.1	***
Presence of Noxious Weeds	2.6	
Pasture Leafiness	5.1	***
Amount of Trees	5.8	
Amount of Legumes	17.9	
Grasses - High Fertility	14.6	
Grasses - Low Fertility	6.3	
Bare Ground	18.4	

*** significant differences (at the 95% level) exist between group members for the relative importance given these indicators

Table 4. Weightings for Levels for Vegetation Indicators

Indicator	Degree of preference: Most			Least
Pasture Height (cm)	6-10 7	11-20 6	0-5 2	20+ 0
Pasture Density	dense and prostrate 14	dense and upright 6	open and prostrate 5	open and upright 0
Pasture Colour	dark green 11	light green 5	yellow 0	brown 0
Weedyness		low 7	moderate 2	high 0
Noxious Weeds			not present 6	present 0
Pasture Leafiness		high 5	moderate 3	low 0
Trees	a lot 6	some 4	none or very little 2	too much 0
Legumes	a lot 50	plenty 43	some 19	very little 0
Grasses-high producing	a lot 29	plenty 28	some 2	very little 0
Grasses-low producing	plenty 7	some 5	very little 2	a lot 0
Bare Ground	very little 42	some 37	plenty 3	a lot 0

Discussion

Significant Indicators

The field assessment of the condition of agricultural soils by experienced regional council staff depended mainly upon their evaluations of: soil fertility, soil damage, compaction, depth of topsoil, and soil aggregates. The results of these indicators influenced 50% of their final scores. The highest weightings for soil indicators were given to: no apparent soil damage from erosion, loose uncompacted soils, and soil fertility unlimiting. These results are consistent with the components of productive soils previously identified by other farmers in the Waikato (Parminter et al, 1993). They are also consistent with management practices for resource management identified at another workshop involving scientists (Parminter et al, 1994). At the latter workshop the scientists suggested that it was important that farmers should be: controlling the mass movement of soil, avoiding compaction of vulnerable soils, and managing a nutrient balance.

Integrative Indicators

During the workshop to assess the cards, the respondents developed their own processes for examining and scoring them. The respondents described how they used 2-3 of the most important indicators to carry out a primary sorting of them into high, medium, or low resource status. Then they examined the cards in each of these categories, and using 2-3 additional indicators did their final sorting and scoring. The respondents used these approaches to reduce the complexity of the task of evaluating resource condition based upon up to thirteen indicators. Some researchers other than ourselves (eg Romig et al, 1996), have developed even larger numbers of indicators to be included in farmer resource assessment. The experience of this study is that more research should be carried out into indicators that integrate a number of components for assessing resource condition In this way the assessment burden can be kept to a practical level for observers.

It will be useful for researchers to examine the potential use of soil fertility, soil compaction, soil damage, legumes, high fertility grasses, and bare ground as integrative indicators. Production of pasture (usually measured in dry matter) is another indicator that some farmers are experienced and calibrated at observing. Although the farmers in this study did not include pasture production as an indicator of sustainability (associating it more with productivity), it too may be a useful integrative indicator.

Setting Priorities

The Self Assessment Scales use weightings to combine the results of several indicators into an index. The index simplifies the task for property owners of combining a range of indicators that may be only weakly linked directly. The index integrates indicator results in such a way that land owners can readily identify which indicators should be improved. From the results farmers can identify the need for more objective tests or management changes.

Example of Using and Interpreting the Self Assessment Scales

In this example the farmer has a block of land that he has been monitoring over a number of years. In the last couple of years his index has shown two sharp drops. On looking at why the index is dropping, the farmer in this example realises that it is because his soil is becoming more compacted. The compaction is resulting in poorer drainage, shallower rooting plants and so reduced availability of nutrients. The example farmer is aware that in the last two years this block has been seriously pugged over winter by grazing cattle.

Table 5. Example Use of the Soil Index

Indicator	Indicator Levels				Potential Score	Actual Score
Soil Damage		none	little	lot	39	39
		✔				
Depth of Top-Soil		11+	6-10	0-5	14	14
		✔				
Colour of Sub-Soil	black	brown	yellow	grey	14	14
	✔					
Depth to Parent Material		1.1+	0.6-1.0	0-0.5	23	23
		✔				
Size of Soil Aggregates (cm)	0.6-2	0-0.5	3-6	7+	14	1
			✔			
Drainage		well	imperfect	poor	12	3
			✔			
Drought		rare	occasionally	usually	23	23
		✔				
Compaction		loose	lumpy	tight	33	27
			✔			
Soil Fertility	unlimited	generally sufficient	sometimes deficient	limiting	42	26
		✔				
Plant Roots	deep and well developed	deep	shallow	shallow and poorly developed	13	8
			✔			
Earthworms		11+	4-10	0-3	14	2
			✔			
Organic Matter Breakdown		rapid	slow	very slow	9	9
		✔				
Soil Pests		none	little	lot	10	10
		✔				
Index Total					**260**	**199**

He knows that this will be starting to affect his production. Therefore the farmer resolves to graze his cattle on a different area and use this block for his young stock.

Conclusions

Linking Farmers , Policy Makers, and Scientists

The Self Assessment Scales combine the experience and knowledge of farmers, and the experience and knowledge of regional council land managers. Using them can provide a basis for both parties, identifying areas of common ground in resource assessment and priority setting. They have not been compared to, or combined with alternative means of assessing resource status based upon indicators from scientific research. Therefore there has been no measure of how well the indexes achieve their aims of improving soil and vegetation sustainability. This will be the focus of future research.

Establishing Records of Observations

The Self Assessment Scales have helped farmers to make more objective observations of resource indicators. By combining their results into an index, farmers are provided with a guide for deciding how much priority they should be giving to resource monitoring and management. The use of the Scales has encouraged farmers to establish a permanent recording system and reflect on changes to the condition of their resources on a regular basis.

Heightened Resource Awareness

The development of the Self Assessment Scales has been based upon farmer knowledge and experience. However not all farmers were aware of how other farmers assess resource condition. The information included in the Self Assessment Scales has raised the awareness of some property managers in indicators they have not been very familiar with. Using the scales is intended to be informative and some farmers have used them to discover for themselves the inter-relationships and ecological sensitivity the scales highlight.

Social Consensus

Regional resource management requires social consensus. As an alternative to the weightings used in the index developed in this study, property owners can vary the weightings in an index and customise the results to their own goals in much the same way as animal breeders can vary their weightings for breeding indexes. When a number of property owners agree on which weightings to use, the Self Assessment Scale indexes can become a way of developing and communicating social consensus.

Further Development of the Indicators

Some regional variation (eg the presence of peat soils) has already been accounted for in the Self Assessment Scales. Further development should ensure that more geographical variation can be included. Adapting the scales to include local features can help ensure farmer confidence in using them. Some Regional Councils (eg Otago) are already producing material that can be used by farmers to follow-up assessments made with the Self Assessment Scales. There is also the potential to develop decision support software that will help farmers access supporting management information and assist in making investment priorities.

The differences that showed up within the group about the relative importance of different indicators when assessing resource condition suggest that further research work is needed on land user decision making processes.

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We were also assisted by science staff from AgResearch's Sustainable Hill Land Programme and Farm Systems Group. They readily contributed their time, and adapted their contribution to suit the expectations of the farmers involved.

Other individuals who directly contributed to the study were Steven Orr, Annie Perkins, Jenny Moore, and Moana Petre. However the authors take full responsibility for the material included in this report.

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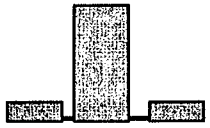
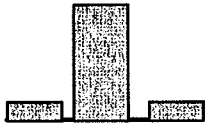
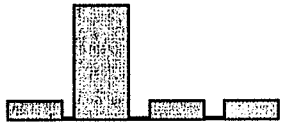
Soil Damage
little



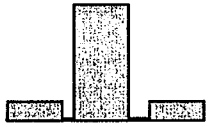
Depth of Topsoil
6-10cm



Colour of Sub-Soil
yellow

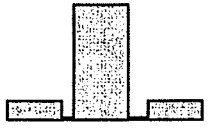


Depth to Parent Material
0.6 - 1.0m



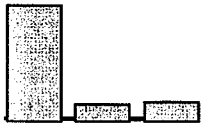
Size of Soil Aggregates
0 - 0.5

Drainage
imperfect

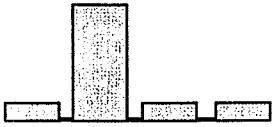


Drought
Usually

Compaction
tight

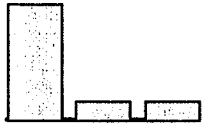


Soil Fertility
sometimes deficient

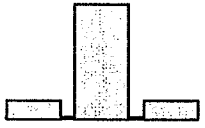


Plant Roots
shallow

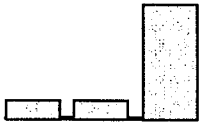
Earthworms
0 - 3



Organic Matter Breakdown
slow



Soil Pests
lot



THE EFFECTS OF SOIL QUALITY ON LAND VALUE

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ABSTRACT

The value of farmland in New Zealand is dependent on many factors, most of which, farmers have little or no control over. This research is an attempt to establish if and to what extent sustainable land management practices are capitalized into land value.

In order to test this objective a framework was established whereby factors which influenced land price but were in no way influenced by farm management practices were removed. These exogenous elements include farm location, soil topography, farm size and farm type.

A scenario analysis approach was adopted using a structured workshop with Manawatu rural valuers and interviews were conducted with several local farmers. From this, hedonic pricing models for land value was estimated. This study revealed that aspects of land quality such as soil fertility, drainage, erosion control and compaction were perceived to be important soil quality characteristics to both rural valuers and farmers. However, because of market factors they may have a limited bearing on the land value of a farm.

INTRODUCTION

The willingness of farmers to sustain or even improve soil quality will be related to the importance they place on soil quality. Surveys show that farmers recognise that using practices associated with improved soil quality will also provide productivity gains (Wilkinson and Cary 1993). One way to identify the importance farmers place on soil quality is to determine whether they would be willing to pay for improved soil quality. Scrimgeour (1995) suggests that soil compaction is an important enough soil quality characteristic for the Manawatu farmers he surveyed to be willing to pay for protection of their soil from compaction (an average of $61/ha per annum).

The question is "to what extent do farmers value soil quality?" If farmers are willing to pay an amount per annum to maintain or improve the quality of their soil then this amount will be capitalised into land prices. Our aim in this research was to develop a methodology to estimate the extent to which selected land quality characteristics are capitalised into land value.

We identified two groups of individuals whose perceptions would assist us in testing this relationship, farmers and rural land valuers. Farmers have a personal involvement with their land, and their assessment of land value may take into account a range of values and perceptions, and these may be different for each farmer. The market is set by the collective decisions of all these farmers. By interviewing a small group of farmers in localised areas we obtained an approximation of the perceptions of a large number of farmers in these areas. To determine the place of soil quality in land value we would have to interview a large number of farmers representing a market for a particular type of farmland. This is our eventual aim, but this piece of exploratory research represents the first step of our project. Therefore, we began by interviewing rural land valuers, who are obliged to assess land value by considering the perceptions of the sellers and potential buyers of pieces of land.

This paper reports some initial findings from interviews conducted with rural valuers in the Manawatu. This step was the first in a study being undertaken by Landcare Research and Massey University which is investigating the relationship between soil quality, land values, and the use of land management practices that maintain or improve soil quality.

RESEARCH METHODOLOGY

Hargreaves (1974) identifies several land quality characteristics, which are important factors when estimating land value, including, topography, farm location, soil type and quality and farm size. However many of these variables are not influenced by farm management practices. Specific attention in this research focuses on aspects of soil quality that can be influenced by farm management practices, and the relationship between the level of these soil quality factors and land value. Hargreaves (1974) used regression analysis in an attempt to explain the relationship between various factors and land value. However, preliminary discussions with land valuers and farmers indicated that, in practise, insufficient variation in observed soil quality factor levels would make regression analysis of actual farm level data an unlikely candidate for achieving the objectives of this research project.

What we required then was a methodology for estimating a hedonic pricing model (Deaton & Muellbauer, 1980):

$$P_g = f(c_i;\pi)$$

Where P_g is the price of the good (land).
C_i is the level of the ith land characteristic (soil quality factor).
π is a vector of the factor weights.

Since, in our judgement, observed data on market or government land values and observed factor (soil quality) levels would not be suitable, we decided to elicit land values associated with different soil quality "scenarios" from land valuers and seek their comments on the approach adopted. This approach has much in common with the method of conjoint measurement, frequently used in human behavioural studies, (for example see Brascamp (1996)).

Luce and Tukey (1964) provided the methodological framework for conjoint analysis measurement. The method originated from the fact that many quantities that one would like to measure and explain do not lend themselves for conventional measurement based on concatenation (the linking together of the quantities). Mathematical psychologists soon adopted Luce and Tukey conjoint measurement axioms. Green and Rao (1971) stated that conjoint measurement is concerned with the joint effects of two of more independent variables on the ordering of a dependent variable, (such as preference rating).

A close relationship exists between conjoint measurement and Analysis of Variance, where variation in the response variable is decomposed to obtain measures of proportions of the variation accounted for by contributions of separate factors. Where the response variable is continuous, conjoint measurement is in fact synonymous with factorial measurement (Brascamp, 1996).

In the case where the dependent variable is the price of a good, and the factors are attributes of the good, the factorial ANOVA model becomes a hedonic pricing model.

The usual problems encountered in conjoint measurement relate to the number of factors, and their levels, which are relevant to explaining variation in the dependent variable. This results in the impracticability of using a complete factorial design to obtain responses. Focus then turns to partial factorial and incomplete block design to measure main effects and selected factor interactions with desired levels of efficiency. However, in this research there appeared to be relatively few soil quality characteristics that could be influenced by farm management practice and, accordingly, the complete factorial arrangement of the 'treatments' could be used.

Development of Study Areas

The next objective was to identify areas within the Manawatu that were as homogeneous as possible in physical land characteristics apart from soil quality factors, for a range of agricultural industries. This allowed a direct comparison of soil quality characteristics between farms within each area. After initial discussions with two valuers we identified three representative areas which were homogenous in land characteristics (apart from differences arising from management practices) and land use. These areas are described below.

Area 1. Opiki

The Opiki area is located 20 km Southwest of Palmerston North. This area is characterised by peat and peat loam soil types and a flat topography with an adequate level of rainfall. The Opiki area is regarded as superior for dairy farming and potato growing. The soil type (peat) has a high organic content. Because of its forgiving nature, unsustainable land management practices may not be as evident as would be the case on soil types of lesser quality.

For the purpose of this study we identified dairy farming as the highest and best land use in the Opiki region. Consultation with six farmers in the Opiki area identified soil fertility and drainage as two of the most important soil quality characteristics under management control.

For each of the soil quality characteristics we developed scenarios which were representative of different levels of soil quality. For example, we defined three levels of fertility (natural, medium and optimal). These levels were defined in terms of pH, Potassium and Phosphate ranges, which were gathered from soil tests obtained from dairy farms in the region. We defined two levels of drainage, natural and optimum. The natural or sub-optimal level of drainage was defined as main drains only. This was considered to be the minimum requirement for dairy farming and considered far from satisfactory by the farmers interviewed.

The optimal level of drainage was identified as being mains and secondary drainage with novaflow tiling. This level of drainage was considered to be preferable by the dairy farmers interviewed in the Opiki area.

Area 2. Pakihikura Valley

This area is located approximately 60 km north of Palmerston North. The highest and best land use in this area is sheep and beef farming. The land is typically hill country with a poor soil type, which makes it prone to erosion in wet conditions. In recent years this area has been subject to considerable erosion damage due to wet conditions and has been under a Manawatu Catchment Board programme to reduce the risk of erosion.

Consultation with six farmers identified soil fertility and erosion control as the key soil quality characteristics in the Pakihikura valley. Again three levels of fertility were identified. From farm soil test in the area, pH and Phosphate levels were obtained which were representative of sheep and beef farm fertility for each of the three levels. We identified two levels of erosion control, no erosion control and with erosion control. This reflected what was seen on farm. Farmers had either valued erosion control, in which case they had planted trees to protect soils from slipping, or they had not.

Area 3. Kairanga Plains

The third area in this study is located 20 km Northwest of Palmerston North. This area is predominantly flat with a free draining silt loam soil. The highest and best land use in this region is mixed cropping with sheep and beef. In this area we identified three important land quality characteristics, soil fertility, drainage and compaction.

Since we identified three key soil quality characteristics in this area we limited the levels of each characteristic to optimal and natural. This was done to ensure that the scenario analysis of this area was not confounded by a complex experimental design. In this area, only optimal and natural levels defined soil fertility. Drainage was defined the same way as in the Opiki area. Soil compaction was defined as being either compacted, in which case half the farm was in crop for one year then grazed the next year (½ yearly rotational cropping) or not compacted (no previous cropping). The latter would be extremely unlikely to find within the area, however this still represents a preferred optimal soil quality situation on the Kairanga Plains.

SCENARIO ANALYSIS

Scenarios were developed to represent the different level of each land quality characteristic in each area. For each of the different land uses, a case study "farm" was developed which fitted into the tables below (represented by a (*)). A land value per hectare was also given to provide a reference point for the valuers.

The case study farm for each of the areas is described in appendices 1-3.

The different levels of soil fertility were also placed in table formats that correspond to the tables for each region. The tables for each of the regions are shown below.

Sheep and Beef

Sheep & Beef		**Fertility**	
	Natural	**Medium**	**Optimum**
No Erosion Control		* LV $1,600/ha	
Erosion Control			

Fertility was defined as follows;

	Natural	Medium	Optimum
pH	4.9-5.2	5.3-5.6	5.7-6.0
olsen P	<10	11-18	>18

Dairy

Dairy		**Fertility**	
	Natural	**Medium**	**Optimum**
Inadequate Drainage (Mains only)			
Adequate Drainage (Mains, secondary, Nova flow		* LV $ 13,000/ha	

Fertility was defined as below;

	Natural	Medium	Optimum
pH	4.9-5.2	5.3-5.6	5.7-6.0
Potassium (K)	<4	5-8	>8
olsen P	20-30	30-40	>40

Cropping

Cropping	Compaction	(½ farm cropped yearly)	No Compaction	(No cropping previously)
	Natural Fertility	Optimum Fertility	Natural Fertility	Optimum Fertility
Inadequate Drainage (Mains only)				
Adequate Drainage (Mains, Secondary, Nova flow/ tiles)				* LV $15,000/ha

In the cropping scenario we did not define the 'natural' and 'optimum' levels of fertility.

To complete the scenarios, a set of photographs was produced for each of the three areas. The pictures were representative of each of the soil quality levels. For example, in the Opiki area, pictures were taken to represent each combination of soil quality, from natural fertility and poor drainage to optimal fertility and adequate drainage, on a dairy farm.

The pictures, case study farm information and tables were presented to the rural valuers and they were asked to place a value ($/ha) on each of the different scenarios. To allow for a degree of consistency the case study farm (and corresponding value ($/ha)) was used to provided a reference point from which to start. Once this was completed, results were collated and the participants discussed the results and the general research approach.

RESULTS AND DISCUSSION

Because this is a preliminary study of the perceptions of rural valuers, these results should be interpreted with caution. To draw definite conclusions a larger sample is obviously required. The analysis of valuer responses is completed for each of the three areas separately. For each of the areas, the main variations in land value are presented.

Dairy farming - Opiki

The data collected from the scenario analysis conducted with the valuers was tested for the main effects of valuers, soil fertility (both linear and quadratic) and drainage and the interaction effects between fertility and drainage. The interaction effects and the quadratic fertility effect were found to be not significant and thus are not included in the analysis.

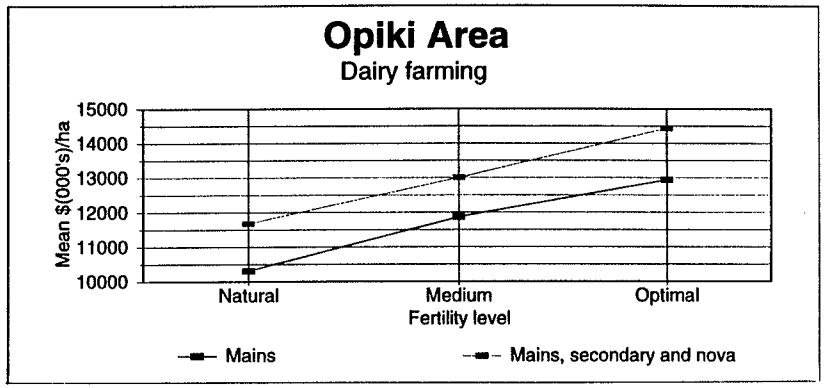
The hedonic pricing model for the dairy farming scenario in the Opiki area, shown below, illustrates the effects of fertility and drainage on land value ($/ha). Keeping all other factors constant, the hedonic pricing model suggests that each increase in the level of fertility increases land value by $1344/ha and an increase in the level of drainage increases the land value by $1334/ha.

$$P_{df} = 12375 + 1344F + 667D$$
$$(387.83) \quad (231.99) \quad (189.41)$$

P_{df} = land value ($/ha)
F = Fertility (-1=natural fertility, 0=medium fertility, 1=optimal fertility)
D = Drainage (-1=Natural Drainage, 1=Optimal Drainage)

Note: Figures in parentheses are estimated standard errors.

Both drainage and fertility appear to be important determinants of land value individually. This is shown in the graph below. Clearly there is a positive linear relationship between land value and soil fertility levels and land value and drainage.



Sheep and Beef – Pakihikura Valley

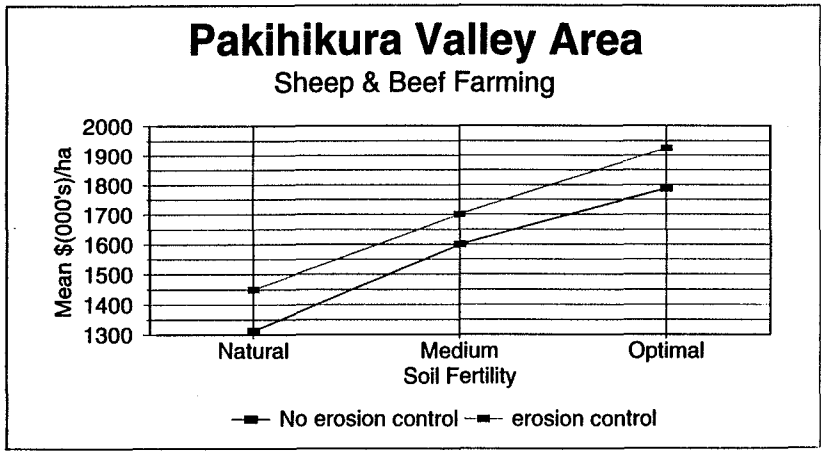
The hedonic pricing model for the sheep and beef farming scenario in the Pakihikura valley area, shown below, clearly demonstrates the effects of fertility and erosion control on land value ($/ha). Again the interaction and quadratic effects were not significant and are omitted. Each increase in the level of fertility increases land value by $238/ha and an increase in the level of erosion control increases the land value by $124/ha. It is evident from this model that the soil quality factor fertility has a greater influence on land value than erosion control factor.

$$P_{de} = 1629 + 238F + 62E$$
$$(65.263) \quad (39.96) \quad (32.63)$$

P_{de} = land value ($/ha)
F = Fertility (-1=natural fertility, 0=medium fertility, 1=optimal fertility)
E = Erosion control (-1=no erosion control, 1=erosion control)

Note: Figures in parentheses are estimated standard errors.

The analysis of the valuer responses from the Pakihikura valley area indicates that soil fertility is a significant factor in the determination of land value. Erosion control is a significant factor but not at the 5% level. The graph below again indicates that soil fertility and land value are positively correlated. The relative closeness of the two lines indicates the smaller effect of erosion control on land value in the Pakihakura valley.



Crop Farming - Kairanga Plains

The hedonic pricing model for crop farming in the Kairanga area shows that all the soil quality characteristics have a bearing on land value. The difference in land value between compacted and non-compacted land (holding all other variables constant) will be $1280/ha, the difference in drained verses non-drained soils will be $1030/ha and the difference in soil quality with optimal and natural levels of fertility will be $906/ha.

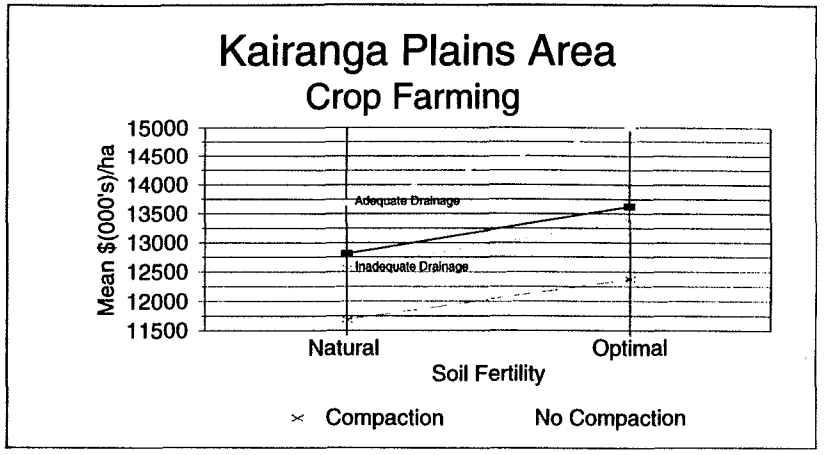
$$P_{cdf} = 13140 + 641C + 516D + 453F$$
$$(245.21)\ (122.60)\ (122.60)\ (122.60)$$

P_{cdf} = land value ($/ha)
C = Compaction (-1=compaction, 1-no compaction)
D = Drainage (-1=inadequate drainage, 1=adequate drainage)
F = Fertility (-1=natural fertility, 1=optimal fertility)

Note: Figures in parentheses are estimated standard errors.

In this situation all three soil quality characteristic appeared to be significant at the 5% level. However it should be noted that the valuer variable was also significant in this analysis. This is the result of one valuer's estimates of land value being significantly different from the others.

The graph below shows the positive relationship between land value and each of the three soil quality characteristics tested in the cropping scenario.



ISSUES RAISED IN THE GROUP DISCUSSION

After the valuation task, the valuers participated in a group discussion, moderated by the researchers. The valuers said that one way to compare the values of properties of different quality was to estimate the costs of improving a property. This included improving the soil quality of a property. However, cost did not necessarily equate with value, and a farm with different types and qualities of land would have all the different land values per hectare averaged out.

The valuers suggested that farmers did a similar exercise when they estimated land values before offering to buy land. However, farmers would not do detailed calculations of these costs. Also, they would factor in their management skills to improve the land up to its productive potential. Because farmers tended to be optimistic about their abilities, they may not take into account the full costs and time delay involved in improving a property. Further, people tended to notice the extremes of soil quality, but not the middle of the range. Thus, although farmers would place some value on soil quality, the premium they would pay for better soil quality may not reflect the full cost of maintaining it. Similarly, farmers would not discount land of lesser soil quality by an amount that reflected the cost of improving it.

Another way the valuers thought farmers assessed land value was by estimating the productive potential of the land. For example, based on the visual characteristics and the productive history of a farm, farmers would value a dairy farm in terms of dollars per kilogram of production, and pastoral land tended to be valued on the basis of its carrying capacity (stock units per hectare). Ultimately, land would be valued in terms of the outputs of production, rather than the inputs. These productivity differences between farms were more important than soil quality differences.

The valuers thought that farmers in different industries place different emphasis on soil quality. Cropping farmers tended to take more notice of soil than livestock farmers, perhaps because they looked at their soil more often. Pastoral farmers tended to assess the quality of soil by looking at the condition of the pasture that was growing on the top of the soil. The valuers noted that dairy farmers were more aware of pasture condition that sheep and beef farmers, perhaps because they are more highly geared to production. As one valuer remarked, "we don't know how to tell the (soil) quality, but we can see the (pasture) condition".

Premiums for soil quality were seen to be market dependent. In a depressed market farmers would devalue poorer properties, but in a buoyant market there would be less price discrimination for soil quality. Soil type was considered to be more important than soil quality in affecting land values. It was difficult to see variations of soil quality within a soil type. Also, soil type influenced the land use and limitations of a soil.

CONCLUSION

Our discussions with farmers confirmed that soil quality characteristics are important. Dairy farmers in the Opiki area fertilise to improve pasture performance and ensure drains are maintained in good condition to reduce pugging. Opiki and Kairanga crop farmers rotate their crops with grass to reduce the effects of disease and compaction. Many Pakihikura sheep and beef farmers have soil erosion programs in place. All suggest that farmers are aware of the effects of poor soil quality. However, it may be the effects on production, rather that the consequences on land value, that are foremost in the minds of farmers.

Despite the fact that only a small number of rural valuers participated in this study, the soil quality characteristics tested were significant at a high level. Both drainage and fertility were significant determinants of land value on dairy farms in the Opiki area. Erosion control and fertility appear to be significant soil quality characteristics on sheep and beef farms. Compaction, fertility and drainage all appear to be important determinants of land value in cropping in the Kairanga area.

The discussion conducted with the rural valuers suggested that the effect of soil quality characteristics on land value will vary, depending on the market conditions and the industry involved. In a buoyant real-estate market, soil quality characteristics may have little influence on land value. Soil quality characteristics are more noticeable, and hence likely to have greater influence on land value, at extremes of the soil qualities. Further, cropping farmers may look at soil conditions more closely that sheep and beef farmers and dairy farmers. Pastoral farmers may tend to assess soil quality in terms of pasture quality. Finally farmers may measure the soil quality characteristics in terms of productive capacity and will factor in their management skills when assessing land value. Overall the survey results indicate that soil quality characteristics are important to consider when determining land value, but their importance is dependent on many other market influences.

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APPENDICES

Appendix 1.

Case Study: Sheep and Beef

Land value ($/ha) : 1,600

Farm type: Sheep and beef is the highest and best land use for this farm.

Location: Pakihikura

Land Size: Total area of this property is 352 hectares.

Soil Types: Pouwhakaura Slit Loam
Managatea Clay Loam Hill Soil
Wilford Silt Loam Hill Soil
Kumeroa Sandy Loam Hill Soil
Turakina Steepland Soil

Topography: the farm is moderately steep rolling hill country with a balanced aspect.

Erosion: Overall the erosion risk on the property is moderate to fair, being prone to slip and slump and gully erosion. Wet winters in the early 1990's caused considerable erosion to approximately one tenth of the farm. Presently there is no program to control erosion on this property.

Soil Test results :

pH	5.6
Phosphate MAF (olsen P)	11

Fertiliser history: Fertiliser application on this farm is rotated, one half the farm receiving 150 kg/ha Super phosphate yearly. This is adequate to sustain current fertility levels.

Appendix 2.

Case Study: Dairy

Land value ($/ha) : 13,000

Farm type: Dairy unit, milking between 185-195 cows.

Location: Opiki

Land Size: 70 hectares

Soil Types: Opiki silt loams

Drainage:
The farm is adequately drained with open drains, both mains and secondary with nova flow.

Soil Test results:

pH		5.4
Phosphate MAF	(olsen P)	36
Potassium (K)		6.5

Fertiliser history:
The fertiliser application on this farm has been sufficient to ensure that present soil test results are maintained.

Production History:
Yearly production varies between 33,000-36,000 kg milk fat total for the farm. This equates to an average milk fat production of 160 kg/milk fat/cow.

Appendix 3.

Case Study: Cropping

Land value ($/ha): 15,000

Farm type: Previously a fattening block, in the first season mixed cropping

Location: Kairanga

Land Size: Total area of this property is 120 hectares.

Soil Types: Kairanga silt loams

Drainage:
Drainage on this farm is good with a mix of open drains (mains and secondary) and nova flow tiles.

Soil Test results :

pH	5.8
Phosphate MAF (olsen P)	38
Potassium (K)	6.4

Fertiliser history:
The fertiliser application on this farm has been sufficient to ensure that present soil test results are maintained.

Production history:
Previous land use was a sheep and beef fattening block with no damage to any of the land.

The Development of Management Guidelines for Sustainable Livestock Farming in the Hawke's Bay

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1.0 Abstract

Regardless of how sustainable land management is defined, it will never be achieved unless land users are involved in, and committed to, its attainment. To commit to a goal of sustainability, stakeholders must share in the identification of resource management problems and in the development of solutions that are both economically and socially acceptable.

Facilitated workshops were held with twelve farmer and two agribusiness groups in the Hawke's Bay during 1994, to involve participants in the development of guidelines for pastoral farming. The farmer workshops were used to develop an operational description of sustainable livestock farming and to identify the main components of sustainability.

The advantages associated with sustainable farming applied to all components of the system, such as the farmer and family, natural resources (the farm), the community and future generations. Through the workshops, the farmers identified the components and criteria that describe sustainable farming. They suggested that sustainable farming may be recognised by practices that result in productive soil, sufficient water quantity, good water quality, productive pasture, appropriate trees, productive animals, and successful, prosperous and flexible farmers. Using the concept pyramid process, farmers identified key management practices that would result in the sustainable use of soil, water, animals and plants in the farming system.

The management practices identified by farmers were written to a set of guidelines, which were circulated for public comment and submission. The workshop participants, stakeholders and the general public were involved in the consultation process, to continue the participatory approach utilised in the workshops.

2.0 Introduction

Since the 1980's, there has been growing acceptance in New Zealand that the involvement of stakeholders in environmental decision-making underwrites the attainment of socially acceptable sustainable land use. To commit to a goal of sustainability, stakeholders must share in the identification of resource management problems and in the development of solutions to these which are both economically and socially acceptable. Involving land users in planning, developing and implementing more sustainable land use systems, leads to the point where they assume responsibility and ownership of this endeavor (Campbell, 1992a; Campbell, 1992b; Wardle 1994).

Agriculture in some form, is the dominant land-use for over 75% of New Zealand's physical land area (Statistics New Zealand, 1995). Farmers and Government recognise that there are new ecological and social challenges facing agriculture, and hence, the use of land. Environmentalists, conservationists and those involved in the use of land for leisure, are claiming the right to comment on and influence the management of land under agriculture.

Farmers have a direct stake in resource-use and thus, logically should be closely involved in the identification, planning and implementation of sustainable farming systems. This paper outlines the development of resource-use guidelines for sheep and beef cattle farmers in Hawke's Bay and Wairoa.

3.0 Background

The Hawke's Bay Regional Council proposed a Regional Hill Country Erosion Control Plan in September 1993. Although no more restrictive than the preceding rules, the regional plan was perceived by farmers to be a threat to their normal practices, and therefore, a threat to their lifestyle and profitability.

Hawke's Bay Federated Farmers opposed aspects of the Regional Hill Country Erosion Control Plan. They were concerned that the plan was: too restrictive; contained greater control than farmers thought was necessary; too dictatorial and that "farmers were concerned they would be told what to do". This prompted Hawke's Bay Federated Farmers to approach the Regional Council for help in preparing a Pastoral Code Of Practice or Pastoral Guidelines for Hawke's Bay and Wairoa farmers. Federated Farmers and farmers (members and non-members) considered they were in a better situation than a planning organisation, to write their own guidelines on how their resources should be managed. This approach to regional resource management was termed "*by farmers for farmers*".

A Pastoral Code of Practice would result in self-regulation of land use and a positive, educational approach to encourage improvement of land-use methods rather than restricting activities. Such a document would also indicate a desire to work towards sustainable resource use - a 'target' sought by domestic and overseas customers.

4.0 Objectives

The overall aim of the research reported in this paper was to develop a process for resource user' participation in the development of resource management guidelines, in order:

- to develop a resource-user definition of sustainability in pastoral farming; and
- to study a participatory approach to the development of resource guidelines.

5.0 Method

Hawke's Bay Federated Farmers wanted farmers to contribute towards the definition of sustainability and its implementation at a local level, in order that practical and workable on-farm solutions could be developed. To initiate the process for preparing the guidelines, a small steering group of four farmers (the Farming Committee) was elected to represent farmers, and work with its consultant and the Hawke's Bay Regional Council. The three men and one woman represented farmer interests in four main areas, namely Wairoa, Kotemaori, Tangoio/Napier and Central Hawke's Bay. The President of Hawke's Bay Federated Farmers and the Chairman of Wairoa Federated Farmers were members of the committee.

The committee's aim was to prepare a document highlighting sustainable farming practices in Wairoa and Hawke's Bay. They established reasons for carrying out the exercise at the outset and these were used to maintain direction and focus throughout the process. These included:

- to avoid the imposition of rules by local authorities;
- to satisfy environmentalists and other pressure groups; and
- to help maintain access to and develop new markets for produce.

To achieve farmers' aims, 14 facilitated workshops were held in the Hawke's Bay region. Six were held in the Wairoa area (Putorino to Mahia) and eight in Hawke's Bay (Patoka to Porangahau). The purposes of the workshops were to collect as many ideas as possible about what sustainable farming should mean and to develop what should be included in the pastoral guidelines.

The majority (12) of workshops were for farmers. These were held at locations that reflected local communities of interest, for example, local school halls. Meetings for smaller districts, were combined where appropriate. The remaining two workshops in Wairoa and Hastings, involved invited agribusiness personnel and some farmers who had been unable to attend their local workshop.

The Hawke's Bay workshops were based on the method developed for, and used by, the Waikato Federated Farmers in the Waikato workshops (Parminter et al., 1993). The purpose of a concept pyramid is to help farmers create 'mental pictures' of the components of sustainable farming. The concept pyramid process is detailed in Collins, 1996 and Parminter et al., 1993. Figure One diagramatically illustrates the concept pyramid process and the "good farm bike" example, used in the farmer workshops.

6.0 Results

6.1 Context for sustainable farming

Farmers described the advantages that they believed they would obtain (or are obtaining) from farming in a sustainable way. Advantages to the farmer and family that occurred on-farm comprised the majority of responses (91%). The remainder (9%) occurred off-farm and related to community benefits, marketing advantages and reduced off-site environmental impacts. The key advantages are listed below in Table One.

Category	No. of mentions	% of total mentions
Farmer/personal/lifestyle	115	23
Financial/money	105	21
Benefits to future generations	77	16
Land/soil	46	9
Off-farm benefits	36	7
Plants/trees	26	5
Stock/animals	23	5
Environmental considerations	22	4
Others	35	10
Total	495	100

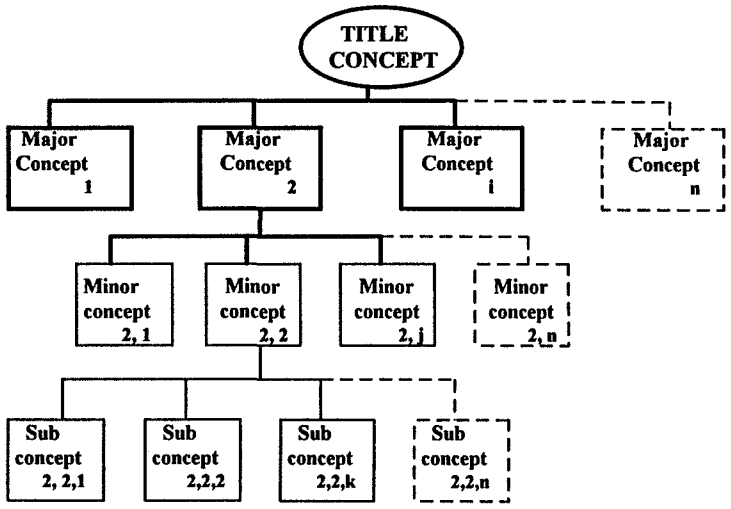
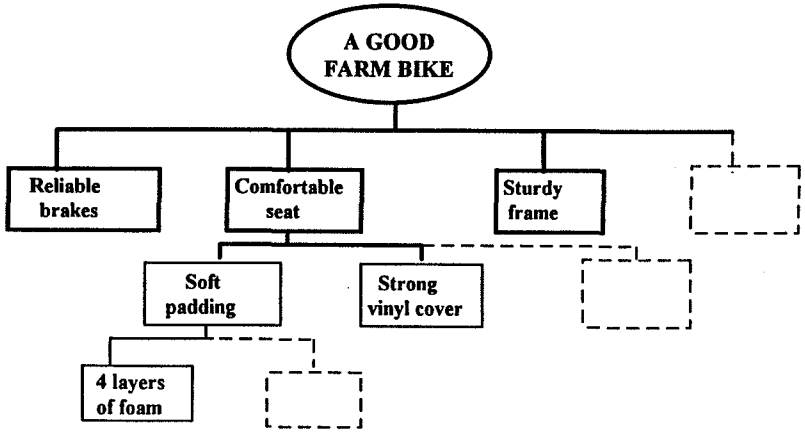


Figure 3.2 : Elements of a concept pyramid



An example of the concept pyramid process based on the farm bike.

Farmers suggested that advantages from sustainable farming applied to all components of the farming system. They indicated that the farmer and family, natural resources (the farm), the community and future generations all benefited from a sustainable farming system. For example, the farmer and family are personally satisfied, have ongoing profitability and are able to pass the farm on to the next generation. The farm also benefits from stable soil, healthy stock and clean water. Off-farm advantages included increased employment and overseas marketing opportunities.

Farmers also commented that advantages from sustainable farming were inter-generational. By farming sustainably, both the current and future generation are able to derive benefits from the farm. Farmers described the current generation (themselves and their family) as: being less stressed and enjoying farming; being more satisfied; having a sense of achievement; and having a good standard of living. As a result, future generations should receive a farm in better or improved condition from the present generation of farmers and their ability to farm is not compromised.

6.2 Description of sustainable farming

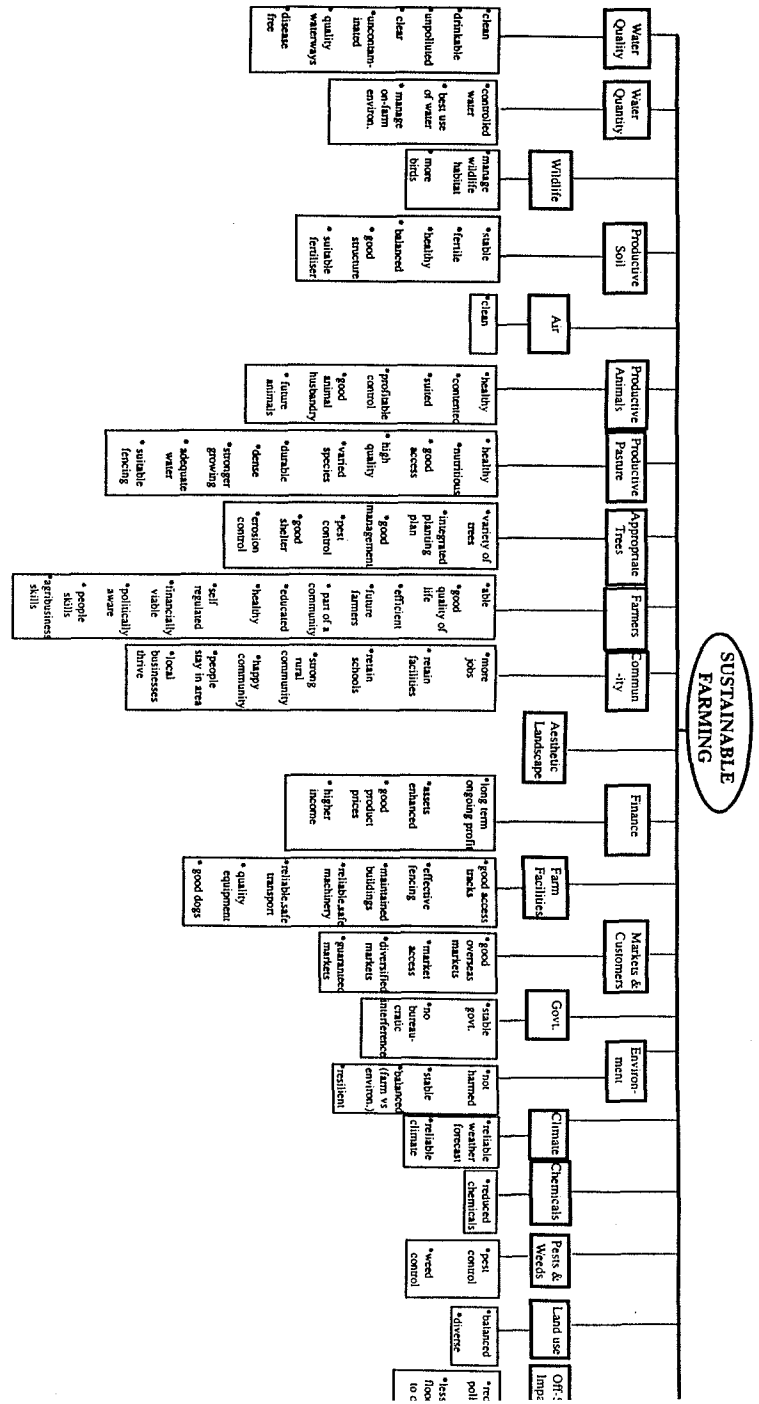
Rather than formulate a concise definition of sustainable farming, farmers at the workshops identified the components and criteria which describe it. A number of components of sustainability were identified by workshop participants.

By using the number of mentions of advantages from the 'advantage' question, two 'levels' of components for sustainability were identified. The 'primary level' comprises the components cited most often by participants, and on this basis, farm resources such as water, soil and pasture plus the farmer and rural community appeared. The landscape, chemicals and air were at a 'secondary level'. Secondary level components are not necessarily less important, but were mentioned less often by the workshop participants. Figure Two details the farmer's concepts of sustainable farming.

Using these components, farmers suggested that sustainable farming may be recognised by management practices that result in:

- productive soil;
- sufficient water quantity;
- good water quality;
- productive pasture;
- appropriate trees;
- productive animals; and
- successful, prosperous and flexible farmers.

Each concept was expanded by the participants in sub-groups to explain the various levels of management practices. Productive soil is expanded here for the purposes of this paper and the other concepts are detailed in Collins, 1996.



The components of sustainable farming as identified by the farmer participants

Productive soil

The title concept is productive or quality, with major concepts (adjectives) to describe soil being stable, healthy, fertile and balanced. ('Balanced soil' could appear to be similar to 'healthy soil', however these terms differed in the minds of farmers). The sub-concepts describe each major concept, for example, if a soil is friable, has adequate fertiliser, is managed organically and good soil husbandry techniques are applied, it is (by farmers' definition) a 'healthy' soil. Figure Three illustrates the concept pyramid for productive soil.

Farmers believed that soil ultimately affects both plant and animal health, but recognised that the converse also applies since stock and pasture management affect soil productivity. Consequently, many of the management practices for healthy, stable, fertile or balanced soil related to pasture and stock management. The management practices identified as resulting in productive soil, were used as the basis of the Guidelines for Pastoral Farming. Some examples of the management practices identified by farmers include: re-grassing earthworks on completion; planting shelter belts and pole planting (e.g. gully planting, space planting); recognising and separating different land capability areas by fencing; and soil testing before applying fertiliser.

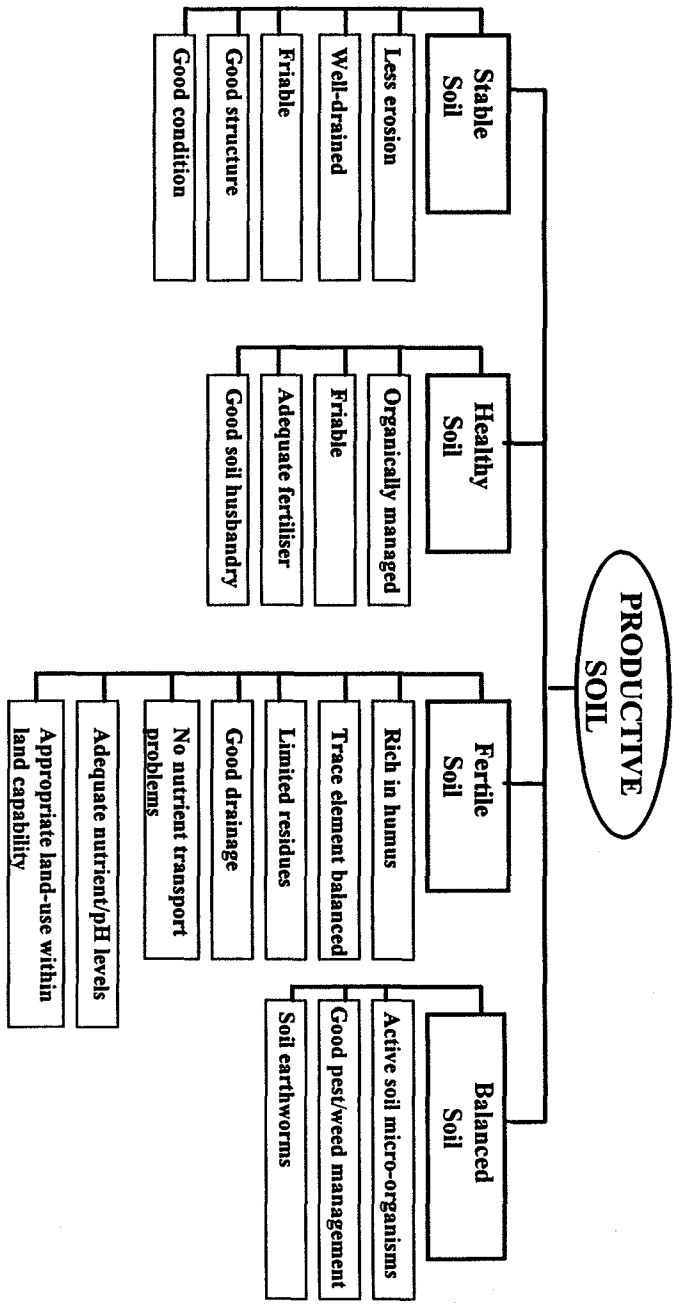
7.0 Producing the guidelines

The management practices identified through the farmer workshops were used to compile the set of guidelines for pastoral farming. A content outline for the guidelines was also established by the elected farming committee to provide a structure within which the guidelines could be written. The key elements of the guidelines were identified as:

- establish the accepted ways to do things (options);
- supply reasons for doing things;
- provide suggested ways of doing things; and
- acknowledge current legislation (eg RMA and OSH).

During the workshop process, many farmers commented that the document should not contain rules and regulations, but rather guidelines which would help them adopt sustainable management practices. Consequently, the committee elected to change the name of the document from a Pastoral Code of Practice to Pastoral Guidelines to better reflect the emphasis of the document. A Pastoral Code of Practice was envisaged as a document with a set of practices to achieve a specific outcome, whereas guidelines were perceived as being more general and suited to achieving a range of outcomes.

Workshop participants, other farmers and the wider community were involved as fully as possible during the production stage. An awareness programme using a wide range of media was adopted, including public consultation on the draft guidelines. From sixty five requests for the document, fifteen submission were received with most being supportive of the approach taken. The majority of submissions suggested minor changes to the text rather than changes to the philosophy or rationale of the document.



Workshop farmers concepts of productive soils in a sustainable farming system.

8.0 Analysis of the process used

8.1 The key successful factors

The research method used was successful as farmers were able to participate in a process, in a manner, that respected their opinions and encouraged their ownership of the final outcome(s). The process was community-based, and therefore, organised and "owned" by the community it sought to involve and represent.

1. Each workshop was organised by the members of the local community that it sought to represent, and the local contact told the facilitators which day and time to 'turn up and facilitate their workshop'. The local contact advertised the workshop in the school newsletter; local store and used established telephone circles. Participants at the majority of workshops "brought a plate" for supper, thereby encouraging community involvement and social interaction.

2. The process was simple enough that members of the local community were able to facilitate their own sub-groups. The facilitators provided simple guidelines (eg all must have a chance to have their say) and only intervened when asked. Discussion was lively and many quieter farmers felt more comfortable commenting when talking with their peers.

3. Farmer attendance at the workshops appeared higher than that previously noted for other resource management development processes. Many 'new' farmers attended the workshops (i.e. farmers who do not usually attend resource management meetings), and this illustrated the importance of the topic to many farmers.

4. Farmers developed a dynamic description of sustainable farming, which to them was practical, understandable and obtainable. The description is specific to the Hawke's Bay farming systems it represents, and it seeks to be implementable at the farm-level.

5. The process of constructing a concept pyramid allowed participants direct involvement in the workshop, generated considerable discussion, and provided a framework for systematically working through the complex topic of sustainability, which has a direct effect on their livelihood.

6. The facilitators were local, well-known, and respected in their respective communities. They were also well-versed in land management and sheep and beef cattle production, and therefore, understood and were able to freely discuss the ideas presented by farmers. This proved to be an important factor in encouraging farmers to attend and participate in the workshops, especially in districts where they had previously had negative experiences with planning authorities.

8.2 The less successful factors

1. Participants must receive accurate information about the purpose of a workshop before attending, so that they arrive with an awareness of the objectives and outcomes expected from the process. The organiser of one workshop told participants they *"would be told about a new set of rules that would control their farming activities"* in order to motivate locals to attend, because *"he wanted his workshop to have the most people, and therefore, be the best"*. The participants at this workshop had a different perception of the workshop's purpose and many came expecting a confrontational situation. The workshop was difficult to run, some participants were dissatisfied with the result, and others were negative about the process. The objectives and outcomes of the process need to be clearly and positively established with stakeholders at the outset. Writing out the workshop objectives and placing these in a visible place in the meeting hall, is an important step in achieving a positive atmosphere.

2. The concept pyramid method relies on a certain literacy level, yet not all participants have the same level of reading and writing ability. In one workshop, an older farmer who could not read was unable to contribute to the process. He felt alienated, was not prepared to let others know of his inability to read, was disruptive, and eventually walked out of the workshop. Another farmer at the same workshop who had dyslexia was unable to write his contributions on the pieces of paper provided, yet worked with his neighbour and shared his ideas in this manner. The facilitator needs to reinforce that discussing ideas and working with neighbours is acceptable during the first stage of the process, and should avoid placing participants in situations where they are unable to contribute..

3. Not all farmers feel comfortable sitting within a large group or writing in public, and all participated more freely and were more relaxed working in sub-groups. Encouraging farmers to work with neighbours can help overcome early feelings of discomfort.

4. Some farmers felt embarrassed at their poor spelling or illegible handwriting, particularly when others in the group made jokes of mis-spelt words. It is crucial for the facilitators to emphasise that spelling and neat handwriting is not important. For this reason, the facilitator often mis-spelt a word on purpose or asked the participants for help with spelling to emphasise this point and placed farmers at ease.

5. Legible writing of name and address details is important as a few early reports from workshops were returned with incorrect address details. Consequently, the facilitator should check the participant list and confirm any queries before the workshop closes.

9.0 Three years on - "the acid test"

After any consultation process it is crucial to review progress and to address any issues that may have arisen. There are five noted outcomes following a review of this project.

1. The Pastoral Guidelines were nominated for a 1995 MFE Green Ribbon Award in recognition of "their significant contribution to improving the environment". The Green Ribbon Award is a way of publicly thanking those people who have shown outstanding initiative and effort to preserve and improve New Zealand's environment. The Pastoral Guidelines were one of two Green Ribbon Award winners in 1995, and this culminated a successful participatory process for developing an operational resource management plan.

2. The district and regional councils are aware that farmers have 'done something about resource management', although not too certain of what 'this something' involves.

3. Wairoa District Council and Gisborne Federated Farmers are both "quoting" from the guidelines. For example, Wairoa District Council are using the code when discussing stock-proof fencing issues with local farmers.

4. The guidelines remain in 'the bottom drawer' for many farmers. Some will refer to the guidelines at times and others will use the guidelines as the basis of discussions about resource management issues.

5. Those who attended the workshops remain aware of resource management issues; enthusiastic about the process used and still interested in 'doing something more'. The 'something more' could be providing more detail about some of the listed best management practices. There has been no noted change amongst those farmers who did not attend the workshops.

10.0 Conclusion

This paper outlines a successful farmer initiated planning exercise, also coined by the participants as "*by farmers, for farmers*". Farmers were proactive rather than reactive in developing guidelines for sustainable livestock farming in the Hawke's Bay.

Sustainability is an emotive topic; involves livelihoods and is therefore difficult for many farmers to openly discuss. The guidelines process enabled farmers to think about sustainability issues and what they mean to them on their farms.

The process was successful primarily because the farmers were committed to seeing it happen. Farmers were able to contribute because: the workshops were organised by their peers; run in their local communities; and with a process that gave them a chance to "have their say". Workshop ideas were translated into guidelines using the language that the farmers developed, thereby ensuring that the ownership was not lost. The high attendance; full participation; enthusiasm and honest sharing of ideas and feelings all contributed to a usable outcome.

Farmers recognised that the guidelines were a start-point in addressing on-farm sustainability and resource management issues. Farmers are also aware that it is time to strengthen the ideas that were developed *for farmers by farmers*.

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FIGHTING THE TWIN PERILS
A CASE STUDY OF THE LEFT BANK OUTFALL DRAIN IN PAKISTAN

Draft Working Paper presented at the New Zealand Agricultural and Resource Economics Society Conference, Blenheim 4-5 July 1997[1]

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ABSTRACT

The Left Bank Outfall Drain is a major integrated irrigation and drainage programme in Sindh, Pakistan. Construction of the first stage covering some 500,000 hectares started in 1985 and is expected to be completed by the year 2000.

This paper examines aspects of the cost benefit analysis by which the project was appraised and later subject to a mid-term review. The results of this analysis are then put in the context of a number of broader issues which will be critical to the overall success of the project: sustainability and public participation; design issues; and alternatives.

INTRODUCTION

Background to the Left Bank Outfall Drain

The Left Bank Outfall Drain (LBOD) is a major integrated irrigation and drainage project in Sindh, Pakistan. Construction of the first stage covering some 500,000 hectares started in 1985 and is expected to be completed by the year 2000.

Irrigation in Sindh has been practised for several thousand years; without it there would be no agriculture. Modern irrigation started in the mid nineteenth century with the improvement and construction of new inundation canals, but it was not until 1932 that the first barrage was built on the River Indus. The Sukkur Barrage serves three million hectares on the left and right banks of the Indus. It was always known that the diversion of irrigation water to areas with no natural drainage would result in raised watertables and salinisation[2], but prevention by constructing drainage systems was deferred - initially because the watertable was at apparently safe levels and later because of the high cost.

By 1959, waterlogging and salinity had become serious and a series of studies were undertaken. A major master planning exercise, the Lower Indus Project (LIP) which started in 1962, included a comprehensive examination of irrigated agriculture in Sindh. During this study the Left Bank Outfall Drain (LBOD) was identified as central to the improvement and sustainability of agriculture in the left bank of the Sukkur command. The 1966 LIP report contained proposals for this major drain from Khairpur in the north running south, parallel to the Indus, to discharge into the Rann of Kutch. LBOD was to be part of a comprehensive development plan involving surface and sub-surface drainage, canal remodelling, surface storage, groundwater irrigation and complementary agricultural development.

Various reports were prepared between 1969 and 1981 on the technical and economic feasibility of LBOD. In 1975 the Government of Pakistan (GoP) started construction of the LBOD spinal drain; by 1987 the drain which involved the excavation of a 270 kilometre long channel with a total outfall capacity of about 4,000 cusecs was substantially complete.

In 1982 the World Bank was requested to examine the proposals for LBOD Stage 1. The Staff Appraisal Report (SAR), produced in November 1984, confirmed the feasibility of the proposals for LBOD Stage 1 Project covering 516,000 ha. The project was to be implemented over a period of eight years and, including consulting services, training, monitoring and evaluation, was estimated to cost about US$ 640 million.

The project was expected to result in increased cropping intensities and yields such that overall agricultural production would be 30 percent greater than the without project case. Direct beneficiaries would number about 910,000 (140,000 farm families) plus about 120,000 receiving secondary benefits. Increases in incomes would range from 22 to 118% while employment would rise by 47%, excluding project construction. The total net benefits were estimated at Rs 2.2 billion (US$ 160 m at that time) giving an ERR of about 14 percent. No significant adverse environmental impacts were foreseen.

Halfway through the programme it became clear that the work would not be completed within the timescale or the cost estimates set out in the SAR and a mid term review (MTR) was requested by the co-financiers. The draft report of the Mid Term Review was produced in 1993 with a final version being circulated in 1995.

The Project Area

The project area has a hot arid climate with maximum temperatures ranging from 20°C in November/February to 40°C in May/June. Rainfall is sparse and erratic ranging from 125 to 175 mm per year. Water rather than land is the main constraint to agriculture in the LBOD area. However, as the watertable rises more water must be applied in order to control salinity and this leads to salinisation of unirrigated land. Land is steadily going out of production, and hence the remaining land is cultivated more intensively.

The principal crops in the project areas are wheat, cotton and sugarcane, but mangoes are an important and valuable crop, and increasing amounts of vegetables and fodder are grown for export to Karachi. Large numbers of livestock are kept, particularly buffaloes for milk production. Draught animals are of declining importance since tractors are now widespread. Most households own some oxen, buffaloes and goats.

The population is predominantly rural and was estimated in 1981 to be 1.2 m and to be growing rapidly at over 3% pa. This exceeds the rate of growth in agricultural production. Large landowners dominate the social system, despite attempts at land reform. Most of their land is

[1]This paper is based on work carried out by the author and LBOD Mid Term Review team between 1992 and 1995.

[2]Often referred to locally as "the twin perils" ... of waterlogging and salinity

cultivated by sharecroppers (*hari*). Literacy levels, particularly among women, are very low, and there is poor access to education, health care or other social services.

The Project

The main objectives of LBOD are to prevent productive land from going out of production because of salinity and waterlogging; to reclaim areas already affected; and to increase the supply of irrigation water, in order to increase agricultural production and raise the standard of living of the population in the command area. This is to be achieved by:

- maintaining the watertable at safe depths through installation of *sub-surface drainage systems* (1608 tubewells);
- disposing saline drainage effluent and removing floodwaters by providing a *surface drainage/outfall system*(length of outfall exceeds 600 km);
- saving or recovering water lost from the irrigation system by means of *370 scavenger wells and interceptor drains;*
- increasing irrigation supplies by *remodelling main and distributary canal systems* and construction of *Chotiari Reservoir*; and
- improving water management at farm level by a programme of *watercourse improvements.*

In 1995 it was expected that the final cost of the project would be around US$770 million. This has been funded by the Government of Pakistan and by grants and loans from a consortium of donors[3].

PROJECT APPRAISAL

This section of the paper will focus on the some of the practical difficulties of carrying out good project appraisal. The Left Bank Outfall Drain has been the subject of at least eight separate project appraisals over the last 30 years. The most recent studies are the World Bank Staff Appraisal Report (World Bank, 1984) and the reports of the Mid Term Review (Sir M MacDonald and partners, 1993 and 1995).

Economic Rate of Return

"The internal rate of return[4] is a very useful measure of project worth. It is the measure the World Bank uses for practically all its economic and financial analyses of projects and the measure used by most other international financing agencies." (Gittinger, 1982)

While the problems associated with overreliance on Economic Rate of Return (ERR) are well known (Tiffen, 1987) it continues to occupy a central position in most donor project approval processes. Three recent appraisals of LBOD estimated broadly similar economic rates of return (See Table 1). They concluded that the project was justified (assuming an opportunity cost of capital of 10%), but that there were significant risks which should be addressed where possible through project design and attention to the policy framework.

[3]Consortium consists of: World Bank, Asian Development Bank, Saudi Fund, ODA (UK), Islamic Development Bank, OPEC Fund, SDC (Swiss), CIDA (Canada).

[4]The economic rate of return (ERR) is the internal rate of return calculated using economic values.

Table 1 Base Case Economic Analysis Results (1992/3 Rs million)

	SAR 1984	Draft MTR 1993	Revised MTR 1995
Net Present Value Costs (40 yrs @10%)		8,646	7,293
Net Present Value Benefits		11,212	9,193
NPV Incremental Benefits	3,890	2,566	1,901
Benefit: Cost Ratio		1.3	1.3
Economic Rate of Return (ERR)	13.6%	12.5 %	11.8 %

The following discussion will show that the apparent similarity in the above results masks major differences in assumptions. The degree of uncertainty which should be attached to the estimates is also emphasised.

Import and Export Parity Prices

"In projects that produce a commodity significant in international trade, the price estimates are often based on projections of prices at some distant foreign point". (Gittinger 1982)

If the commodity is expected to be imported, then the local price will be estimated from the price at the foreign point plus the cost of transporting it to the local market - the import parity price. If the commodity is expected to be exported then the local price will be estimated from the price at the distant foreign point less the cost of transporting it from the local market to that point - the export parity price.

Insufficient attention is often paid to the basis by which economic prices of project outputs are calculated. The 1984 Staff Appraisal Report projected that Pakistan would become self sufficient in Wheat and Sugar so incremental production of these crops resulting from the project was valued based on export parity prices. By the time that the project was reviewed in 1993 and again in 1995 there did not appear to be any grounds for this optimism - wheat and sugar imports were in fact tending to increase. The revised cost benefit analysis (Sir M MacDonald and partners 1993 and 1995) assumed that Pakistan would continue to be a net importer of these crops - this had the effect of increasing economic prices by 24 % in the case of wheat and 26 % for sugar.

It is worth noting that the government intervenes in order to try and hold down the financial price of wheat for the benefit of urban consumers. If the government stops intervening in the market for these crops it is entirely possible that production will rise sufficiently to make Pakistan into a net exporter. This further complicates the question of whether import or export parity prices should be used to value incremental wheat production.

Benefits

The project was justified on the assumption that yields will increase (or at least not fall) as a result of improved drainage, while cropped area will rise because of a 37% increase in the availability of irrigation water during the kharif planting season.

In spite of various series of official statistics and annual sample surveys there is considerable uncertainty over the present levels of production, yield and cropped area in the project area.

> Estimates of present yields and cropping intensity are based on the results of the annual agro-economic surveys carried out by SDSC in the project area since 1987. These yields are significantly lower than those indicated by the Department of Agriculture statistics. However DoA's yields are based on crop area statistics from the Revenue Department which are generally regarded as being an unreliable underestimate. This has the effect of producing yield estimates which are too high and cropping intensity estimates which are too low. SDSC estimates of present yields are significantly lower than those assumed in the Project Preparation Report (PPR) economic analysis and cropping intensities are higher. PPR estimates were based on official statistics so at least a part of the difference between PPR estimates and those of SDSC may be attributed to area under estimation in the official statistics. (Sir M MacDonald and Partners, 1993)

Estimates of yield improvements and changes in cropping intensity which may be attributed to improved drainage could be obtained by comparing these parameters in areas which are broadly similar except for in the degree of waterlogging. Unfortunately such data is not available thus resulting in wide variation in consultants estimates of the yield benefits which may be attributed to improved drainage; see Table 2. The MTR estimates were generally conservative, they took account of recent survey results but were generally somewhere between the estimates of the two previous reports. MTR estimates were rounded to the nearest 5% in order to avoid giving a false impression of accuracy!

Table 2 Yield Benefits Attributable to Drainage Alone
(% Yield Difference Future With compared to Future Without)

Crop	SAR 1984	Project Preparation Report	Adopted by MTR
Wheat	15	9	10
Cotton	36	8	10
Sugarcane	27	14	15
Fodder *kharif*	6	1	10
Fodder *rabi*	55	35	25
Orchard	19	8	10

The Small Print

Several major items included under the project will have major benefits outside the project area. The most significant of these are construction of Chotiari reservoir, remodelling of the Nara river and twinning of a major irrigation canal at a total cost of around Rs 3.3 billion (US$ 130 million). A little noticed feature of all recent appraisals of LBOD is that costs which are attributable outside the project area have been excluded from the economic analysis. Around 40% of the additional irrigation water made available by Chotiari reservoir will be supplied outside the project area, while 60% of the benefits of other works will accrue elsewhere. On this basis Rs1.7 billion (US$ 56 million) was taken out of the cost stream when the ERR was estimated.

This decision was taken on the pragmatic grounds that no reliable crop production data was available outside the project area, and that the time and resources necessary to collect such data were similarly non existent. The decision may be defended on the grounds that if provision of additional irrigation water for the LBOD area is justified then a similar result may be expected in adjoining areas. It is nonetheless worth noting that expenditure of US$ 56 million was approved without being subject to formal appraisal.

PUBLIC PARTICIPATION AND SUSTAINABILITY

The public have always been poorly informed about the Left Bank Outfall Drain. Project design has generally been "engineering led" with public consultation being very limited. Public involvement in detailed design could have increased local "ownership" and avoided many of the disputes and supplementary works which have characterised the construction process. The less informed the public, the less the prospect of public interest, involvement and contribution to operation and maintenance, the worse the prospects for long term sustainability.

Sustainability is undoubtedly the biggest single issue facing LBOD. Historical experience in Pakistan is not encouraging - government drainage projects have often performed adequately for the first few years but have then tended to fall into disrepair. In the Punjab - where farmers are generally better off and more progressive fewer than 25 % of saline tubewells are functioning.

Issues such as the provision of sufficient operation and maintenance (O&M) funds, effective O&M procedures and facilities, incentives, and public awareness have to be addressed if these projects are to function properly and continuously. It has been argued that privatisation could solve many of these problems and that watertable control should be in the hands of farmers in the same way as irrigation below the watercourse head. All new tubewell irrigation development in Pakistan is now in private hands, generally resulting in a more efficient and sustainable system. Privatisation of saline tubewells will be far more difficult for a number of reasons:

- the saline tubewells cover several land holdings and so will require co-operation between all affected farmers. Some farmers may not contribute, but may benefit from

improved drainage;

- the benefits of saline tubewells are low relative to irrigation tubewells and less immediate; and
- adequate saline drainage may be achieved even when one third of tubewells are not operating. This increases the temptation for tubewell operators to attempt to freeload.

On the other hand it can be argued that co-operation between farmers is easier for drainage. Unlike irrigation it is non-exclusive: an individual cannot appropriate drainage in the same way that he can steal water. In fact the converse is true: if one farmer drains his land, his neighbours may benefit. He may resent this or ask them to contribute, but he can, individually, evaluate his investment in drainage. The main problems arise if drainage can cause damage on other land. This may occur as a result of seepage or spillage from disposal channels.

Even though there is a general understanding of the benefits which will come from drainage, it is proving difficult to ask farmers to take over even limited responsibility for an installation which they did not ask for and were not involved in planning. However, there are significant advantages in them doing so.

- it will give them a stake in the drainage system, so that they can put more pressure on government to maintain their part of the system if they are keeping their side of the bargain
- a well is less likely to be damaged if farmers look after it, since they have strong interest in it, whereas a government *chaukidar* will be paid whatever the condition of the well; and
- saline disposal channels are less likely to be blocked and to damage crops if the farmers who would be affected also maintain them.

The Mid Term Review recommended that tile drainage systems should be designed so that each drainage sump, drains water from the land of an individual or group of farmers. Such a design would encourage farmer operation and maintenance and discourage freeloading. Unfortunately tile drainage was rejected in most project sub areas on cost grounds. Where tile drainage is being installed the engineering design is not related to land holding patterns above the ground thus making farmer operation and maintenance much more difficult.

DESIGN ISSUES AND ALTERNATIVES

Lack of public participation and overemphasis on engineering aspects of project design has meant that some project components have been described as - "engineering solutions looking for a problem". Scavenger wells use clever design to skim freshwater for use in irrigation from the top of the watertable. Saline water is pumped out of the same tubewell in order to combat salinity and rising groundwater levels. Scavenger tubewells are inevitably more complicated, expensive and prone to break down, compared to ordinary tubewells.

Unfortunately areas suitable for scavenger tubewells are generally waterlogged and not short of fresh water. Utilisation rates for the first scavenger wells to become operational were low, with most freshwater being returned to the drain unused. Adequate farmer consultation might have revealed that production of freshwater from scavenger wells was not always economically justified.

Interceptor drains are another innovative feature of LBOD design; water leaking from irrigation canals is collected in interceptor drains on either side of the canal and then returned to the canal. The economic viability of interceptor drains depends largely on the degree to which they are able to increase the availability of irrigation water and the economic value of such water. At the time of appraisal and mid term review estimates of the volume of water returned to the canal was based on an indicative model. A major question was the percentage of water returned to the canal which was induced leakage as a result of the suction effect of pumps on the interceptor drains. Overall it was clear that the economic viability of many sections of interceptor drain was open to question.

Engineering solutions to water loss tend to direct attention away from non engineering alternatives which would be more cost effective although politically and administratively more difficult such as:

- irrigation water pricing;
- improved on farm water management;
- improved management of the irrigation canal system; and
- an end to government intervention in the wheat market

CONCLUSIONS

Appraisal and review of LBOD have tended to focus too narrowly on the estimated economic rate of return of the project. There is considerable uncertainty over the real level of future benefits and so of the future rate of return. Debate about the risk attached to cost and benefit levels tends to direct attention away from the key question of sustainability. Base case assumptions indicate that the project will be justified provided that the project is adequately maintained and provided that the level of supporting services, policy framework and price levels encourage and allow farmers to profitably increase their crop production.

Waterlogging and salinity have too often been regarded as engineering problems which are amenable to engineering solutions. Over emphasis on a narrow engineering approach has limited public participation, produced "engineering solutions looking for a problem" and led to insufficient consideration of alternatives. Public participation has never been sufficiently stressed with the result that farmers feel that the government "owns" the project and should maintain it. This lack of "ownership" by project beneficiaries may have serious effects on the long term sustainability of LBOD. Engineering solutions have been designed and implemented with insufficient attention to beneficiary needs, economic viability and the possibility of more cost effective alternatives.

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COST BENEFIT ANALYSIS OF RESOURCE USE UNDER UNCERTAINTY

Paper contributed to the Conference of the New Zealand Agricultural and Resource Economics Society, Inc., 4-5 July 1997, Blenheim,

by

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ABSTRACT

Cost Benefit Analysis (CBA) is used widely in agricultural and resource economics applications to assess projects or alternative practices over long periods of time.

As the technique has been derived from static welfare economics, its applications to environments which are subject to change and, in particular to uncertainty caused by technical innovations, should be questioned.

If uncertainty is present, cost benefit analysis should only be used with extreme care. Its findings should be subjected to explorations by means of other techniques.

The paper proposes the use of systematic scenario construction as a method of checking the results of cost benefit analysis. A methodology for a systematic construction of scenarios is described and compared with the methodology developed by the Shell Oil Company.

KEY WORDS: cost benefit analysis; uncertainty; scenario methodology.

RISK AND UNCERTAINTY

In 1921 Knight [2]introduced a critical distinction between risk and uncertainty. If the probability of an adverse event can be calculated from the pattern of similar past events, then we are dealing with risk. If this is impossible, either because our knowledge of the past is lacking or insufficient (volcanic eruptions and earthquakes) or because we are dealing with an entirely new event for which the past cannot be a guide (for instance, the introduction of genetically modified organisms), then we are confronted with uncertainty.

Uncertainty, however, should not be equated with ignorance. Since there is a basic continuity between past, present and future, we can surmise how an unknown event might interact with a likely environment. We can develop an intuition for possible future developments. Philosophers and artists are often able to sense future directions from a deeper understanding of the present than most of us possess. They are equipped with antennae which are able to pick up signals we normally fail to perceive. Thus, a novel may reveal future trends in a realistic manner because the author is able to "see" patterns we normally do not see.

The construction of a scenario of future developments is like writing a novel. Since we are not born novel writers we need a systematic framework for developing a view of the future. This is the essence of Shell's scenario methodology.

In this paper I shall argue that cost-benefit analysis is not suitable for analysing futures which are subject to uncertainty, basically because this method is derived from welfare theory which rules out uncertainty. This does not mean, however, that the systematic approach used in the analysis of future costs and benefits is useless. On the contrary, it can be very useful, provided we use it as part of a scenario construction.

[1] I thank my colleague John Lepper for his constructive criticisms and comments. Any errors remaining are my own responsibility.

[2] Knight F.H., *Risk, Uncertainty and Profit*, Boston, Houghton Mifflin Company, 1921.

PART ONE: PROBLEMS OF COST-BENEFIT ANALYSIS

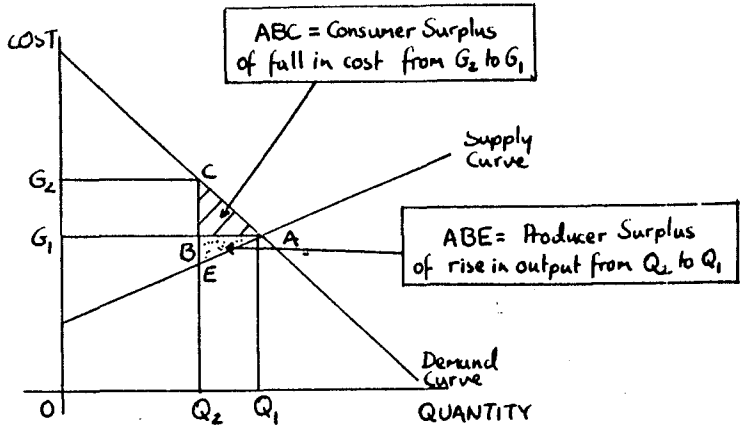
Theory

CBA is an application of welfare economics, its rationale being to discover whether a certain project will lead to a Pareto improvement in the welfare of society as a whole.

The benefits of a new activity cannot be measured by just taking he price of the activity and seeing how many people want to use it. At the going price there will be some people who would be willing to pay a much higher price for the activity. At the current price these people are getting what they want at less than they would willingly pay and so are obtaining a surplus. The sum of all these surpluses for all consumers is called consumer surplus.

CBA is based on the idea that the welfare gains from a new activity can be estimated by measuring the consumer surplus which that activity generates. Consumer surplus is defined as the benefit which consumers will gain from the provision of an activity by virtue of the fact that they would be prepared to pay more for its provision than is in fact charged. It is measured by the area under the demand curve. This is pictured in Chart One.

FIGURE 1
CONSUMER AND PRODUCER SURPLUSES



The benefits are the area under the demand curve ABC.

It should be noted that this CBA approach is a form of partial equilibrium. For it to be translated into Paretian general equilibrium a number of assumptions are necessary. Nath [3]summed up these assumptions as follows:

1. A stationary economy in which everything exactly repeats itself from one period to another.
2. All decisions are made only once; once made, they are relevant for all time because the things decided upon (which can be expressed as rates of flow) remain constant for all time.
3. There is no uncertainty about the future, although there may be imperfect knowledge about one another's actions at the present moment of time.
4. There are constant quantities of homogenous factors of production; no indivisibility is allowed in any factor or product.
5. The size of the working population remains constant.
6. There is no involuntary unemployment.
7. There is no net investment, because the quantities of factors stay constant.
8. All production functions are of smooth curvature, and show non-increasing returns to scale with diminishing marginal rate of substitution between any two factors along an iso-product curve.
9. There is no increase in technical knowledge.
10. Individual utility functions do not change.
11. Ex ante welfare and ex post welfare are always the same since everybody has perfect certainty and knowledge.
12. No consumer is ever fully satiated. Along an indifference curve for any two goods the marginal rate of substitution between the goods diminishes for each individual.
13. There is no divergence between the private and social valuation of economic activities.
14. All individuals aim to maximise their individual utility and business aims are to minimise costs and maximise profits.
15. All markets are perfectly competitive and in equilibrium.
16. Lump-sum transfers of purchasing power between individuals are possible.

This very abstract world, one could say, is a purely functional world. Consumers and producers move smoothly along their curves. Time only plays a role inasmuch as one passes from one period to another. Within a given period, time plays no role.

In this world many human functions are assumed not to operate. The function of designing new things and of re-arranging the organisation of society, what we might call the technical function, does not 'work'. Technical processes and societal structures are given. Only rates of flow may change. Stows of technical, scientific knowledge and social processes are carried forward from one period to another without change. [4]This appears to mean that flows which result in stows or which increase or reduce stows are not allowed to operate. Presumably, farmers and other producers are not allowed to accumulate knowledge from experience, so that the stow of practical knowledge they pass on to the next generation of farmers must be equal to the one they inherited.

The fact that welfare economics invites us to contemplate such a strange static world has advantages, although often we have to resort to acrobatics such as imagining that the preferences of consumers include concerns for the welfare of animals, the preservation of natural resources and a dislike for the disutility of travelling to work in slow traffic queues. A key advantage is that it compels us to consider all possible costs and benefits pertaining to a particular situation.

[3] S.K. Nath, *A Reappraisal of Welfare Economics*, Routledge and Kegan Paul, London, 1969, pages 11 and 12.
[4] See for these distinctions: John Lepper and Petrus Simons, *Systems of Economic Relationships, Three Essays on Rhizoids and Their Application to Social Sciences*, Integrated Economic Services Ltd., Wellington, 1996.

Social Welfare Function

CBA is often applied when decisions are called for on public or social investment projects. They are not used when an individual firm considers a capital investment. The reason for this is that public investment tends to take place in the absence of markets. CBA purports to simulate some of the features of a market.

However, the need for public investment often arises through the effects which technical-economic processes in the private sector have on the welfare of society as a whole. If wastes accumulate, roads get congested, people's health suffers or energy sources become insufficient, then, Government takes action to counter the negative effects on social welfare.

The existence of such public policy reactions means that many assumptions of welfare economics are violated in significant ways. The growth of the population and the effects of technical change are key factors underlying demand for public investment. However, welfare theory allows neither for population growth nor for changes in the composition of the population nor for technical change.

This implies that the effects of making economic choices cannot become visible in social and technical ways. Consumers and producers move along their stationary demand and supply curves, but what this means for social relationships such as income distribution or for technical processes cannot be discerned, because they are not allowed to be affected. This limits very severely the usefulness of cost benefit analysis in situations where such dynamic interaction over a series of functions is important. In practice such interaction is in a fact the order of the day.

In practice, public investment may also be undertaken in order to raise the level of economic welfare. It is intended to change the possibilities we face. Its whole point is to shift demand and supply curves. The public investment projects of Julius Vogel in the 19th century could be mentioned. Again, such investment violates the assumptions of welfare theory.

Whatever the motivation for public investment, the basic assumption for it is that there are processes of technical, social and economic change and, at present, also processes of climate change and biotic change which threaten to reduce social welfare, so that public action is called for.

The criteria for judging the adequacy of proposed projects require a social welfare function. If a Government only requires that benefits exceed costs on the basis of a pre-determined social discount rate, then that social discount rate expresses a social welfare function. This may not be the only criterion. In New Zealand, the Resource Management Act 1991, the Biosecurity Act and other legislation involve criteria for judging investment projects which in their totality are part of New Zealand's social welfare function.

The New Zealand social welfare function omits the distribution of income and wealth. Under the "minimal state" model used, the general presumption is that whatever distribution of income and wealth is generated by private sector economic activity is right. The state should try to interfere with this result as little as possible. Hence, since 1986/87 New Zealand has significantly reduced the degree of progressivity in income tax and has abolished land tax and estate duty. The absence of distributional effects in the social welfare function, however, is bound to increase uncertainty. Net incomes and net business profits will be much more variable than they would otherwise be. Estimating costs and benefits, on a net after tax basis will, therefore, be subject to a larger margin of uncertainty.

The implied use of a social welfare function in Government administration, is, in fact, inconsistent with the doctrine of a "minimal state". K.J. Arrow[5] showed that it is impossible to construct a collective preference scale from individual welfare functions, unless it was either imposed or dictated. This is true of all social welfare functions which consist of an aggregation of individual ones. Such aggregation requires that inter-personal comparisons of welfare are possible and quantifiable. This, in turn, means that no value is attached to income distribution.

Internalising Uncertainty

There are two ways of internalising uncertainty in CBA. The first is by specifying a high benefit/cost ratio. If one cannot be sure about benefits and costs, then, a high ratio at least ensures that doubtful projects are eliminated. However, this method is by no means fool-proof. If there is uncertainty about the nature and value of costs and benefits, then there is always a possibility that projects which reach the minimum benefit/cost ratio may have overstated the benefits or understated the costs by considerable margins, whilst the converse might apply to programmes which were disallowed.

General uncertainty may also be allowed for by using a high discount rate. A higher discount rate implies a lower valuation of the future by the community than a lower one. This biases the analysis against long-term projects. If the present generation were to believe that the future were so uncertain that it would not be prepared to invest anything at all, then, its discount rate would be infinitely high. If, on the other hand, its view of the future were to imply a belief that the future would be always like the present, its discount rate would be very close to nil. In other words, the use of a social discount rate implies a form of general uncertainty engendered by the presence of uncertainty due to change arising from a potential multiple of causes.

Variations to a social discount rate only deal with uncertainty in an indirect manner by assuming that uncertainty is related to risk or to the length of the benefit stream.

Consumer Sovereignty

Consumer sovereignty is a key aspect of welfare theory. It is the foundation of measuring consumers' surpluses (also in the form of costs avoided) in cost benefit analysis. If there were no consumers' surpluses in a particular project, there would be no point in proceeding, as the costs would necessarily exceed the benefits. Ascertaining consumer surplusses, however, is no sinecure because it implies asking potential consumers what they would be prepared to pay for a new product or how they would value savings of time or avoidance of certain activities. In many cases they would have difficulty in imagining exactly what the proposed benefits and/or costs are in a future situation which would in various ways be affected by other factors than just the change being contemplated.

There will always be interactions between a variety of economic actors and Government bodies against the background of on-going technical change. As the consumers questioned will be assumed to act as if the proposed action or project will be the only change from the present, the effect might be that the answers they give might deviate so much from what they would actually do, that the resulting consumers' surpluses would be virtually meaningless.

Irreversible Change

There are projects which involve ecological change. However, estimating the costs and benefits of such projects is often impossible, without actually destroying the ecology concerned. The construction of a road through a wetland would be a case in point. Until the road is constructed one does not know which species would be dislodged, how flows of water would be altered or which habitats destroyed beyond repair. Whilst one can try to simulate such effects, this is often possible only on the basis of knowledge which

[5] K.J. Arrow, *Social Choice and Individual Values*, New York, 2nd Edition, 1963.

must be assembled first by close observation over a number of years. Even, then, simulation might be difficult.

Strengths of CBA

CBA appears to have three main strengths. First, it is clear and leads to unambiguous results even if those results may have doubtful theoretical foundations. Second, the procedure is well-developed and well accepted. Third, most other methods of assessment have even bigger theoretical and practical drawbacks.

By way of example I refer to a recent CBA study. It is a case study in dryland salinity in New South Wales[6]. The paper reports an economic evaluation of a large scale perennial pasture and tree planting project in the Boorowa River Catchment Area. The alternatives of a continuing rise in salinity, if no action were taken, and of reducing salinity by a judicious tree planting programme involved each very high costs and benefits. Tree planting on a large scale was costly, but the costs of rising salinity, even without considering downstream effects were also high. Within the area concerned, it was not too difficult to find the costs of the various techniques. The benefit/cost ratios were rather modest at about 1.4. The author noted that the economic analysis was meant to strengthen the landcare group's resolve and to encourage others to plant trees. As the problem of salinity was acute and its effects clear, the use of tree cover to reduce harmful effects appeared an obviously advantageous course of action. The main use of CBA in this example appeared to be the availability of an objective framework to identify costs and benefits and, second, the social one of encouragement. The study in fact involved a minimal degree of uncertainty because it confronted a continuation of current agricultural technology, with no change in infrastructure in the area, under conditions of increasing salinity with a situation of reducing salinity. Other land uses or other agricultural or forestry technologies were not considered.

PART II: SYSTEMATIC SCENARIO CONSTRUCTION

Introduction

The future presents to decision-makers risks and rewards, uncertainties, threats and opportunities. If particular opportunities or threats appear likely, the organisation's or society's ability to confront these must be ascertained.

Scenarios should be used particularly when uncertainties have to be faced.

Uncertainties are not to be equated with ignorance. We can surmise the existence of uncertainties on the basis of whatever knowledge of the world we happen to command. For example, nobody can establish the probability that the Taupo caldera or Tongariro volcano will erupt within the next ten years. However, we know that these volcanoes have been active in recent geological time and that this activity will continue because the tectonic plates keep moving. So, we can surmise that eruptions might occur within the next ten years. We could then build a scenario of the development of Taupo as a tourist resort, for instance, assuming that eruptions of a certain severity will occur. We can contrast that with a scenario without any eruptions or with eruptions of greater or lesser severity. Such scenarios, of course, must consider the possibility of volcanic eruptions in relation to other factors which impinge on the profitability of investment in tourism.

Definition of Scenarios

A scenario is an internally consistent account of how the business environment or the external environment in which an organisation operates might develop over time. An organisation which assesses

[6] Christine M. Hill, *Economics for Landcare Groups: A case Study in Dryland Salinity*, paper contributed to the 1997 Conference of the Australian Agricultural and Resource Economics Society, Gold Coast.

long-term prospects with the aid of scenarios would typically build up multiple scenarios to make sense of the large number of diverse, but inter-connected factors in the external environment, and to deal with the critical uncertainties that could affect the organisation's future direction.

Essentially, scenarios are stories about the future. Like any good story they will have a plot and often sub-plots. Plots, of course, bind the various elements or variables in a story together. A planner considers how the forces in the plot converge and attempts to understand how and why they might intersect. Thus, coherent pictures of alternative futures, that is scenarios, are constructed.

Scenarios address:

- issues, trends or events in the current environment that are of concern to the decision-makers;
- elements in the environment that are determinable and somewhat predictable pre-determined events or variables; and
- elements in the environment that are more uncertain, trend breakers that affect a system in unpredictable ways, but with understandable dynamics such as turning points in the business environment, identifiable in the present although often as weak signals of change.

The test of a good scenario is that it is:

- plausible to a critical mass of managers in a group;
- internally consistent;
- relevant to the topic or issue of interest;
- recognisable from signals of the present;
- challenging, containing some elements of surprise or novelty in directions in which the organisation's vision needs to be stretched (encouraging managers to 'think the unthinkable').

Nevertheless, there should be links to the existing organisational mental maps.

Scenario Methodologies

There are a number of methodologies available for the construction of scenarios such as:

- Intuitive Logic; usually used by large organisations where the key decision-makers become part of the team constructing scenarios of alternative futures.

- Cross Impact Analysis; this emphasises the inter-relationships between key events.

Whatever methodology is used, the important point is that the construction of scenarios should be seen as a learning process. Whilst outsiders may be called in to provide expert advice, they will have to interact closely with the organisation concerned. The final product should be capable of being used by the organisation's decision-makers as a tool to map strategies.

Royal Dutch Shell, which has pioneered the construction and use of scenarios as a tool in strategic planning, uses intuitive logic as methodology. This method involves eight steps:

1. Define the topic and scope of the analysis, for example market strategies or diversification.
2. Identify key decision factors that is factors which most directly influence the outcome of each decision.
3. Identify the key environmental forces such as social, economic, political and technical factors.
4. Analyse environmental forces, by means of historical trends, critical uncertainties and interrelationships between them.
5. Define scenario logics i.e. organising themes, principles or assumptions that provide each scenario with a coherent, consistent and plausible underpinning. They must provide alternative futures, for example regulated or deregulated markets.
6. Elaborate the scenarios. The underlying logic and key assumptions should be set out explicitly.
7. Analyse implications for decision factors (as identified per step 2).

8. Analyse implications for decisions and strategies. This covers the identification of threats and opportunities suggested by the scenarios, issues which need to be addressed and factors to be monitored.

The intuitive logic approach would be very suitable for an organisation which must deal with an uncertain environment, for which it needs to have a strategy which can deal effectively with threats and opportunities. The scenarios should be developed in close co-operation with the teams which must implement the strategy.

The Cross-Impact methodology uses procedures similar to intuitive logic except that it generates a series of scenarios based on consistency and relative likelihood of occurrence. A computer programme is used to produce static scenarios at the end of the forecast period. The method aims at establishing probabilities for defined events. The user of these scenarios then has to work out the time dynamics which take place between now and then.[7]

Widening the Scope of Scenarios

A drawback of both methodologies is that they are too closely tied to the strategic planning problems of large organisations. If we want to use scenarios for the type of problems studied by CBA, then we need to develop a more general approach that can be applied not only to Transnational Organisations and defence forces but also to the construction of transport systems, urban or rural re-vitalisation projects, salinity problems, introduction of biotechnology in agriculture, the development of the dairy industry or the future for pastoral farming. Care must be taken in these cases to examine the consequences of such projects for economic welfare. We may have to develop a concept of economic welfare that is different from the Pareto concept of welfare economics and which is more suited to the dynamic interactions explored in scenarios. Pareto welfare is basically a measure of economic efficiency inasmuch as it considers how given means of production should be allocated to achieve a maximum of consumer satisfaction. Consumer preferences are always considered as given and their satisfaction as the paramount welfare criterion. This might be put simply as welfare being a sum of apples or money. The satisfaction of consumer preferences may well lead to an enormous waste of resources. So, when means are not given, we might use as welfare criterion that waste should be avoided. This implies a much more objective concept of welfare, based in particular upon the need to avoid long-term waste of plants, bio-diversity, animals, fertile soil and so forth.

Since one description of philosophy is the systematic analysis of the world and life in its totality, it would seem that philosophies which aim to do this, might offer insights which can be used to develop a general scenario approach.

I believe that the philosophy of the law idea developed by H. Dooyeweerd (1894-1977) and D.H.Th. Vollenhoven (1892-1978) in the Netherlands between 1920 and 1970 provides such a general conceptual framework.[8] The following draws on their general systematics.

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[7] For a useful descriptionof the intuitive logic and the cross-impact methodologies see Michael Blyth and Ralph Young, *Scenario Analysis-an Alternative Approach to Assessing the Future*, paper contributed to the 38th Annual Conference of the Australian Agricultural Economics Society, 1994. See also: Kees van der Heijden, *Scenarios; the Art of Strategic Conversation*, John Wiley and Sons, Chichester, 1996.

[8] The movement which has been associated with Dooyeweerd and Vollenhoven has generated has generated a large volume of literature, mostly in Dutch but also in English. A key text is H. Dooyeweerd, *A New Critique of Theoretical Thought* Volumes I-IV, a revised translation of *De Wijsbegeerte der Wetsidee*, H.J. Paris, Amsterdam, 1935, and published by the Presbyterian and Reformed Publishing Company, Philadelphia, 1953-1955. Most of Vollenhoven's works are yet to be published in English.

The Systematic Construction of Scenarios

The following is a summary of the methods used for many years by Integrated Economic Services Ltd. in scenario construction. In this case, we apply it to a situation which has previously been analysed using CBA.

Continuity and Change

Two key statements can be made about the future:

- It will be different from the present;
- It will display a continuity with the present and the past.

There are universals which will remain universals. To use a trivial example: we can be sure that people living in 2030 will experience tooth decay and will have to use dental services.

However, we can also be sure that the techniques for fighting tooth decay will be somewhat different from the present. As dentists learn more about the physiology of our teeth and the interaction between our eating, style of life and tooth decay, they will adapt their treatment methods. Moreover, as technical tools become generally more refined and precise, so the tools wielded by dentists are likely to become more sophisticated.

Now, we could think the unthinkable and play with the idea that in 2030 we might use self-help kits to do our fillings, aided by computer technology in the home. Dentists would be consulted only via a computer screen to advice or to do only difficult jobs. We might also get self-physiotherapy, as well as various forms of self-diagnosis, through such technical change.

In other words, dynamic change occurs against the background of what has been firm or fixed for a long time. Dynamic change can spring from many factors. A key factor in modern times has been the advance of science and technology. Thus, the example given focusses on change resulting from the application of new technologies. Technological change is at the same time a key source of uncertainty, albeit by no means the only such source.

Scenarios of alternative futures must consider, therefore, technical change as it affects many other aspects of life. This only makes sense, however, if these interactions occur according to recognisable patterns. What we need, therefore, is a systematic way of identifying change against the background of what tends to be much more unchangeable.

Three Dimensions

Vollenhoven looks at reality as being subject in its entirety to God's ordering or law. This law has three parts. First, the creation displays a rich structure with an incredible diversity (structural law). Second, humankind is subject to the law of love (love God and love your neighbour) and, third, officebearers in various institutions and communities are called upon to set rules for the well being and proper operation of the bodies for which they bear responsibility (positive law). I draw on the structural law for the basic elements of scenario construction. This law offers three ways in which the whole of reality is ordered, corresponding to three basic differences or dimensions observable in reality: the modal dimension; entities and the genetic.

Modalities and Entities

Modalities express whether something is this way or that way (modus). Something can be logical, beautiful, economic, aesthetic or ugly, historic, moral, biotic etc. We can, however, also point to things,

events and structures and say: this state, that company or that school. This distinction gives us two entry points for a view on life and the world. These two dimensions are closely related. We observe modalities as they are expressed by individual entities. The latter function always in all modalities.

Modalities are seen as modalities of realms (things, plants, animals and human). The significance of this is that these realms always interact, being inter-related. Humans use things, plants and animals in various ways and by means of technical and economic processes they change the natural environment.

Even though entities and events function in all modalities, they are characterised by one or two typical modalities. A family, for instance, is an ethical relationship and a farm an economic relationship involving plants, animals, material and technical things.

Thus far, a total number of 14-16 modalities has been identified by various authors working with this philosophy. It is a matter of empirical investigation how many there actually are.

For the construction of scenarios, modalities provide ways of viewing reality. They are like windows on the world. We can look at the future from an economic point of view, a legal point of view, a technical point of view etc.

It should also be noted that modalities are inter-linked through sets of analogies. For example, the least complex modality is that of number. The one following is that of space. Within space, however, we have a multiple of dimensions (numerical analogy). In biotic life we talk about the living space or habitat of birds or lions (spatial analogy).

In scenario construction, these inter-linkages provide a check on the consistency of the scenarios and on the important interconnections. In the following chart I set out modalities, realms and a few typical entities.

CHART TWO: MODALITIES, REALMS AND ENTITIES

Modalities:	Realms:	Entities:
1. Arithmetic		
2. Space		
3. Kinematic		
4. Energetic	Things	
5. Organic	Plants	
6. Psychic	Animals	
7. Analytic		Universities
8. Technical		
9. Symbolic		
10. Social		Clubs
11. Economic		Business
12. Aesthetic		Museums
13. Juridical		Courts, State
14. Ethic		Families
15. Certitudinal	Human	Churches

The world is never static. It is always moving. This is accounted for in the idea of genetic development. There is evolution in the kingdoms of plants and animals. Within the realm of things, geological, atmospheric and astronomical events cause change. Animals and humans reproduce. Human society is subject to changes in ways of thinking, believing and experience.

Together, these three dimensions of reality provide a three-dimensional "space" to design a scenario. First, one must choose a period. Second, a scenario must have a subject in the form of an entity or realm

and, third, one should have a specific viewpoint (sometimes more than one) to see how the entity concerned may develop over the selected period of time. The analogical inter-relationships of the modalities should at all times provide a reality check on the scenario as it develops. Thus, a major infrastructural development such as the construction of a railway would have social, economic and technical effects on a region. There will also be effects on the habitat of animals and plants. There may be waste problems as a result of the construction process or ways of getting rid of accumulated wastes in the neighbourhood of the new railway.

If we now look again at the CBA of tree planting in a dryland area affected by salinity, then, we would have introduced social factors such as the demographic composition of the population into the basic scenario. This would have required the collection of such data and then a modelling of the interaction between on-going salination, farming, related activities, local government, infrastructure and population change. It is not inconceivable that the burden of salination on the roads and water-pipes of the area might have required an increase in rates. Older farmers might have decided to sell up and leave the area. Loss of population would have increased the rates burden. Thus, the costs of the base case would have been higher than the mechanic calculation of a loss of future harvests and repair costs of roads and other infrastructure. Conversely, the benefits of tree planting would have been higher.

Individual Entities or Events

Whereas modalities as such do not change, individual entities or events may change over time or may be shaped differently by policy-makers in different cultures. Importantly, individual entities bear the imprint of a leading or sometimes a number of leading or qualifying modalities. A business organisation is an economic entity, but it has also a social work relationship between management and staff. An army or police force is marked by the function of the state to protect citizens, fight enemies and maintain law and order. Social organisations also have a foundation. In the case of a company this is the amount of capital invested in the business. To function properly, the basis must be maintained.
Human activities interact with the realms of things, plants and animals. The CBA study of dryland salination provided an interesting example of such an interaction. A modelling of these interactions may start with a description in terms of flows, stows and transformations. A dairy farm, for instance, aims at extracting a flow of high quality milk from stows of cows, pastures and technical equipment. The flow of milk is collected and transported to factories for transformation into dairy products. The flow of dairy products is then shipped and distributed to shops and consumers around the world. The stow of cows generates a flow of calves at regular intervals. The transformation of milk may produce a flow of waste which could damage the quality of water flows, unless treated.

For scenario construction, we must be clear about the entity and the network of flows, stows and transformations it is involved in and which would be affected by future developments which play the key roles. We must also be clear as to the interaction between key entities and events in a scenario. This is the rationale for using rhizoids as basic organising devices. [9]

Time

Time brings about change in a wide variety of ways. Geological events follow a different pattern in time than changes in the ecology of a particular area. Relationships between countries change in their own peculiar way. In general the shorter the period of calendar time we consider, the less dramatic or noticeable changes will be.

For scenario construction we must, therefore, select a period of calendar time. Usually, periods of 3-20 year are considered. Should, for instance, we be interested in the development of forestry in New Zealand, then we should use a period of at least 30 years.

[9] See Lepper and Simons, op. cit. for a description of rhizoids and their potential applications.

Human responsibility

Since we are looking at the shape of alternative futures, it is crucial to know how the movers and shakers of the organisations or events in our scenario are likely to behave. What motivates them? What is their outlook on life? In general, the power of prevailing ideologies should be taken into account as well as the possibility that paradigms or ideologies would alter during the time period under review. Is the present New Right Ideology going to prevail over the next ten years or would it change? If so, how?

The fall of the Iron Curtain is a case in point. It represented a major discontinuity and led to large changes in the relationships between the USA and the Soviet Union. The latter, of course, was changed into a set of different political entities.

Economic Welfare

CBA is about measuring changes in economic welfare, understood in the sense of Pareto. Is it possible to use scenarios as an alternative measuring device? Since scenarios are devices for dealing with a changing world, this will be difficult, especially in view of the static nature of welfare economics which is at the base of CBA.

Paretian welfare is a measure of how well certain activities satisfy certain welfare criteria. It is, thus, a measure of how effective various welfare generators are at what they do. This can just as easily be examined in the converse, i.e. how wasteful are the various welfare generators?

It seems to me that in order to realise the benefits of scenario construction in this respect a more dynamic and comprehensive concept of economic welfare is called for. If we take the view that in essence economics is about avoiding waste, then we should be able to bring into the social welfare function criteria which reflect this norm. Wastes can occur within each of the four realms. A loss of biodiversity is a waste. Encumbering the physical environment with waste flows originating in farming and industrial activities may damage the quality of water flows and so generate a secondary waste flow. New technical processes which make human labour redundant without any compensating projects being initiated lead to a waste of human labour.

In all of these cases, there are social processes which either help avoid or help generate waste flows. Industries, farmers, consumers and public authorities are always interacting in economic relationships. Their economic welfare improves if the flow of goods and services they generate is able to increase without an increase in wastes of all types.

The traditional flow of funds matrix can be adapted to measure economic welfare in this way. [10] Thus, a two-stage procedure emerges. First, a scenario is constructed to explore the project. Second, the relevant flows are estimated as accurately as possible. The calculations should indicate whether the welfare of all actors would increase or decrease as a result of the project.

Case Study: Urban Revitalisation

When Integrated Economic Services Ltd. was commissioned in 1990 to construct a scenario for the possible revitalisation of an urban area (Upper Hutt) which was experiencing an erosion of its economic base, we adopted an economic point of view (modal) to analyse how future economic developments could affect the area. We then considered systematically how the resources of the community concerned (individual component) could be harnessed in the light of that analysis, given a required timeframe of 10 years (temporal component). Finally, the key elements of the scenario were incorporated into a financial

[10] John Lepper and Petrus Simons, *Measuring Money and Money's Worth; Towards a System of Economic Statistics*, Report for Statistics New Zealand, Integrated Economic Services Ltd., 1996.

plan for the area. To indicate the sensitivity of the variables, a conservative, a bold and a middle-of-the road financial plan were prepared.

Essential elements of the procedure were:

a) To identify the strengths and weaknesses of the area and the reasons for its decline. This required interviews, statistical analysis, economic/political analysis.

b) On the basis of strengths and weaknesses identified, an attempt was made to identify the factors which would make the area attractive or otherwise in relation to its economic space.

From a historic point of view, the area's economy had been built upon the availability of land at relatively cheap prices, access to water, access to a large city, subsidised housing and public transport, import protection. All these factors had been falling in importance, so that the industrial base was footloose. Technical developments were seen as reinforcing this potential migration (computers/telecommunication).

The relevant future space was identified as the whole of Australasia. Viewing the possible future of Australia as tied up with the Asia/Pacific area, we viewed New Zealand as a de-facto part of the Australian economy. This on the basis of a change in economic policy, particularly in New Zealand, with much less emphasis upon regional intervention. As a result, economic movement and energy would be towards the larger urban Australian centres with Auckland as a "suburb" of Sydney. Manufacturing industries would prefer to locate to areas close to main markets or shift to "low-wage" countries.

Future growth of the area would, therefore, have to come from other sources. Since the area has important educational facilities and is located close to a major urban area with its university being short of space, education was envisaged as a growth industry. This could also build on a science-based industry in the area which relies on being close to a major research institute. A second aspect of future development was identified in the attractiveness of the region from a tourist point of view. Development of the area would depend on the political will and the vision/faith of the areas leadership. Moreover, communication of the vision to the population was seen as important.

Whilst not all modalities were actively used in this scenario, by using the whole frame of reference, a stylisation was possible.

Clearly, this type of analysis can be made much more complex, especially if the time frame gets longer and the entity to which it applies becomes more complex.

CONCLUSION AND SUMMARY

CBA is not the most suitable methodology for the exploration of the economic effects of public investment projects. It is based upon static welfare theory, which assumes general equilibrium and Pareto welfare. Public investment is designed to alter private demand and supply functions on the basis of public welfare criteria. This is consistent with the doctrine of consumer sovereignty if it is assumed that such sovereignty is reflected in the democratic choice of Government.

Paretian welfare is essentially a device to show how given means can be allocated so as to achieve maximum consumer satisfaction. Consumer sovereignty, however, may well result in wasteful choices and practices. Due to uncertainty about the future effects of public investment projects, as they interact with mnay other changing factors, consumers will be very uncertain about future prices and consumer surplusses. The choices based upon CBA may well be inconsistent with present consumer preferences for the future.

In view of the dynamic nature of reality the future should be explored systematically by means of well constructed scenarios which allow the study of future projects within a changing environment. A systematic analytical framework for the systematic construction of scenarios is outlined. Its use leads to a two-stage process of Cost Benefit Analysis. First, the investment project is studied in a dynamic context. Second, the flows indicated are analysed and quantified. The concept of rhizoids, consisting of flows, stows and transformations, is applied especially for the purposes of the second stage.

The criterion for the admissibility of an investment project is that it avoids or eliminates waste of human, material, plant and animal resources.

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Implementing Transferable Water Permits in the Waimea Catchment, Nelson, NZ

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ABSTRACT

Making water permits transferable from site to site has been touted as an economic instrument which will improve water use efficiency, economic efficiency and flexibility in water resource management. A Transferable Water Permit (TWP) system is being considered for implementation on the Waimea Plains, an area near Nelson, NZ. The purpose of this paper is to briefly review what is a TWP system and why it is being investigated. The main focus of this report is to outline how a TWP system might be implemented, using the Waimea Catchment as a case study. It is suggested in this paper that the key issues when considering implementing a TWP system are presenting a simple, practical system that users can relate to, and effective consultation. The key issues relating to consultation are allowing time for users to understand the changes involved, listening to their concerns and developing a system that they can use.

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INTRODUCTION

Water is a critical resource to mankind. With water becoming a scarce resource in some parts of New Zealand, it is appropriate to look at ways of improving the efficiency of use.

The purpose of this paper is to look at the practical issues involved in implementing a Transferable Water Permit (TWP) system rather than discuss the theory of TWP's. Theoretical issues will be covered as background and in relation to the issues raised by users, but this paper does not propose to cover all theoretical aspects. (For a fuller discussion see Fenemor 1993, Fenemor & Markham 1993 or Fenemor & Kearney 1997)

The paper will firstly provide background on what a TWP system involves and how it compares to the present system and other options for improving water use. Secondly, it will outline why a TWP system is being considered, giving a brief description of the main benefits and costs expected. Next, the Waimea Plains will be used as a case study to show the resource involved, the main features of the proposed system, the process of implementation and the main issues that have arisen out this process. Finally, suggestions will be made as to key issues and processes that are involved in implementing a TWP system.

Present stage in implementation process

It is worth noting at this point that the case study described in this report is only part way through the implementation process. An outline of a proposed system has been put to the public in the Tasman District. Tasman District Council (TDC) has yet to decide to go ahead with drafting up a system for later trial. This paper can therefore on report on actual results up now but some aspects such as the detail of a system can only be suggested as not firm decisions have been made yet.

BACKGROUND

What is a Transferable Water Permit system and how does it differ from the existing system

A Transferable Water Permit is one which can be transferred from one place within an existing water resource to another point in the same water resource. For example, the right to take 1000 m^3 of water per day from point X on a river could be transferred to allow 400 m^3/day to be taken from point Y and 600 m^3/day from point Z.

Existing water permit systems are usually of the command and control type. A permit would specify the maximum amount of water that could be extracted at a certain point and specify the point of take and restrictions on use.

Permits can be and are transferred now using the existing system when land is sold. Water value is bundled in with land value. It is also possible to transfer permits under the Resource Management Act (RMA) regardless of the transfer system. However, it is a cumbersome method requiring public notification and appeals.

Why investigate Transferable Water Permits

TWP's are a type of Economic Instrument. The purpose of Economic Instruments is to provide a mechanism to allow resources to be valued so that users are aware of the full value of use of a resource, including externalities. The generic advantages, summarised from Meister and Sharp (1993) are : more cost effective than existing systems, provide a permanent incentive to manage resources, and increase flexibility.

The purpose of a TWP system is to price water separately, by unbundling water value from land, and make transfers easier.

It is important to put TWP in perspective. The overall goal of a community is to manage water resources wisely while providing water to meet communities needs. Other means of achieving this goal are:

- augmentation - increasing the total amount of water at a point of take has been the most common response in the past. However, the easily available sources of water are generally fully allocated.
- conservation - using more efficient methods of applying water is another way. It normally relies on education to encourage users to change their practices. However, a monetary incentive often is a faster way of encouraging change than education. For example, the Richmond township recently installed water meters and charged residential users on the volume of water used. This has led to a 25% reduction in water use in 2 years.

The advantages and disadvantages of a TWP system from a practical point of view can be summarised as (adapted from Fenemor and Kearney 1997):

Advantages:

- greater security of supply for existing users who want to 'top up' their allocations through purchase.
- opportunity for those without permits to purchase allocations, rather than wait for a Council to review and reallocate unused allocations
- creates a more marketable asset able to be traded separately to the land, if the holder so wishes
- more of the water allocated under permits should end up being used for productive purposes, hence improved production and possibly employment
- improved physical efficiency of water use because of the incentive provided by the ability to trade part of a permit
- improved economic efficiency through water permits being transferred to higher valued uses
- ascribes a value to water which will assist economic evaluation of water augmentation schemes and water use efficiency measures
- reduced conflict among users and between users and District Authorities over availability of water for allocation
- potentially reduced administrative costs compared with a fully regulated regime
- increased flexibility for water users, for example being able to lease short-term allocations when water demand is highest
- reduced need for District Authorities to develop complex restrictions and criteria to improve water use efficiency through regulatory means
- allows users to match their water use with their individual risk preferences

Disadvantages:

- Fear of urban control of water resource to the detriment of rural users
- Fear of monopoly or dominant user control of the water resource
- Perceived loss of community control of resource
- Transaction costs may be too high if there are few users or the system is too complicated
- More resistance to changes in management rules such as minimum flow rationing triggers
- Increased exercise of allocations could put pressure on environmental bottom lines and trigger rationing limits more often

HOW THE PROCESS HAS BEEN IMPLEMENTED IN THE WAIMEA PLAINS

Tasman District has large areas of land used for intensive horticultural and agricultural production on the coastal strip between Richmond and Motueka. The other main land uses are lifestyle blocks, forestry and pastoral farming. Most of the land in horticultural production is irrigated. Water is a scarce resource in this coastal strip over the summer months.

This project focussed on the Waimea Plains which is an alluvial plain near Richmond.

The water system

(a) Supply of water

The main water source is from two rivers - the Wairoa and Wai-iti. Extraction is mainly from a series of aquifers under the Waimea plains, although there is some extraction directly from the river (eg Waimea East irrigation scheme). (see Figure 1)

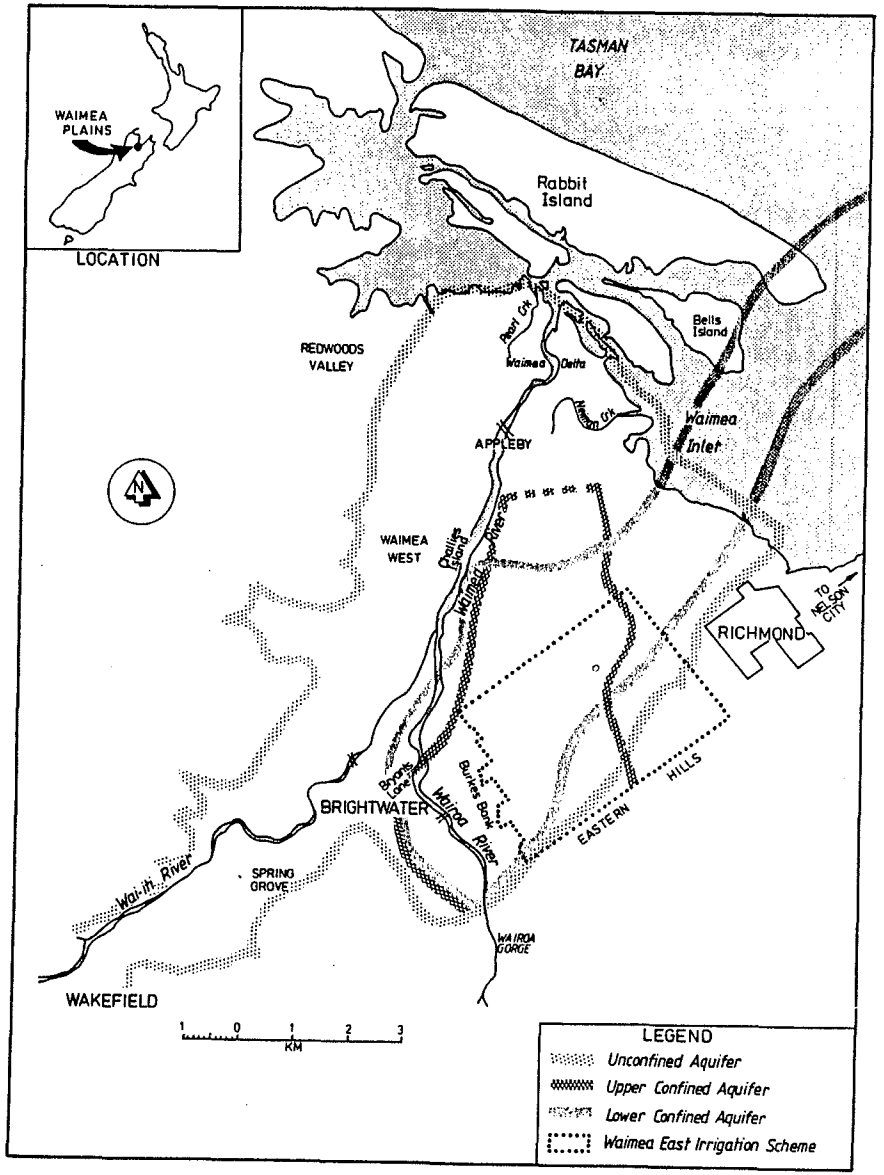

Figure 1 : Waimea Plains water resources

The nature and extent of the water resource is relatively clear. Investigations to identify the aquifers of the Waimea Plains and to estimate how much water was available underground and in rivers and streams were begun in the early 1970s by the Nelson Catchment Board. Thirty years later, the results of countless drill holes, pump tests, water quality measurements, calculations and modelling are now held by TDC.

(b) Demand for water

There are a number of different uses of water in the Waimea plains - consumptive use is the largest, but other important uses are environmental, recreational and for aesthetic values.

Water for consumptive demand is predominantly used for long term purposes. Urban use is approximately 24% of the total water allocated, approximately 2/3's of which is used for residential uses in the Tasman district and Nelson City Council, with the remainder being used of industrial purposes. 76% of the water is allocated to rural users which is used to irrigate approximately 4,400 hectares out of the available productive land of approximately 7,500 ha.

Water available for irrigation has been fully allocated in all management zones on the Waimea plains since 1992, with some areas fully allocated since 1979. During a 1 in 10 year drought rationing cuts of around 35% are expected.

There are no easy, reasonably economic, water sources that can be used to augment existing supplies for the whole area. Dams are being considered for one part of the plains around the Wai-iti valley. Users and Tasman District Council continue to look at ways to conserve water. Many growers put considerable resources into monitoring soil moisture using neutron probes and tensiometers. Urban users are in the process of having their water use measured and charged for on a volume basis which provides an incentive for efficient water use.

(c) The existing allocation system

Water is allocated to users by TDC from a waiting list, on the basis of first in, first allocated. TDC's philosophy for water allocation has historically involved three interrelated principles:

1. *Allocation limits:* These set total quantities of water available for allocation in each water management zone, currently calculated as the sum of weekly allocations on relevant water permits. The allocation limit is the total amount of water determined by Council as available for allocation above a defined 'Environmental Bottom Line' (EBL) such as a minimum river flow or groundwater level. Under RMA, water permits cannot be held environmental and recreational purposes and Council is responsible for protecting these and ensuring sustainability of the water resource by defining EBLs.

2. *Rationing rules:* Cutbacks, as a percentage of volumes allocated, are invoked when environmental triggers such as minimum river flows or aquifer water levels are reached, and currently apply regardless of what the water is used for. Together with the allocation limits, these rules aim to avoid excessive adverse effects on the environment and on other users.

3. *Usage rates:* These are primarily limits on the maximum amount of water allowed to

be applied per hectare for irrigation (currently 35 mm/week in the Waimea catchment). Usage limits are intended to provide a basis for equitable sharing of the resource, to encourage efficient use of the resource and help to minimise effects on water quality through excessive leaching of nutrients and contaminants

Allocation limits are based on a philosophy that a 35% reduction in water availability can be expected on average during a 1 in 10 year drought (although few reductions have occurred in the past 10 years).

When permits expire, Council staff review water usage which involves checking what irrigated crops are being grown, whether the available irrigation equipment is sufficient to apply the amount of water allocated, and whether any metered water usage reflects the available allocation. Subject to appeal, any unexercised permit or portion of a permit allocation will not be renewed. This has occasionally allowed Council to grant allocations to new users registered on its waiting list. Some users regard this procedure as unnecessarily interventionist and bureaucratic, and one which promotes wastage of water.

The main points specified in the terms and conditions of an existing permit are:

- The owner - an individual or business entity
- Use of water and legal description of land where water is applied (for irrigation users)
- Maximum rate of take (allocation) - expressed in cubic metres per hour, day and week based on the area to be irrigated
- Term - fixed term with no right of renewal specified
- Enforcement ensured by
  - requiring water meters to be installed in some areas
  - allowing access for Council staff to check operation and site
- Rationing - rationing trigger point is stated as well as rationing steps and maximum weekly pumpage at each step.
- Cancellation of permit is allowed if the permit is not used in whole or part for more than two years ('use it or lose it' principle)

Other aspects of the current permit system are:

- Transfers of a water permit to a new owner require notification to the Council and are usually associated with the sale of the land to which the water permit is tied.
- Value of permit- the value of an irrigation permit is effectively bundled with the land value. Water permits are levied an annual administration, supervision and monitoring charge dependent on the size and location of the permit, averaging around $100 per irrigation permit. Renewals of permits cost $250 incl. GST for straightforward cases.
- Ownership of the permit is not always clear when land is leased. Sometimes the permit is held by the owner of the land and sometimes by the lessee.

History of TWP in Tasman District

Transferable Water Permits (TWP) are seen as one option to improve water efficiency. Transferable Water Permits are not a new idea in Tasman District, but they have not yet been formally provided for by TDC in any water management plan. The concept was first raised in 1990-91 at public meetings with water users in the Waimea Basin when the Regional Council was preparing the third Waimea Catchment Water Management Plan. As this predated the enactment of the 1991 Resource Management Act, no TWP provisions could be included in the 1991 Waimea Catchment Water Management Plan.

Tradeable permits were considered for introduction in TDC's proposed Motueka/Riwaka Plains Water Management Plan (1992) and proposed Moutere Water Management Plan (1992). In both cases, TDC considered that insufficient was known about the resource at that stage to adequately judge the third party effects of transfers, so TWPs were not provided for in plans for those areas.

In 1993, Council considered a policy paper on economic instruments, which evaluated the TWP concept in detail. That paper was opened to public submissions. 22 were received, approximately evenly in support and opposed. Opinions appeared polarised and often distorted by the dogma associated with the concept. Nevertheless, Council agreed in its Proposed Regional Policy Statement (1995) and following its hearing of submissions to further investigate TWPs.

Because of the water shortage in the Waimea Basin, and good knowledge of the way the water resource works, Council agreed to support a trial of the concept in the Waimea Basin, subject to further consultation with water users and interest groups. Considerable time and effort since then has been put into researching overseas experience and developing an outline for a TWP system that would be applicable for the Waimea Plains.

A further series of public meetings has been held this year to get users feedback. TDC is now evaluating these responses. If it is decided to proceed further, the next step is to draft up a plan that meets users concerns.

Outline of Current Proposal

- Choice of water allocation system - equal sharing is the recommended option, which is the current system. All permits holders have the same priority to water and suffer the same rationing cuts during drought. Other options that were considered were: Proportional Sharing, which issues permits as a percentage of the total resource; and Preferential Rights which is senior and junior (A,B,C..) classes of permits.

- Transition to TWP - the recommended option is "Grandparenting", which is converting existing allocations to TWP's. Other options considered were: Reissue permits on the basis of past use rather than allocations, which might get rid of "sleeper permits" but would involve contentious hearings and appeals; and Auction allocations, which was not really considered as TDC can not directly sell permits under S36 of the RMA. (It was also seen as unfair to existing users who had, in one way or another, already paid for their water permits.)

- Ensure sustainable Water Management with TWP by controlling broad allocations. The issue here is that in the future the community might decide that it wanted less water extracted for consumption. The recommended option is for a TWP to have no recourse to the TDC if overall allocations are changed in the future. The other option of TDC buying back permits to meet the new allocation levels was not favoured. The uncertainty that this could lead to would be factored into the value of water permits.

- Security of tenure of a TWP is affected by the term of a permit. The recommended option was to have a presumptive right of renewal if conditions were met. This option fell in between the two extremes of no automatic right of renewal (current situation) and permanent right of renewal

- An efficient system for negotiating and executing transfers was recommended to be provided by the TDC, in the short term with the private sector being involved at a later date

- Monopoly or speculative transfers - the recommended option was to rely on the Commerce Act. Other options considered were : limit single party ownership to an agreed level; and Retain current "Use or Lose"

- Controlling Environmental effects and effects on other users (3rd party effects) - the recommended option was to retain some restrictions although possibly less than the existing system of all transfers requiring TDC approval.

- 3 out of 6 possible water management zones were suggested as being suitable for a trial. Only those areas where the existing permits matched the sustainable allocation and water meters were installed were considered.

TWP compared to existing

The main differences between a TWP and the existing system are shown in table 1. The key differences, in the authors opinion, are :

- water valued separately from land
- more flexibility with TWP
- more individual control, as permits can not generally be taken without compensation
- less community control over water use
- less regulation

As most of these issues are discussed in more detail in the next section, no further comment will be made at this stage.

Main issues raised during Consultation process to date

The main issues raised in the consultation process are summarised below (see Kearney and Sinner 1997 for further details). *Paragraphs in italics represent users views*

Transfers from Rural to Urban/Industrial

Irrigators believed that water allocations would be bought up by Towns and/or big industrial users. These users are seen to have deeper pockets than Rural users. Once water went to Urban/Industrial users, it would not come back to rural. Therefore parts of the Waimea plains would no longer be irrigated, and rural production would decline.

We do not think that transfers from Rural to Urban will be a large issue as the projected future needs of Urban are a small part of the available water resource. However, while some of the

Table 1: Main differences between existing system and proposed TWP for Waimea Plains

Feature	Current (Without TWP)	Proposed (With TWP)
Regional Economic Growth	constrained	less constrained
Efficiency of water use - physical	OK	Better
- economic	constrained	water moves from low to high value uses
Conflict	TDC adjudicates	Users negotiate
Flexibility for users	constrained	Able to buy, sell, lease
Water Permit	attached to land	separate
Value of water	included in land value	more explicit
Ownership of water	public resource- no difference	
Max water usage - regional (EBL)	public consultation	public consultation (but more difficult to change)
- individual	regulation	(probably) private choice
Total water extracted	marginal increase through permit reviews	more water in total extracted??
Transfer process	TDC approval always required (publically notified)	TDC approval sometimes automatic
Renewal of water permit	no clear criteria for renewal	clear criteria for renewal
Use or lose	Yes	probably No
Match of risk and return	Max use set by regulation	probably Individual choice
Monopoly/speculation	highly unlikely	possible but expensive
Transfer of water	expensive (buy land & water or formal consent)	cheaper - buy water only
Water availability- regional	no difference	
- individual	hard to get additional	easier to top up supply
Compensation if lose permit	No change (probably none)	
Issue new water	Waiting list	Waiting list/auction/existing users
Compliance	more affected by scarcity of water than form of permit	

concern is based on irrigators protecting their own interests, there is a genuine concern from many people that the future is too difficult to predict. There may be large users of water (eg forestry processing) coming onto the scene in the future which could put pressure on the resource.

Although rural users are, in effect describing a low discount rate, the general economic argument would be to let the market decide. Users do not have to sell and would not sell if they did not receive fair value in exchange. Restricting transfers may increase transaction costs and lead to less optimal resource use.

However, the hard line market approach will not work in practice. We do not think users will accept a system with unrestricted transfers from rural to urban. How to put restrictions on is a difficult issue as the RMA explicitly prevents trade competition matters from being considered in district plans.

The issue of rural to urban transfers is the key issue that is holding up implementation of a TWP system on the Waimea Plains. And yet it was not the main issue that users brought up first. The initial objections concerned monopoly, speculation and windfall gains from sleeper permits. Although it was obvious that rural users would be concerned about losing water to urban users, it took time for the real issue to emerge. Having a series of meetings, some of them with small groups, also helped to establish the priorities of issues. We believe that if agreement can be reached on transfers from rural to urban, other issues such as monopoly and speculation will be easier to resolve.

Temporary compared to permanent transfers

A number of people were unhappy with permanent transfers either by sale or long term lease. They preferred transfers to be limited to temporary transfers.

There appear to be three factors leading to this issue. Firstly, users are concerned about the transfer from Rural to Urban. If sales are permanent, rural users believe that they will never get that water back. The best method of solving this concern is to put restrictions on the amount of water that can be transferred to Urban.

Secondly, some users do not like the concept of selling water permanently. This is mainly a perception problem as water is already transferred permanently under the present system when land is sold. Education is the key to resolving this point.

Finally, some users appear to be trying to limit the effectiveness of a TWP system in the event it is implemented. Having a TWP system with only short term leases allowed would be worse than the existing system. Short term leases would only allow part of the gains of a TWP system but, without a use or lose principle, there would be less incentive to make efficient water use than under the present system.

Some users may suggest having only short term leases during the trial period. However, we feel that this would be a bad feature as it could lead to a false sense of security. Users may get through the trial period and think they understand the system. However, there will be parts of the TWP system that have not been tested until after the end of the trial period.

Short term transfers will also not lead to the full benefits of a TWP system.

Monopoly

Users were concerned that it would be possible under a TWP system for big corporates to buy up water and force up the price, beyond what small users feel able to pay.

It is not in the community's best interests to allow monopoly control of water permits. We doubt that a monopoly would occur, but if it remains a concern , other options should be investigated.

We have some concerns about how useful the Commerce Act will be to prevent a monopoly forming. It may require considerable time and expense to get the Commerce Commission to rule against a monopoly. It may be better to have restrictions in the TWP that make it easier to prevent a monopoly forming. The Fishing industry do have restrictions on monopoly control. However, there are also problems with restrictions as entities use associated parties and front companies to hide the real owner.

Efficiency Gains under TWP system

There was very little disagreement that TWP would lead to gains in economic efficiency with water moving from low to high value uses.

Experience overseas suggests that water is transferred from low to high value crops. For example, along the River Murray, there was a switch from water use on fodder crops and vines to vegetables and citrus (Pigram 1992) after TWP was introduced. It is likely that transfers from low to high value uses will occur before transfers to improve efficiency as there is more risk involved if users are considering selling some of their water permits.

The situation was not so clear relating to physical efficiency gains. Many people were concerned that with a TWP system, users would trade to maximise their asset value. They believe that the net effect would be increased water use, which would trigger rationing points earlier.

On the other extreme, there were some concerns that some users would buy up extra water permits to suit their own risk preference. This would lead to water not being used, assuming there is no restriction on maximum water allocation to an individual.

It is very difficult so say which view is the more correct concerning physical efficiency with the limited knowledge available in NZ. It is likely that one effect will tend to cancel out the other - some users will try to pump more while others will have reserves that are infrequently used.

It may be difficult to find transfers for economic efficiency reasons in the early years of a TWP systems. Users will not reduce their water permits until they are sure that they do not need some of their water. However, Harris (1992) reports that in North Adelaide plains there was a switch in water use towards soils with better moisture retention capacity. We believe that this type of transfer will occur over time in the Tasman district. Assuming land values do not

change as a result of such a move, irrigators would be able to reduce their capital investment in a particular crop by moving from a very free draining soil to a silt or clay.

Further research needs to be done in this area to see if introduction of TWP in other areas led to more pressure on the resource. It may also be an area for further analysis looking at the effects of risk preferences on how much water users may purchase. In general, risk adverse individuals may want to purchase more water than they currently have, while risk takers may sell water.

Windfall gains

There was general consensus that no individual user should be able to make a windfall gain by selling permits that they do not need. People felt that individuals should not be able to profit at the expense of the community in the Tasman District.

Although economic theory might suggest that transfers relating to windfall gains would be efficient, on an equity basis, people would consider this unfair and vote against a scheme being introduced. The solution is to review all existing permits to make sure allocations match use before a TWP system is introduced.

Loss of community control

Some people were uncomfortable with TWP being allocated by private transactions. They felt that TDC should continue to allocate water permits

This issue was often driven by individual's dislike of market mechanisms. In fact, the community has limited control of water permits issued to individuals under the current system. Also, water is transferred permanently under the present system when land is sold. The community would still have control over how much water is allocated to environmental uses, the maximum that can be extracted in total from a management zone, and siting of uptake points under both systems.

The two aspects that would change under a TWP system are : how much water an individual water user can have permits for; and whether water is used within the management zone or not. The first point is one key difference between the existing and proposed systems. Interfering with the right of individuals to choose the amount of water they need would seriously undermine the efficiency of a TWP system. The second point is best handled by having specific rules on Rural to Urban uses as discussed above.

Lessor vs lessee

Some existing water permits relating to leased land are held by the lessee not the land owner. Who owns the water right? Under a TWP system, there needs to be some method for a holder of a TWP to prevent the permit being sold without the lessors permission.

The situation is quiet clear about ownership - the person whose name is on the permit is the owner.

Preventing a lessee from selling a water permit is best addressed through lease agreements restricting subleases without the lessors permission rather than including restrictions in the water management plan.

Conflict with land subdivision rules

Presently there are restrictions in the Tasman District on the minimum sub-dividable land area. The purpose of these restrictions is to maintain the productive capacity of land. Some people saw a conflict between the restrictions on land and TWP. TWP would allow water to be traded away which would leave some land dry which would affect the productive capacity of land. The allied concern was that once water was transferred away from a piece of land it would not return, so the land would be dry forever.

There is a difference between the two resources - land and water. Land is immovable and, once it is used for housing, it is practically impossible to reverse that and use the land for productive agricultural purposes.

Water flows. Transferring water away from one piece of land does not mean that land stays dry forever. Water can be brought to the dry piece of land through augmentation or purchasing water permits from elsewhere

TDC role in TWP system

The general feeling was that the TDC should not be involved in the price negotiation process as it has a conflict of interest with the permits that it holds for urban/industrial use. The TDC should confine itself to matters related to the sustainable use of the resource.

A third party involved in the transfer process has to be seen to be fair and impartial with no conflict of interest. In the case of TWP, the TDC could be seen to have a conflict of interest, so ideally it should not be involved in price setting or commercial aspects of transfers.

The TDC could, however, offer to act as a backup to the whole process of establishing a TWP system. If private enterprise or another organisation seems better qualified to carry out a task, the TDC could leave it to them.

Speculation

There were a range of opinions expressed under this issue, with some users seeing speculation as very bad and others as very good.

There is speculation now in land and other assets. We do not think it is the role of TDC to stop speculation. The key issues are : stop monopolies being formed (which has been discussed separately); and ensure that speculators encourage, not prevent, efficient use of the water resource.

Value

Some indicative information on values was presented to users (see summary in tables 2 and 3). It was interesting that there was very little comment on the prices. Users accepted that the value of a TWP would be significant but suggested there was little value in guessing what the

value would be. Users suggested that it was better to wait and let the market decide on values.

The method of transferring permits form the current to proposed - Grandparenting - may have taken some of the sting out to this issue. If users are getting exactly the permits they already have, then they lose nothing when a value is set on their TWP. Currently the value of water is bundled in with land. When water value is unbundled from land under a TWP system, land value may decrease by the water value but the total capital value is likely to be unchanged. Using a different method of issuing TWP's may generate more interest in the likely price.

Table 2: South Australia - price and value for permanent water transfers

Location	Crop	$/ha	% irrigated land value
Riverland	Grape Vines	A$5,500	80%
Barossa Valley	Grape Vines	A$550	4%
	Vegetables	A$2,750	20%
Coonawarra	Grape Vines	A$825	3%
	Pasture	A$2,500	10%
North Adelaide Plains	Fresh Vegetables	A$8,000	n/a

NB: Temporary transfers (ie annual leases) are 5 to 10% of permanent prices.
Source: DENR (1997), Valn SA (1997)

Table 2 shows a big range in water value per hectare which is a result of the amount of water needed and the returns from different crop types. Riverland, for example, is dependent on irrigation for cropping. If water was not applied, then only pasture would survive. Therefore water cost is a significant component of irrigated land. In the Barossa Valley, less water is needed to get good crops so water's share of irrigated land value is much less.

Estimated values for the Waimea plains are included for comparison in table 3. These values are indicative only as the real values will not be known until water is traded in the area. The values are based on some valuation comparisons of land with and without water, supplemented by some brief calculations of the value of water.

Table 3: International Comparison

	$/cu m	$/ha	% irrigated land value
Aust	0.55-2.25	550-6,700	3-80%
USA	1.20-6.0	n/a	n/a
Waimea	0.6-3.0 ??	1,600-8,000 ??	5-35% ??

Exchange rates used : NZ$1=A$0.89=US$0.69
Source: DENR(1997), Valn SA (1997), Fenemor (1994), Colby (1990), NZHES estimates

Water is likely to be a significant component of irrigated land value. The actual value will vary from time to time and place to place depending on supply and demand.

Frequency of trading

One requirement for a market to set prices efficiently is that there are sufficient trades for a fair value to be reached. Overseas experience suggest that there has been a low volume of trade in water rights between irrigators. In the North Adelaide Plains only 7% of water used annually was transferred in the period from 1985 to 1989 . Along the River Murray, transfers averaged 0.46% of total water use over the period 1984 to 1990 (Pigram 1992).

The implication for NZ is that the volume of transfers would probably be low - perhaps less than 5%. However, this does not mean that the market would be inefficient at setting prices. Markets for long term assets are usually set by low annual volumes of trade. For example, the average turnover of rural properties was 5.2% of total rural properties in the period 1990 to 1995 (Valuation NZ 1996).

SUGGESTED IMPLEMENTATION PROCESS

Based on the experience gained in the Tasman District to date, there are a number of steps involved in a successful implementation process.

Find the right situation to test TWP

There are a number of pre-conditions that need to be checked before a TWP is considered (Fenemor and Kearney 1997)

(a) A fully allocated resource where demand exceeds availability

If further water permits can be obtained by application, no one will be willing to buy an existing (more expensive) consent from another person.

(b) Sufficient knowledge of resource

Definite constraints on water allocations and on site-to-site transfers must be able to be set to minimise effects of transfers on other users and the environment. The resource must be well researched to ensure the allocations are sustainable. The use of the water should also be considered as it will have an effect on the options considered in a TWP system - eg short term/long term use, urban vs rural.

(c) Permits which are enforceable and completely enforced

Unless resource users know that other users are complying with the conditions on their permits, the permits will be of little value.

(d) Allocations must match actual usage

If actual usage is less than allocations, some parties will be able to make a windfall gain. This factor has been a stumbling block for a number of areas. On the other hand, if allocations exceed the water available, it may be difficult to get users agreement to a TWP system being introduced.

(e) Private and community benefits exceed transaction and other costs

Benefits include the more efficient use of the available resource, while transaction costs include the cost of resource investigations for establishing management constraints, the cost of operating a market in permits, and enforcement costs. Many of these costs exist of course with the present water management system. Restricting the operation of a TWP system to meet user requirements, such as restricting rural to urban transfers, may increase transaction costs to the point where costs exceed benefits.

(f) Range of water uses with different values

Trade between users with similar value uses will allocate water to the most efficient users, but overseas experience suggests the gains may be quite small on an annual basis. The major gains appear to be from transfers from low value to high value use (economic efficiency) rather than from physical efficiency gains.

(g) Efficient system for allowing interested parties to negotiate

There must be a reasonably efficient system to allow parties to be aware that permits are available for transfer and for parties - including Council - to negotiate on the terms for transfer. If communication is poor or the transfer process administratively complex, few transfers of water allocations will occur.

Develop a case study

Although authorities dealing with water often need to present a regional or district viewpoint to get a mandate for further investigations, we believe that any analysis should present information focussed at user level as part of on overview. A general discussion tends to be treated as a hypothetical argument. As such, users hypothetical answer is usually NO, as the system is new and they do not understand it.

The best feedback that was obtained in the Waimea Plains started from when a map was put up and areas suggested for a trial. This focussed users minds quickly onto the issues that might affect them.

TWP is one method for improving efficiency of water use. It should be compared to other ways of improving efficiency for a particular area. The discussion then is on TWP as a means of achieving the goal of water efficiency rather than TWP as the only or preferred method.

When presenting information to users on TWP for the first time, a key factor is to keep the system outlined as simple as possible. Start with the broad options and work down to the details later. For example, in our view it is confusing to start discussions while including options such as A+B shares. The key issue should be that water can be transferred and sold under a TWP system. The detail of whether there should be one, two or more types of permits can be worked out later in consultation with users.

Find out issues relevant to resource

Consultation is the key. If users are not listened to, the wrong policy may be set. For example, in the Waimea Plains, although monopoly was an issue raised in early discussions, the real issue driving this concern was rural to urban transfers. If users do not understand the issues or are not happy that their concerns are being met, they will vote against the proposal.

Change takes time. Water management issues are complex and critical to users well being. Holding one series of public meetings to discuss a proposal is unlikely to be enough. In the most recent discussions with user in the Waimea Plains, a series of public meetings was held, followed by a series of smaller meetings. We noticed that after the second meeting, many users had a better understanding of the proposal and what it meant to them. Sometimes this led to a change in attitude.

It is easy to overestimate how much users know about the existing resource and system. Based on our observations in Tasman District, we believe users only understand those aspects of the existing system that affects them. The consultation process needs to allow time to review the existing resource and system as well as discussing the new proposal.

Develop legal and commercial framework

There are a number of issues to be resolved regarding a legal and commercial framework if it is decided to proceed further with TWP's in the Tasman District. For example, how to register a charge (mortgage) against a title.

We believe that it is important to start with the full framework rather than leave some pieces out. For example, the Fishing Industry implemented a transferable permit system (ITQ's) without providing a legal framework to register charges. This turned out to be a major source of discontent with the operation of the system (Pearce 1991). There appears to be very little new procedures needed to handle legal and commercial aspects of TWP. It is more a matter of adapting existing than developing new procedures.

Implement and review

Although a district plan has set review periods, we believe that it will be useful to review the operation a TWP system 3 to 5 years after it is implemented. The review should look at whether the system is achieving efficiency gains. It may also be worthwhile reviewing some of the constraints, such as rural to urban, to see if users are happy with the limits set earlier.

SUMMARY AND CONCLUSIONS

Water is a critical resource. While NZ is not a desert, there are areas where water is fully committed to existing use. TWP has a place in helping to improve efficiency of water use.

We hope that the case study presented in this paper is useful when considering TWP in other areas. However, there are some features of the Waimea Plains that may be different to other areas - eg proximity to urban areas, long term nature of water use and the mix of possible water uses. Each situation needs to be considered individually.

There are a number of stages to go through when considering a TWP system. The right resource needs to be identified, and then a simple proposal developed for discussion with users. Simple does not mean uncomplicated, but focussing on the big issues and working out the details later.

It is important to allow adequate consultation with users while trying to change the water allocation system. Users are very aware of the importance of water to them. Rushed or poorly targeted consultation will not be well received.

Economists have a valuable role to play in the implementation of TWP. As a group we can highlight the economic benefits and costs of the system as a whole and the effects of different options. Discussion of water management can easily get emotional. At times, the economic and commercial effects of various options need to be pointed out, diplomatically, to interested parties.

However, we believe there is little value in detailed analysis early in the implementation process. It is better to wait until the options appropriate to a situation are clearer and then use analytical procedures to shed light on key points.

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The Amenity Value of Waterway Enhancement in Christchurch
A Preliminary Analysis[1]

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Abstract

The Waterway Enhancement Programme was established by the Christchurch City Council as part of an ongoing commitment towards the sustainable management of tributary waterways throughout the city. Enhancement activities involve landscaping to emphasise the natural contours of the waterways, and planting native species to promote the establishment and maintenance of aquatic and bird life. Waterway enhancement activities provide increased opportunities for recreation and education, as well as drainage and water quality improvement services for the city. To the extent that they improve the habitat for native flora and fauna they also contribute to a valuable natural ecosystem that enhances the quality of life for all Christchurch residents. The public good aspects of these benefits raise interesting policy questions regarding willingness to pay for waterway enhancement services, and the role of the public sector in their provision. In this study a simple statistical model is specified and used to explore the relationship between property values and proximity to a particular waterway enhancement site. Results indicate a statistically significant positive relationship between property values and waterway proximity, therefore suggesting a positive willingness to pay for enhancement activities.

KEYWORDS: Nonmarket valuation, waterway enhancement, urban open spaces, hedonic pricing, locational rent, public policy.

1 Introduction

The land under much of what is now the city of Christchurch was originally swampy wetland. To facilitate development, city planners modified a self contained land drainage system comprised of three small coastal rivers (the Avon, Heathcote and Styx) and their tributary systems. For 120 years prior to local government amalgamation in 1989, the management of the waterway system in Christchurch was the responsibility of the Christchurch Drainage Board, whose primary objective was to remove storm water from the district (Couling, 1993). Historically, therefore, the dominant concern in the management of Christchurch's waterways has been efficient drainage.

A number of factors since 1989 have led to a change in philosophy in waterway management, and in 1991 the Drainage and Waste Management Unit concluded that management should emphasise the natural attributes of waterways wherever practicable. Catalysts for change were factors such as local government reform, the passage of the Resource Management Act, increasing environmental awareness of the general public, and the increasing cost of managing and extending the existing drainage system (Ibid). This change in philosophy has led to the establishment of the Waterway Enhancement Programme (WEP) for the long term improvement of the tributary waterway system.

The WEP specifically involves tributary waterways that have been classified as utilities or environmental assets. The broad aim of the WEP is to manage Christchurch's waterways in a sustainable manner, consistent with the philosophy of the Resource Management Act. Although each waterway has its own unique characteristics, enhancement activities generally involve emphasising the natural contours of the waterways and planting native species to promote the establishment and maintenance of aquatic and bird life. The enhancement alternative is in stark contrast to the previous drainage philosophy, which

favoured either piping or straightening surface watercourses, which were generally bounded by man-made materials and bordered with minimal vegetation.

Waterway enhancement activities provide increased opportunities for recreation and education, as well as drainage and water quality improvement services for the city. They also contribute to a valuable natural ecosystem that enhances the quality of life for all Christchurch residents. Economic theory suggests that the value of adjacent properties will reflect some of the benefits of waterway enhancement activities. The objective of this study is to explore the relationship between property values and waterway enhancement activities, and draw some preliminary conclusions about Christchurch residents' willingness to pay for the services of the Waterway Enhancement Programme.

The ensuing subsections provide background information on tributary waterways in Christchurch. Section 2 reviews the concept of economic value within the context of waterway enhancement benefits. A review of the literature on valuing open spaces in urban areas is presented in Section 3, and used to develop the simple statistical model outlined in Section 4. Results of the statistical analysis are presented in Section 5, and compared to *a priori* expectations and conclusions drawn from previous studies. The policy implications of this preliminary analysis are explored in Section 6, and the study concludes with suggestions for future research.

1.1 *Tributary Waterways In Christchurch*

For management purposes Christchurch waterways have been classified as either rivers or tributary systems, depending upon the size of the waterway and the nature of its banks and margins. There are currently 90 kilometres of rivers, and almost 300 kilometres of tributary waterways in Christchurch. Traditionally these tributary waterways have been piped and buried as the city developed. Piping is an hydraulically efficient means of transporting

water, allowing dense property development to take place extremely close to (in some cases on top of) existing waterways. Unfortunately piping destroys the recreational or amenity value that may be associated with the waterways, and greatly modifies existing wildlife habitats (Watts, 1994).

Since the establishment of the WEP, improvement options for the tributary waterways have been extended to include enhancement as well as piping. While there are advantages and disadvantages associated with both options, a number of factors combine to make enhancement an extremely attractive alternative. On a discounted basis, for example, enhancement is a lower cost option at approximately $165 per metre compared to $540 per metre for piping. In addition to being aesthetically pleasing, therefore, enhanced waterways provide flood protection for their catchment areas at a lower discounted cost than piping. The natural waterways also offer the potential to improve the quality of the water that percolates into the underground aquifers or discharges into the sea.

There are disadvantages associated with enhancement as well. Open waterways can provide a breeding ground for nuisance insects, and a source of organic odour that some people find unpleasant. There has also been concern over the safety of open waterways. Although historical records show that there are very few vehicle accidents involving open waterways, there is a perception that unfenced bodies of water may pose a safety threat to children. Finally, open waterways can collect debris that imparts an extremely untidy look to the area.

Spending on enhancement activities totalled $200,000 in 1994/95, compared to $1,180,000 for piping. The advantages mentioned above, however, have prompted a proposal from the Water Services Unit of the Christchurch City Council to shift the expenditure on Land Drainage Waterway Enhancement from approximately 85:15 in favour of piping to

65:35 through time. The vision of the current unit is to create a network of linear parks from the sea to the Port Hills and rural outskirts. This 'green corridor' will provide a key linkage between natural habitats and an important recreational amenity for Christchurch residents. The programme will also provide a guarantee that the waterway environment is improved and maintained for future generations, as required by the RMA.

1.2 *Property rights and Christchurch's waterways*

Much of the tributary waterway system in Christchurch lies within private residential properties. Historically, therefore, landowners have been responsible for erosion protection and maintenance of bank stability along smaller waterways. Residential development on the Port Hills, for example, has been allowed to occur very close to watercourses which generally pass through private lots (Couling, 1993). The drainage solution to cope with the bank erosion which inevitably occurred has been piping, which satisfied engineering criteria and alleviated many of the nuisance factors mentioned above. Unfortunately these benefits involved a high capital cost, and were achieved at the expense of the natural aesthetic quality of the waterway.

The 1995 Christchurch City Plan alters the property rights to undeveloped land adjacent to waterways by stipulating a series of setbacks which vary from 5 to 30 metres. Any activity involving filling, excavating or building within the setback zones is at the discretion of the Council, and requires a resource consent. This feature of the city plan facilitates improvement of tributary systems which may otherwise have been piped.

1.3 *Public Good Aspects of Christchurch's Waterways*

Improvements proposed by the Waterway Enhancement Programme exhibit two important characteristics traditionally associated with public goods: nonexclusion and nonrivalry. Nonexclusion implies that it is impossible, or at least very costly, to exclude

people from enjoying the amenities provided by a particular good. Although many of the waterways in Christchurch adjoin private residential property, public access at some sites means that members of the general public can enjoy a variety of outdoor activities by the water's edge. The consumption of a nonrival good by one individual does not diminish the quantity or quality of consumption available to another individual. This is in stark contrast to private goods such as food items, where one person's consumption precludes consumption possibilities by anyone else. Like public roads, enhanced waterways exhibit the characteristic of *congestability*, which allows nonrival consumption up to a certain 'threshold' of users, and diminished enjoyment for all concerned once the public area becomes over-crowded.

The existence of public good characteristics such as nonexclusion and nonrivalry implies that the market can not be relied upon to provide waterway enhancement activities at socially optimal levels. The challenge from a policy perspective is therefore to determine the level at which these goods should be provided, and the extent to which the public sector should be involved in their provision. Before either of those questions can be answered, however, we must establish that there is a positive willingness to pay for enhancement services. The magnitude of the willingness to pay for waterway enhancement activities will provide some guidance as to how extensive the enhancement activities should be. In addition, it is important to know whether the benefits associated with enhancement activities can be appropriated. If at least some of the benefits are appropriable, then there is scope for private sector involvement in the provision of enhancement activities. The extent of the private sector involvement will depend, in part, on how much of the total economic value associated with waterway enhancement can be captured by those who provide the benefits.

2 The concept of economic value

A good has economic value if someone is willing to pay for it. Although this is a somewhat anthropocentric concept of value, it does not deny that a good may be valuable for reasons that are unrelated to human use. Identifying and quantifying the benefits associated with waterway enhancement activities will assist policy makers who must determine how these services will be provided.

2.1 *Categories of economic value*

Economic values have been defined in a variety of ways by a number of economists. Following Mitchell and Carson (1989), goods may have use and/or nonuse values. Use values include all current direct and indirect ways in which people can make use of a good. Services provided by the WEP have direct use benefits in so far as they provide a pleasant environment outdoor activities. The programme also provides drainage and flood protection for inhabitants of the city, which implies significant indirect use benefits. In addition, enhanced waterways provide habitats for plant and animal life which supports such activities as bird watching and botanical outings.

The recognition of nonuse values implies that people do not have to visit a public amenity to benefit from its maintenance or improvement. Nonuse benefits of the WEP include the enjoyment that an individual derives from current vicarious consumption activities of people who may or may not be known to them. They also include stewardship values which may stem from knowing that the enhanced environment exists to provide a natural habitat regardless of whether any humans visit the sites. Stewardship benefits of the WEP also include bequest values which exist because of the knowledge that current provision of the enhanced waterways will ensure that the interests of future generations will not be compromised.

Table 1. Economic values associated with the waterway enhancement programme.

Use Values	
Direct Use	• recreational activities on waterways • picnic activities at waters edge
Indirect Use	• provision of drainage for city • provision of habitat for flora and fauna • improvement of water quality
Nonuse Values	
Vicarious Consumption	• satisfaction associated with other's enjoyment of the enhanced waterways
Stewardship	• satisfaction associated with the knowledge that future generations will enjoy amenities provided by enhanced waterways • satisfaction associated with knowing enhanced waterways exist, unrelated to any present or potential human use

Source: Adapted from Mitchell and Carson

2.2 *Measuring economic value*

As long as a market exists for a particular good, the price that evolves from the interaction of supply and demand generally provides a reasonable indication of its marginal value. Both buyers and sellers improve their welfare by taking advantage of the opportunities for exchange, with a sale being agreed upon so long as the price offered is at least as great as the value of the good being sold. In a competitive market the total willingness to pay for a particular good can be calculated mathematically as the area under the demand curve. The net benefit to consumers (referred to as consumers' surplus) is represented by the area under

the demand curve, but above the price line. The measurement of economic benefits therefore traditionally involves the statistical estimation of a demand curve, which in turn requires the collection of market data representing transactions between buyers and sellers.

Since environmental improvements such as those provided by the WEP are not traded in ordinary markets, however, their values must be inferred indirectly from consumer purchases of related commodities, or directly from experimental methods. The three techniques used most commonly to estimate the value of goods not traded on conventional markets are the Hedonic Price (HP) approach, the Travel Cost Method (TCM), and the Contingent Valuation Method (CVM). The conceptual link to traditional economic theory is that while a demand curve is not observable in the absence of a formal market, it may still be possible to obtain an estimate of the value that people place on a particular good through other means. The literature review presented in the next section indicates that a number of innovative non-market valuation techniques have been applied to urban parks. The majority of the previous work, however, has explored the link between property values and willingness to pay for open spaces.

3 Previous work on valuing open space in urban areas

In an early paper on urban park valuation, Knetsch (1962) observed that the important social values associated with urban parks are unlikely to be expressed explicitly in the market place. Knetsch identified two components of value, one of which amounts to willingness to pay for park proximity, and would be capitalised into the value of houses which are close to public parks. The other component reflects benefits enjoyed by users of park amenities. Knetsch's paper was a theoretical discussion rather than an empirical study, but he did suggest that property differentials may be used to estimate the first component of value, and

the travel cost method may capture user values. While the relative contribution of each of these components of value is an empirical question, Knetsch stressed that estimates of these values can not be summed without the risk of double counting. Knetsch further postulated that most of the value of small neighbourhood parks would be captured using a land value approach, while user values may be more important for large regional parks.

Kitchen and Hendon (1967) used simple correlation analysis to test the hypothesis suggested by Knetsch's theoretical paper: that properties close to urban neighbourhood parks are of greater value than properties located further away from park amenities. These authors experimented with total assessed value, assessed value of land, and sale price as proxies for property value. The 'zone of influence' defining park proximity was defined as a 2.5 block area, or five parcels of land surrounding the park. Their results indicate a statistically insignificant *positive* correlation between distance from the park and total assessed value, as well as distance and sales price. The correlation coefficient between assessed land value and distance from the park, however, indicates a small but statistically significant negative relationship between land values and distance from the park. These authors defended the last correlation as being the most representative because land is a homogeneous commodity whose value does not include non-uniform structural improvements. The results of this simple bivariate linear analysis do not, however, conclusively support their original hypothesis.

In an attempt to calculate the benefits of urban water parks, Darling (1973) compared estimates resulting from two separate methodologies. Darling used multiple regression to test the hypothesis that the value of property attributed to park amenities is a decreasing function of distance. Sales price and assessed value were used as proxies for value, and various structural characteristics of the house and neighbourhood were included as explanatory

variables. The zone of influence for Darling's study was defined as property 3,000 feet from the shore. Capitalised property values resulting from the regression analysis were compared to consumer's surplus estimates obtained through interviews. Interviews were limited to people living within the zone of influence, so the consumer's surplus estimates were alternative to, not additive to, the land value estimates. Results indicated that people are willing to pay for park amenities, but the property value technique consistently indicated a substantially larger willingness to pay. Analysis of three separate water parks implied that the magnitude of the willingness to pay will also depend on park facilities.

Weicher and Zerbst (1973) focused exclusively on obtaining estimates of what they defined as the externalities associated with neighbourhood parks. These authors hypothesised that the benefits associated with pleasant views of open space will be capitalised into the values of property that is specifically adjacent to neighbourhood parks. Multiple regression analysis was used to test this hypothesis, and to estimate the value of the park externalities. When sales price was regressed against structural characteristics of the house, year of sale and three locational dummies, the authors discovered that the sign of the externality depended critically upon the way the property bordered the park. A positive externality was associated with a pleasant view of open space, while a negative externality was associated with a back boundary or a view of heavily used sports/recreational facilities. These results are consistent with those of Darling's: local residents' willingness to pay for urban park amenities depends upon the nature of the facilities provided.

Using similar methodology, Hammer, Coughlin and Horn (1974) argue that land values may capture accessibility/active use values as well as benefits associated with scenery and wildlife numbers. They used multiple regression to test the hypothesis that the 'location rent' associated with park proximity is a decreasing function of distance from the park. More

specifically, the sale price of properties within 2 000 feet of an urban park in Philadelphia was regressed against explanatory variables which captured structural and locational characteristics of the houses in question. Proxies for park proximity included straight line distance and distance along public walkways, both measured in feet. Results indicated that proximity to the park was a significant indicator of value, and that the locational rent did indeed decline with distance from the park.

Correll, Lillydahl and Singell (1978) also hypothesised that residential property values decline with distance from a public amenity, but their attention was focused on the benefits associated with greenbelts in Boulder Colorado. These authors employed multiple regression analysis to isolate the capitalised value of the externalities generated by the public land, which controlled development and helped to preserve the city's scenic mountain backdrop. Sales prices of properties within 3 200 feet of the greenbelt were regressed against the walking distance to the greenbelt, as well as various structural and locational indicators. Results indicated that distance from the greenbelt had a statistically significant, negative influence on the sales price. The authors also noted that the increase in property taxes attributable to a particular greenbelt area could potentially pay for the purchase price of the land set aside for public use, making greenbelts attractive from a cost benefit perspective.

The central focus of a similar paper by Li and Brown (1980) was to test the impact of a variety of micro-neighbourhood variables on housing values. Their multiple regression model included twenty-eight independent variables representing structural and site specific characteristics of the house, neighbourhood characteristics, public services, accessibility to the central business district, and micro-neighbourhood characteristics such as visual quality, noise pollution, and proximity to natural features such as rivers and the ocean. Results indicated that the structural characteristics of the house were the most important indicator of

sales price, but that proximity to the ocean and rivers was also significant. The sign of the coefficient associated with these variables implies that sales price declines as distance to oceans and/or rivers increases.

Schroeder (1982) used multiple regression analysis to test the general hypothesis that people are willing to pay more for property in a community with relatively good park and recreational facilities than for a similar property elsewhere. To measure the quality of park and recreational services, Schroeder specified per capita expenditure on park and recreation services, and acreage of parkland per 1 000 people. The data included sales price of the property, as well as 14 independent variables reflecting structural and locational characteristics of the houses. The data set was split prior to analysis so that any significant results could be verified. Results indicated that there was no significant relationship between property value and either per capita expenditure on parks or acreage of parkland per 1 000 population. While Schroeder was testing a slightly different hypothesis, his results do not provide support for the theory that quality public parks and recreation services improve property values.

In a theoretical discussion comparing various methodologies for measuring the benefits of urban parks, Allen, Stevens and More (1985) warn that property value studies may under estimate the value of parks because they do not capture benefits enjoyed by distant users. Although the authors suggest that the travel cost method may be used to estimate 'distant user benefits', they acknowledge that people may not travel very far to visit small urban parks. The authors argue that hedonic pricing studies capture the benefits of a park as perceived by purchasers of nearby properties, which include both visual amenities or externalities and user benefits. The travel cost method, on the other hand, reflects only user

benefits. Estimates from these two methodologies clearly can not be summed without double counting.

In an empirical study of four urban parks in Massachusetts the same authors combine the property valuation technique and personal interviews to statistically estimate the total benefits of urban parks (More, Stevens and Allen, 1988). Hedonic pricing was used to capture user benefits and externalities for nearby residents, while interviews were conducted to determine user values for those who lived outside the 2 000 foot zone of influence. As opposed to conducting a contingent valuation survey, however, a daily user fee of $1.00 was assigned to represent the willingness to pay for distant users. The hypothesis tested with the hedonic pricing model was that the price differential attributable to park facilities will vary with the level of amenities provided. Sales price was regressed against various indicators of housing characteristics and distance from the park for properties within the 2 000 foot zone. Following Correll, Lillydahl and Singell, proxies for distance included straight line and public road to nearest access point. Results indicate that park proximity does have a statistically significant influence on property value, and that the location rent does vary with the amenities that the park provides. In addition, the authors determined that in all four cases the benefits outweighed the cost of operating each park, suggesting a positive net benefit for urban parkland. Unfortunately the opportunity cost of the land was not included in their analysis, so their study can not be considered a rigorous cost benefit analysis.

Lupi, Graham-Tomasi and Taff (1991) used regression techniques to examine the extent to which property values can be used to measure the non-market benefits of urban wetlands. These authors regressed sales prices against site specific, structural and environmental variables. Acres of wetland per survey section was used as a proxy for the amount of wetland in a particular 'neighbourhood'. A similar variable indicating the number

of 'lake acres' per survey section was used to control for the amount of lakes in a region. Additional environmental variables included proxies for lake adjacency and adjacency to the Mississippi River. Results indicate that lakes and wetlands have a significantly positive effect on property values, although the marginal willingness to pay for additional wetland acreage becomes negative at high levels of existing wetlands. In addition, the willingness to pay for marginal changes in wetland acreage per section is greater in areas with fewer acres of existing wetlands, and areas with higher density housing.

In a subsequent paper Doss and Taff (1993) use a more sophisticated data set to capture the relative value placed on four different types of wetlands, from very forested to very open. Doss and Taff use regression analysis to test the relationship between property values and proximity to wetlands. The 1990 assessed value was used as the dependent variable, and distance from each property to the edge of the nearest wetland was used as the proxy for distance. Their results indicate a statistically significant relationship between property values and distance, with open and scrub/shrub wetlands receiving a higher ranking than forested or emergent vegetation wetlands.

Although the results of this wide range of studies are not entirely conclusive, they do suggest that there is a high degree of willingness to pay for publicly provided open spaces. In addition, they highlight an important link between property values and the non-market benefits associated with open space amenities. Not surprisingly, the magnitude of the willingness to pay for urban parks appears to depend upon the facilities provided, the precise spatial relationship between the property and the park in question, and the existence of other open spaces in the area. Where it was available, actual sales price was preferred to assessed value as a proxy for price, and distance along public roads yielded more desirable results than linear distance to indicate proximity to the environmental asset. While the analysis presented

below is restricted by a lack of data, it does indicate that Christchurch residents are willing to pay for waterway enhancement services, and at least some of these benefits may be appropriable by the private sector.

4. Methodology

The discussion on economic value presented in Section 2 suggests that, while people may value the benefits associated with waterway enhancement in Christchurch, there is currently no direct market which allows them to express their preferences. Nonmarket valuation techniques must therefore be used to elicit preferences directly, or infer them from behaviour in a related market. The literature review presented in Section 3 clearly indicates that the nonmarket valuation technique most commonly applied to urban park valuation involves the analysis of property market price differentials. Proximity to open spaces such as urban parks and waterways implies a greater potential to benefit from the services that these amenities provide. According to economic theory, if the land adjacent to a park is in short supply, its price will increase to reflect the capitalised value of the benefits of the park. In equilibrium, therefore, property price differential should approximate the value of the park benefits.

4.1 *The model*

Data limitations preclude the specification of a sophisticated hedonic pricing model for this empirical application. It is possible, however, to draw some preliminary conclusions about the amount that people are willing to pay for WEP activities using a very simple linear model. For this preliminary analysis a simple linear regression model is specified, where sales price is hypothesised to be a function of house-specific characteristics, and proximity to the waterway. More specifically:

(4.1) $SP = \beta_0 + \beta_1 D_1 + \beta_2 D_2 + \beta_3 SIZE + \varepsilon,$

where SP represents sales price, D_1 and D_2 are proximity dummies, SIZE indicates the size of the section or the floor area of the dwelling, and the β's represent parameters to be estimated. The random error term (ε) is assumed to be normally distributed with a zero mean and constant variance across all observations.

While a more sophisticated model supported by a larger data set would be preferred, the results of this simple statistical model provide enough information to determine that Christchurch residents do, in fact, value enhancement activities. A positive willingness to pay for proximity to waterways also suggests that there is some private incentive to provide enhancement services. Whether the incentive is sufficient for a functioning market will depend in part upon the costs of providing these services relative to the subsequent increase in property values surrounding the waterway(s).

4.2 *Data and statistical hypotheses*

The empirical application involves property in the vicinity of Corsers Stream, an enhancement site initiated in a new suburb in northeastern Christchurch in the early 1990's. WEP activities at this site include widening and adding curvature to the existing stream banks to give the watercourse a 'meandering' effect. The banks have also been landscaped with several native species, which creates a park-like setting and attracts waterfowl and aquatic life. There are several aspects of this site that make it appropriate for the present analysis. Corsers Stream was one of the first sites to be enhanced, so the surrounding property values have had some time to reflect enhancement activities. The housing stock in the area is also relatively homogeneous, making the omission of alternative housing characteristic variables a less serious problem. Finally, some of the development of the surrounding suburb took place

at the time the waterway was being enhanced, allowing architects to incorporate the stream amenities into their plans.

The literature review uncovered a vast array of housing characteristics which influence sales price. Data restrictions in the current analysis, however, limit our choices to floor area or section size, both expressed in square meters. While this lack of choice may introduce specification bias, it is interesting to note that floor area is often the most significant explanatory variable in multiple regression models employing a much larger selection of independent variables. Price and area data were collected from Valuation New Zealand. Sales price is the actual transaction price, adjusted for inflation with an index of housing prices. Floor area and section size are expressed in square metres, and properties were divided into three discrete categories so that proximity could be incorporated with the use of dummy variables. Categories included properties adjacent to Corsers Stream, properties on the same block as but not adjacent to the stream, and properties located across the street from the stream. Dummy variables were associated with the first two proximity categories, so their coefficients can be interpreted as the locational rent associated with waterway enhancement services. Specifically, $D_1 = 1$ if the property is adjacent to Corsers Stream and 0 otherwise. Similarly, $D_2 = 1$ if the property is on the same block as, but not adjacent, to Corsers Stream, and 0 otherwise.

The hypotheses to be tested are:

1. H_O: $\beta_1 = 0$, and

2. H_O: $\beta_2 = 0$,

with the alternative hypotheses stated as $\beta_1 > 0$, and $\beta_2 > 0$. In other words, houses that are closer to an enhanced waterway are expected to sell for more than distant properties. We also

expect that $\beta_1 > \beta_2$, which implies that there is more locational rent associated with adjacent properties.

5. Results

Results of two regressions are reported below (Table 2). In the first equation sales price is hypothesised to be a function of proximity to the waterway, and the floor area of the dwelling. The data set for this regression consisted of 45 observations. The adjusted R^2 indicates that nearly 70% of the variation in sales price is captured by the explanatory variables, which is a fairly good result given the limitations associated with the data set. Both proximity dummies are significant at the 5% level.

Table 2. Regression Results

Equation 1: Dependent variable: Sales Price				Adj $R^2 = 0.69$
	Constant	Adjacent	Same Block	Floor Area
Parameter Value	62,176	34,721	13,696	779
t statistic	(3.76)	(2.38)	(1.64)	(9.61)
Equation 2: Dependent variable: Sales Price				Adj $R^2 = 0.13$
	Constant	Adjacent	Same Block	Section Size
Parameter Value	65,266	6,896	3,471	19.58
t statistic	(7.84)	(2.31)	(1.69)	(1.91)

The parameter values in equation 1 suggest that, holding floor area constant, adjacent houses sold for $34,721 more than properties located across the street from Corsers Stream.

Similarly, houses on the same block as Corsers stream sold for $13,696 more than distant properties. These values represent 15.71% and 6.2% of the mean of the dependent variable, respectively. These figures compare favourably to previous results by Weicher and Zerbst (1973), who report that houses with a scenic view of an urban park sold for approximately 7% more than properties one block away. More recently, Lupi, Graham-Tomasi and Taff (1991) calculated that lakeside houses sold for $41,000 more than houses which were not adjacent to a lake. This figure represents nearly 50% of the value of the dependent variable[3].

A comparison of properties adjacent to Corsers Stream with those located further away led us to suspect that the estimates from the first equation may reflect housing characteristics as well as waterway proximity. We therefore specified the second equation, which included only sections that had not been improved. In this equation the sales price reflects only the value of the land, which is hypothesised to be a function of proximity to the waterway and section size. Although much less of the variation in the dependent variable can be attributed to the explanatory variables, the proximity variables are still statistically significant in this specification. Parameter values indicate that sections adjacent to Corsers Stream sell for almost $7,000 more than sections across the street. Similarly, there is a $3,472 premium for sections on the same block as the stream. These results provide corroborative evidence for the observations of one local realtor, who estimated that properties adjacent to Corsers Stream sold for an additional $5 000.

6. Policy Implications

Despite severe data limitations, this preliminary analysis has established a link between property values and waterway enhancement services. In particular, the existence of

[3] There was a much higher standard deviation associated with housing prices in their data set

an attractively enhanced waterway has a significantly positive impact on property prices in a northeastern suburb of Christchurch. This observation raises two interesting policy questions. The first has to do with the magnitude of the benefits of Corsers stream. A related policy question is whether private individuals can be expected to provide waterway enhancement services. In other words, are the benefits enjoyed by people living in close proximity to a waterway 'appropriable' by a developer who must choose between piping and enhancing waterways prior to development, or by private individuals seeking to improve the value of their property?

With regards to the first question, Equation 1 implies a locational rent of $34,721 per property for houses adjacent to Corsers Stream, and $13,696 per house for properties on the same block. Amortised over a 50 year time horizon using a discount rate of 6.5%, these figures represent an annual benefit of $2,358 and $930 per property, respectively. Multiplying the annual benefits by the number of houses adjacent to (20) or on the same block as (51) Corsers Stream yields an aggregate benefit of $94,600 for those living close to Corsers Stream. It is important to recall that these figures do not reflect the use or non-use benefits enjoyed by more distant residents.

Data limitations did not allow us to control for housing characteristics other than the size of the dwelling. It is quite likely, however, that houses near the waterway are more desirable due to factors such as unique architectural design or the quality of the building materials. If this is the case, the statistical analysis will attribute too much of a premium to waterway proximity. It can therefore be argued that the second equation may provide a more accurate reflection of the benefits of waterway enhancement. A similar aggregation procedure applied to the coefficients from Equation 2 implies an annual benefit flow of

$21,393 for Corsers Stream. Once again, this figure reflects only part of the total economic value of the enhancement activities at Corsers Stream.

While the Waterway Enhancement Team should find these results encouraging, the figures do not imply that waterway enhancement is the most socially productive use of the land. The regression coefficients indicate a positive willingness to pay for waterway proximity. They do not reveal precisely which of the many waterway enhancement services are particularly valuable. Similar results may have been obtained, for example, if the open space had contained extensive playground equipment for children. In addition, the results are indicative only of the benefits associated with a well enhanced site located in a relatively affluent suburb, and should not be extrapolated to all waterway enhancement sites.

It is difficult to provide a definitive answer to the question of whether private individuals can be expected to provide waterway enhancement services. The results of this study do indicate that enhancement activities have a significantly positive impact on adjacent properties. Enhancement services will therefore provide a return to those who own the property at the time of enhancement. Unfortunately we can not determine whether there is sufficient incentive to prompt developers to choose enhancement over piping, or to encourage the improvement of waterways in developed areas, without more information on the full economic costs of enhancement. It is also important to remember that waterway enhancement provides subtle benefits in the form of contiguous wildlife habitats that are very diffuse and not fully reflected in adjacent property values. Under these circumstances economic theory suggests that a competitive market will underprovide waterway enhancement services. This raises the contentious question of the extent to which private versus public funds should be used for enhancement activities.

7. Limitations and suggestions for future research.

This exploratory study into the economic benefits of waterway enhancement services in Christchurch reveals a statistically significant positive relationship between property values and waterway proximity. Although these results indicate that Christchurch residents do value the services provided by the Waterway Enhancement Programme, data limitations preclude a precise understanding of the complex relationship between property value and waterway proximity. It is not clear, for example, which enhancement features are particularly valuable in the sense that people are willing to pay relatively more for them. It is also an open question as to whether socio-economic status has any influence over the level of preference towards waterway enhancement services. In addition, the results reveal very little about the value that distant residents place on enhancement activities, other than suggesting that the locational rent declines with distance from the waterway. This last question is particularly important, because the existence of diffuse externalities which can not be appropriated by private individuals provides additional justification for public sector involvement in the provision of waterway enhancement services.

The Waterway Enhancement Team is in the process of restoring a vast array of tributary waterways throughout Christchurch. Through time the activities of the WEP will therefore include a wide variety of services across a diverse natural and socio-economic landscape. This rich source of information, combined with the comprehensive GIS database maintained by the Christchurch City Council, should alleviate many of the limitations associated with the current data set and support the future development of more sophisticated models.

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Current and future developments in agri- environmental support policies and the CAP in the EU and their implications for NZ

Caroline Saunders

The previous reform of the CAP is well recognised as just a first stage in the reform process. This is not just due to the anticipated pressures from the WTO in the next round of trade negotiations but internal pressures for reform due to enlargement, budgetary factors as well as changing public perceptions and demands from rural areas.

This paper examines the changing degree and systems of support for EU agriculture, (in particular in the UK); the rising developments of agri-environmental policies; and the likely impact of these changes on NZ agriculture. The analysis calculates for the UK the EPR for main commodities and illustrates the amount of these in relation to typical NZ farms. In conclusion the paper stresses the changing nature of EU farming. The implications of this for NZ are a possibility of increased restrictions in trade for environmental reasons not only relating to food safety and quality but also the way it produced.

Introduction

The main purpose of this paper is to illustrate the level of support to EU agriculture, using the UK as an example, and how this has changed. It then illustrates the degree of support in NZ context and assesses the future direction of agricultural policy and how that may affect NZ.

The degree of support in UK agriculture is illustrated by using calculations of the public exchequer cost and social value of agricultural output[1]. To calculate the social value of agricultural output it involves revaluing output using shadow prices to reflect the resource cost of production.

EU intervention in agriculture

The basic system of support in the EU was, and to some extent still is, based upon the fixing of target prices, that is the ideal price for producers. From this the intervention and threshold prices are derived. The intervention price is effectively a minimum price at which supplies are removed from the market by Government agencies. The threshold

[1]The original purpose of this analysis was to value social cost/benefits of compliance with stewardship schemes. Stewardship schemes here refer to policies which affect farming systems with the aim of improving economic efficiency by reducing negative externalities and/or increasing positive externalities.The methodology for this paper draws upon earlier work examining the public exchequer and social cost of agricultural output lost due to compliance with conditions of management agreements on three SSSI in the North of England (Saunders et al 1987) and updated fro a study of Stewardship polices in the EU (Saunders 1996).

price is the price at which imports are allowed into the domestic market and is maintained by a system of import levies. These common prices were, in the case of most commodities, set well above world market prices. This led to increases in production within the Community, aided by increases in productivity through technological change. Thus self-sufficiency increased and the EU became a major exporter of temperate zone products, disrupting world markets especially for traditional food exporters like NZ.

This policy led to a number of well documented problems and therefore pressures for reform the main ones being the rising cost of the CAP, the deterioration of international relations, as well as environmental degradation. There have been various reforms to the CAP, generally on a piece meal basis, especially over the 1980's, but it was the McSharry reforms in 1992 which were the most comprehensive. Whilst these left the basic price structure in place they have reduced fixed prices to, or closer to, world market levels and compensated producers by direct payments based upon past production patterns. These changes are reviewed in detail later.

Public exchequer cost and social value of agricultural output

The level of support given to agricultural commodities is considerable. In particular since the CAP reforms, the level of public exchequer support in the form of direct payments has risen. To measure the public exchequer value of output, the impact on the public exchequer has to be assessed and through a detailed analysis of the operation of the policies and how they translate into a per hectarage or per head basis.

The social value of agricultural output are measured by removing the impact of intervention policies[2]. Many studies have tried to measure the degree of support in various countries. These have tended to concentrate on the trade effects and measuring the rate of protection and mix public exchequer impacts with resources impacts.

Early work in valuing agricultural support consisted of valuing agricultural output at import parity prices, and comparing this with the domestic value of output (Nash, 1955; McCrone, 1962). These methods, if adapted and used for the calculation of the Social value of agricultural output, involve the revaluing of domestic output at world prices. But this would overestimate the social value of agricultural output as no account has been taken of protection on inputs and the alternative uses to which these could be put.

[2]The changes here are considered marginal and do not affect equilibrium market prices. In addition the effect of other market imperfections have largely been ignored and perfect competition has been assumed.

Josling (1973) adapted these methods for use in measuring income transfers and derived the Producer Subsidy Equivalent (PSE). The PSE has been considerably modified to measure protectionism, and includes some of the distortions to input markets, especially subsidies, and there are several conventions as to its measurement. It has developed as the main measure used to assess protectionism in the recent GATT negotiations. However its use in the current study is limited as it concentrates upon farm incomes, "the cash value of policy transfers occasioned by price and non-price policies" (Josling and Tangermann, 1989) and therefore mixes public exchequer transfers and market distortions.

Cordon (1966), in the development of his theory of effective protection, was of the earliest writers to include the effects of protection on inputs. This was based upon using the value added element of production, that is the difference between the price of the product and the price of inputs. To measure the degree of protection, the difference between the value added at domestic prices and the value added at world prices is calculated (this can be expressed as a proportion of the value added at world prices):

Effective Protection Rates, as with all other methods of calculating protectionism, are based on a number of assumptions as analysed in detail in Saunders (1996). These include changes in markets conditions if imperfections were removed; fixed input/output coefficients; no transportation costs; homogeneity of production; full employment; and non-traded inputs. Certain assumptions also become of more relevance when adapting the theory of effective protection to agriculture. These include allowing for fluctuations in exogenous factors such as the weather; and estimation of protection on joint products or crops

Thus Corden's Theory of Effective Protection is adapted to estimate the social value by revaluing agricultural output at world market prices and deducting from this the world market value of the inputs. This assumes that these inputs have alternative uses elsewhere and although this may be the case for some inputs such as fertiliser and fuel, in agriculture this is not likely to be the case for inputs such as capital, labour and other fixed costs. Therefore, in calculating the value added, it will be necessary to take into account the systems used and the relative increases in output on farms.

There are also further resource implications of policies which affect the level of output. This is seen most clearly with milk quotas which reduce the level of output below that which would occur in their absence. This means that the level of output from other sectors is greater than it otherwise would have been. This does not just apply to quotas but also to headage payments or arable area payments where support is based upon production. It is difficult to estimate the impact of this without a general model of the whole agricultural sector to estimate the cropping pattern which would exist in the absence of support. The value of the quota would give an indication of the distortion to that market but not help in the calculation of the social value of output which is still at the world market price.

To calculate the value added, the farming systems in Nix Farm Management Pocketbook were used. It is assumed here that the farming systems are the same under domestic and world prices. Where possible an average of three years data has been used to calculate the value added. In some cases, especially where there has been a radical policy change, the transitional period has only just ended, then the latest years data has been used.

The value added has been calculated at both domestic and world prices for the UK, as has the public exchequer costs, for a selected number of commodities, as reported below. Firstly the relevant policies are outlined and the methodology of calculating the value added and public exchequer cost described. In the case of inputs, the UK tariff of 5 per cent for fuel, 6 per cent for pesticides, and 7 per cent for fertiliser are used (HM Customs, 1996); the same protection for output as for inputs is assumed for seed and livestock; and on other inputs no protection is assumed. The results of the analysis are summarised in Table 2 for arable crops and in Table 3 for livestock crops. The detailed calculations are presented in the appendix in Tables A.1, A.2, A.3 and A.4.

Cereals

The CAP was, and still is, based upon price support, with the original cereal regime effectively forming the blueprint for other sectors. After the McSharry reforms, the only institutional price is now the intervention price which has fallen in stages to be closer to world market levels. This was originally proposed to be 90 ECU/tonne in 1995/6 but due to changes in the agri-monetary system this has risen to 119.19 ECU/tonne for crop year 1995/6. The threshold price was abolished under the reforms and the import price is now equal to 155 per cent of the intervention price, thus in 1995/6 this will be 184.74 ECU/tonne. Exports refunds still apply to exports although their level is to be reduced by 36 per cent from the 1986/90 level, over six years starting in 1995.

Producers are compensated for the fall in cereal prices by arable area payments, given the condition that they set-aside a proportion of arable land currently 10 per cent (Agra

Europe). Small farmers, producing less than 92 tonnes of cereals per year, are exempt from set-aside. The compensation farmers will receive is derived from the fixed tonnage payments converted to hectarage payments on the basis of regional yields. The compensation for set-aside is linked to the price compensation (57 ECU/tonne) for cereals. The converted levels for the 1995/6 harvest year is illustrated in Table 1 for UK.

Table 1
Compensation for crops in the UK 1995

£ per hectare

	cereals	oilseeds	protein crops	set-aside	linseed
England	320.05	565.75	462.31	405.43	619.04
Scotland	308.10	633.72	445.03	390.25	595.92
Scotland LFA	283.10	521.67	408.92	358.59	547.57
Wales	280.93	576.78	405.78	355.84	543.37
Wales LFA	274.41	576.78	396.36	347.58	530.52

Source: Agra Europe: CAP Monitor

The change in the cereal regime has effectively fixed the area and location of cereal production, thus any incentive to switch back to grass based production, extensify, diversify or otherwise change farming practice has been removed. Lower cereal prices may encourage cereal based feeding of stock, for example intensive beef production, but this will be counteracted by changes to the beef regime outlined below.

The public exchequer cost of the regime is therefore the arable area payments plus the export refund and storage costs of disposing of any surplus. The arable area payments is £320, the level for England in 1995/6, see Table 1. The level of expenditure on market support has fallen rapidly due to the reform from £400 million in the UK in 1993/4 to £68 million 1994/5. Therefore an average of the two years 1994/5 and 1995/6 is used giving a total of £60 million (MAFF 1996). This is then divided by the average output of cereals in the UK over the two years, of 17.23 million tonnes, to obtain an average public exchequer expenditure per tonne of £3.48, which when converted using average yields is £26 per hectare. Whilst this is not the marginal costs of a change in public expenditure as cereals output varies, it will be used here as a proxy. So the total public exchequer cost of cereals is in 1995/6 estimated to be £346 per hectare.

The EU is self sufficient in both wheat and barley, particularly in the case of feed-quality cereals. Therefore the Social value of a marginal increase in production is the export price the UK can obtain on world markets. As prices in the UK are close to world market prices then domestic prices have been used (HLCA 1996). The detailed calculation of value added at world and domestic prices are given in Tables A.1 and A.2. These show the value added per hectare of wheat was £298 and £314 at domestic and world prices respectively, for winter barley £184 and £198, and for spring barley £119 and £130. So the Social value of one hectare of land under wheat is £314 per hectare, and barley £198 and £130 depending upon whether it is winter or spring.

Milk

The CAP for milk is based on a target price for liquid milk, an intervention price for butter and skimmed milk powder, and a threshold price for twelve milk products. Milk was the commodity which had most consistently been in surplus within the Community. In 1984 the EC introduced a system of milk quotas based on historic production, and production in excess of quota is effectively valueless. The McSharry reforms left the milk regime largely untouched, with the quota system to remain in place until the year 2000. However the target price was abolished in 1995 and variable import levies replaced by fixed tariffs.

The public exchequer impact of changes in milk output would be the cost of storing and exporting surplus production. The average expenditure on milk in the UK from 1992/3 to 1995/6 was £200 million which when divided by the average output gives 14 pence per litre of public expenditure.

The social value of production is the value that would obtain on world markets. This would entail converting liquid milk into butter/skimmed milk powder equivalents to enable trade price to be calculated, (MMB). The value added at both domestic and world prices is given in Tables A.3 and A.4 which shows the value added per cow was £485 at domestic prices and minus £165 per cow valued at world market prices. Thus reducing output of milk would actually be a gain to society.

Sheepmeat

Support for sheepmeat is based upon an annual ewe premium, calculated as the difference between a representative market price and fixed basic price. The

McSharry reforms introduced rights to ewe premia based upon historical production. Farmers in LFA are entitled to an additional annual payment per ewe, the Hill Livestock Compensatory Allowance (HLCA). The LFA is divided into two types of area: Severely Disadvantaged (SDA) where two levels of payment are made, depending on breeding policy and the smaller Disadvantaged Area (DA) where only one rate of HLCA payment is offered. Trade in sheepmeat is restricted by voluntary import quotas with the major suppliers.

The public exchequer cost of sheep production is therefore the ewe premia with any HLCA. The ewe premia was an average of £19.65 per ewe in the lowlands and £25.24 in the uplands. The HLCA was £5.75 per ewe at the higher rate and £3.00 at the lower rate in the severely disadvantaged area (SDA); and £2.65 in the disadvantaged area (DA). The Social value of sheepmeat production in the EU is the price at which alternative supplies could be obtained. Most of EU imports come from New Zealand. The value added for two systems of production are shown in Tables A.3 and A.4. These show that the value added at domestic prices is £12.75 per ewe on the hill and £25.2 on the lowland and at world prices these fall respectively to £9.2 and £17 per ewe.

Beef

The CAP for beef is similar to the original cereals regime. A guide price is fixed with the intervention price set at 90 per cent of this. Intervention occurs when the market or reference price is below the intervention price for two weeks, and continues for three weeks after the reference price is above the intervention price. Import levies and export refunds apply to trade in beef.

The changes to the beef regime include a 15 per cent reduction in the intervention price over three years. The ceiling on intervention was to fall from 750,000 tonnes in 1993 to 350,000 in 1997, with a new safety net if the market price falls to 60 per cent of the intervention price (Saunders 1996).

To compensate farmers for these changes, headage payments on beef animals and suckler cows have been increased. The Special Beef Premium is not only raised but was originally to be paid twice in the animals' lifetime, at the ages of 10 and 22 months, although the commission proposes to drop the second payment. The payment is subject to a maximum of 90 animals per holding and a stocking restriction. The Suckler Cow Premium has also been increased but subject to a system of rights based upon previous stocking.

The beef and suckler cow premiums are subject to a maximum stocking density of 2 Livestock Units (LU) per forage hectare. In calculating the stocking density, all animals eligible for premium are included, that is ewes and suckler cows. There is an additional payment of 30 ECU per head if the stocking rate is below 1.4 per hectare. As stocking densities are calculated using forage area, intensive beef producers lose their right to premia beyond 1992 unless, of course, they have spare forage area.

Again the introduction of rights does to some extent freeze production patterns. However the ability to sell and transfer rights to ewe and suckler cow premia does reduce this to some extent. Beef cows in the LFAs are eligible for the HLCA.

Therefore the public exchequer cost of beef production is the suckler cow premium; special beef premium; the cost of intervention buying and export refunds; and any HLCA. The 1995/6 value of suckler cow premium and special beef premium is used here rather than an average of the last three years as this excludes the transitional period. Therefore the suckler cow premium was £114 per cow and the special beef premium £86 with an additional £29 extensification premium. The HLCA was £47.7 in the SDA and £23.75 in the DA, (FBS, 1996). Thus for the systems given in Tables A.3 and A.4 the suckler cow premium would be full rate plus the higher HLCA giving public exchequer per cow of £191. On the lowland 18 month finishing system the full beef special premium is assumed although this might not be payable due to higher stocking rates. For intensive beef production due to the assumption of no forage area no special beef premium is assumed.

To estimate the Social value of beef production, output has been revalued using EU export prices of beef (MLC). However it should be noted that estimates of world beef prices vary considerably and therefore care should be used in interpreting the results. The value added at domestic prices therefore ranges from £154.9 per cow on hill farms; to £170 per calf on one month finishing; and £44.3 on intensive beef farms. At world prices the value added falls to minus £71 per suckler cow on hill farms; minus £180.3 on 18 month finishing per calf and minus £251 on intensive beef farms. The public expenditure on market support is excluded because it is insignificant at under two pence per liveweight kilo of output and also difficult to allocate to the different production systems.

These results of the financial/domestic value added, public exchequer cost and social value added/opportunity cost are summarised in Tables 2 and 3. This shows that in the case of cereals the domestic value added is less than the social value added due to

protection on inputs, as is the case with oilseed rape. However the cereal crops included here have a positive social benefit.

Table 2
Financial, Public exchequer and Social value of arable output

£ per hectare

	Wheat	Barley (W)	Barley (S)
Private Financial Cost	298.5	184.4	119.5
Social Opportunity Cost	314.0	198.3	130.2
Public Exchequer Cost	346.0	346.0	346.0

The public exchequer expenditure ranged from £346 per hectare in the case of cereals to £560 for oilseed rape, the arable area payments making up the bulk of this.

The domestic value added for livestock is summarised in Table 3 converted from per head into livestock units. The domestic value added ranges therefore from £485 for dairy; £380 in the case of suckler cows; to between £200 and £230 for lowland ewes, hill ewes and suckler cows; down to £98 for intensive beef. All production has a negative value at world prices with the exception of sheep. Public exchequer savings of reducing output range from £770 for dairy; £517 for hill sheep; £255 for hill suckler cow production and £191 and £179 respectively for 18 month beef and hill sheep.

Table 3
Financial, Public exchequer and Social value of livestock output

£ per livestock unit

	Dairy	Beef, Single Suckler	Beef, 18 month	Beef, Intensive	Sheep	
					Hill	Lowland
Private Financial Cost	485.3	206	380	98	213	230
Social Opportunity Cost	-164.8	-95	-401	-558	153	155
Public Exchequer Cost	770	255	191	0	517	179

Therefore the level of support, to UK agriculture is still large despite recent reforms as is illustrated in the next section where these support policies are out in a NZ context.. However the reforms did at least start the process of moving away from support which distorted markets towards direct payments.

EU subsidies and NZ agriculture

To illustrate the level of support to UK agriculture the returns to three types of Canterbury farms have been recalculated using EU/UK prices and subsidies the results are as follows:-

Table 4: Canterbury farm returns with EU subsidies

- Dairy farm $373,000
($55,000 of which direct subsidies)
- 50% greater return than farm incomes in Canterbury

-Beef and Sheep hill - $188,000
($405,000 of which direct subsidies)
- over four times the return in Canterbury

-Summer moist sheep farm - $120,000
($110,000 of which are direct subsidies)
- nearly twice the returns in Canterbury

The differences in the relative amount of subsidies reflecting the different support regimes in the EU. These illustrate the degree of support to UK agriculture in NZ context. However it must be remembered that support in EU has a long history, much longer than that in NZ. Therefore these high support payments have been capitalised into inputs such as land prices. It is this and social factors which mean politically that the removal of agricultural support in Europe is not feasible.

Agri-environmental support schemes

In parallel with, and additional to, these changes, recognising the environmental and social problems with conventional agriculture, the EU has introduced measures to encourage the development and continuation of measures/policies to encourage low input farming. These measures are specific to member states and generally relate to designated areas (Environmentally Sensitive Areas (ESA). They were first recognised in EU policy in 1987 with regulation 760/87 and were strengthened in 1992 as part of the Mac Sharry reforms. The extent of these measures are illustrated in table 5.

Table 5: Agri environmental policies in EU member states

	of agricultural area	Cost Million Ecu per year
Belgium	4.6	7.75
Denmark	7.5	18.58
Germany	25.0	426
Spain	15	139.65
France	21	325.5
Ireland	8	69
Italy	8.4	10.4
Luxembourg	12	2.63
Netherlands	3.3	9.75
Austria	91	335.3
Portugal	19	47.5
UK	16	94.4

Source: Whitby, Ed (1996)

As table 1 shows the area covered by the schemes varies across member state from 3.3 % in the Netherlands to 25 % in Germany, and to the exceptional 91% in Austria. It is significant that Germany's area under environmental schemes is high given Germany's influence in EU policy making.

The Level of EU expenditure on these schemes however is relatively small as a percentage of its budget on agriculture, but given that member states contribute a major proportion of spending actual spending is much higher. EU expenditure has risen from 0 .76% of guarantee agricultural spending in 1994 to 4 % in 1995 and is proposed to be 4.4% in 1997 and 5.3 % in 1998 (Agra Europe 1996).

In addition to the above there are general policy measures, both at the EU level and by member state, encouraging low-input farming such as the nitrate directive which limits the amount of nitrate run-off and other measures adopted by countries to reduce pesticide use. The main two countries affected here are the Netherlands and Denmark, both of which have undertaken to reduce pesticides by 50%.

Future reform of the CAP and its potential effect on NZ

It is generally recognised that the 1992 reforms were just the start of the change in EU agricultural policy and that the next reform round coinciding with the WTO round of negotiations will be as radical.

The change in support from market support to direct headage/area payments has been radical. For example in the UK in 1991/2 72 % of the expenditure was on market support and 27 % on headage/area payments (most of which were for sheep producers). In 1995/6 these percentage has been reversed with only 20 % on market support and 80 % on headage/area payments (most of which was on arable area payments) (MAFF 1996).

In the previous reform round the switch from market to headage/area payments as outlined above are expected to continue. However, recent changes in US policy mean that these payments as they current stand will not be acceptable under the next WTO round as they are based on production (Agra Europe 1997).

The level of expenditure on direct payments in 1995/6 were £2 billion in the UK alone. As stated above these are likely to be banned under the next WTO round. Therefore the increase in non-production based payments to those based upon environmental criteria will expand, especially as public pressure for greater justification for agricultural subsidies grows. When this $2 billion expenditure is put in relation to the £100 million spent on agri environmental schemes in the UK in 1995/6 and the change in farming systems will be extensive.

At the EU level this implies that the current agricultural budget on market support and area/headage payments of around 40 plus billion ecus could be diverted into headage/area payments base upon low-input environmentally sensitive farming, which is a radical change when compared to the 2 billion ecus expenditure on these schemes at the EU level (Agra Europe 1997).

This would transform the output from EU agriculture which has important implications for NZ. Whilst the next trade round will continue dismantling of traditional restrictions on imports as the EU switches to low-input farming systems it may well use these production and process methods to restrict imports not produced under the same or similar conditions. However these reforms would also have the other benefit of reducing EU output, therefore exports; reducing competition for NZ in international markets.

Indications of what this reform are expected to look like in more detail is to be released this summer by Legras the Director generate of Agriculture (Legras 1997).

Conclusion

The estimates of social value of agricultural output in the UK above show that the change in support for cereals has removed much of the market distortion Thus cereals have a positive social value in the UK. However both diary and beef production has negative social value in the UK both sectors continuing to receive a high degree of protection both from the public exchequer and through the market. Sheep has positive opportunity cost of output which is similar whether produced on the hill or in the lowlands. Thus further removal of production based support systems in the UK will have the greatest impact on the dairy and beef sectors.

The next round of CAP reforms will further reduce market distortions. This will have the impact on NZ of freeing up both EU and international markets although the negative effect on some sectors of reducing the quota rent currently earned from preferential access, a factor not discussed in this paper.

However it is not politically feasible for the total removal of agricultural support from the EU, or the UK, so direct payments are expected to increase further in importance. These direct payments will likely to be conditional on low-input farming schemes. The threat, or opportunity, to NZ is that these policies will be used as basis for restricting trade in products not produced under similar conditions and therefore may well mean NZ to obtain continued access to the EU may have to alter its production methods as well.

Appendix

Table A.1
Value added of arable crops at domestic market prices

£ per hectare

	Wheat	Barley (W)	Barley (S)
Output			
Yield, tonnes/ha	7.3	6.0	5.0
Domestic Price £/tonne	114.0	114.8	114.8
Output, £/hectare	826.4	689.0	574.2
Inputs, £/hectare			
Fertiliser	73.3	66.7	54.2
Pesticides	110.0	90.8	50.8
Fuel	76.7	76.7	76.7
Seed	45.0	47.5	50.0
Contracting	223.0	223.0	223.0
Transport			
Total Inputs	528.0	504.7	454.7
Value Added, £/hectare	298.5	184.4	119.5

Table A.2
Value added of arable crops at world market prices

per hectare

	Wheat	Barley (W)	Barley (S)
Output			
Yield, tonnes/ha	7.3	6.0	5.0
Domestic Price £/tonne	114.0	114.8	114.8
Output, £/hectare	826.4	689.0	574.2
Inputs, £/hectare			
Fertiliser	68.2	62.0	50.4
Pesticides	103.4	85.4	47.8
Fuel	72.8	72.8	72.8
Seed	45.0	47.5	50.0
Contracting	223.0	223.0	223.0
Transport			
Total Inputs	512.4	490.7	444.0
Value Added, £/hectare	314.0	198.3	130.2

Table A.3
Value added of livestock products at domestic market prices

per head

	Dairy	Beef,	Beef, 18	Beef,	Sheep	
		(Hill) Single Suckler	month	Intensive	Hill	Lowland
	per cow	per calf	per calf	per calf	per ewe	per ewe
Output						
Yield	5500 lit.	275.0 kg	488.3 kg	460.0 kg	0.8 lambs	1.5 lambs
Domestic Price, £	0.23 lit	1.24 kg.	1.24 kg	1.24 kg.	2.84 kg	34.2 kg.
Output, £	1265.0	341.9	576.2	552.0	21.3	49.5
Other Output, £						
Cull Cows, 22.5 per cent	114.3					
Calves	113.3					
Replacements	-225.3	-61.0				
Cost of calf			-162.0	-236.7	2.7	
Net Output	1267.3	280.9	414.2	315.3	24.0	49.5
Inputs, £ per head						
Concentrates	612.0	41.7	136.3	230.0	3.6	9.6
Forage Grown	76.7	36.3	44.7		3.4	7.3
Forage Bought		15.0	11.0	6.0		
Bedding	10.0	7.0	19.0	13.0		
Veterinary costs	58.3	18.0	16.7	7.5	2.7	4.1
Sundries	25.0	8.0	15.7	14.5	1.6	3.2
Total Inputs	782.0	126.0	243.3	271.0	11.3	24.3
Value Added, £ per head	485.3	154.9	170.9	44.3	12.8	25.3

Note: The stocking rate is assumed to be 2 cows per hectare for dairy enterprises; 0.9 cows per hectare for; 3 calves per hectare for 18 month beef; and 11 ewes per hectare for lowland farms

Table A.4
Value added of livestock products at world market prices

per head

	Dairy	Beef, (Hill) Single Suckler	Beef, 18 month	Beef, Intensive	Sheep Hill	Sheep Lowland
	per cow	per calf	per calf	per calf	per ewe	per ewe
Output, £	616.0	85.5	144.1	138.0	17.8	41.3
Other Output ,£						
Cull Cows, 22.5 per cent	57.2	0.0	0.0	0.0		
Calves	56.7	0.0	0.0	0.0		
Replacements	-112.7	-30.5	0.0	0.0		
Cost of calf	0.0	0.0	-81.0	-118.3	2.7	
Net Output	617.2	55.0	63.1	19.7	20.5	41.3
Inputs, £ per head						
Concentrates	612.0	41.7	136.3	230.0	3.6	9.6
Forage Grown	76.7	36.3	44.7		3.4	7.3
Forage Bought		15.0	11.0	6.0		
Bedding	10.0	7.0	19.0	13.0		
Veterinary costs	58.3	18.0	16.7	7.5	2.7	4.1
Sundries	25.0	8.0	15.7	14.5	1.6	3.2
Total Inputs	782.0	126.0	243.3	271.0	11.3	24.3
Value Added, £ per head	-164.8	-71.0	-180.3	-251.3	9.2	17.0

Note: The stocking rate is assumed to be 2 cows per hectare for dairy enterprises; 0.9 cows pei hectare for sucklers; 3 calves per hectare for 18 month beef; and 11 ewes per hectare foı lowland farms

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FARM MANAGEMENT

A STOCHASTIC SPREADSHEET MODEL FOR ANALYSING INVESTMENT OPTIONS FOR PASTURE DEVELOPMENT ON BEEF CATTLE FARMS

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ABSTRACT

Declining real returns for livestock products over the past decade and increased business uncertainty have raised questions about the profitability of pasture development for beef production. Few studies of farm development in the context of a deregulated and non-subsidised economy for agriculture have been undertaken and those that have, generally have not formally accounted for production and price risk. A stochastic spreadsheet (Microsoft Excel® + @Risk®) model, the subject of this paper, was therefore developed to predict the profitability, feasibility and risk of pasture development. The model includes components of feed demand and supply, stock reconciliations, sale prices, pasture development costs and the farm's cashflow. Pasture was developed at different rates and the model was used to predict the associated physical and financial changes over time. A probability distribution of the net present values (NPV) of the net operating profit after tax and before interest (NOPAT) relative to the status quo situation was derived. The extra pasture was used solely for increasing beef cattle production. Stochastic analysis of the pasture development investment options gave a better insight into the likely outcomes for a project, and would provide a farmer with more information for making a decision on whether, and how, to proceed with farm development. The model could easily be adapted for studying farm development with respect to other types of livestock enterprises.

Keywords: pastures, development, risk, feasibility, profitability, model.

INTRODUCTION

Declining real returns for livestock products over the past decade and increased business uncertainty (Martin, 1994) have raised questions in farmers' minds about the profitability of pasture development for beef production. On the other hand, surveys of New Zealand sheep and beef cattle farmers indicate that farmers who have intensified their level of inputs, particularly in relation to fertiliser, are considerably more profitable than those who have maintained or reduced inputs (Davison, 1988). Other than Daniel (1993), few studies of sheep and beef cattle farm development in New Zealand, in an economic environment where no Government subsidies or inputs on price supports on outputs are available, have been reported. It therefore seemed appropriate to revisit the question of farm development and to utilise the increased power of computers and new risk analysis software to assist with this task. This paper reports on a stochastic spreadsheet model that was developed to predict the profitability, feasibility and risk of pasture development for beef production.

MODEL DESIGN

An inter-temporal simulation model was constructed using the Microsoft Excel and @Risk software to analyse the physical and financial results of implementing a pasture development programme on a pastoral beef cattle farm (Figure 1). The model could be modified to include other classes of livestock. Pasture was assumed to be developed from a 'native' to an 'improved' state, and the number of extra cattle that the farm could support every year was derived from the rate of development, the extra pasture grown and its quality (Figure 2). Changes in cattle numbers are reflected in the sales and purchases for the farm changes in pasture, and hence the farm annual cash flow. The profitability of development options was calculated as the net present value (NPV) of the discounted annual cash balances and the salvage value of the project. The feasibility of development was measured by changes in the size of mortgage held by the business relative to its ability to meet other expenses. Risk was measured as the stochastic dominance of one option over the other using stochastic variables for the beef schedule price and pasture growth.

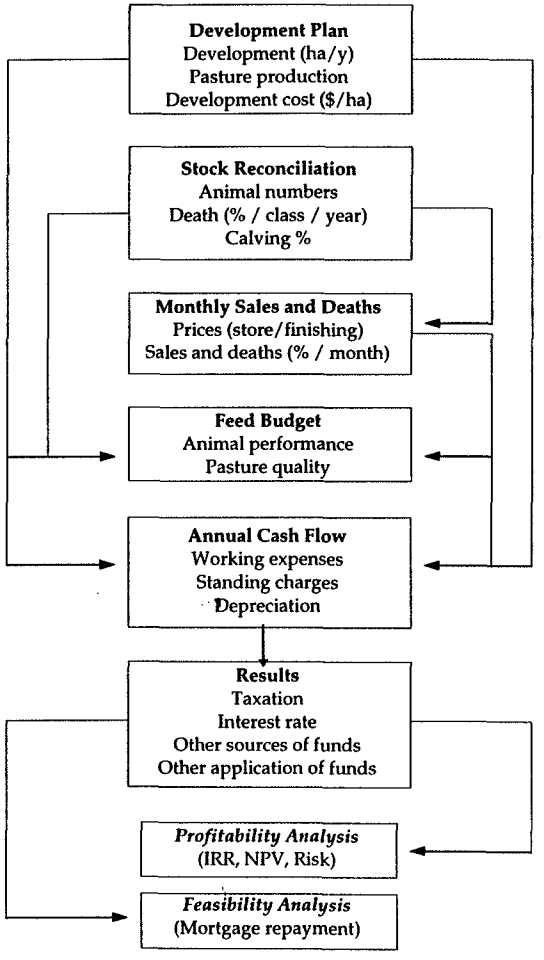

Figure 1: Schematic outline of model components and direction of data flows.

Development Plan

Crop Area	0
New Pasture Area (ha/y)	0
Native Pasture Area (ha)	1157
Development Cost ($/ha)	838
Pasture in Year 1(ha)	7
Pasture in Year 2 (ha)	41
Improved Pasture (ha)	1049
Total Pasture area (ha)	2255
tocking Rate increase	0.00%
Total Project NPV	0
Pasture to develop (ha)	247

Month	Native Pasture Production Actual	New Pasture Production (kgDM/ha/d) Year 1	Year 2	Improved
Jul	10	10	21	21
Aug	13	12	32	32
Sep	21	21	40	54
Oct	31	31	45	56
Nov	35	35	60	60
Dec	31	31	55	56
Jan	19	12	39	38
Feb	16	0	15	39
Mar	25	0	13	50
Apr	23	32	32	49
May	16	24	24	35
Jun	11	15	16	24
Total (kgDM)	7643	6810	11866	15630

Figure 2: Input template for pasture development.

New pasture area

The area of pasture to be improved per year (r), one of the main drivers of development, was specified in hectares. The area of pasture developed each year (χ_j) is dependent on (r) but limited by the total area available for improvement (PD) (Equation 1 & 2), so that when all of the area to be improved has been developed, the value of new pasture area for that year (χ_j) becomes zero (Equation 3).

$$\chi_j = r$$

Equation 1

Provided:

$$PD - \sum_{n=0}^{j-1} \chi_n > r$$

$$\chi_j = PD - \sum_{n=0}^{j-1} \chi_n$$

Equation 2

Provided:

$$0 < PD - \sum_{n=0}^{j-1} \chi_n < r$$

Equation 3

$$\chi_j = 0$$

Provided:

$$PD - \sum_{n=0}^{j-1} \chi_n = 0$$

Where:

r = new pasture area (ha/y);
χ_j = pasture to develop in the jth year (ha);
PD = total pasture to develop (ha).

The value of the improved pasture area (A_{ij3}) increased year by year according to the rate of development (Equation 7). This decreased the area of native pasture (A_{ij0}) (Equation 4, 5 & 6) until it had all been developed (PD). Developed pastures successively increased their monthly production (PP_{ij}) (Equation 8) until they reached their potential in year 3 (Figure 2). Pastures in year 1 or 2 of development (ie. k=1 or 2) were distinguished from those which were undeveloped (k=0) or fully developed (k=3). The same approach was used to estimate the farm average for pasture quality.

$$A_{j0} = A_{(j-1)0} - \chi_{j-1}$$

Equation 4

$$A_{j1} = \chi_{j-1}$$

Equation 5

$$A_{j2} = A_{(j-1)1}$$

Equation 6

$$A_{j3} = A_{(j-1)3} + A_{(j-1)2}$$

Equation 7

$$PP_{ij} = \frac{\sum_{k=0}^{3} (A_{jk} x Y_{ik})}{\sum_{k=0}^{3} A_{jk}}$$

Equation 8

Where:

PP_{ij} = weighted average pasture production in the ith month of the jth year (kg DM/ha);
A_{jk} = pasture area in the ith month of the jth year and k^{th} category (ha);
Y_{ik}= pasture production in the ith month for the kth category (kg DM/ha);
k=0 = native pasture;
k=1 = pasture in year 1 of development;
k=2 = pasture in year 2 of development;
k=3 = improved pasture.

Some items of farm expenditure increase in conjunction with the increase in area of improved pasture. For example, more fertiliser is used on improved pasture areas than on native pasture. The extra inputs were entered as a percentage increase relative to the new pasture area (χ_j), as discussed further in the Annual Cashflow template section. Similarly, the money invested in development each year is dependent on the area developed and the development costs per hectare. The development therefore directly influenced the farm's annual cashflow, and profitability.

Livestock inventory

The 'Stock Reconciliation' template was designed to enter the number of animals wintered on the farm, the calving percentage (%), animal losses (%), the percentage (%) of cows and bulls replaced per year, and the percentage of stock (in stock units) other than beef cattle on the farm. This allowed a status quo stock reconciliation for the farm to be calculated and net sales to be determined. Gross cattle revenue was calculated as a function of the number of animals sold, their liveweight and dressing out percentage and the monthly schedule price. Opening stock numbers were converted to stock unit (su) equivalents (Cornforth and Sinclair 1984) to calculate the stocking rate/effective hectare of grazing land.

When development occurred, commensurate adjustments in stocking rate and animal sales were made each year by decreasing sales or increasing purchases. This adjusted the stocking rate (Equation 10), relative to the amount of pasture eaten in the status quo situation (Equation 9). It was necessary to stabilise the first year's feed budget of the farm with a constant (α) because no measured pasture growth data were available. The Grow model (Butler, 1994) was used to generate the data required. The same constant was retained to equilibrate the feed demand and supply during the development program. In a more sophisticated pastoral system model it would be prudent to adjust for the effects of surplus pasture on feed quality (see, for example McCall, 1984).

The proportion of livestock in each animal class on the farm was kept constant over time, and it was assumed that 50% of the progeny were bulls and heifers, respectively. A nominated percentage of bulls could be castrated and replacement heifers could be mated at either 15 or 27 months. To simplify calculations nominated values were held constant over the life of the project.

$$\frac{N_0 x C_0}{PP_0 x A_0} = \alpha \qquad \textbf{Equation 9}$$

$$N_j = \frac{\alpha(PP_j x A_j)}{C_j} \qquad \textbf{Equation 10}$$

Where:

N_j = Number of animals in the jth year;
C_j = Animal consumption in the jth year (kg DM/animal);
j=0 = Status quo situation of the farm (before development);
α = percentage of pasture eaten by stock;

$$PP_j = \sum_{i=1}^{12} PP_{ij};$$

$$A_j = \sum_{k=0}^{3} A_{jk}.$$

Livestock sales and deaths

A 'Sale and Death' template was used to input the percentage of animals sold and killed or lost in each month of the year for each animal class. These inputs determined the number of animals sold and lost in each month and this information was incorporated in the feed budget. Animals could be sold either as store (per head price) or finished ($ per kg of carcass weight). The selling option for each category of animals, and the prices for store and finished animals for each month of the year and for each animal class were also entered in this template. The taxation implications of changes in cattle numbers, through the herd scheme, were entered into this template as well. The sale value of animals was

calculated from their liveweight (calculated), dressing out percentage (user-defined) and schedule price (user-defined).

Feed budget template

The 'Feed Budget' template was used to calculate feed demand and supply for the case-farm. Performance in terms of liveweight gain was entered for each month of the year and animal class and pasture quality values are entered per month (Figure 3). Animal numbers enter automatically from the stock reconciliation, and sale and death templates. Animal performance (liveweight change, calving %) and pasture quality parameters were utilised to predict animal intake and the total quantity of pasture consumed.

MONTH	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Cows	665	665	664	653	647	642	641	641	640	640	639	532
Intake/head/day	12.7	14.2	7.0	6.4	7.1	8.1	9.0	7.4	4.3	3.9	7.4	8.7
Initial liveweight	380	411	440	418	402	387	372	364	357	349	349	365
Liveweight gain/day	1	1	-0.75	-0.5	-0.5	-0.5	-0.25	-0.25	-0.25	0	0.5	0.5
End liveweight	411	442	418	402	387	372	364	357	349	349	365	380
R1yr Steers	296	296										
Intake/head/day	3.6	3.6										
Initial liveweight	179	195										
Liveweight gain/day	0.5	0.5										
End liveweight	195	210										
R2yr Steers	500	499	296	503	503	503	503	502	502	502	502	501
Intake/head/day	8.5	8.5	4.6	6.1	7.9	8.8	9.0	8.0	10.3	8.1	9.0	7.7
Initial liveweight	453	469	210	225	256	286	317	341	362	393	415	438
Liveweight gain/day	0.5	0.5	0.5	1	1	1	0.75	0.75	1	0.75	0.75	0.5
End liveweight	469	484	225	256	286	317	341	362	393	415	438	453

Figure 3: Partial view of the feed budget template where animal performance data are entered. Required inputs are shaded.

The user can follow the liveweight pattern of animals during the year and manipulate the level of animal intake to achieve a biologically feasible pattern of monthly pasture cover (Marshall et al., 1991). Animal intake requirements were based on their liveweight, rate of liveweight gain and quality of pasture consumed (Geenty & Rattray, 1987).

Pasture quality

Pasture quality was expressed as megajoules of metabolised energy per kilogram of dry matter (MJ ME/kg DM) for each month of the year for the various pasture types. The pasture quality values used in the feed budget represented the weighted average of the "native" and improved pastures (Equation 11). Improvements in pasture quality influenced animal performance. In the case of this model, increases in quality were used to increase stocking rate rather than the performance of existing animals.

$$Q_{ij} = \frac{\sum_{k=0}^{3}(q_{ik} x A_{jk})}{\sum_{k=0}^{3} A_{jk}} \qquad \textbf{Equation 11}$$

Where:

Q_{ij} = weighted average of pasture quality for the ith month of the jth year;
q_{ik} = pasture quality for the ith month of the kth class of pasture.

Annual cashflow template

The 'Annual Cashflow' template calculated the farm's annual cash flow for stock sales, farm working expenses, standing charges and depreciation. Gross cattle revenue, total farm expenditure, and the farm's annual cash surplus were also derived by this worksheet. Total farm expenditure increased during the project according to the correlations between the various expenditure categories and their assumed association with stocking rate and the area of improved pasture.

Working Expenses	Value $	Cor. Stocking Rate	Cor. New Pasture
Wages	230000	0%	0%
Administration	15244	0%	0%
Animal Health	50000	80%	0%
Contract	0	0%	0%
Electricity	3510	0%	0%
Feed and Grazing	21413	0%	0%
Fertiliser	110000	0%	75%
Freight	5187	0%	0%
Fuel	12223	0%	0%
Lime	0	0%	0%
Repairs and Maintenan	80000	0%	0%
Seeds	0	0%	0%
Vehicles	16501	0%	0%
Weed & Pest Control	20000	0%	50%
Other expenses	195750	0%	0%
Standing Charges	**Value $**	**Cor. Stocking Rate**	**Cor. New Pasture**
Insurance and ACC Le	0	0%	0%
Rates	37929	0%	0%
Managerial Salaries	0	0%	0%
Interest	0	0%	0%
Rent	19722	0%	0%
Depreciation	40405		

Figure 4: Input template for farm working expenses, standing charges and depreciation.

Farm working expenses for the status quo situation were held constant during the whole project unless the items were positively correlated with an increase in cattle numbers and/or an increase in the area of improved pasture. Depreciation was based on a straight line calculation from the farm's capital assets (user defined).

All items of farm expenditure and standing charges could be correlated to an increase in improved pasture and/or an increased stocking rate. For example, if animal health expenditure increased as the stocking rate increased and the correlation was 100%, then if stocking rate in year$_j$ increased by 1%, animal health expenditure increased by 1%. Correlation factors eliminated the need to independently enter farm working expenses for each year of the development project.

Profit and Feasibility template

The 'Profit and Feasibility' template had two main functions: to perform a profitability analysis on the project, and to estimate the feasibility of the project by accounting for the whole farm system. The analysis used data entered from previously described templates, data entered into the template and data simulated by the model. The profitability analysis was derived from the net present value (NPV) of the difference between the NOPAT (Net Operating Profit After Tax and before Interest) of the project's discounted cash flow and the NOPAT of the continuation of the status quo (i.e. the changes expected due to improvements made in previous years).

The feasibility analysis considered the whole farm business, the debt situation of the farmer, drawings and other non-farm income. The feasibility analysis provided an overview of the farm's predicted financial position in the years to come in terms of the need for extra borrowing and mortgage repayments. Inputs for the profitability analysis were: other farm income(s), taxation (%), depreciation on the capital investment (%), capital investment (%), and the discount rate factor (%). Inputs for the feasibility analysis were: sources of funds, application of funds, mortgage initial balance and interest rate (%).

Risk modelling

In this study the probability distribution of net operating profit after tax and before interest (NOPAT) was used as a measure of business risk. Expected NOPAT for the farm system was simulated with the probability distribution of inputs using the @Risk software (Purvis et al., 1995; Patrick and DeVuyst, 1995).

The stochastic values for weather and price, and their respective probabilities were entered in the risk modelling input template. Price risk was entered by fitting historical data to a Fourier curve (Equation 12 & 13). The variables in the equation, and the number of years per cycle, and the first year for the model are user defined. Production risk was calculated from historical data on the farm's water balance deficit and the associated variation in animal production expected by the farmer. The latter was estimated subjectively and inputted into Equation 14 & 15. Gross cattle revenue for the current year was calculated, accounting for the stochasticity in price and production, as shown in Equation 16.

$$\beta = \frac{z}{s} x 360 x \frac{\pi}{180}$$ **Equation 12**

$$P_j = a + b\cos\beta + c\cos 2\beta + d\sin\beta + e\sin 2\beta$$ **Equation 13**

Where:

β = value in radians for the year;
z= year in the cycle;
s = number of years of the cycle;
P_j = cattle price for the ith month of the jth year (NZ$);
a = intercept in the Y-axis (stochastic);
b, c, d, e = coefficients for the Fourier curve (stochastic).

$$R_j = \frac{(W_j - \overline{W})}{\overline{W}}$$ **Equation 14**

$$V_j = R_j xf + R_{j-1} xg$$ **Equation 15**

Where:

R_j = amount of deficit of the jth year as a rate of an average year;
W_j = water deficit for the jth year;
$\overline{W}$ = water deficit of an average year;
V_j = decrease/increase in production for current year;
f = percentage decrease/increase in production for a bad/good year;
g = percentage decrease/increase in production as a consequence of previous bad/good year.

$$G_j = Cr_j * \frac{P_j}{P_{1996}} * (1 + V_j) \qquad \textbf{Equation 16}$$

Where:

G_j = gross cattle revenue in the jth year;
Cr_j = gross cattle revenue in the jth year given 1996 prices;
P_{1996} = cattle price for 1996.

CASE STUDY APPLICATION

The New Zealand case-farm used in the model simulation had 247 hectares of undeveloped land and had recently developed 48 hectares at a cost of $837 per hectare. The 295 hectares of development land represented 13% of the total effective pasture area on the farm. Development offered the potential to double present pasture and animal production on the area concerned through fertiliser inputs and oversowing with more productive and better quality pasture species. The farm is situated to the west of Waitotara in southern Taranaki, and the pastures are being developed on flat sand plains that are free draining and of low to medium fertility, with potential for minor wind erosion. At 1996 beef cattle prices the farm was not able to generate sufficient net operating profit after tax (NOPAT) to meet its financial commitments. Prior to the 1996 decline in beef cattle prices, a surplus was generated. The model was used to calculate possible outcomes for development at rates of 25 and 50 ha/y both at constant 1996 prices and from a simulation of likely price trends from 1996.

Business risk

The incorporation of price and production risk into the analysis changed the value of the NOPAT before interest for the development program. The New Zealand beef cattle prices were assumed to be at a low on a seven year cycle (Figure 5). The historical pattern of prices has not been consistent because beef cattle prices in the international market are influenced by many factors that are not easily predicted. Nevertheless, beef cattle prices for New Zealand are expected to increase in association with the current (1997) decrease in beef cattle numbers in the United States of America.

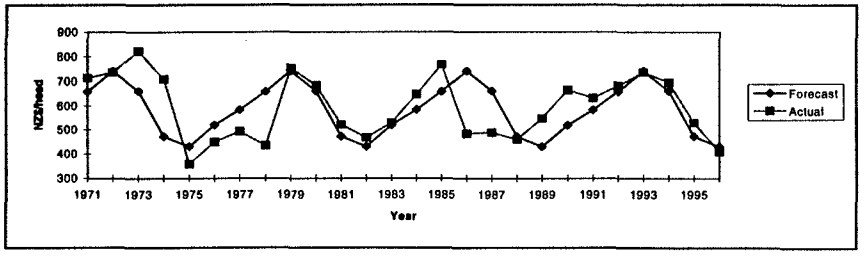

Figure 5: Historical and forecast beef cattle prices for New Zealand.

Production risk was incorporated by simulating between year variation in rainfall; summer drought is the most important weather constraint of the farm. Historical data were used to derive the cumulative probability distribution of a water balance deficit (Figure 6). The effect of rainfall variation on cattle performance (i.e. liveweight at sale) was assessed by the farmer. The average water balance deficit for the farm is 342 mm pa. For a water balance deficit as low as 200 mm the farmer expected cattle to gain 10% in liveweight for the present year and a further 5% the following year. On the other hand, when the water balance deficit was as high as 500 mm the farmer did not expect cattle liveweights at sale in the current year to be lower but a carry-over reduction of 5% in sale weights was expected the following year. Production and price risk using these predictions were incorporated for the three scenarios analysed: status quo, and the development of 25 and 50 ha/y.

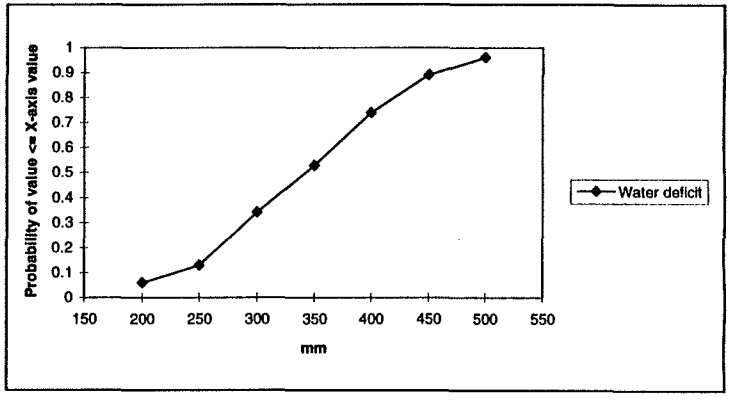

Figure 6: Cumulative distribution of the water balance deficit for the New Zealand case-farm.

Development outcomes

Developing 'native' pasture was profitable at a 6% discount rate when production and price risk were incorporated in the analysis. Gains obtained for developing 50 ha/y or 25 ha/y were large in comparison to the status quo scenario (Figure 7). The 50 ha/y scenario had first degree stochastic dominance over the two other options at a 6% discount rate. The expected increase in the beef cattle schedule from the low returns of 1996 are likely to produce good returns for developing pastures and increasing production. The salvage value of the project and for the status quo, already incorporated in the NPV (Figure 7), did not have a big influence on the NPV suggesting that the development would be profitable even if the salvage value was not accounted for. For either development project (25 ha/y or 50 ha/y) the salvage value was between NZ$ 111,000 and NZ$ 170,000.

In contrast, neither development rate was feasible at 1996 prices, assuming a 6% discount rate, as illustrated by Figure 8. In both cases, the farm would be unable to pay interest on debt and the mortgage would continue to grow through to 2015. Thus, while the project at 1996 prices was profitable overall (e.g. NPV 25/ha/y = $128,500), it could not be funded through time because of the accumulation of debt.

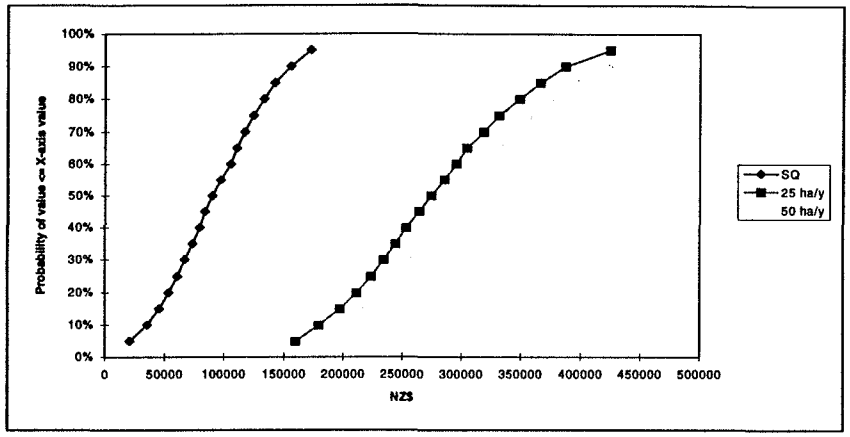

Figure 7: Probability of NPVs for the New Zealand case-farm at a 6% discount rate when future price trends for beef are included.

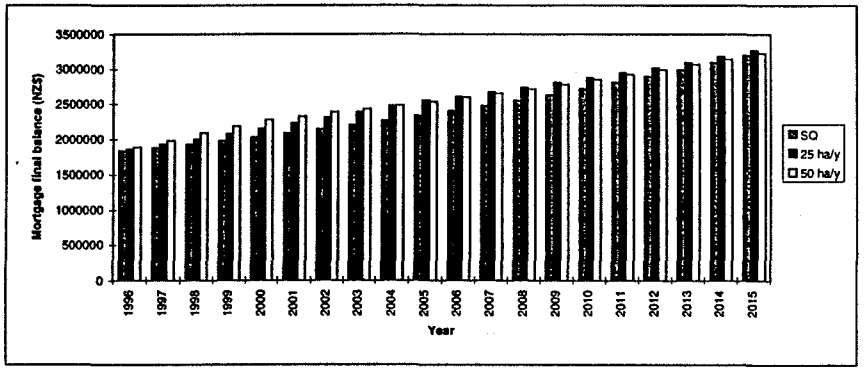

Figure 8: Mortgage final balance for Status quo and for developing 25 and 50 ha/y.

GENERAL DISCUSSION

The spreadsheet software (Microsoft Excel®) together with the @Risk® software provided an easy to use interface through which stochastic simulations could be implemented. In its present form the model fulfilled the objectives of the project, by providing the required information on the profitability, feasibility and risk of a pasture development program. The software is easy to use, widely adopted and flexible, and these attributes provided advantages over a fixed programming approach.

The whole farm approach allowed the financial consequences of development for the whole business to be considered rather than in the narrower terms of a marginal analysis. The farm's cash flow, interest payments and debt situation were modelled and this allowed the farmer to gain an appreciation of the magnitude of changes to the system. The tax liability was assessed and the influence of tax on future cash flows, which in some cases may be substantial, during development was accounted for.

Stochastic simulation was used because the analysis of average values or 'what if' scenarios do not allow the farmer to visualise the variability of the possible outcomes nor to identify the critical inputs for developing the farm system. When analysing the consequence of the variability of more than one input on the final output, the impact of each input as well as its variability on system output is important. This additional insight into the consequences of alternative management decisions is important to farmers who face increased risk in New Zealand's deregulated, market-led economy (Martin 1994).

The present model could be improved by adding options such as a dairy conversion, forestry, cropping or buying/leasing an additional area of land. Stock classes other than beef cattle could be utilised in the model to predict economic returns for pasture development on farms with mixed livestock enterprises. The biological model could be refined but it may be more useful to interface with an existing model such as Stockpol™ (Marshall et al. 1991) than to develop this independently. Improved techniques for forecasting long-term trends in the farm price for animal products would help with the assessment of the financial value of the extra production obtained from improved pastures. For example, in this study the historical factors which influenced beef prices were assumed to also apply in the future; this may not be the case.

CONCLUSION

New Zealand farmers are sometimes required to make decisions, with imperfect knowledge, that are not easily reversible without a significant monetary loss. Whether to invest in pasture development is an example of such a decision. The model reported here generated information for the farmer on the likely results of farm development so that s/he can assess the overall picture of how decisions could affect long-term farm profitability.

ACKNOWLEDGEMENT

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Implications of embryo technology on the structure of the New Zealand beef and dairy herds

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Abstract

Embryo technologies have the potential to provide flexibility to the Beef Industry by allowing the production of high quality table beef in conjunction with the Dairy Industry.

A model of the population dynamics of the national beef and dairy herds is presented, and used to look at the implications of using pure-bred beef embryos in dairy cows and the impact of these pure-bred beef embryos on beef supply in the industry.

This paper focuses on the production of prime and manufacturing beef. The extent to which embryo technology can either improve the efficiency of prime beef production by requiring fewer beef cows, or buffer manufacturing beef production against a trend towards increased Jersey genetics in the dairy herd is indicated in terms of the embryo technology uptake by dairy farmers.

The possibility of reducing the national beef breeding herd is proposed.

1 Introduction

A number of reproductive technologies are potentially available for use in the dairy industry as supplements to natural mating or artificial insemination[3]. Semen sexing would allow the increased production of heifer calves at the expense of bull calves. Oestrus synchronisation also supports the use of other technologies by improving logistics and ameliorating effects of low conception rate on mean calving date. These methods facilitate genetic improvement through sire selection, but do not allow for dam selection. Embryo technologies using *in vitro* produced (IVP) embryos[7] offer even more control over genetic outcomes and allow embryo production from normally inaccessible sources such as pre-pubertal, infertile or slaughtered animals. By inducing a surrogate pregnancy, embryo transfer technology—perhaps using sexed

embryos—allows both dam and sire selection, eliminating the effect of the breeding herds on genetic outcomes

Dairy calves surplus to dairying operations have two fates: they are either bobbied (*i.e.* slaughtered at about a week of age) or more profitably sold for beef production. These latter ("dairy-beef") animals are either Friesian or Friesian×beef: a small breed such as the Jersey is unsuitable for beef industry use.

A scenario presented by SriRamaratnam and Reynolds[5] indicates that an increase in dairy cattle numbers can have the impact of increasing beef production, presumably as a consequence of increased dairy calves born. If there were a high enough demand for dairy-beef animals, the presence of large amounts of Jersey genetics in the dairy herds could act as a limiting factor on availability in such sales.

In such a scenario, embryo technologies could offset such limitations by allowing the production of calves with higher genetic merit for beef production than could otherwise be achieved. Indeed, the use of pure-bred beef embryos in Jersey cows has the potential to provide a source of calves valuable for the production of table beef.

The cost of embryo technologies would determine the viability of their use as a means of producing pure-bred beef animals from dairy herds, as would the conception ratio—Tervit[7] notes that the conception rate for embryo technologies is currently lower than for natural mating or artificial insemination. McCall *et al.*[3] suggest that effects of low conception rates in embryo transfers may be offset through the conjoint use of oestrus synchronisation. For the purpose of this paper, it is assumed that both the cost and reproductive efficiency of embryo technologies make it economically accessible to dairy farmers. The potential of these technologies is indicated.

2 Herd types

New Zealand's national dairy herd is dominated by the Holstein-Friesian (Friesian) and Jersey breeds, with other breeds such as the Ayrshire making a small contribution[2]. For simplicity, dairy breeds are separated into a Friesian (largely Friesian) herd and a non-Friesian herd (including Friesian-Jersey crosses).

For analysis, the national beef and dairy herds are divided into a total of eight herds: three breeding herds and five offspring herds. The breeding herds are taken to be comprised entirely of females (the males used as sires are considered negligible in number). Two of the breeding herds are of dairy animals (Friesian, F, and non-Friesian, N), while the third is of beef breeding cows (with no breed distinction made). From these herds come the 5 offspring herds: Friesian and non-Friesian dairy females (y and x respec-

tively), dairy males (z), and beef males and females (u and v respectively), as is summarised below.

- Breeding herds:
  - Non-Friesian, N
  - Friesian, F
  - Beef, B
- Offspring herds
  - Non-Friesian females, x
  - Friesian females, y
  - Dairy males, z
  - Beef males, u
  - Beef females, v

The breeding herd variables (N, F, B) are taken as one-dimensional quantities. The offspring herds variables (x, y, z, u, v) are each 4-dimensional vectors corresponding to year classes 0, 1, 2, 3, where class 0 corresponds to the calf stage. The following shorthand notation is used for the offspring herds,

$$\{\xi_\alpha\} = \{x, y, z, u, v\}, \tag{1}$$

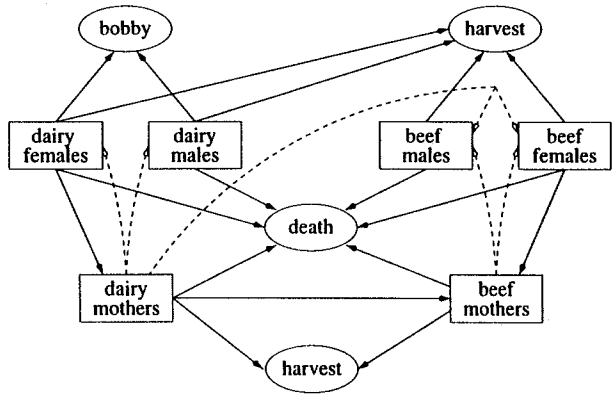
These offspring herds are classed only according to their sex and breed type, and not according to the breed of the cows which bore them. For example a calf from a Friesian sire across a Jersey-Friesian dam would be classed as a Friesian (predominately Friesian) if it had sufficient Friesian genetics to give it Friesian qualities; else it would be classed as a non-Friesian. Thus all three breeding herds can make a contribution to each offspring herd. This recognises the distinction between genetic and surrogate motherhood, which occurs when embryo technologies are used.

3 Formulation

The beef and dairy year is the year to the end of June. At the end of each year, statistics reflect numbers of animals born in that year, lost or harvested that year, and the sizes of each herd, and the fraction of animals in the breeding herds which are in calf. These herd sizes and pregnancy rates are in fact the starting values for the next year, starting on the first of July.

Time, t, is considered in steps of years, with the understanding that t corresponds to the year from the first of July.

It is assumed that on a national level there are three fates awaiting an animal: it can die a natural death, be harvested (slaughtered) or be transferred to a breeding herd. These fates are depicted in Figure 1, with deaths, harvests and flows of animals from one herd to another indicated by solid arrows. The dashed lines indicate offspring produced by the breeding cows, and include dairy cows acting as surrogates mothers for beef calves. Heifers are transferred only to breeding herds of their breed type; beef breeding cows are not transferred to dairy breeding herds, but dairy animals can transferred to the beef breeding herd. There is no transfer from Friesian to non-Friesian, or *vice versa*.



bold lines indicate flows of animals
dashed lines indicate origins of animals

Figure 1: Schema of fates of beef and dairy animals

In any year, the numbers of animals either dying, harvested or transferred from a herd are expressed in terms of fractions of the size of the herd at the start of the year. The number of calves of a particular class born from a particular breeding herd is given by a calf-type ratio multiplied by the herd size. The parameters used are listed below together with sample parameter values for a scenario without embryo technology. These were estimated from survey data.[6]

- ν_α, μ_α, ω_α are calving ratios of each class type, for N, F and B respectively. These ratios are multiplied by their respective breeding herd to give the number of calves of each class, ${\xi_\alpha}^0$, which are produced by N, F and B each year

  For example the number of non-Friesian females produced by the non-Friesian herd is $\nu_x N$ while the number of Friesian females produced by the same herd is $\nu_y N$—see Table 1 for values estimated for the New Zealand beef and dairy industries.

  The values for these parameters assume both a 57:43 Friesian to non-Friesian dairy herd composition and a 74:26 ratio of Friesian to non-Friesian semen in natural and artificial inseminations[2]. The overall calving rate is assumed to be 0.84 for all three breeding herds.

	Non-Friesian breeders	Friesian breeders	Beef breeders
Non-Friesian females	$\nu_x = 0.25$	$\mu_x = 0.11$	$\omega_x = 0$
Friesian females	$\nu_y = 0.17$	$\mu_y = 0.31$	$\omega_y = 0$
Dairy males	$\nu_z = 0.42$	$\mu_z = 0.42$	$\omega_z = 0$
Beef males	$\nu_u = 0$	$\mu_u = 0$	$\omega_u = 0.42$
Beef females	$\nu_v = 0$	$\mu_v = 0$	$\omega_v = 0.42$

Table 1: Calving ratios of each calf class, for the three breeding herds

- ${\delta_\alpha}^i$ are respective fractions of ${\xi_\alpha}^i$ dying—Table 2
- ${\beta_\alpha}^i$ are respective fractions of ${\xi_\alpha}^i$ harvested—see Table 2; at the year nought stage, the fractions ${\beta_\alpha}^0$ correspond to the calves which are bobbied. Assuming that all non-Friesian males either die natural deaths or are bobbied, ${\beta_z}^0$ would be affected by the Jersey to Friesian composition of the herd: if all males produced were Jersey, ${\beta_z}^0$ would be 0.97

	Natural death	Bobbied/Harvested	
Non-Friesian females	${\delta_x}^i = 0.03$	${\beta_x}^0 = 0.46$ ${\beta_x}^2 = 0.97$	${\beta_x}^1 = 0$ ${\beta_x}^3 = 0$
Friesian females	${\delta_y}^i = 0.03$	${\beta_y}^0 = 0.21$ ${\beta_y}^2 = 0.55$	${\beta_y}^1 = 0$ ${\beta_y}^3 = 0.97$
Dairy males	${\delta_z}^i = 0.03$	${\beta_z}^0 = 0.59$ ${\beta_z}^2 = 0.30$	${\beta_z}^1 = 0$ ${\beta_z}^3 = 0.97$
Beef males	${\delta_u}^i = 0.03$	${\beta_u}^0 = 0$ ${\beta_u}^2 = 0.30$	${\beta_u}^1 = 0$ ${\beta_u}^3 = 0.97$
Beef females	${\delta_v}^i = 0.03$	${\beta_v}^0 = 0$ ${\beta_v}^2 = 0.55$	${\beta_v}^1 = 0$ ${\beta_v}^3 = 0.97$

Table 2: Death and harvest rates for calf classes

- ${\rho_\alpha}^i$ are respective fractions of ${\xi_\alpha}^i$ transferred into breeding herds as replacements—Table 3; for accounting purposes, the transfer of dairy heifers as beef breeding cow replacements is handled by a movement via the Friesian breeders

  The value of 0.84 for ρ_x assumes that the number of non-Friesian females retained in their first year is equal to the required breeding replacements, allowing for a 0.84 calving rate. The other values were estimated from data, and assumes that 25% of replacements in the beef breeding herd are of Friesian or Friesian-Hereford origin, hence the low value for ρ_v.

- For N, F, B, δ is the fraction dying, β the fraction harvested, and ρ the fraction transferred to another breeding herd—the second column in Table 4 reflects the assumption that no Jersey or beef breeding cows are transfered to other breeding herds, but that a fraction of Friesian breeders is used for replacements in the Beef breeding herd. These replacements include both cull Friesians breeders plus rising two-year-old Friesian and Friesian×beef heifers which end up in the beef breeding herd.

The year-nought classes born in year t can be expressed in terms of the sizes and and calving ratios (Table 1) for the breeding herds at the beginning

	Replacements to breeding herds
Non-Friesian females	$\rho_x{}^1 = 0.84$ $\rho_x{}^0 = \rho_x{}^2 = \rho_x{}^3 = 0$
Friesian females	$\rho_y{}^1 = 0.63$ $\rho_y{}^0 = \rho_y{}^2 = \rho_y{}^3 = 0$
Dairy males	$\rho_z{}^i = 0$
Beef males	$\rho_u{}^i = 0$
Beef females	$\rho_v{}^1 = 0.31$ $\rho_v{}^0 = \rho_v{}^2 = \rho_v{}^3 = 0$

Table 3: Transfer rate to breeding herds

of year t:

$$\xi_\alpha{}^0(t) = \nu_\alpha(t)N(t) + \mu_\alpha(t)F(t) + \omega_\alpha(t)B(t). \tag{2}$$

The other age classes for the offspring in year $t+1$ are given in terms of the previous year's classes and the various losses during the year starting at t:

$$\xi_\alpha{}^i(t+1) = \left(1 - \beta_\alpha{}^{i-1}(t) - \delta_\alpha{}^{i-1}(t) - \rho_\alpha{}^{i-1}(t)\right)\xi_\alpha{}^{i-1}(t) \tag{3}$$

The breeding herds in year $t+1$ are expressed in terms of the herd sizes in year t, plus losses and gains (with the assumption that transfers from the offspring herds to the breeding herds are from only the year 1 stage, and that the only transfer between breeding herds is from Friesian to beef):

$$N(t+1) = (1 - \delta_N(t) - \beta_N(t))\,N(t) + \rho_x{}^1(t)x^1(t) \tag{4}$$

$$F(t+1) = (1 - \rho_F(t) - \delta_F(t) - \beta_F(t))\,F(t) + \rho_y{}^1(t)y^1(t) \tag{5}$$

$$B(t+1) = (1 - \delta_B(t) - \beta_B(t))\,B(t) + \rho_F(t)F(t) + \rho_v{}^1(t)v^1(t) \tag{6}$$

4 Solution

From equations (2) to (6), the beef and dairy herds in year $t+1$ can be expressed as

$$\boldsymbol{N}(t+1) = A(t)\boldsymbol{N}(t) + M(t-1)\boldsymbol{N}(t-1) \tag{7}$$

	Natural death	Transferred to other herds	Harvested
Non-Friesian breeders	$\delta_N = 0.05$	$\rho_N = 0$	$\beta_N = 0.12$
Friesian breeders	$\delta_F = 0.05$	$\rho_F = 0.04$	$\beta_F = 0.12$
Beef breeders	$\delta_B = 0.05$	$\rho_B = 0$	$\beta_B = 0.12$

Table 4: Death, harvest and transfer fractions for breeding herds

$$\boldsymbol{N} = \begin{pmatrix} N \\ F \\ B \end{pmatrix}, \tag{8}$$

where

$$A = \begin{pmatrix} \psi_N & 0 & 0 \\ 0 & \psi_F - \rho_F & 0 \\ 0 & \rho_F & \psi_B \end{pmatrix}_{|t}, \tag{9}$$

$$\left| \begin{array}{l} \psi_N = 1 - \delta_N - \beta_N \\ \psi_F = 1 - \delta_F - \beta_F \\ \psi_B = 1 - \delta_B - \beta_B \end{array} \right., \tag{10}$$

$$M = \begin{pmatrix} \rho_x{}^1 & 0 & 0 \\ 0 & \rho_y{}^1 & 0 \\ 0 & 0 & \rho_v{}^1 \end{pmatrix}_{|t} \times \begin{pmatrix} \zeta_x{}^0 & 0 & 0 \\ 0 & \zeta_y{}^0 & 0 \\ 0 & 0 & \zeta_v{}^0 \end{pmatrix}_{|t-1} \times \begin{pmatrix} \nu_x & \mu_x & \omega_x \\ \nu_y & \mu_y & \omega_y \\ \nu_v & \mu_v & \omega_v \end{pmatrix}_{|t-1}, \tag{11}$$

$$\left| \begin{array}{l} \zeta_x{}^0 = 1 - \beta_x{}^0 - \delta_x{}^0 - \rho_x{}^0 \\ \zeta_y{}^0 = 1 - \beta_y{}^0 - \delta_y{}^0 - \rho_y{}^0 \\ \zeta_v{}^0 = 1 - \beta_v{}^0 - \delta_v{}^0 - \rho_v{}^0 \end{array} \right. . \tag{12}$$

Equation (7) is a system of second-order difference equations (see reference [1]) and can be transformed to a first-order system by making the

identification

$$K(t) \equiv M(t-1)N(t-1), \tag{13}$$

giving the following system:

$$V(t+1) = Q(t)V(t), \tag{14}$$

$$V = \begin{pmatrix} N \\ K \end{pmatrix}, \quad Q = \begin{pmatrix} A & I \\ M & 0 \end{pmatrix}. \tag{15}$$

For the case when $A(t)$ and $M(t)$ are constant with time (reflecting unchanged management and harvesting schemes) equation (14) has the solution

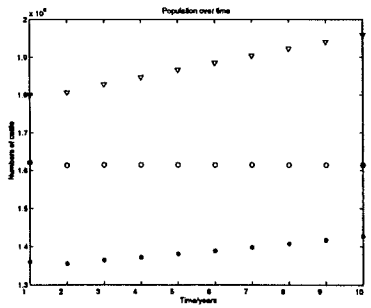
$$V(t+n) = Q^n V(t). \tag{16}$$

A steady state results when $V = QV$.

Examining equation (2), one sees that calves born in year t are determined by the first three components of $V(t)$ (simply the herd numbers N, F and B, respectively), but, as equation (3) indicates, the other calf age groups are determined by values of V in the three preceding years: calves can stay in the calf herds for three years after their birth year.

The values for the parameters in the previous tables approximate a steady state in the short term, and are used in section 5 for analysing the effects of embryo technology on beef production.

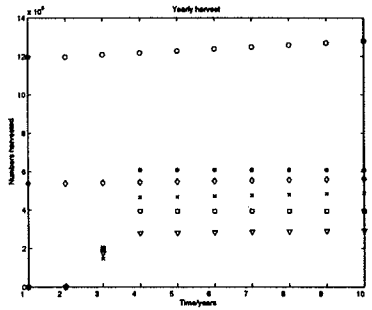
A simulation was performed for a system in which the dairy herds are increasing, with results graphed in Figure 2. With the management schemes



▽ Friesian ○ Beef ∗ Non-Friesian

Figure 2: Breeding herd population over time

corresponding to this simulation, beef herd numbers remain fairly constant while there is an increase in both non-Friesian and Friesian dairy herds. From N, F and B, values for calf class sizes and harvests are obtainable from equations (2) and (3). Harvests for this sample management strategy are given in Figure 3. A constant beef herd size in this scenario accords



○ Bobby calves × Dairy male ▽ Dairy female
∗ Bull beef □ Female beef ◇ Breeding cow

Figure 3: Animals harvested each year

with constant harvests of both male and female beef animals, while the increase in dairy herds and concomitant increase in dairy calves born gives rise to increasing bobby calf and dairy male slaughter. The harvesting of dairy females is buffered against increased dairy females being born by the transfer of some of these animals to the breeding herd. An effect of this is the delayed increase in cull-cow beef.

Since no assumption has been made about the sizes of the calf classes for $t = 1995$, the predictions reflect harvests from only the 1995 breeders and animals born in or after 1995. The first three years show the relative impact of each year class on harvests.

5 Impact of embryo technology

Substituting parameter values from Table 4 into A and those from Tables 1, 2 and 3 into M, gives:

$$A = \begin{pmatrix} 0.83 & 0 & 0 \\ 0 & 0.83 & 0 \\ 0 & 0 & 0.83 \end{pmatrix}, \quad M = \begin{pmatrix} 0.11 & 0.05 & 0 \\ 0.07 & 0.13 & 0 \\ 0 & 0 & 0.17 \end{pmatrix}. \tag{17}$$

Assuming a 43:57 ratio for non-Friesian to Friesian[2], and using beef and dairy cattle numbers for the 1994 and 1995 June years[4], numbers for the breeding herds are shown in Table 5. These give an approximately steady-

t	N	F	B
1994	1.28×10^6	1.71×10^6	1.58×10^6
1995	1.36×10^6	1.80×10^6	1.62×10^6

Table 5: Breeding herd sizes

state system which is useful for indicating impacts of technologies such as embryo transfer.

Animals of dairy origin which are used for beef ("dairy-beef") are largely Friesian. Non-Friesian dairy animals being generally too small for use on beef farms are either bobbied if not retained for breeding/milking purposes.

Since dairy-beef animals make up a significant proportion of animals reared on beef farms, the trend towards increased Jersey genetics in the dairy herd would see a decline in dairy-beef animals and thus beef production (although bobby calf production would increase). Increasing the beef herd would offset the decline in beef animals; the adoption of embryo technology on the non-Friesian herd could do so also. Now, from equations (2), and (3), and Tables 2 and 3, 26% of dairy females are used for beef (these will mainly be Friesian-Hereford crosses) and 64% of males (assuming that all non-Friesian males are bobbied). Thus 45% of all Friesian and Friesian×-beef calves born are used in beef production.

Suppose a trend towards Jersey genetics in the dairy industry saw a reduction of the Friesian herd by a fraction r, from F to $(1-r)F$, with an accompanying increase of rF of the non-Friesian herd. Also suppose the ratio of Friesian to "Jersey" semen used changes such that both the Friesian calves born per Friesian breeder and the Friesian calves born per non-Friesian breeder are reduced by a fraction r. To keep the calving ratios constant, the number of non-Friesian calves born per dairy cow must increase.

Then, the reduction in Friesian calves being born would be $r(.90F + .34N) - .28r^2F$, and with the losses incurred through natural death and bobbying, and adjusting for the decreased number of females needed for replacements in the Friesian breeding herd, the loss of animals flowing to the beef industry would then be $r(.45F + .23N) - .19r^2F$. If embryo technology were to buffer this loss, the number of animals born from embryo technology to the non-Friesian herd would be $r(.48F + .25N) - .20r^2F$ (allowing a 3%

death rate at each stage).

Tian *et al.*[8] showed that in a system using sex control for the production of replacement heifers, 3 times as many beef calves from embryo technology can be produced as in a non-sexed system (ratios of beef calves to cows were 0.39 and 0.13 for sexed and unsexed dairy systems, respectively).

It is assumed that the average farm contains 158 dairy animals[6], that the Friesian to non-Friesian mix is uniform throughout the herds, that calf sexing adoption is uniform throughout the industry and that only non-Friesians are targeted for beef embryo transfers. If embryo transfers of beef embryos are to buffer a percentage decline in the Friesian herd in favour of increased numbers of non-Friesians, certain levels of adoption of this technology by dairy farmers are needed. These required adoption levels are shown in the last two rows of Table 6, for farms both using and not using sexing technology to obtain replacement heifers. For an industry using sexing technology (a sexed system), a 10% adoption rate is needed to buffer a 5% decline in the Friesian herd; for a decline of 20%, a 34% adoption rate is needed. The level of embryo technology adoption needed is three times as high for unsexed systems as for sexed systems.

Required adoption rates are buffered by the increase in numbers of non-Friesians per herd, allowing more embryo transfers per herd. Also, since a substantial number of Friesians are born (see Table 1) from non-Friesians, this also has a buffering effect on the loss of Friesians to the dairy industry.

In this scenario, both the total numbers of animals raised for beef and the total numbers of breeding animals are unchanged. Cull-cow beef (beef from culled breeding cows and barren non-Friesian females from the rising two-year-old cohort) is almost constant for any change in the composition of the dairy herd since the proportion of breeding animals harvested is independent of their breed. However, the increase in non-Friesian breeders has a slight flow-on effect with a small increase in cull-cow harvest (row 3 of Table 6). Rounding errors exaggerate these effects: overall beef harvests are negligibly increased (0.4% increase).

However, with increased beef embryo transfers performed on the dairy herd, the proportion of dairy animals harvested for beef decreases in proportion to the proportion of pure-bred beef animals being harvested. These trends are shown in the first two rows of Table 6, with prime beef increasing from a 44% share of total harvests (for no decline in Friesians) to a 53% share (for a 20% decline in Friesians). Concomitantly, the fraction of beef which is of dairy origin decreases from 29% to 20%. The fourth row in the table shows an increase in the number of prime beef harvests.

Embryo technology could also buffer beef production against a fall in the beef breeding herd (or indeed be used to reduce the latter). Since all non-Friesians males and non-Friesian females not intended for milking or

Beef composition	% Reduction in Friesians 0	5	10	15	20
% Beef of dairy origin	29	27	25	23	20
% Pure-bred beef	44	47	49	51	53
% Cull beef	26 *	26	26	27 *	27
% Increase in prime beef	0	4	9	13	17
Required ET adoption %					
Sexed system	0	10	19	27	34
Unsexed system	0	30	57	81	—

* failure to add to 100% caused by rounding errors

Table 6: Implications of embryo technology used to buffer a decline in Friesian herd

breeding use are bobbied, they have little impact on beef numbers. This allows the opportunity to replace beef breeders by using embryo technology to produce beef calves instead of non-Friesian calves from the dairy herd.

This opportunity is useful in a scenario where beef farm resources are fully utilised: embryo technology could be used to reduce the beef breeding cow population and allow those resources to be used by animals reared for beef. Assuming a beef cow is equivalent to 6 stock units, and a beef animal to 4.5 stock units, 1.33 beef animals could conceivably be grazed for each beef breeding cow removed from the system (assuming that the quality of feed is high enough for finishing a beef animal). Since a finishing animal must be grazed for a period of up to 3 years—ignoring grazing costs at the calf (year nought) stage, the number of extra finishing animals needed each year will be significantly less than 1.33 times the number of beef cows removed.

Suppose the beef breeding herd is reduced by rB. Allowing for harvests made of animals in their second year, it was estimated through simulation that the number of extra finishing animals entering their second year which are required to use the freed resources is $.58rB$.

Analysis of equations 2–6 shows that reducing the beef breeding herd, B, by a fraction r would actually allow $.04rB$ Friesian females to be finished for beef instead of being used as replacement beef breeding cows. The reduction in beef animals coming from the beef breeding herd would be $.66rB$. Allowing for natural deaths at each stage, maximal utilisation of resources would require $1.28rB$ beef animals from embryo technology applied to the non-Friesian herd.

Results of simulations for several different values of r show that the ratio of pure-bred beef to total beef increases with a reduction of the beef breeding herd, while this ratio for cull-cow beef decreases (Table 7). The fraction of beef which is of dairy origin decreases slightly (obscured by rounding effects). The percentage decrease in cull-cow beef accompanies an actual reduction in numbers of harvested breeding cows and the percentage increase in pure-bred beef accompanies an increase in harvests from pure-bred beef animals. However, the percentage decrease of dairy-beef harvests with increased r simply reflects increased total beef production: the actual numbers of dairy animals harvested increases slightly.

Beef composition	% Drop in beef cows 0	5	10	20
% Beef of dairy origin	29	29	29	28
% Pure-bred beef	44	45	47	49
% Cull-cow beef	26 *	26	25 *	23
Efficiency of beef farming				
% Increase in prime beef production	0	4	8	16
% Increase in total beef production	0	2	3	6
Pure-bred beef calves/beef cow %	84	91	98	116
Pure-bred beef to finish/beef cow %	66	73	80	96
Total beef to finish/beef cow %	110	119	129	152
Required ET adoption %				
% Adoption rate: sexed	0	20	39	78
% Adoption rate: unsexed	0	59	—	—

* failure to add to 100% caused by rounding errors

Table 7: Implications of embryo technology buffering of beef breeding herd reduction in order to keep beef farming resource use constant

The increase in pure-bred beef production with a decreased beef breeding herd is more marked than the increase in total beef production (entry lines 4 and 5 of Table 7); the latter is mediated by the stability of dairy-beef harvests and the decline in cull-cow beef.

The ratio of pure-bred beef calves born per beef breeding cow increases rapidly with a decline in the beef breeding herd (entry line 6 of Table 7). The difference between the number of pure-bred beef calves born per cow, and the number available for finishing (entry line 6) is due to natural death

and the use of some females as replacement breeders.

The required rates of adoption, by dairy farmers, of embryo technology in order to implement the different levels of decrease in the beef herd are shown in the last two entries of Table 7. Again, as was the case for buffering against a decline in the Friesian herd, the required adoption rates for a dairy industry not using sexing technology are three times as high as for one that uses sexing technology to obtain replacement milking heifers. The required rates are relatively high (so much so that embryo technology, when not used in conjunction with sexing technology for dairy replacements, cannot buffer even a 10% decrease in the beef herd).

Both Tables 6 and 7 clearly indicate that embryo technology use in the dairy sector has more impact on beef sector production if a sexed dairy system is used.

There also appears to be more potential for embryo technology to buffer a fall in the Friesian herd, than to implement a reduction in the beef breeding herd: the rate of technology adoption required is much less for the scenario of reducing the Friesian herd than it is for reducing the beef herd.

The increase in total beef production with adoption rate of embryo technology is greater when the beef herd is reduced than when the the Friesian herd is reduced; however the reverse holds for the increase in prime beef production. Therefore it is not clear which scenario would be more profitable to the beef industry, and thus allow greater return to dairy farmers adopting embryo technologies.

The 20% rate of adoption required in a sexed system for even a 5% reduction of the beef herd may be difficult to implement in the short to medium term. The question must be asked whether increased beef-industry profits from the forecast 2% increase in total beef production would be sufficient to pay for the required embryo transfer calves from the dairy industry: this would determine the level of adoption of embryo technologies by the dairy industry.

In conjunction with sexing technology, embryo technologies can be used to improve efficiency of animal use in both the beef and dairy industries.

However, overall efficiency needs to be evaluated. Apart from the cost of implementing the technology, factors such as nutrient requirements (whether the extra beef animals can be suitably grazed on the pasture made available by the breeding herd reduction) need to be taken into account. Also, there are extra are milk feeding costs when dairy animals produce pure-bred beef calves from embryo transfers, instead of dairy calves which can be bobbied. The effect of using embryo technology to reduce the beef breeding herd while maintaining the same population of calves retained over both industries is to increase the ratio of calves needing milk to the mothers available to feed them.

These are only some of the issues that can bear on the viability of using embryo technologies in the beef and dairy industries. While this paper has indicated some of the potentials of using embryo technology, the economic implications are yet to be considered, to gauge the impact of embryo technologies could have on dairy and beef farming.

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THE POTENTIAL FOR OUT-OF-SEASON BEEF FINISHING SYSTEMS ON FARMS IN THE LOWER NORTH ISLAND

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ABSTRACT

Beef production in New Zealand is strongly seasonal and reflects the pattern of pasture production on which livestock farming is based. The aim of this study was to investigate the potential of Out-of-Season (OOS) beef finishing systems to reduce the seasonality of beef cattle supply to meat processors. The study focused on developing an understanding of the biophysical, social and economic factors that would affect the implementation of OOS policies for a sample of 14 farmers in the lower North Island. A Farming Systems Research (FSR) approach provided the framework for the field work and methods used in the study. Semi-structured interviews with key informants and 14 farmers with contrasting farming resources in a defined study region were completed. Data were obtained from these farmers in order to identify the constraints, costs and opportunities they associated with OOS beef finishing policies. Three in-depth case farm studies were then conducted. The whole-farm computer simulation model, StockPol™, was used to investigate and quantify the costs and implications of OOS finishing systems for each case farm.

Although processing and marketing representatives believe that on-farm OOS finishing systems provide a realistic option for addressing seasonal supply disadvantages, farmers believe that OOS finishing systems are less suited to and more demanding of their pasture-based systems. The effects of OOS policies on winter feed levels, summer pasture quality, and soil damage were identified by farmers as constraints to their adoption. Simulation of alternative production systems for the case farms suggested that premiums for cattle produced OOS would need to be about 20% above normal schedule payments in order to compensate for the lower biological efficiency of OOS systems.

Keywords: Out of season, beef supply, farming systems, farm modelling.

INTRODUCTION

Beef production in New Zealand is seasonal. This seasonality is clearly shown in monthly livestock slaughter data and is reasonably repeatable across years (Figure 1). The seasonality of livestock slaughter results from limitations imposed on producers by the pattern of pasture production on which New Zealand livestock farming is based, and the natural breeding cycle of the livestock farmed.

Improving the continuity of beef production has the potential to increase returns to the New Zealand meat industry by increasing its competitive advantage in two important areas. First, the higher priced markets for beef require a reliable, year round supply of quality chilled beef cuts (Frith, 1992). Second, the seasonal slaughter of livestock lowers the utilisation and efficiency of capital and human resources invested in meat processing plants (Sheppard, 1982; Taylor and Clarkson, 1982). A more uniform supply of beef cattle from producers would, in the long-term, increase the utilisation of processing capacity and lower the average fixed costs of processing.

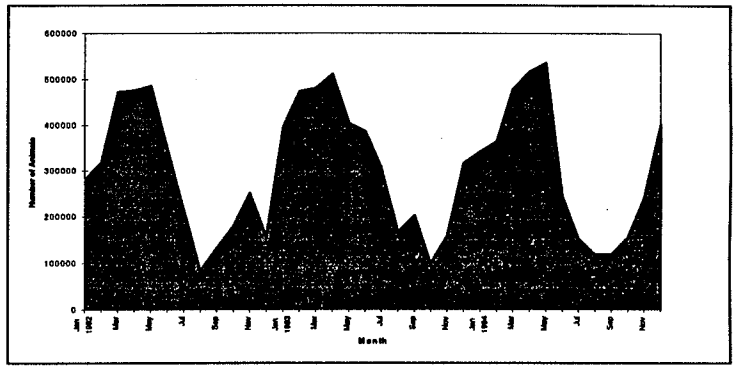

Figure 1 Monthly export beef slaughter pattern from 1992 to 1994.

Increased use of out-of-season (OOS) beef production systems on farms provides one mechanism to reduce the seasonality of beef supply. Through these systems, farmers would produce a greater proportion of beef cattle for slaughter during the winter and early spring months when livestock supply is traditionally low as illustrated in Figure 2. This paper reports on the potential use of OOS beef production systems as a method to reduce the seasonal supply of beef cattle within the New Zealand beef industry. The study focused on the on-farm implications of the use of OOS production systems in the lower North Island and utilised Farming Systems Research (FSR) methodology. The goal of Farming Systems Research in agriculture is to develop solutions and technologies with increased relevance to, and consequently higher adoption by, end-users (Merril-Sands, 1986; Brazendale, McRae, and Reid, 1993). To achieve this outcome, FSR methods seek to incorporate the circumstances and constraints of farmers and other end-users of research through their active participation in the investigation and development of solutions and technologies. Any exploration of the potential benefits to the meat industry of a more continual supply of beef cattle must take into account the constraints and circumstances that exist on farms to changing beef cattle production systems.

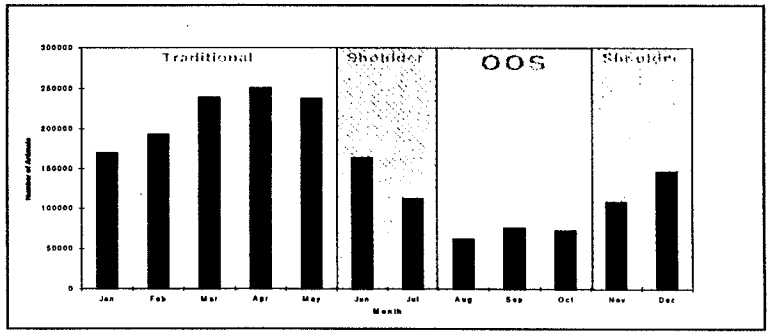

Figure 2 Definition of OOS, Shoulder and Traditional Beef production periods relative to the average number of beef cattle slaughtered between 1991-1994.

METHODS

The study comprised three phases; preliminarily key informant interviews; farmer interviews and farm case studies. The key informants (Rhodes, 1985) included: three individuals involved at management level in different North Island meat companies; three agricultural consultants operating in the lower North Island; a rural banker; and a research officer with a background in agricultural consultancy. Overall, the individuals provided a range of perspectives and knowledge of the New Zealand meat industry. Semi-structured interview techniques were used to obtain their perspectives on the problem of seasonal beef supply and OOS beef production. This provided a holistic overview of the problem within the "environment" of the meat industry in which farmers operate. Topics covered in the interview included processing, marketing, supply problems, price incentives and payment systems, and on-farm aspects of OOS.

The farmer interviews focused on developing an understanding of the on-farm constraints and implications of OOS beef production systems. Fourteen farmers were interviewed personally, again using the semi-structure interview technique. The farmer interviews were completed within a transect of the Manawatu region and included farms in a range of biophysical circumstances (Table 1). Data collected from the interviews were analysed and summarised to provide a description of the constraints and circumstances of farmers in relation to the use of OOS beef systems. A matrix was used to rate elements (alternative farming systems) and constructs (implications or constraints of OOS) as illustrated by Table 2.

Table 1 Summary description of farms involved in interview stage.

Zone	Area (ha)	Topography	Type
A	160	Flat - Rolling	• Cropping • Beef Finishing
A	1500	Flat	• Beef & sheep breeding and finishing • Forestry • Cropping
A	110	Flat	• Cropping • Beef Finishing • Lamb Finishing
A	180	Flat - Rolling	• Sheep & beef breeding and finishing
A	155	Flat	• Sheep breeding and finishing • Beef finishing • Cropping
B	530	Rolling - Easy Hill	• Beef finishing • Sheep breeding and finishing
B	950	Easy Hill	• Sheep breeding and finishing • Beef breeding
B	480	Easy Hill - Hill	• Sheep breeding and finishing • Beef finishing
B	600	Hill	• Sheep & beef breeding and finishing
B-C	530	Hill-Hard - Hill	• Sheep & beef breeding and finishing
C	450	Hill- Hard - Hill	• Sheep breeding and finishing • Beef finishing
C	810	Easy Hill - Hill	• Sheep & beef breeding and finishing
C		Hill	• Sheep & beef breeding and finishing
C		Hill	• Sheep & beef breeding, finishing and stud

Table 2 Example of matrix used in semi-structured interview during farm case study phase of research. (Score 1 = very poor; 5 = very good compatibility).

Constructs	*Elements*			
	Current System	**All OOS**	**All Shoulder**	**Shoulder/ Traditional**
Feed Management	4	1	3	5
Compatibility with cropping	4	2	3	3
Ground damage	3	1	4	5
Type of country	3	1	2	2
Financial advantage	4	2	3	2
Price risk	3	3	2	1
Production risk	3	2	4	4
Preferences/ goals	3	1	2	3

In the final phase, a more in-depth investigation of the use of OOS beef systems was carried out on three case farms. These were identified from the 14 farmers surveyed in phase two of the study; one was selected from each zone (Table 1) within the research area. The farms provided a representative example of the physical environments and farming systems in the study area as illustrated by Table 3 and in Figure 3 by the variation between farms in the derived pattern of monthly pasture production for each farm.

Table 3 Summary of characteristics of the case farms.

Characteristics	**Farm**		
	A	**B**	**C**
Location	Rongotea	Cheltenham	Taihape
Area (ha)	110	450	500
Altitude (masl)	20	200-500	620
Contour	Flat	Medium to steep hills	Flat-hill
Soils-drainage	Poor	Poor-Medium	Medium
Rainfall (mm)	900	900	800
Farm Policy	Cropping/livestock finishing	Breeding ewes/ finishing cattle	Breeding ewes/ breeding cows
Beef	70 steers (18 mth) 70 bulls (18 mth)	100 steers (18 mth)	156 cows, finish progeny & buy in 170 steers (18 mth)
Sheep	700 lambs	2000 ewes	2500 ewes

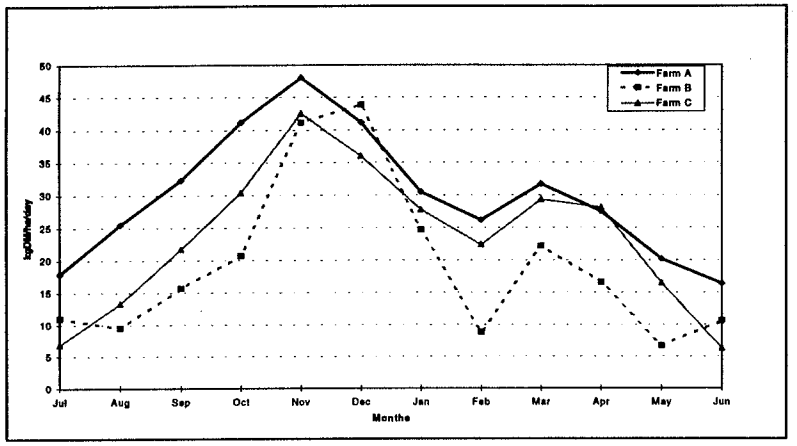

Figure 3 Pasture growth rate estimates used for case farms.

A modelling analysis of alternative beef production systems identified in collaboration with each farmer, was undertaken using the computer simulation model, StockPol™ (Marshall, McCall, and Johns, 1991). Current farm systems were first simulated using the model to define 'base' systems, which then were used to answer 'what if' scenarios in relation to OOS finishing. StockPol™ was used to test the biological feasibility of the scenarios and compare production and management options. The overall aim of the modelling analysis was to investigate how farm productivity and profitability could be affected by different cattle growth and selling strategies, and price premiums. In this paper, only the outcomes for OOS options are presented in terms of pasture cover (a measure of biological feasibility), total production, production efficiency and gross margins. Full details of the case analyses are contained in Sherlock (1997).

RESULTS AND DISCUSSION

Key Informant Interviews

From the key informant interviews, the main issues relating to seasonality and out-of-season supply in the meat industry were summarised. Figure 4 depicts the issues facing the two major industry stakeholders, meat companies and farmers. The supply of raw product from farmers is the first stage in the marketing channel, and its seasonal supply pattern affects the other processes in the chain through to the consumer markets. The specific implications of seasonality to meat companies as derived from the key informant interviews are depicted on the right hand side of the diagram. The possible issues facing farmers are hypothesised on the left of Figure 4. From the perspectives of industry key informants, OOS beef production on farms was seen as an important option to increase the continuity of beef supply, and thus reduce the effects of seasonality on processing efficiency and marketing opportunities. Without exception, all key informants expressed the view that more uniform supply of beef cattle would become increasingly important to the meat industry as it focuses more on servicing higher value markets for chilled beef. Increasing the use of OOS beef production systems on farm would reduce the effects of seasonality by addressing the problem at its source but it was agreed that the success of this strategy would depend largely on the price signal sent to farmers since OOS production increases farm production costs. The key informants generally agreed that schedule premiums for OOS cattle would need to be increased compared to current levels in order to encourage a significant increase in OOS beef cattle production. However, the ability of meat companies to meet this cost was less clear, since it was suggested that it may not be profitable for meat companies to offer more for stock at that time in order to maintain throughput.

Farmer Interviews

The farmers' views and opinions on OOS production and its potential application on their properties are summarised in Table 4. The broad areas of concern for farmers were: feed management; damage to wet soils; problems in efficiently achieving weight gain in cattle during winter; higher costs of replacements; increased

workload and risk; compatibility with the physical and climatic attributes of the farm; affects on overall farm profitability and personal preference. Examples of farmer comments with respect to each of these issues are presented in Table 4

The perspectives and issues raised by farmers in the interviews, as summarised in Table 4, can be condensed into three major categories: management factors, risk factors and financial factors, as illustrated in Figure 5. These categories, briefly discussed next, are not mutually exclusive because some issues overlap category boundaries.

Feed Management

A major concern raised by farmers regarding OOS finishing systems was feed management. In temperate environments like New Zealand, pasture grazed *in situ* is usually the cheapest and most available source of livestock feed. In general, efficient low cost grazing systems seek to manage pasture supply and feed demand to avoid feed surpluses/shortages which may be costly in terms of subsequent pasture growth and animal production, pasture quality, and the extra expense of feed conservation and/or supplementation. Stock policy decisions such as buying/selling dates, stocking rate, and calving/lambing dates determine the match between seasonal feed supply and demand. Out-of-season production systems contravene these pasture management principles.

Wintering Difficulties

a) Soil/Pasture Damage

Out-of-season beef production systems may increase soil pugging. This can decrease farm productivity by affecting plant growth, soil properties, feed utilisation, and animal health (Climo and Richardson, 1984). Farmer concerns about soil damage and associated negative impacts on productivity, therefore, are well founded. Any strategy to increase OOS beef production would have to provide ways for farmers to address this concern. For example, systems that involve finishing smaller numbers of younger stock (eg, as two versus three year olds) at lower liveweights would help minimise the effects of pugging.

b) Achieving Winter Liveweight Gains (LWGs)

Several factors make it more difficult to achieve high liveweight gains with cattle grazed on pasture during winter compared to spring or summer. First, less pasture is usually available during the winter and decreased pasture covers restrict animal intake (Poppi, Hughes, and L'Huillier, 1987). Second, climatic conditions and low liveweight gains increase the proportion of feed required for maintenance, which lowers the efficiency of animal growth from pasture (Geenty and Rattray, 1987). In order to achieve target LWGs for OOS production, farmers would need to carefully manage the late autumn and winter feed supply. More conserved pasture or other feed supplements could be used to increase feed supply, but these generally have a lower nutritive value than good quality pasture and, thus, result in lower liveweight gains (Ulyatt, Fennessy, Rattray, and Jagusch, 1980; Butler-Hogg and Cruickshank, 1989). The use of supplements and pasture conservation would also increase costs. Reducing livestock numbers is another alternative to increase feed supply relative to demand and would also help minimise soil treading damage. However, the fewer cattle numbers available for sale would need to be balanced by greater carcass weights and/or higher schedule prices for OOS cattle.

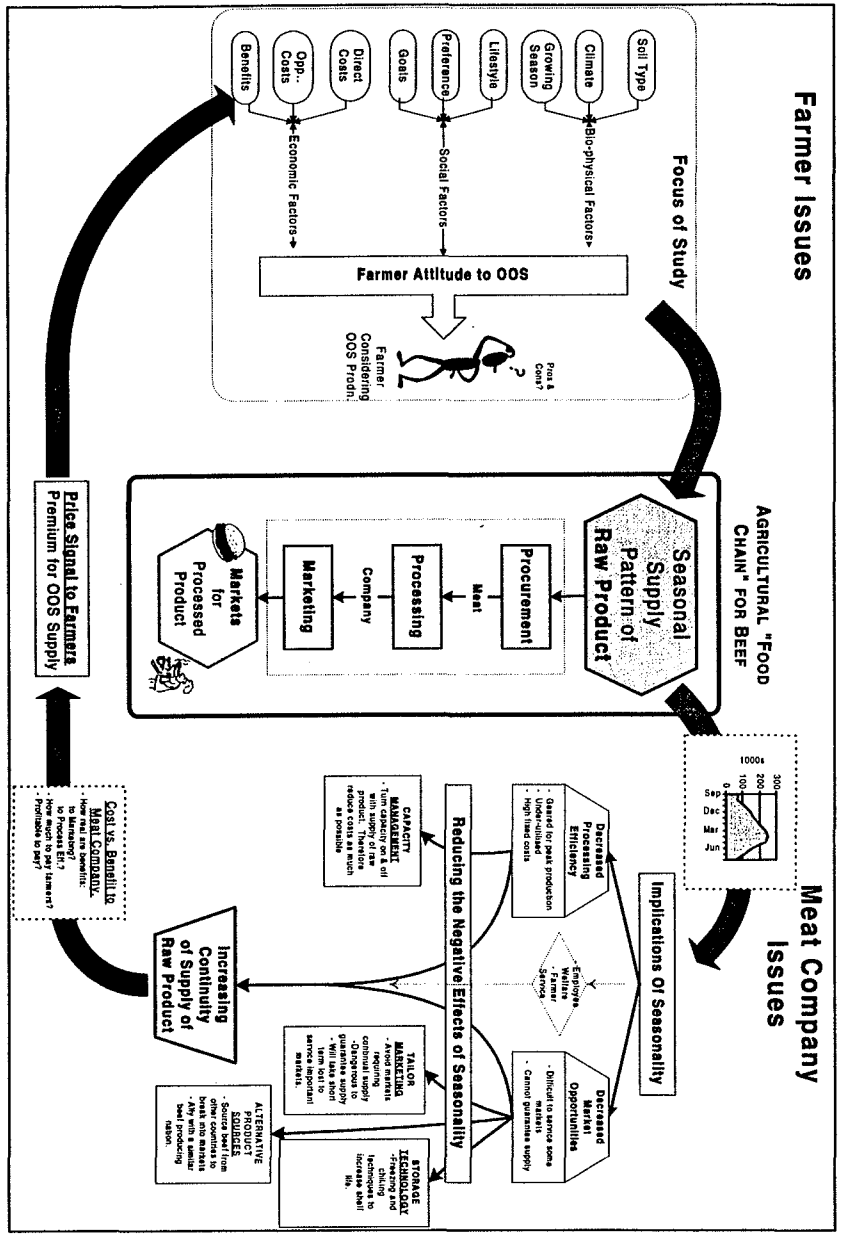

Figure 4 Seasonal beef supply issues - summary of key informant interview phase.

Table 4 Summary of issues identified by farmers with respect to OOS beef production and examples of comments associated with each issue.

Issues	Farmer Comments
Feed Management	
Winter Feed Availability	• It's difficult to have enough feed in winter to finish cattle • The cost of feeding the animal at that time of year (OOS) is the major constraint. • It really comes down to the feed issue.
Feeding Priority	• You can't do everything well at that time of the year. Some stock will suffer at their (OOS cattle) expense. • I've got other stock on the property that require feeding at that time. If I don't feed my breeding stock well enough, that can have long term effects. • It just ends up being a 'rob Peter to pay Paul' situation.
Spring Pasture Control	• You'd have to really work to get through the winter, and then get rid of them just as the feed takes off. • It's not making use of the good growth periods • Would definitely lose some summer pasture management which is important for quality pasture, especially on the hills.
Required Changes	• Would have to look at wintering cattle on silage and winter crops, and that starts getting very expensive. • I would have to reduce the number of stock wintered to finish OOS.
Ground Damage	• Cattle, especially heavy cattle, can make a huge mess of paddocks during the winter. • The pasture and soil damage caused by carrying more cattle in the winter would be a major constraint on this property.
Achieving Winter LWGs	• It's hard enough to have the feed to hold cattle over the winter, let alone put any weight on them. • I'm not convinced that I could achieve adequate liveweight gains using silage to pay for producing it. • Farmers that appear to be doing the best are the ones who are achieving maximum liveweight gains. That's easier to do in times of the year that allow it.
Replacements	• The conservative approach is to buy and sell stock on the same market so you always get a margin. With an OOS system, you'd be getting a premium for the cattle you sold, but you'd also be paying a premium for replacements on the grass market.
Management Ease/Workload	• That's a busy time of year with lambing and calving. I'm trying to reduce my workload not increase it. • ... it's making more work for little or no gain...its just not worth it.
Risk	
Price Risk & Contracts	• Price certainty would be paramount for OOS production. Price is a big risk factor. • You're really guaranteed a premium at that time of the year. It's riskier to sell in the traditional market when everyone is selling stock and killing space is at a premium.
Production Risk	• You're definitely sailing a bit closer to the wind with OOS production. It's hard when you're fighting against the elements all the time. • You would be more vulnerable to a bad winter, like this one. • I think that there's less margin for error.
Suitability to Property	• It would be better suited to areas that are good for finishing cattle, with free draining soils and a longer growing season. • Could easily produce more cattle OOS. I've got good soils for wintering and a good winter growth. But I think it's making more work for little or no gain...its just not worth it. • I really haven't got the scope to do it here.
Profitability	• "I would not hesitate if the premium offered made it economically viable". • "The extra premium is worth the extra work and cost of finishing them OOS. But it depends on the price and feed situation at the time". • "My land and system are set up to handle OOS production right now, but at the current premium its just not worth it".
Preferences	• I'm reluctant to change a system that is working well. • I'm happy with what I'm doing now, so I haven't really thought about it. • With beef prices the way they are, I might be giving the sheep side of things more priority.

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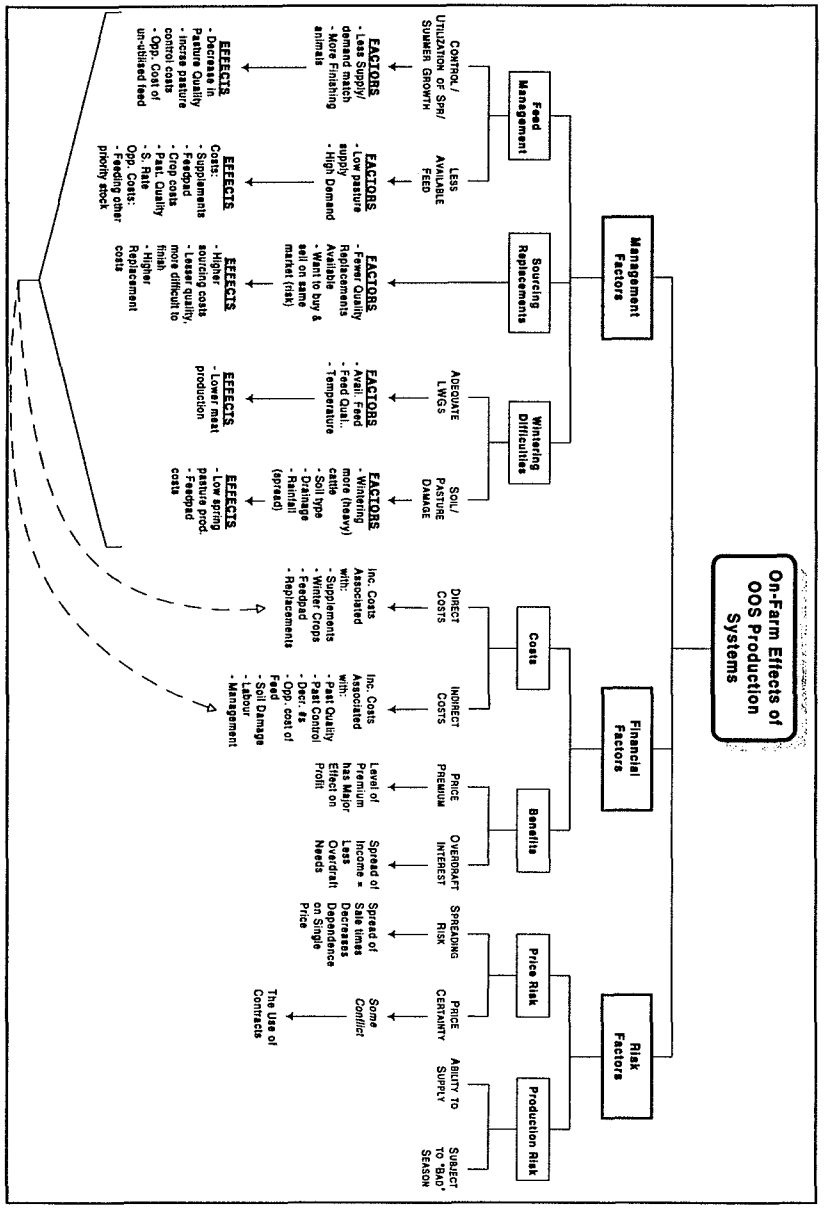

Figure 5. On-farm implications of OOS beef production systems.

Risk Factors

Appropriate strategies to manage production and price risk are required for OOS production to be more acceptable to farmers. For example, decreasing livestock numbers reduces demand for pasture during the autumn and winter, and also lowers the incidence of soil pugging. Both of these issues contributed to the perceived greater risk of OOS systems. Contract agreements that provide some flexibility in LWG targets and/or selling dates, and which guarantee a minimum price would be an acceptable option to some farmers concerned about price risk.

Financial Factors

The most important potential benefit to farmers of OOS cattle production is the price premium that would be received for cattle at that time. However, other possible benefits were identified. Some farmers believed that selling a proportion of their stock OOS would spread risk by reducing their dependence on the prices at traditional selling times. The more even cashflow that would result from this selling pattern was also seen by some farmers as a benefit of OOS finishing.

The financial advantages need to be balanced against the farmers' perceptions of the increased costs of OOS production. These include costs related to: increased pasture conservation and/or supplementation; increased use of winter forage crops; feedpad installation and maintenance; and higher replacement costs if cattle need to be purchased during the early spring.

Farmers also identified non-monetary costs associated with the implementation of OOS production systems. For example, higher winter feed demands related to OOS systems would place pressure on pasture cover levels and the performance of other stock classes on the farm. Thus, OOS systems are likely to involve opportunity costs of reducing livestock numbers and/or their performance. If increased pugging occurred, costs in terms of decreased pasture production and animal performance would also be incurred. Premiums set by meat companies for OOS beef cattle will need to incorporate a knowledge of these costs and disadvantages if they are to be set at a level that encourages farmers to supply more cattle OOS.

In summary, farmers' perceptions of the viability of OOS production systems related to their circumstances. The land resources of the farm business were important in determining this viability. In general, farms with mild winter temperatures and high soil fertility have pasture and animal growing conditions that are most suited to OOS production systems. Farms with moderate winter rainfall, combined with well drained soils would be less constrained by the risk of increased pugging under an OOS production system. Farmers' goals and objectives relating to profit, preferences, and security also have an important influence on their willingness and ability to implement OOS production systems.

Case farm analysis

The match between pasture supply and demand for alternative production systems for case farms A, B and C are presented in Figures 6, 7, and 8, respectively. A high feed supply relative to demand during a particular period is represented by high average pasture covers during that period. This is indicative of less effective control of pasture growth over the period, and has important implications in terms of pasture quality and associated animal performance.

The pasture cover profiles indicate that increasing OOS beef production would have most affect on farm A, a minor effect of farm B, and a moderate impact during the summer-autumn period on farm C. The degree of change reflected the initial proportion of cattle relative to total stock units wintered and the structure of the beef herd (ie, breeding vs. finishing animals) on the farms.

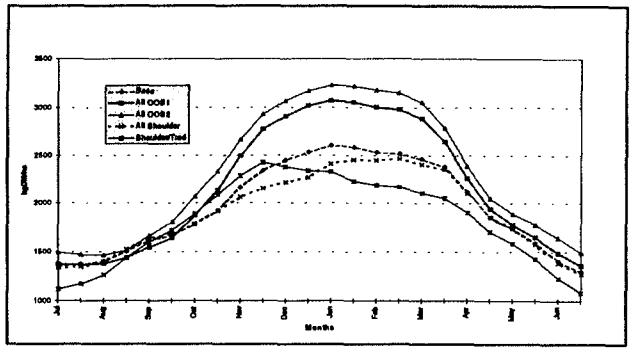

Figure 6 Comparison of monthly pasture covers for alternative beef production systems on case farm A.

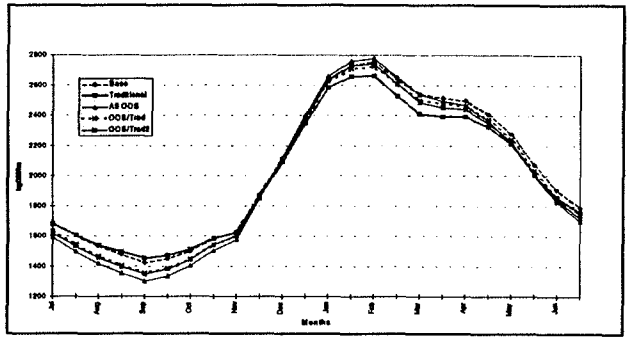

Figure 7 Comparison of monthly pasture covers for alternative beef production systems on case farm B.

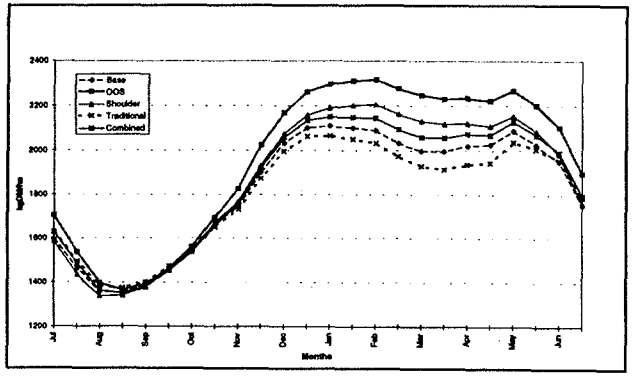

Figure 8 Comparison of monthly pasture covers for alternative beef production systems on case farm C.

Summaries of the StockPol™ analyses for each case farm are presented in Table 5. These analyses indicate both biological efficiencies and profitability of OOS vs. systems selling at more traditional times. Although systems on individual farms can be compared, direct comparisons cannot be made for similar policies between farms because of differences in resources and herd structure. Nevertheless, Table 5 clearly shows that systems that involve higher proportions of OOS production generally have:

1. lower pasture utilisation (due to less match between pasture supply and demand, as discussed above), and
2. lower total meat production, which is the ultimate indicator of biological efficiency since it incorporates feed conversion efficiency and pasture utilisation.

Table 5 Comparison of meat production and efficiency of alternative beef finishing systems on case farms A, B and C. (Note: c/c wgt = carcass weight.)

Farm A	**Base (OOS/shldr)**	**All OOS1**	**All OOS2**	**All Shldr**	**Shldr/ Trad**
Feed Conversion Efficiency (kg c/c wgt sold/1000kg pasture)	79.6	80.9	83.8	79.7	84.1
Pasture utilisation (%)	86	76	72	90	84
Total Meat Production (kg c/c wgt)	42,648	37,178	36,386	44,610	49,517
Beef GM/1000kg DM	$48	$35	$48	$50	$52
Total Farm GM/ha	$574	$487	$530	$597	$624
Farm B	**Base (shldr/trad)**	**Traditional**	**All OOS**	**OOS/ Trad**	**OOS/ Trad2**
Feed Conversion Eff. (kg c/c wgt sold/1000kg pasture)	53.8	67.5	62.9	58.1	76.4
Pasture utilisation (%)	68	72	67	69	68
Total Meat Production (kg c/c wgt)	30,653	46,971	34,668	34,514	44,676
Beef GM/1000kg DM	$41	$47	$48	$44	$44
Total Farm GM/ha	$254	$274	$260	$260	$259
Farm C	**Base (shldr/trad)**	**OOS**	**Shoulder**	**Trad**	**Combined**
Feed Conversion Efficiency (kg c/c wgt sold/1000kg pasture)	25.9	25.1	25.5	26.3	24.0
Pasture utilisation (%)	84	79	82	85	83
Total Meat Production (kg c/c wgt)	25,032	17,864	23,219	26,512	21,675
Beef GM/1000kg DM	$67	$58	$64	$68	$64
Total Farm GM/ha	$439	$391	$419	$448	$425

Systems on the case farms with high maintenance requirements relative to growth had lower feed conversion efficiencies, particularly when low animal growth rates were combined with heavy liveweights. In this respect, OOS finishing systems were less efficient at converting pasture to beef if they involved selling cattle later and/or at heavier liveweights. Conversely, OOS finishing systems that involved selling cattle earlier and/or at lower liveweights generally increased the feed conversion efficiencies compared to more traditional beef cattle policies. Because OOS systems involve selling cattle during periods when pasture is often in short supply and the climate is cold, they tend to have greater maintenance feed requirements than the traditional 'in-season' options. Importantly from the farmers' point of view, the StockPol™ simulations did not include the effects of soil pugging on pasture utilisation and production. Including a "pugging effect" would result in more conservative estimates for the OOS options.

Table 5 also indicates profitability in terms of the gross margins, with GM/ha being the appropriate indicator of farming system profitability. It must be noted that the analyses in Table 5 are based on a static price schedule and do not include any price premium for OOS cattle. The generally lower profitability of OOS beef cattle finishing systems as compared to traditional selling polices reflects their lower biological efficiency. However, even when price premiums of 20% for OOS cattle were assumed, on case farms A and C, finishing options that

involved the highest proportions of OOS production continued to be the least profitable. On these farms the finishing options involving shoulder and traditional production returned total farm gross margins that were between $11/ha and $101/ha more than the OOS cattle finishing options. On case farm B, while the OOS option appeared to be the most profitable on a whole farm basis (assuming a 20% price premium for OOS cattle), this was because the finishing system involved growing cattle more quickly (higher cattle liveweight gain profile) than the other options. The case farm studies show that the profitability of the OOS options will be closely related to the physical characteristics and circumstances of individual farm systems, and the premiums required to encourage the uptake of OOS production will, therefore, vary between farms and regions. Obviously, meat companies should target regions or districts with lower OOS costs to minimise premium payments.

CONCLUSIONS

A farmer's decision to adopt an OOS finishing system is influenced by the costs and constraints of such a change, as well as his/her individual circumstances and attitudes. Farmers identified a number of factors which could affect and limit the use of OOS beef finishing on their properties. Winter feed levels, summer pasture quality, and potential for increased soil damage were major concerns of farmers with respect to OOS systems. In general, farmers associated OOS finishing systems with increased production costs, higher levels of risk and greater complexity of grazing management. Case farm analysis confirmed that OOS production generally had a lower biological efficiency compared to traditional beef finishing systems, due to the poorer overall match between pasture feed supply and animal demand.

Farmers considered OOS beef finishing to be more demanding of, and therefore less suited to their pasture-based farming systems. Nevertheless, farmers expressed the desire to decrease the proportion of cattle they sold during peak kill times in order to improve cattle returns and spread price risk. Finishing a higher proportion of cattle during the shoulder periods (Figure 2) was preferred to OOS systems. Shoulder production was considered (and this was confirmed by the modelling analysis) to have medium costs and risks relative to OOS and traditional finishing, whilst also reducing exposure to low cattle prices during the peak kill.

It was also clear from both the case studies and the farmer interviews that factors other than profitability are important in farmers' consideration of OOS production. In particular, farmers associated OOS cattle finishing with increased risk and more demands on management. Thus, farmer acceptance of OOS finishing is affected by their attitudes, circumstances and goals, as well as a required level of profitability. These non-financial concerns of farmers need to be considered by the Meat Companies.

A more uniform pattern of beef supply would provide the NZ meat industry with the opportunity to compete more effectively in the higher value market for meat, and would provide direct benefits to the beef marketing and processing stakeholders in the industry. Although there is perceived potential for OOS production systems on farm to increase uniformity of supply, the related costs and the perceived management disadvantages would have to be outweighed by improved financial returns through premiums offered for OOS beef cattle. The case farm analysis suggested that OOS finishing systems were less profitable than the existing cattle polices on a whole farm basis, even when assuming price premiums of up to 20% for OOS cattle. Thus, for the pattern of beef supply to become more uniform, meat companies will have to re-think their pricing strategies and offer significantly larger premiums than at present for cattle finished OOS. It is still unclear whether meat companies have the ability to pay these required premiums. Clearly, this is an important part of the puzzle that needs to be researched.

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OPTIMAL SELECTION OF FERTILISERS IN HORTICULTURAL ENTERPRISES

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ABSTRACT

Horticultural consultants recommending fertilisers must consider a large amount of information to make an optimal selection. However, difficulty arises when matching the required nutrient levels with those available in fertiliser products, as it is unlikely that a single or a combination of fertilisers will exactly match the nutrients required. Consultants currently make decisions regarding fertiliser use on the basis of an estimate of the required nutrients in conjunction with some degree of personal knowledge about previous fertiliser application and crop performance. This is unlikely to result in the optimal fertiliser selection either in nutrient needs or cost effectiveness. The objectives of this study were to describe the process horticultural consultants use to make fertiliser recommendations and to develop a decision support system that can aid the fertiliser selection process.

The system developed comprises client and fertiliser databases, an optimisation component, and a user interface. The optimisation component uses a compromise programming approach to minimise the deviation of fertiliser costs and nutrient requirements from target goals. The decision support system was implemented using Microsoft Access for the database component and Microsoft Excel for the optimisation component. The results from the optimisation model were compared to fertiliser mixes proposed by consultants. The mixes generated by the decision support system were generally cheaper and weighed less, but some contained unacceptable differences that could be corrected with expert knowledge. The results from the model, however, provide a good starting point from which horticultural consultants can make their final recommendation.

INTRODUCTION

Fertiliser use can have far reaching effects on yield and quality and, therefore, returns to the grower, even though fertiliser expenditure is only a small expense within the budget (e.g., approximately 3% for a kiwifruit orchard (Oliver & Burtt, 1995)). The effective use of fertiliser improves the soil's suitability for growing crops, while a lack of required nutrients can lead to a reduction in yield and reduce returns to the grower. Fertiliser used in the wrong soil or climatic conditions may be ineffective, for example, in dry conditions sulphate is likely to be more effective than elemental sulphur, while in wet conditions the reverse may be true (McLaren & Cameron, 1986). The use of fertilisers containing nutrients that are not required can cause an excessive build-up of nutrients in the soil, which may be toxic to the plants, and is likely to be leached from the soil into the waterways. Incorrect timing of the fertiliser application and uneven spreading can also be detrimental to the crop and the environment.

Consultants recommending fertilisers use a considerable amount of information to make an optimal fertiliser recommendation. Fertiliser recommendations typically begin with soil and leaf sample analysis, noting the fertiliser use history and the fertiliser preferences of the grower. The consultant then makes an estimate of the nutrient requirements of the crop and the appropriate fertilisers that can be used to replenish the nutrient loss. Considerable time is spent by consultants when matching the required nutrient levels with those available in fertiliser products, as it unlikely that a single product or a combination of fertilisers will exactly match the ratios of nutrients required. Unfortunately the approaches used by consultants to make fertiliser recommendations often generates fertiliser mixes that have excesses of some nutrients. The approaches include using software that finds fertiliser mixes that minimise fertiliser cost or testing a combination of fertilisers using a trial and error approach until a combination is found that matches the consultants objectives.

This study reports on a prototype decision support system which can be used by the consultant to store client information, and the use of this information to aid the fertiliser selection process.

THE PROCESS OF RECOMMENDING FERTILISERS

The approach used by three horticultural consultants to recommend fertilisers was studied by Vale (1997). This general approach is summaries in Figure 1.

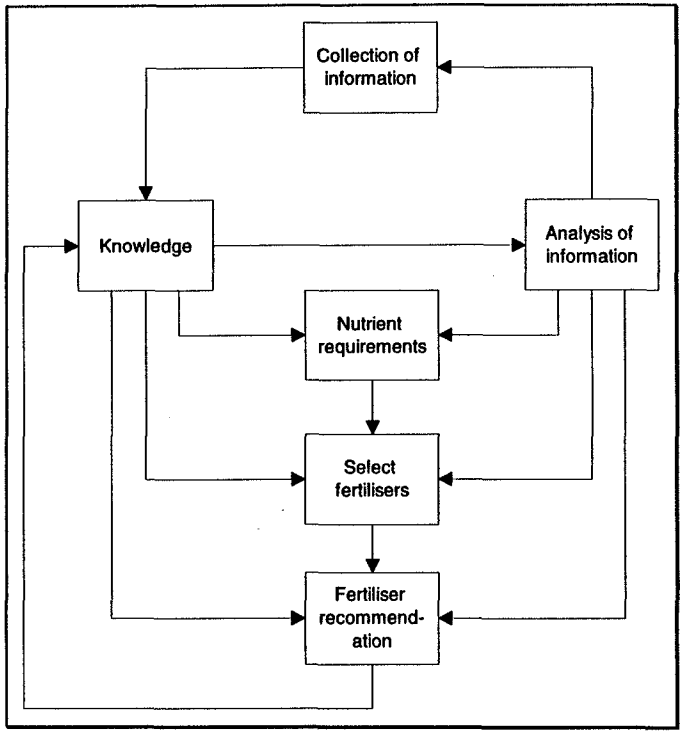

Figure 1 An abstract view of the fertiliser recommendation service offered by consultants.

Information collection methods used by the consultants include, nutrient tests, visiting the grower's property and talking to the grower. The knowledge gained is combined with historical trends of fertiliser usage, nutrient levels, pH and yield response rates to form the basis for estimating nutrient requirement. In general the estimated nutrient requirement is sufficient to correct any known deficiency and maintain nutrient relationships. Fertilisers are then selected to meet the nutrient requirements and a recommendation report prepared.

The selection of fertilisers to that meet the nutrient requirements as closely as possible has proved difficult for the consultants used in this study. Meeting the nutrient requirements as closely as possible implies minimising the excess and deficient quantities of nutrients suggested in the fertiliser recommendation. The current least cost computer software used by some consultants often generates fertiliser mixes that have excesses of nutrients that is considered undesirable. Another improvement in

the approach used by consultants that was highlighted during the interviews was to have a better means of storing and retrieving the information relating to individual clients.

THE DECISION SUPPORT SYSTEM

A decision support system that has been designed to facilitate the process used by consultants to make fertiliser recommendations is shown Figure 2.

The main features of the decision support system are described briefly.

Client information database

The client information database is used to store fertiliser history and preferences, and soil and leaf nutrient test results. The information in the client database can be used to pre-select fertilisers, set-up the optimisation, and then store the results of the optimisation.

Fertiliser information database

There are many suppliers of fertilisers in New Zealand and each sells a multitude of fertilisers. Information that describes these fertilisers, such as the nutrient analysis of each fertiliser, the cost, the manufacturer and retailers are stored in the fertiliser information database.

Pre-select fertilisers

The optimisation process should only use those fertilisers that may form part of the fertiliser recommendation. A screening process that uses client nutrient requirements and fertiliser preferences could reduce the number of fertilisers passed to the optimisation process and thus reduce the time required to generate a solution. For example, the use of nutrient requirements as selection criterion ensures inclusion of only those fertilisers that contain the required nutrients.

Optimisation

The optimisation process receives a list of fertilisers along with set-up parameters from the client information database such as constraints, nutrient requirements, and grower preferences. The optimisation process aims to select the combination of fertilisers that minimise cost, and excess and deficient inclusion of nutrients, while achieving any constraints stipulated. A compromise programming approach is used and allows the generation several options from which a selection can be made.

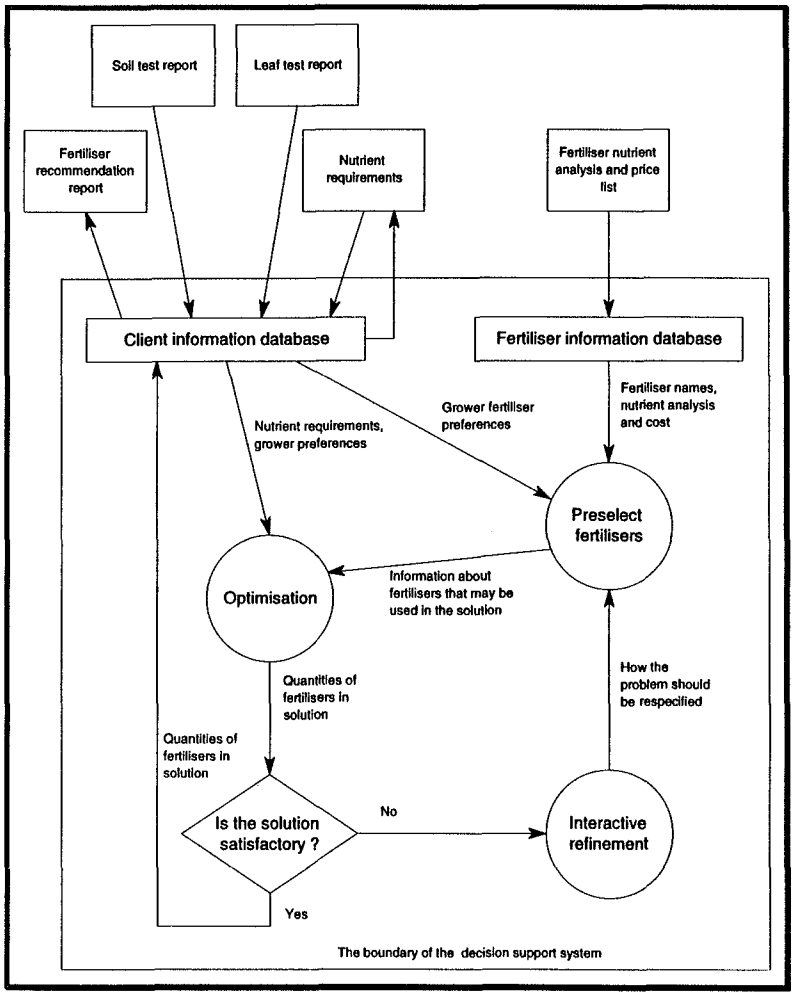

Figure 2 A model of a decision support system to aid the optimal selection of fertilisers by consultants.

(The rectangle with a dashed line in Figure 2 *represents the boundary of the decision support system. The items inside the box are the components of the decision support system, while those on the outside are information either entered or created from the decision support system. The text beside the arrows describes the information flows between components.)*

Interactive refinement

The optimisation process produces a mix of quantities of fertilisers, which the consultant, may or may not, deem as satisfactory. An interactive refinement process allows for the reformulation of the optimisation setup parameters to reduce any dissatisfaction with the output generated. Changes to the optimisation setup could include specifying any of the following: the exclusion of certain nutrients,

minimum or maximum levels of nutrients, or changes to the nutrient requirements. The process of pre-selecting fertilisers can then use this reformulation to see if it alters the fertilisers that the optimisation process should use. Alterations to the list of fertilisers can be made and the optimisation process rerun with its new setup. This iterative and interactive alteration and rerunning of the optimisation process would continue until the user of the decision support system obtains a satisfactory solution. Storage of the solution in the client information database then allows the consultant to create the recommendation report for the grower.

Is the solution satisfactory?

When the user decides that a solution generated by the optimisation process is satisfactory the client database receives the solution for storage. The satisfactory solution obtained from the optimisation process should provide a list of fertilisers, where to purchase them from, the quantity required of each, and the cost of the fertiliser mix. If the consultant decides that the solution is not satisfactory then the consultant must decide how to reformulate the problem when passed to the interactive refinement process.

OPTIMAL SELECTION OF FERTILISERS

An attempt to select an optimum combination of fertilisers that meet consultants' requirements has been made by the Soil Fertility Service, a division of Agriculture New Zealand, and Mínguez, Romero and Domingo (1988). Other authors have studied similar problems involving the selection of an optimum ration formulation for livestock. Notable works in this area of ration formulation models include that by Dent and Casey (1967), Crabtree (1982), Rehman and Romero (1984, 1987) and Lara and Romero (1994). The models developed in these fertiliser and ration formulation studies have used various optimisation techniques including linear programming and several variants of goal programming.

The foundation of compromise programming is based on Zeleny's (1973) axiom of choice, which states that *alternatives which are closer to the ideal are preferred to those that are further away.* Thus, the basic aim in compromise programming is to identify the ideal points for each decision variable and then seek a solution which is as close as possible to these ideal points (Romero & Rehman, 1989). The ideal solution is defined as the one where all of the objective functions reach their preferred values which usually implies the minimisation or maximisation of the functions. Although the ideal solution may be achievable in some cases, generally, such a point is infeasible and a compromise solution will be needed (Zeleny, 1973). A compromise solution is a best approximation to the ideal solution with respect to a distance function (Zeleny, 1984).

The specific objectives of the optimisation and the mathematical equations and techniques used to achieve them, are presented in this section.

The objectives to incorporate into the mathematical model are as follows:

Minimise the excess of unrequired nutrients in the fertiliser mix.

Provide a fertiliser mix that as closely as possible meets the desired nutrient requirements.

Allow for minimum and maximum bounds on nutrient levels contained in the fertiliser mix.

Allow the consultant to specify relationships between a nutrient or fertiliser and any other nutrient or fertiliser

The equations are presented and followed with a brief discussion of each equation.

The objective function is to:

Eqn. 1

$$\text{Min} \sum_{i=1}^{m}\left(W_i^-\left(\frac{d_i^-}{g_i}\right)^p + W_i^+\left(\frac{d_i^+}{g_i}\right)^p\right) + \left(V^-\left(\frac{e^-}{h}\right)^p + V^+\left(\frac{e^+}{h}\right)^p\right) \quad \text{for } p = 1,2,\infty$$

Subject to:

Cost goal

Eqn. 2 $$\sum_{j=1}^{n} c_j x_j + e^- - e^+ = h$$

Nutrient goals

Eqn. 3 $$\sum_{j=1}^{n} a_{ij} x_j + d_i^- - d_i^+ = g_i \quad 1 \le i \le m$$

Constraints

Eqn. 4 $$b_i^{\min} \le r\sum_{j=1}^{n} a_{ij} x_j \le b_i^{\max} \quad 1 \le i \le m$$

Eqn. 5 $$\sum_{j=1}^{n} a_{kj} x_j \le, =, \text{ or } \ge r\sum_{j=1}^{n} a_{lj} x_j \quad 1 \le k \le m,\ 1 \le i \le m,\ i \ne k$$

Eqn. 6 $$x_t \le, =, \text{ or } \ge r x_u \quad 1 \le t \le n,\ 1 \le u \le n,\ t \ne u$$

Eqn. 7 $$a_{ly} x_y \le, =, \text{ or } \ge r\sum_{j=1}^{n} a_{vj} x_j \quad 1 \le l \le m,\ 1 \le v \le m$$

Eqn. 8 $$d_i^+ = \frac{1}{2}\left[\left|g_i - \sum_{j=1}^{n} a_{ij} x_j\right| - \left(g_i - \sum_{j=1}^{n} a_{ij} x_j\right)\right]$$

Eqn. 9 $$d_i^- = \frac{1}{2}\left[\left|g_i - \sum_{j=1}^{n} a_{ij} x_j\right| + \left(g_i - \sum_{j=1}^{n} a_{ij} x_j\right)\right]$$

Eqn. 10 $$e^+ = \frac{1}{2}\left[\left|h - \sum_{j=1}^{n} c_j x_j\right| - \left(h - \sum_{j=1}^{n} c_j x_j\right)\right]$$

Eqn. 11 $$e^- = \frac{1}{2}\left[\left|h - \sum_{j=1}^{n} c_j x_j\right| + \left(h - \sum_{j=1}^{n} c_j x_j\right)\right]$$

Eqn. 12 $$d_i^-,\ d_i^+ \ge 0$$

Eqn. 13 $$e^-, e^+ \ge 0$$

Where:

a_{ij}	the quantity of the ith nutrient in the jth fertiliser
b_i^{max}	*the maximum amount of the ith nutrient allowable in the fertiliser mix*
b_i^{min}	*the minimum amount of the ith nutrient allowable in the fertiliser mix*
c_j	*the cost of the jth fertiliser*
d_i^-	*the negative deviation of the ith nutrient goal*
d_i^+	*the positive deviation of the ith nutrient goal*
e^-	*the negative deviation of the cost goal*
e^+	*the positive deviation of the cost goal*
g_i	*the target of the ith nutrient goal*
h	*the target of the cost goal*
m	*the number of nutrients*
n	*the number of fertilisers*
p	*the parameter of an L_p metric used to weight distance*
r	*the ratio coefficient of a relationship*
V^-	*a weight assigned to the negative deviation of the cost goal*
V^+	*a weight assigned to the positive deviation of the cost goal*
W_i^-	*a weight assigned to the negative deviation of the ith nutrient goal*
W_i^+	*a weight assigned to the positive deviation of the ith nutrient goal*
x_j	*the quantity of the jth fertiliser*

The sum of the objective function represents the total of all deviations (i.e., the difference between the targets of each goal and the actual amount in the solution). A negative deviation occurs when a target for a goal is under achieved, while a positive deviation refers to the amount of over achievement of a goal's target. Each deviation, whether it be positive or negative, is divided by its respective goal's target that it measures the deviation from. This is so that the deviations represent a percentage (relative) rather than absolute deviation from the targets of goals. The actual value of the objective function depends on the value of p used. The objective function is a means to an end, in that minimising it allows the generation of a compromise solution that best approximates the targets of the decision variables sought after.

The weights, W_i^- and W_i^+, in Eqn. 1 are used to emphasise the relative importance of particular goals and can be set differently for positive and negative deviations from the goal's target. The values that W_i^- and W_i^+ can be either positive or negative. In this model the use of negative weights are used to reward solutions that reduce the cost of the fertiliser mix below the specified target of the cost goal.

A problem with the model by Mínguez, Romero and Domingo (1988) for determining optimum fertiliser combinations was that if the cost of the fertiliser mix droped below the target it was not rewarded. This failure to reward when the cost drops below the target may not result in the best solution being reached. In this model a negative weight is attached to V^- so that negative deviations from the target point of the goal is rewarded. Goal one refers to the cost of the fertiliser mix and its target point is based on the least cost solution of a similar linear program version of the model. Due to the relaxation of the constraints (in particular, nutrient requirements) of the linear program version of the model it is possible to actually achieve a cost of the fertiliser mix that is lower than the linear program solution, therefore, the ability to achieve a lower fertiliser mix cost needs rewarding. This

rewarding of a cheaper fertiliser mix is achieved through the negative weighting of a negative deviation from the cost goal target and the level achieved.

The goal depicted in Eqn. 2 is required to determine the positive and negative deviations between the cost of the fertiliser mix and the target value for the cost of the mix goal (goal one). The target value used for this goal is required and can be generated from the solution to a linear programme.

The nutrient requirement goals are based on Eqn. 3. This equation determines the positive and negative deviation variables for each nutrient where the quantity of the nutrient in the fertiliser mix differs from the target requirement of the particular goal.

A constraint to the upper and lower bounds of the quantity of any nutrients is achieved with Eqn. 4. This equation sums the quantity of each nutrient supplied in the fertiliser mix and ensures it is below the threshold for the maximum or above the threshold specified for the minimum constraint.

A relationship between two nutrients is what Eqn. 5 specifies. The equation ensures that a nutrient supplied by fertilisers in the fertiliser mix solution is either less than or equal to, equal to, or greater than or equal to the quantity of a different nutrient supplied by fertilisers in the solution multiplied by a ratio. The ratio can take any value that is greater than zero, if it were zero the constraint would be redundant, if it were less than zero the problem would be infeasible.

Eqn. 6 maintains any specified relationships between two fertilisers. The equation ensures that the quantity of a fertiliser is either less than or equal to, equal to, or greater than or equal to the quantity of another fertiliser multiplied by ratio.

The next type of relationship, one between a particular nutrient in a fertiliser and all other fertilisers containing the same or a different nutrient is possible with Eqn. 7. The equation ensures that the quantity of a nutrient supplied by a fertiliser is either less than or equal to, equal to, or greater than or equal to the quantity of a nutrient supplied by all fertilisers multiplied by ratio. The nutrient on each side of the equation can be the same nutrient.

IMPLEMENTATION AND EVALUATION

The client and fertiliser databases were implemented using Microsoft Access version 2.0, while Microsoft Excel version 5.0 and its Solver Add-In were used for implementing the optimisation component. These two programs both use programming languages (Access Basic in Access and Visual Basic for Applications in Excel) that allow the manipulation and automation of the environment, application and their objects.

In Table 1 shows the nutrient requirements of kiwifruit calculated by a consultant used in this study to illustrate some of the features of the decision support system.

Table 1 The examples of nutrient requirements from Consultant One.

	Nutrients (kg/ha)							
Crop	N	P	K	S	Mg	Ca	Cl	Mn
Kiwifruit	124	29	173	38	38	146	0	0

Table 2 compares the result from the model with a recommendation of fertiliser produced by the consultant. (See Vale (1997) for more comparisons).

Table 2 A comparison of the fertilisers recommended by the consultant and those included in the solution for each solving method (kg/ha)

Fertiliser	Fert. Rec.	LP	p=1	p=2	p=infinity
Reactive Rock		224	224	106	106
N-Rich Urea Bulk		269	269	240	240
Calcium Ammonium Nitrate	275			43	43
Sulphur Super 30		35	35		
50% Potash Serpentine Super		692	692	526	526
Magnox		34	34		
Dolomite				93	93
Kiwifruit Special Mix	400				
Hycane Base Mix	950				
Total fertilisers used	3	5	5	5	5

Table 3 The percentage nutrient excesses or deficits from the target.

Solving method	N	P	K	S	Mg	Ca	Cl	Mn
Fert. Rec.	12%	85%	-18%	18%	33%	19%	large	0
LP	0	71%	0	0	0	0	0	0
p=1	0	71%	0	0	0	0	0	0
p=2	-1%	1%	-2%	1%	1%	-4%	0	0
p=infinity	-1%	1%	-2%	1%	1%	-4%	0	0

Table 4 The percentage difference in weight and cost of each fertiliser mix.

	Fert. Rec.		LP	p=1	p=2	p=infinity
Cost	$578/ha	100%	59%	59%	62%	62%
Weight	1625kg/ha	100%	76%	76%	76%	76%

Several significant fertiliser differences between the consultants and the models choice of fertilisers are evident. The model solutions usually consisted of a greater number of fertilisers than the consultant's mix, and sometimes inappropriate quantities of fertilisers were evident in the model solutions.

In Vale (1997) there were two cases in the examples used where the fertilisers selected, or not selected, seemed odd. Both cases involved a nitrogen deficiency. In the first example N-Rich Urea (a fertiliser containing only nitrogen) was included in the solution, but at a low quantity. Yet there was still a nitrogen deficiency and although it could have been overcome by increasing the quantity of N-Rich Urea, it was not. The second example did not have N-Rich Urea in the solution, or any other fertiliser supplying nitrogen, even though several fertiliser containing nitrogen were available for inclusion in the solution fertiliser mix. There exist several possible reasons why this may have happened:

- There may have been a conflict between the cost goal and nitrogen nutrient requirement goal where the added cost outweighed the benefit of better meeting the nutrient target.
- The solver program in Excel may have found what it thought was the global optima, but was actually a local optima.

The fertilisers in the solutions generated by the model differed from those included in the recommendations prepared by the consultants. There were instances where one or two of the fertilisers that the consultant had recommended were included in the solutions generated by the model, however, this was the exception rather than the norm. It seems that the consultants' may prefer to use a particular small set of fertilisers for all their recommendations. This may be because they feel more confident about using certain fertilisers, perhaps because they know the response of particular fertilisers under the conditions and plants in their region.

CONCLUSIONS

The fertiliser recommendation service begins with a consultant collecting information, which they then incorporate into their knowledge. When a client requests a fertiliser recommendation they draw on this knowledge, some of which is analysed and thus creates new knowledge about the problem at hand. The results of the analysis and their knowledge are then used to establish an estimate of the nutrient requirements, the selection of fertilisers to meet the nutrient requirements, and the fertiliser recommendation. The output of this group of processes is a recommendation report consisting of what fertilisers the grower should use and how and when to apply them. This is sent to the grower and incorporated into the consultant's knowledge.

Based on the optimisation routine solutions evaluated it seems that two is the most appropriate p value. The solutions when p was set to two were closer to the target values, did not take an excessive amount of time to generate, and typically removed unrequired nutrients from the solutions linear programme starting values. The linear programme is still required, however, as it is used to provide the compromise programme with a cost goal target and fertiliser quantity starting values. If the fertiliser quantity starting values are not used then it usually takes much longer to solve the problem, if it can actually find one at all.

The fertilisers in the solutions generated by the model differed from those included in the recommendations prepared by the consultants. There were instances where one or two of the fertilisers that the consultant had recommended were included in the solutions generated by the model, however, this was the exception rather than the norm. It seems that the consultants' may prefer to use a particular small set of fertilisers for all their recommendations. This may be because they feel more confident about using certain fertilisers, perhaps because they know the response of particular fertilisers under the conditions and plants in their region.

The information that the decision support system can provide a consultant should be treated as an additional piece of information to aid the decision making process. The decision support system should not be considered a tool that generates a final decision, instead, it is a starting point from which the consultant can add their personal knowledge, experience, and understanding of the clients they serve to come up with a satisfactory fertiliser mix recommendation.

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IMPACT OF POOR FARM MANAGEMENT PRACTICES ON FARM VALUE: A RANGITIKEI CASE STUDY

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Keywords: New Zealand - Farm values - Treading damage - Pugging

Abstract
This paper reports on the findings of research into the impact of severe pugging damage on rural property values. A case study farm was used to first estimate the cost of repairing damage to severely pugged farm land. Second farm sales were analysed to examine the impact of pugging damage on farm sale price. Following this a group of valuers were questioned to quantify the alteration in farm land value attributable to the severe pugging damage. The research revealed that severe pugging damage will reduce farm land value. There was a close relationship between the cost to repair damage and the reduction in value.

Introduction

The efficient operation of the rural property market is important for those involved in agriculture in New Zealand. Most New Zealand farmers are owner operators with a very high percentage of their business equity invested in farm land. These farmers are seldom actively involved in the property market but the value of their farm is always of importance to them. Farm values impact on financing ability and forward planning of the business operation. So farmers will be interested in how farm management practices impact on the value of their farm.

The farm land market operates in a complex manner as it is affected by such a diverse range of factors. This range includes external factors (eg. markets, inflation rate, political stability) and physical characteristics of the property (eg. location, soils type, topography, climate). Soil is one of the most important physical characteristics of farm value [1] but little is known about how sensitive the rural property market is to varying soil conditions. Degradation of soil can limit the production of farm land [2]. This can have a major impact on the profitability of the farming business that can extend for many years. This research is concerned with investigating how land value is affected by soil degradation caused by stock treading.

In many parts of New Zealand when wet soils are grazed by heavy stock their treading will cause damage to soil and pasture. This is commonly known as pugging. It leads to a decrease in pasture utilisation, plastic deformation and compaction of the soil and deterioration in soil structure [3]. When severe pugging occurs, the best option for the farmer is to cultivate and regrass. This generally restores the land to it's full productive potential. If pugging and soil compaction continues over a number of years soil compaction is more marked and damage is difficult to rectify.

The research was motivated by a 50-hectare case study property located in the Rangitikei region. The property was in permanent pasture and used as a dairy runoff. During the wet winter of 1995 more than 80% of the farm area was severely pugged. The research sought to determine how this

affected land value immediately after the damage had occurred.

The Preliminary Research

Two research objectives were defined. Using a case study property;

1. To estimate the direct and indirect costs of repairing soil and pasture damage to farm land that has occurred as a result of treading by mature cattle.

2. To determine the alteration in value of rural land that is attributable to severe treading damage by mature cattle.

Cost of Repairing the Damage

When severe pugging has occurred, dry matter production is reduced significantly and weed infestation is likely. The best option for a farm manager is to cultivate and regrass the damaged area. Besides the cost of regrassing the opportunity cost of foregone income from the time of cultivation to pasture establishment has to be assessed.

The first research objective required a quantitative analysis of the direct and indirect costs. Direct costs of regrassing were readily available from local contractors and seed merchants. The work to be carried out would be variable according to soil conditions at the time of cultivation but is assumed to include a minimum of the following; plough, level, power harrow, level, drill. Cultivation costs are based on local contracting rates. The grass seed mix is assumed to contain a standard ryegrass and white clover mix. Weed spray and fertiliser is required to ensure establishment of the pasture, costs are based on standard applications in the area. Table 1 below summarises the direct cost to repair damage.

Item	Cost per hectare
Re-grassing	
- cultivation and drilling	$220 - $345
- grass seed	$120
- weed spray (applied)	$20 - $25
- fertiliser (spread)	$60
Re-grassing cost/ha	$420 - $550

Table 1. Per hectare direct cost of repairing damage to severely pugged land

The indirect costs were calculated in two ways, first on the basis that the land could have been used for dairy heifer grazing and second on the basis of rental income foregone. Using the bottom end of the price range for grazing opportunity cost per hectare is $360. For the 20-week period the opportunity cost per hectare of rental income foregone is $142.

The total cost of repairing the damage to pugged pasture is within the range of $560 to $910 per hectare.

Determination of Alteration in Rural Land Value

This research objective required a comparison of land value before and after severe pugging. Ideally this would be assessed using comparable sales evidence. Sales of damaged and undamaged land in the same locality as the subject property were sought but a very limited number of recent sales had occurred. There were no recent sales with a similar level of damage to soil structure.

There was a sale in May 1994 of a property that was said to have been in poor condition. It is believed that the property was severely and extensively pugged, poorly drained and in young pasture. The sale price for land was 13% below the September 1994 Government valuation of the property and is believed to be in the order of 12% below prices paid for land at the time of sale.

It was decided that a more accurate method of investigation of the alteration in value attributable to pugging damage was to survey people with expertise in farm land valuation in the region of the case study farm.

A postal questionnaire was sent to 44 current members of the Central Districts (North Island) Branch of NZIV. Only those members with a rural qualification and experience in the Rangitikei or Manawatu region were surveyed. A response rate of 59% was achieved. Results are summarised below.

Review of Survey Results

Profile of Respondents

All respondents have valuation experience and all are current members of the New Zealand Institute of Valuers. The current field of employment of respondents is illustrated in figure 1 below.

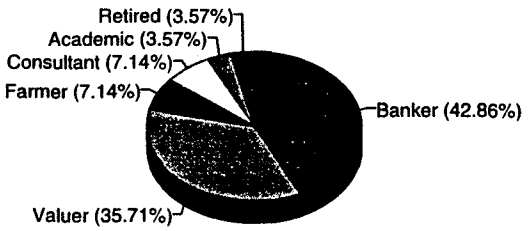

Figure 1. Current employment of respondents

The average number of years of experience of respondents in the Manawatu/Rangitikei region is 15, with a range of two to 40 years experience. Respondents were very well qualified to answer questions relating to farm land values in the Rangitikei region.

Impact on Value of Severe Pugging

Respondents were questioned in three different ways concerning the impact of severe pugging on land value.

First they were asked to put a value range on severely pugged land given a price of $7,500 per hectare for undamaged bare land. This question related directly to the case study farm and photographic evidence was provided. Results to this question showed an average land value range of $6,640 to $7,082 per hectare for the pugged land. This equates to an average percentage reduction in land value of 8.5% due to the pugging damage.

Second they were asked to estimate the percentage reduction in land value that they would make for land in pasture or crop that had suffered from pugging damage. This question was general and covered a range of damage from minimal to severe. Table 2 below shows the number of respondents in each category of percentage reduction for the ranges in severity of damage to land in both pasture and crop.

	Severity of Damage					
Percentage Reduction (LV)	***Minimal***		***Moderate***		***Severe***	
	Pasture	***Crop***	***Pasture***	***Crop***	***Pasture***	***Crop***
0 - 5%	90%	100%	35%	50%	4%	22%
6 - 10%	10%		57%	45%	30%	26%
11 - 15%			9%	5%	39%	30%
16 - 20%					13%	13%
21 - 30%					13%	9%

Table 2. Percentage of respondents in each category of land value reduction for a range of pugging damage to land in pasture and crop.

Results show that for any pugging damage the decrease in value is less for cropped land than for land in pasture. This was expected as the visual impact of pugging will disappear with cultivation.

Where damage is minimal any decrease in land value is very low (0 - 5%).

Where damage is moderate, the decrease in value is most likely to fall within the 6 - 10% range for pasture and the 0 - 5% range for cropping land. Adjustments would be slightly less for severely damaged cropping land.

With severe damage the range of responses was more widespread with 65% of respondents suggesting a decrease in value of more than 11% for land in pasture and 30% indicating a reduction in value of between 6% and 10%. The median range for reduction in value to severely damaged land was between 11% and 15%.

Third they were asked if they valued damaged land at a different rate to undamaged land. This was a general question included to determine the importance of pugging damage in the estimate of land value. The majority of respondents said that they possibly would value the damaged land at a different rate. The need to consider land use and proportion of the farm affected was frequently mentioned by respondents. If most of the farm was damaged, many would value the land at a lower rate. Several respondents noted the loss of farming options with damaged land

and the need to improve subsurface drainage. If only a small proportion of the farm was damaged, most respondents would not differentiate in land value. In this instance many respondents argued that the land would most likely be cultivated and it was a standard farming practice to have sacrifice areas.

Saleability
Respondents were questioned about the saleability of the case study farm immediately after the pugging damage had occurred. All respondents said that the severe pugging would most likely decrease saleability of the property. The reasons given for reduced saleability were; The loss of farm productivity, poor grazing potential and the need for extensive cropping, increased drainage costs, poor appearance and lack of appeal to prospective purchasers.

Financing
Respondents were questioned on the view of financial institutions on lending on properties that had severe pugging damage. Eighty-two percent of respondents said that it was most likely that financial institutions would view lending on severely damaged properties differently from properties with minimal damage. If lending to an existing owner, the damage would suggest poor farm management ability and therefore an increased lending risk. If lending to a purchaser the damaged land would have lower earning potential and increased operating costs until the damage had been rectified.

Conclusions
The research has shown that damage to soil and pasture by stock treading will most probably result in a decrease in farm land value. Where pugging damage is minimal (as to either extent or severity of damage) the reduction in land value will be small, within the 0% to 5% range. Where damage is severe and extensive the reduction in land value will be more significant. Research results show a reduction in land value within the range of 6%-15% would be expected with severe pugging damage.

These results correlate closely with the results of land value estimations for the case study property. With the photographic evidence of the severely damaged case study farm the valuers who responded to the questionnaire estimated that the land value of the property would be reduced by 6% to 11% because of pugging.

The questionnaire results correspond closely with the market evidence from the one older local sale of pugged farmland. In this sale a reduction of approximately 13% was seen in sale price.

Decrease in value caused by pugging damage has to be compared to cost to rectify the damage. In an informed market it is expected that cost and value would be equal. The cost to rectify the damage to soil and pasture on the case study property was calculated at between $560 and $910 per hectare. The decrease in land value estimated by the respondents was within the range of $418 to $860 per hectare based on the photographic evidence of the case study farm and between $450 and $1,125 based on the decrease in value to severely damaged land in general. This result would suggest that the market is well informed regarding the cost of visible damage to pasture and soil structure.

Limitations
There were a number of limitations associated with this research project.

Accurate estimates of the direct cost to regrass damaged land can be obtained. It is possible that actual costs and prices could vary from quoted costs due to weather and soil conditions at the time of cultivation.

Indirect costs of repairing pugging damage can be calculated in several different ways giving widely different results.

Recent sales data should provide the best evidence of alteration in land value due to pugging damage. A lack of recent farm sales and no recent sales of damaged land limited the research. One sale that provided market evidence of land value of a severely pugged property occurred in 1994. Due to the age of the sale verifying farm condition at sale date was not possible personally.

The property market is cyclical and it is possible that factors influencing land value will vary in importance at different stages of the property cycle. During 1995 and 1996 the property market in the Marton area was influenced by a large number of sales to local or adjoining owners.

Without adequate sales data the use of valuation evidence is widely accepted but there is the possibility of appraisal bias in the results. By surveying all local rural valuers the possibility of bias should be reduced.

The response rate to the questionnaire was 59%. This was a good response rate and high enough to provide reliable results.

Further Research
The issue of soil quality will have increasing importance as the need for sustainable farming systems is acknowledged. Farmers do have some control over soil quality in the management practices that they employ. However, little is currently known about the impact of farm management practices on property values. Further research in this area is warranted.

This research project provides an indication of the decrease in land value, attributable to pugging damage, in the Rangitikei area in the 1995 to 1996 period. This could be repeated in other localities at different stages of the property market cycle.

Farm vendors and purchasers determine the rural property market and would provide a very useful source of information. Vendors and purchasers could be surveyed to learn their attitude to the importance of condition of soil and pastures in a property transaction.

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PARTICIPATORY MANAGEMENT OF IRRIGATION SYSTEMS IN THE ILOILO PROVINCE OF THE PHILIPPINES

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ABSTRACT

Increased national food production is an objective underlying irrigation development in the Philippines. Farmer participation in all phases of irrigation development has been shown to be an important factor in the success of a scheme. A study was conducted to describe how farmers participated in their local irrigation systems in the Iloilo Province of the Philippines. Two levels of respondents were interviewed for the study: 15 representatives of Irrigator Associations (IAs) and 144 farmers from four of these associations in the Iloilo Province. The average age of farmers in all four irrigation systems was 49 ± 12 years. The small farms (1.07 ha ± 1.51 ha) were supplemented with leased land. An average of 1.23 ± 2.3 children were present per household. Overall, 49, 40, 45, and 34% of the farmers reported in an involvement in planning, providing labour for construction, cleaning the canals for maintenance and resolving conflicts with fellow members of the IA, respectively. On average, farmers attended almost 3 meetings of the IA per year. Farmers with a high proportion of income from rice and located further from the water turnout were most actively involved in irrigation-related activities. The main cause of conflict between IA members and the officers was lack of water in the dry season.

Keywords: irrigation, participatory management, farmer survey, Philippines.

INTRODUCTION

New irrigation projects and rehabilitation of existing schemes, have been among the major thrusts of governments in developing countries. This has become a necessity since the amount of land available for cultivation has become limited, while the demand for agricultural products continues to rise. Global food security in the light of rapid population growth in developing countries and a corresponding increase in food demand depends largely on the continued expansion of irrigated agriculture until at least the year 2000, and on the improved operation and maintenance of existing irrigation systems (Alicante, 1991). The expansion and upgrading of irrigation infrastructure is an important pre-requisite for improving land productivity because these actions will augment the current land supply as well as enhance per hectare yield (Olavides, 1993). In 1996 the domestic demand for agricultural products in the Philippines was largely met through national production; this success could not have been achieved without the last half-century's investment in irrigation by the government through concessional loans from the World Bank (Campbell, 1995).

Agriculture, being less dependent on imports than the industrial sector, is still the prime mover of the Philippine economy. Approximately 40% of the gross domestic product (GDP) is generated by agriculture. In recent years, the gross value added from this sector has increased at a rate of over 3 % annually, being 3.5% in 1988, 4.6% in 1989, and 2.3% in 1990. Almost two-thirds of the labour force is employed in agriculture, which is characterised by extensive land use, intensive labour use, relatively low yields and low per capita incomes of its farmers. The potential area for irrigation development in the Philippines is about 3.14 million hectares. At the end of 1989, 47 % of the potential area under irrigation was provided with water distribution facilities and, like other developing countries, investment in irrigation was considered crucial to the further economic development of the country's agriculture. In 1996, approximately 650,000, 700,000 and 160,000 hectares was covered by large-scale national systems, small-scale communal systems and pump systems, respectively. The area irrigated amounted to 20 % of the total cultivated area. The Philippine government aims to expand the current irrigated area by 50 % by the year 2000. This paper examines farmer participation in irrigation systems and identifies their perceptions and major constraints to farmer involvement. A brief description of irrigation systems and their development is presented first.

IRRIGATION DEVELOPMENT IN THE PHILIPPINES

In the Philippines, irrigation development dates back to early history (Gonzales, 1993). For example, the indigenous people of the northern mountain areas built an estimated 25,000 ha of paddy field terraces on steep-sloped mountain land in order to grow rice, their staple food crop (Bagadion, 1988). This paddy area is widely praised and regarded as one of the seven wonders of the world (commonly known as 'Ifugao rice terraces'), and is ranked equal to the maize field terraces on the steep land of Nepal. In the lowland areas of the country, farmers also built irrigation systems, either individually or in groups. The systems were physically simple, with dams being made of logs and stones, and the canals dug from the earth. It was only during the Spanish colonial period that masonry dams, some of which still remain in use today, were built. Though irrigation practices started long ago, the pace of development has been slow. It has only been during the last two decades, that the Philippines has made impressive progress with irrigation development. This can be attributed to the creation of the National Irrigation Administration (NIA) in 1964 which has systematically hastened the construction of large scale, communal and pump irrigation systems (Salguero, 1995).

The NIA is mainly responsible for the development of irrigation systems in the Philippines. Its responsibilities include both the national system and the communal systems, which are owned, operated, maintained and managed by the government and farmers. A national irrigation system typically serves more than 1,000 hectares, while a communal or farmer-managed irrigation system usually covers 50 to 1,000 hectares. The NIA serves each of the country's three types of irrigation systems in a different way. For large irrigation systems called "nationals", the NIA's role is to construct the physical facilities, manage the system and collect irrigation fees from the farmers utilising the system. Examples of this type are the Upper Pampanga River Integrated Irrigation System (UPRISS), which services an area of 103,000 ha, and the Bicol River Basin Integrated Systems. Both are located in the central part of Luzon. For smaller irrigation systems, that serve groups of farmers, called "communals", the NIA seeks to involve farmers from the initiation of the project. After construction and commissioning has been completed, these systems are handed over to the farmers through their respective associations. Small scale irrigation systems involve the participation of the local community where a small group of farmers organise into an "irrigator association" and actively participate in the overall operation and management of the local system. The operation and maintenance of the system remains the sole responsibility of the irrigator association. For irrigation systems built and managed by single individuals, called "private" systems, the NIA's role is restricted to providing technical advice upon request.

Due to the increasing cost of operating and maintaining existing large irrigation systems, policy makers are now directing investment funds into smaller irrigation systems which are potentially more productive and more cost effective than the larger systems. Small scale irrigation projects, such as the Small Water Impounding Projects (SWIP), are gaining greater attention because of the relatively low capital investment needed for the construction of small reservoirs compared to the larger national projects (Salguero, 1995). The establishment of the SWIP scheme is seen as a means to prevent possible regional disparities and better serve isolated areas, particularly those in depressed regions of the country which have yet to benefit from national irrigation systems. The SWIPs are also attractive because they encourage the active and on-going participation of the local community and as such tend to be easier to manage.

PARTICIPATORY MANAGEMENT OF IRRIGATION SYSTEMS

Participatory management has been the most widely adopted policy for managing both small and large irrigation systems in South and Southeast Asia. The development of farmer organisations in the form of irrigation associations seeks to increase their capacity for participation in the decision-making process (Raby, 1991), and to encourage farmer involvement in the layout and design of the new canals and structures so that their knowledge of the local area and their desires can be incorporated into construction plans (Cernea, 1991). The objective of participatory management of irrigation systems is to increase land productivity and the income of its immediate beneficiaries, the farmers. Participatory management in the Philippines is most successful in the context of smaller (approximately 50 hectares) systems under NIA supervision. With larger systems, such as UPRIIS, farmer participation is limited to the collection of service fees rather than active management (Raby, 1991). The government's emphasis in recent years on small irrigation projects suggests that new performance parameters will be needed to assess the effectiveness and efficiency of irrigation systems. Therefore, there is a need to understand the overall management efficiency, group dynamics and extent of farmer participation in irrigation projects and to quantify the socio-economic benefits of alternative management approaches for irrigation systems.

STUDY AREA AND DATA

The study was conducted in the Iloilo Province of the Philippines, which is considered to be the food "bowl" of the Western Visayas. It is currently one of the leading rice-producing provinces in the country. Iloilo was selected as a study area because although participatory irrigation management programmes have long been practiced in the Philippines, NIA's focus of study has not been on the Iloilo Province. The study was limited to small-scale irrigation systems (communal irrigation systems, CIS) operated and maintained by the irrigators association and NIA-assisted "communals" that use a participatory approach to management. As such the study reflects a cross-sectional view of one part of the Philippine's irrigation programme.

Two sets of questionnaires were developed: one for individual farmers and the other for representatives of the irrigator associations (IAs). The interview schedule was pre-tested using 12 water-users from a communal irrigation project not included in the final study sample. Only minor revisions were made after the pre-test before implementing the survey instrument. A total of 144 farmers were interviewed from the four different project sites. The sites namely, Siwaragan, Lipata, Palaypay and GIPA were randomly selected from the list taken from the Provincial Irrigation Office. Thirty six farmers were randomly selected from each of the four sites. The four sites included in the sample represented different municipalities of the Iloilo Province. Fifteen irrigator associations were also randomly selected from all of the projects operational in the Province of Iloilo. The irrigators interviewed each represented one association.

Farmers were asked to explain their involvement in irrigation system and express their perceptions about selected practices. The analysis of farmer participation in irrigation management activities such as planning, construction, repairs and maintenance, and resolving conflicts were classified, based on their responses, on a scale of 'very high', 'high', 'moderate', 'low', 'very low', and 'no participation' using numerical values of 5, 4, 3, 2, 1, 0, respectively. These numerical values were further coded into two categories, with 5 and 4 as 1 and 0, 1, 2, 3 as 2 in order to simplify data presentation. Farmer attendance at meetings was entered as the number of meetings attended, while water supervision was based on the individual(s) or organisation representative who supervised it. The responses to the opinion questions concerning aspects of irrigation were recorded on the scale 'strongly agree', 'agree', 'undecided' , 'disagree', 'strongly disagree', and 'no opinion' were converted into corresponding ordinal values of 5, 4, 3, 2, 1, 0, respectively.

RESULTS AND DISCUSSION

Irrigator Associations (IAs) in the Iloilo Province: Their Role and Performance

Of the fifteen IAs, seven had been operational for 20 years or more and active since their establishment. The majority of the operational communal irrigation systems (CIS) had been rehabilitated. Half of the irrigation associations were organised by the NIA-Iloilo Provincial Irrigation Office (NIA-IPIO) in collaboration with the now defunct Farm System Development Corporation (FSDC). The remaining IAs were organised by the NIA-IPIO with the help of the Irrigators' Development Officer (IDO) assigned to the province.

The size of membership of each association varied and included both active and inactive members. Farmer participation occurred during development in terms of the survey activities, location of structures and canals, and right-of-way negotiations. They believed that this contributed to more effective system design. All IAs ensured that member farmers contributed labour to repairs and maintenance of the system, while nearly half of the associations required a cash contribution as well for the same purpose. Farmers were personally responsible for maintaining the irrigation lateral structures, which went to their farms.

The majority (66%) of the IA representatives reported that farmers paid an irrigation fee on the basis of both the number of crops grown and the area irrigated. The irrigation fees were set by the NIA and for the 1995/1996 season this was equivalent to 2 cavans (more or less 80 kg) of rice (or its equivalent in cash) per hectare. Fees were collected in cash by IAs without crop storage facilities. The Head or officer of the Association was responsible for collecting fees. To avoid delinquent payments, the NIA encouraged IAs to provide incentives and awards/recognition for outstanding performance in amortisation collection/payments. These were widely used by the IAs.

All but one of the IAs encountered problems with water distribution. These normally occurred during the dry season because of an inadequate water supply. Some of the problems encountered by the respondents were: poor irrigation facilities, conflicts in water scheduling, favouritism and insufficient water availability during the dry season. The lack of suitable alternative sources of water to meet the demands of farmers actually restricted the opportunity to increase crop yields on some properties (e.g. in the Palaypay irrigation) and the potential to expand the area under irrigation. IAs suggested that improved efficiency of water utilisation by the farmers could help to resolve this problem.

In the sample IAs, 87% agreed that water distribution and water stealing were major problems. A number of the representatives also mentioned that conflict occurred between the IA officers and the farmers. The Head or an officer of the Association or officers was responsible for supervising water distribution, but apparently this did not prevent favouritism and conflict in water scheduling. Other causes of conflicts were: collection of irrigation fees, attendance of meetings and diversion of unscheduled water distribution.

All IAs had a Complaints Committee, which was responsible for taking action on a complaint or grievance by one member against another. The committee established procedures whereby complaints could be promptly investigated and acted upon. Half of the respondents mentioned that "IA O & M policies were observed" as one of the methods used to resolve conflict amongst members. The remaining respondents contended that the appeal process, intervention by IA officers and farmer education were the main methods used to help resolve conflict amongst association members.

Three types of meeting were organised by the IAs in the study region: a meeting of the governing Board, a General Assembly and individual Sector Meetings. The Board Meeting was attended by the officers of the IA, while the General Assembly meeting was attended by both the officers of the IA and the farmer members. The Sector Meeting was held as needed, and involved farmers within the local sector (around 7 or 10 members). During the General Assembly and Board Meetings, operational issues such as activities to be undertaken by the IA, problems confronting the association, payment reminders, conflict resolution and reports were discussed. During the General Assembly officers of the IAs are elected.

The General Assembly meetings were critical for the process of collective decision- making within the IA. The association meetings were well attended by members, although half of the respondents only met annually and one-third met twice in a year. The Board of Directors (BOD) meeting were supposed to be held every month, but only four (27%) of the respondents mentioned that their association met this regularly while the other associations met between two and eight times per year. The farmers' hectic schedule of agricultural activities was cited as the primary reason for not meeting on a monthly basis. The BOD members were relatively better educated and financially well-off compared the 'typical' farmers and thus, they could influence decision-making within the IA. Sector meeting were only held if the members encountered problems within the local community. Three-fifths of the respondents attended half of the meetings of the association.

All of the respondents reported that their association had conducted training sessions and seminars for their farmer members as and when needed. Topics covered included irrigation management, financial management, group dynamics and leadership development. In addition to meetings and training seminars, group discussions and dialogue with *barangay* officials or NIA-IDO staff provided other avenues through which members could express their concerns about the management of their irrigation system.

The most persistent problem experienced by the IAs were water shortages during the dry season. This led to the stealing of the water by some farmers. Other problems identified by the respondents were difficulty in collecting fees, typhoon damage to facilities and conflict amongst members especially during the dry season. One respondents mentioned that "most members lacked education in water use". Farmers themselves took a lead role in resolving these problems but were not always successful.

The majority of the respondents (87%) believed that the IA would still be intact in 10 years time. When asked whether association membership was likely to increase in the next five years, 73% answered positively and 27% were not sure or answered "Don't know." The most likely explanation for this response is that farmers had experienced working with the association and were well aware of the benefits that a member could obtain.

All but one respondent agreed that association membership motivated farmers to assume greater responsibility for irrigation management and likewise, the same percentage of respondents believed that being a member encouraged farmers to participate in key decisions for irrigation. Twenty-seven percent of the respondents strongly agreed that association membership also promoted collective ownership of the irrigation facilities and of these, six (40%) strongly agreed that it would lead to the expansion of the irrigation system. When asked whether being a member provided a means for farmers to increase their income, 53% answered "strongly agree" and 47%

replied "agree." Overall, the respondents in the Iloilo Province perceived clear benefits arising from IA membership.

Farmers Members of IAs

Characteristics of Farmers
Women accounted for 21% of the respondents. An average respondent was 49 years old and had attained nearly eight years of schooling. The average respondent household had 3.8 children. Rice was the major source of household income for the respondents and contributed 83% of the household income. The variation across the four irrigation systems, however, was large with respect to these characteristics (Table 1). For example, the Palaypay respondents were relatively more educated but were older compared to the respondents from other systems.

Farm Characteristics
The mean area farmed was markedly different between the four systems and ranged from 0.25 ha in the Lipata system to 2.44 ha in Palaypay area (Table 2). In Palaypay, more than two-fifths of the farms were over 2 ha, but fewer than 6% of the farms from the other systems were in this size category. The Lipata, GIPA and Palaypay respondents were proportionately more dependent on income from rice farming than those associated with the Siwaragan system (Table 2). The Siwaragan system was different from the other three systems because of its proximity to the fishing centre in the southern part of the Iloilo Province. Consequently, many of the respondents could generate off-farm income from fish-related activities. Poultry, hog raising, cattle fattening and vegetable production were major sources of non-rice income for the GIPA farms.

Farms in Siwaragan were farthest from the main water source (135 minutes of travel time). Respondents from the Palaypay system took nearly one and a half hours to reach the main water source (Table 2), while farms in the GIPA and Lipata systems were only 23 and 33 minutes, respectively, from the main water source.

All of the farms in the GIPA association and most of the farms in the Lipata and Palaypay associations were within 20 minutes of a branch canal (Table 2). Variation in travel time to the branch canals between the farms in the four associations was small. The respondents expressed no problems in reaching their farm from the homestead. The average time from the homestead to the farm was 37 minutes (Table 2). Eight farmers lived two hours or longer from their cultivated land.

Farms farthest from the main water source (i.e. those in the Siwaragan system) in terms of either the main or branch canal, were not necessarily short of water (Table 2). On the contrary, although distance (in travel time) from the main canal in Palaypay was roughly three times closer than in Siwaragan, 58% of the respondents experienced an inadequate supply of irrigation water. These findings suggest management and water distribution problems in the Palaypay system require further investigation.

Overall, an average farm had 1.23 ha under irrigated rice. The respondents served by the Palaypay irrigation system had the largest (1.52 ha) irrigated rice area and GIPA had the smallest (0.92 ha). Amongst the four irrigation associations, GIPA farmers achieved the highest mean rice yield (6693 kg/ha) and Lipata had the lowest average yield (2908 kg/ha). The GIPA system respondents reported significantly greater ($P<0.01$; more than twice) rice yields compared to the remaining respondents. However, rice yields in Siwaragan, Lipata and Palaypay were statistically similar.

Farmer Participation in Irrigation Systems
Farmer participation in irrigation-related activities included: planning, construction (contribution to labour, finances and material), repairs and maintenance (cleaning, repairs to structures and materials), attendance of meetings, participation in resolving conflicts arising from the operation and use of the irrigation system and that related to involvement in water supervision (Table 3). Farmers as a group worked together for the common benefit of the association. By pooling their resources they had accomplished much more than would have been possible by the individual efforts of farmers. Participation in planning by the respondents was "high" or "very high" in the Siwaragan and Palaypay (89%), while it was very low in the other two systems (Table 4). None of the respondents in Lipata and Palaypay had a "high" or "very high" contribution in terms of cash or in kind to their local irrigation system. Only 3% and 39% of the respondents from these irrigation systems, respectively, contributed their labour. Farmers in the Lipata, Palaypay and GIPA associations had to some extent participated in all three of the construction-related activities.

The involvement of the Siwaragan respondents was either "high" or "very high" with respect to the cleaning of canals and undertaking structural repairs. However, their contribution in the form of materials for repairs was low. Only one in seven respondents was highly involved in contributing materials (Table 4). The involvement of the respondents in repairs and maintenance activities varied considerably between the IAs.

Respondents in all four of the IAs experienced conflicts amongst farmers, between farmers and officers, and farmers and NIA/DA personnel (Table 4). Amongst the four irrigation systems, the Siwaragan system members were most active in resolving conflicts amongst farmers and officers of the IA. This may have been due to the proximity of their farms to the water supply (main water source, main canal and branch canal. Water allocation was the most common conflict encountered by the respondents.

All respondents in the Lipata system reported that they had attended at least one meeting in the past year, which implies, that the General Assembly meeting was attended by all of the respondents (Table 4). Notably, no farmer was an officer of the association and none ever attended any emergency meetings, and the frequency of other meetings reflected the needs of the individual IA.

The extent of participation by the respondents was assessed by considering all of the activities mentioned earlier (i.e. planning the irrigation system, contribution to construction, involvement in repairs and maintenance, resolving conflicts and attending meetings). In general, respondents from the Siwaragan and Palaypay associations were more active than those from the other two associations. Their participation was "high" to "very high" for irrigation activities such as planning of the irrigation system, labour and cash contribution during the construction stage, repairs and maintenance (cleaning of the canals, repairs to structures) and conflict resolution (amongst members and officers of IA). This supports the findings of Korten and Siy (1988) who claimed that the NIA encouraged the farmers' involvement from the very start of the project which include planning, constructing the structures, developing skills in resource mobilisation and conflict resolution that are needed for the effective operation and maintenance of the irrigation systems. Respondent participation in meetings, as reflected in the number of meetings they had attended per year, varied according to the needs of the association.

Farmer Opinions about the Management of Irrigation Systems
Farmer opinions about irrigation system management in terms of their involvement in planning, construction, payment of irrigation fees and attendance of the group meetings are summarised in Table 5. Only one of the 36 respondents from Palaypay and six of the 36 respondents from the GIPA association were unsure about their role during the planning stage of an irrigation system. Almost all respondents (97%) "agreed" or "strongly agreed" that their involvement at the construction stage was important. This was consistent with the indication that respondent participation was "high" or "very high" in terms of their labour and cash contribution in Siwaragan, although it was either "low" or "moderate" in Lipata (Table 3).

All but one respondent in the Siwaragan and Lipata systems "agreed" or "strongly agreed" with the statement that they should attend meetings on a regular basis, but this was generally not the case for the Palaypay respondents (Table 5). This may have been associated with their larger farm size (Table 2) and higher living standard compared to those farmers from the other systems.

Association Between Management Factors and Socio-economic/Demographic Characteristics
Farmer participation in planning was negatively and weakly associated with the age of farmers ($r = -0.29$) and positively associated with household rice income ($r = 0.19$). The respondents' gender, number of children and educational attainment did not influence their participation in irrigation planning activities. The findings contradict Soltes (1981), who showed a high correlation between knowledge and participation in irrigation activities. Younger respondents and households with a greater proportion of income from rice, tended to participate more in planning activities.

Male respondents and those who belonged to a household with a higher proportion of household income from rice farming, contributed both labour and cash to their local irrigation system. More educated respondents contributed cash, while those with a lower income tended instead to contribute materials. The households with a higher proportion of income from rice farming were also actively involved in carrying out repairs and maintenance to the irrigation system. In general, younger male respondents were most involved in cleaning the canals and providing materials for repairs and maintenance.

Older men respondents attended most of the meetings, as did the more educated and members of households with a higher proportion of income from rice farming. The latter respondents also influenced water supervision

activities. Olano (1981), also found that an individual's extent of participation in irrigation activities was related to their education.

Association Between Management and Physical Factors

Respondent participation in planning was negatively associated with farm size (r=-0.36), distance from the main water source (r=-0.62), distance from the main canal (r=-0.47), and distance from the branch canal (r=-0.40). Among the physical factors considered, only distance from the homestead did not influence participation in the planning of the irrigation system. The respondents who had smaller farms and who were located farther away from the water source, tended to participate more actively in the planning activities for the irrigation system. This finding contradicts the results of Alicante (1991) who indicated that the owners of larger farms tended to participate more actively in tasks related to a project than those who had smaller farms.

Participation in terms of resolving conflict with officers of the IA, amongst members and with NIA/DA personnel were significantly related to the distance from the main water source, main canal, branch canal and homestead. Respondents whose farm was far from the supply turnout were more active in resolving conflicts. This could be due to the fact that these farmers are more likely to be affected by problems with water availability.

Respondents from larger farms and those that were far from the main water source and homestead were more active in attending meetings. Also, the greater the amounts of water the respondents accessed, the more they attended meetings. The respondents were generally satisfied with the way water was distributed amongst the users. This is consistent with Alicante (1991) who suggested that the greater the benefit the respondents received, the more likely they were to participate in irrigation-related activities.

Association Between Socio-economic & Demographic Factors and Farmer Opinions

The strength of opinion about factors such as, timely payment of irrigation fees, regular attendance of meetings and consultation during the planning stage were significantly ($P< 0.05$ and $P< 0.10$) associated with farm income (expressed as a proportion of total household income) and age and education. Generally, and as could be expected, respondents with a higher share of rice farming income were positively associated with paying irrigation fees on time. Gender and the number of children per household had no bearing on the respondents' opinion about aspects of irrigation system management.

Association Between Physical Factors and Opinions

Farm size was positively associated with the farmers' perception of the timely payment of irrigation fees (r=0.26) and negatively associated with meeting attendance (r=-0.43). Water availability was positively associated with the respondent's opinion about system construction and irrigation payment, but negatively linked with meeting attendance. Respondents who accessed the largest volume of water were more likely to have a favourable attitude toward the irrigation system. Physical factors such as the distance of the farm from the main water source and the homestead also influenced the respondent's views about the timing of irrigation fee payments.

CONCLUSIONS

The current emphasis by the Philippines Government on small irrigation schemes calls for a better understanding of management performance of existing systems and underlying mechanisms for achieving this, such as farmer participation and group dynamics. This study was conducted to assess the performance of farmer managed small-scale communal irrigation systems in the Iloilo Province of the Philippines, which is one of the leading rice producing regions in the country. Farmer participation in IA activities were found to vary considerably. Irrigation management was significantly associated with socio-economic/ demographic (household income from rice, age, gender, educational attainment) and physical factors (proximity from the main water source, main canal, branch canal and the homestead, farm size and water availability). In particular, respondents with a higher proportion of income from rice farming and who were furthermost from the water turnout, and who were relatively better educated, and who accessed the largest volume of water were likely to be the most actively involved in irrigation-related activities. These aspects need to be closely monitored by the IAs, otherwise the poorest and least educated farmers are likely to become increasingly disadvantaged. Overall, farmers were supportive of their IA and actively participated in irrigation management.

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Table 1. Socio-demographic characteristics of the farmers associated with different irrigator Associations in the Iloilo Province.

Characteristics	Irrigator Association				
	Siwaragan[1] N= 36	Lipata N= 36	Palaypay N= 36	GIPA N=36	All Sites N=144
1. Age (years)	52 (14)[2]	43 (11)	55 (11)	47 (8)	49 (12)
2. Sex	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Male	32 (89)	35 (97)	26 (72)	30 (83)	123 (85)
Female	4 (11)	1 (3)	10 (28)	6 (17)	21 (15)
3. Educational Attainment	6.5 (3.3)	6.4 (2.7)	9.4 (3.3)	8.1 (3.1)	7.6 (3.3)
4. No. of Children	3.5 (2.5)	(3.9) (2.8)	4.3 (2.1)	3.6 (1.6)	3.8 (2.3)
5. Percent Income from Rice Farming	64 (21)	95 (8)	93 (12)	79 (20)	83 (20)

[1] Siwaragan, Lipata, Palaypay and GIPA are the names of the irrigation systems within each municipality selected for the survey.
[2] Figures in parentheses underneath the mean values are the standard deviation.

Table 2. Farm size, accessibility to irrigation systems and adequacy of water for irrigator association within the Iloilo Province.

Characteristics	Irrigation System				
	Siwaragan	Lipata	Palaypay	GIPA	All Sites
1. Total farm area (ha)	0.68 (0.78)[1]	0.25 (0.56)	2.44 (2.29)	0.91 (0.54)	1.07 (1.51)
2. Distance from the main water source (travel time in minutes)	135 (65)	33 (24)	88 (51)	23 (7)	69 (62)
3. Distance from the main canal (travel time in minutes)	86 (50)	19 (10)	30 (32)	11 (7)	37 (42)
4. Distance from the branch canal (travel time in minutes)	31 (19)	9 (6)	13 (14)	6 (6)	15 (16)
5. Distance from the homestead (travel time in minutes)	27 (16)	18 (14)	37 (26)	25 (18)	27 (20)
6. Adequate water availability for rice Adequate/moderately Adequate (% respondents reporting)	92	100	58	97	87

[1] Figures in parentheses underneath the mean values are the standard deviation.

Table 3. Farmer participation in irrigation system activities for four irrigator associations within the Iloilo Province.

Farmer Activity	Siwaragan	Lipata	Palaypay	GIPA	All Sites
1. Participation in: (% respondents reporting)					
a. Planning	89 (32)[1]	6 (23)	89 (32)	11 (32)	49 (50)
b. Construction					
Labour	83 (38)	3 (17)	39 (49)	36 (49)	40 (49)
Financial	67 (48)	0 (0)	0 (0)	3 (17)	17 (38)
Materials	11 (32)	0 (0)	0 (0)	3 (17)	3 (18)
c. Repairs and maintenance					
Cleaning	81 (40)	8 (28)	50 (51)	42 (50)	45 (50)
Repairs to structures	75 (44)	3 (17)	28 (45)	14 (35)	30 (46)
Providing materials	14 (35)	0 (0)	0 (0)	3 (17)	4 (20)
d. Resolving conflict					
With fellow members	92 (28)	0 (0)	33 (48)	11 (32)	34 (48)
With officers of IA	86 (35)	0 (0)	92 (28)	8 (28)	47 (50)
With NIA/DA personnel	13 (35)	0 (0)	8 (28)	6 (23)	7 (26)
2. Attendance of meetings (No. of meetings attended in a year)	2.00 (0.41)	1.00 (0)	7.33 (2.10)	1.56 (2.16)	2.97 (2.96)
3. Water supervision (% of respondents reporting)					
			0		49
Individual farmer	97	100	100	0	51
Head and officer	3	0		100	

[1] Figures in parentheses are standard deviations.

Table 4. Farmer participation in the irrigation system at the planning, construction and maintenance stages for four irrigator associations in the Iloilo Province.

LEVEL OF PARTICIPATION	Siwaragan	Lipata	Palaypay	GIPA	All sites
Planning	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
No Participation/ Low/Moderate (0)	4 (11)	34 (94)	4 (11)	32 (89)	74 (51)
High/Very high (1)	32 (89)	2 (6)	32 (89)	4 (11)	70 (49)
Mean	0.89[1]	0.06	0.89	0.11	0.48
Std. dev.	0.32	0.23	0.32	0.32	0.50
Construction					
A. Labour					
VeryLow/Low/Moderate (0)	6 (17)	35 (97)	22 (61)	23 (64)	86 (60)
High/Very high (1)	30 (83)	1 (3)	14 (39)	13 (36)	58 (40)
Mean	0.83	0.03	0.39	0.36	0.40
Std. dev.	0.38	0.17	0.49	0.49	0.49
B. Financial					
VeryLow/Low/Moderate (0)	12 (33)	36 (100)	36 (100)	35 (97)	119 (83)
High/Very high (1)	24 (67)	0	0	1 (3)	25 (17)
Mean	0.67	0	0	0.28	0.17
Std.dev.	0.48	0	0	0.17	0.38
C. Materials					
VeryLow/Low/Moderate (0)	32 (89)	36 (100)	36 (100)	35 (24)	139 (97)
High/Very high (1)	4 (11)	0	0	1 (3)	5 (3)
Mean	0.11	0	0	0.28	0.03
Std. dev.	0.32	0	0	0.17	0.18
Repairs & Maintenance					
A. Cleaning					
No participation/Verylow/ Low/Moderate (0)	7 (19)	33 (92)	18 (50)	21 (58)	79 (55)
High/Very high (1)	29 (81)	3 (8)	18 (50)	15 (42)	65 (45)
Mean	0.81	0.08	0.50	0.42	0.45
Std. dev.	0.40	0.28	0.51	0.50	0.50
B. Repairs to structure					
No participation/Verylow/ Low/Moderate (0)	9 (25)	35 (97)	26 (72)	31 (86)	101 (70)
High/Very high (1)	27 (75)	1 (3)	10 (28)	5 (14)	43 (30)
Mean	0.75	0.03	0.28	0.14	0.30
Std. dev.	0.44	0.17	0.45	0.35	0.46
C. Providing Materials					
No participation/Verylow/ Low/Moderate (0)	31 (86)	36 (100)	36 (100)	35 (97)	138 (96)
High/Very high (1)	5 (14)	0	0	1 (3)	6 (4)
Mean	0.14	0	0	0.03	0.04
Std. dev.	0.35	0	0	0.17	0.20

Table 5. Farmer opinions about aspects of irrigator association management in the Iloilo Province.

ATTITUDE	Siwaragan	Lipata	Palaypay	GIPA	All sites
1. Farmers should be consulted during the planning stage.	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Agree/Strongly agree	36 (100)	36 (100)	35 (97)	30 (83)	137 (95)
Undecided/disagree	0	0	1 (3)	6 (17)	7 (5)
2. Farmers should help construct the system.					
Agree/Strongly agree	36 (100)	36 (100)	35 (97)	32 (89)	139 (97)
Undecided/disagree	0	0	1 (3)	4 (11)	5 (3)
3. Farmers should attend group meetings regularly.					
Agree/Strongly agree	35 (97)	36 (100)	11 (31)	28 (78)	110 (76)
Undecided	1 (3)	0	25 (69)	8 (22)	34 (24)

THE ECONOMICS OF SPRAY IRRIGATING PASTURE FOR DAIRY PRODUCTION IN THE MANAWATU

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ABSTRACT

Until the 1990's irrigation for livestock farming in the Manawatu was considered to be an insurance against drought rather than a "high-returning" investment. However, more recently financial pressure has driven farmers to look for alternatives to increase their economic farm surplus (EFS). Improvements in irrigation technology have reduced the labour required to operate irrigation systems and the introduction of seasonal payments could provide reward for shoulder milk produced through extra summer-autumn pasture. Both of these factors have increased farmer interest in irrigation even in higher rainfall regions such as the Manawatu. A methodology was developed to evaluate future returns from an investment in dairy farm irrigation. The methodology accounts for variation in soil moisture deficits, and links this with additional costs (electricity, fertiliser and labour). Beta analysis was used, in conjunction with historic meteorological data and simulated pasture growth rates, to derive the profitability and financial feasibility of investments with different irrigation systems, over a number of seasons for a case dairy farm in the Manawatu. Using a ten year average milksolid price, a $124,000 investment in irrigation on 40 hectares was estimated to have a post-tax IRR over a 15 year period of 8.17% and 8.09% for the Long Lateral and Big Gun irrigation systems, respectively. The post-tax NPV's for the Long Lateral system ranged from $20,640 to ($13,349) with discount rates of 6% and 10%, respectively. Those for the Big Gun system ranged from $18,654 and ($13,131) for the same discount rates. Both investments were considered financially feasible with a weighted average cost of capital of 8%. Out of a possible 50 outcomes, 20 would not meet the funding costs associated with the investment (average deficit $3,700). It is possible that there could be at least three consecutive years when the post-tax income would be unable to meet this cost of funding. The remaining 30 outcomes generated an average surplus of $6,100. A second evaluation assessed a Manawatu property similar to the case farm but without key resources already in place for irrigation. The total investment for irrigating 40 ha of $151,000 generated a post-tax IRR of 6.34% and 6.21% for the Long Lateral and Big Gun irrigation systems, respectively. A reduced weighted average cost of capital of 6% was required for the project to be considered financially feasible. The key factors impacting on irrigation profitability in the Manawatu are: variation in soil moisture deficits; capital costs; running costs and feed quality for milk production.

Keywords: **Irrigation, summer pasture, milk production, risk and investment.**

INTRODUCTION

In most parts of New Zealand a seasonal lack of water is a major factor limiting pasture and crop production, and a primary cause of year to year variability in yield. Droughts can have serious consequences for pastoral based systems (Kerr et al., 1986). The 1990's has seen higher fixed costs drive farmers to increase stock numbers while still aiming to maintain "per head" livestock performance. This has resulted in increased risk associated with production declines due to drought conditions (Engelbrecht, 1995).

Irrigation development is currently being carried out in higher rainfall localities and on soil types once considered marginal in terms of irrigation viability (Engelbrecht, 1995). Changes in irrigation technology have made irrigation less labour intensive and it is now a serious input consideration on many farms throughout New Zealand provided that access to water is available and the cost of extraction is reasonable (Phillips, 1996). However, limited recent published research has been completed on the profitability of irrigation for dairy production. Farmers are also considering irrigation due to some dairy companies offering shoulder milk payment rewards. These payment systems aim to reduce the ratio of peak to shoulder milk supply, by rewarding shoulder milk production.

The primary aim of this research was to determine whether spray irrigating a Manawatu dairy farm is economically profitable and feasible. An investigation was undertaken into different types of spray irrigation systems that would be suitable for irrigating Jackson's and other Manawatu properties. The research, however focused on Peter and Edward Jackson's property located near Ashhurst township. Their farm is 110 ha, divided approximately into three equal areas by soil type. These are Manawatu silt loam, a fine sandy soil and a clay loam on the top terrace.

It was proposed to investigate and evaluate the financial outcome of two options for irrigation on this property. The options are detailed below:

- Irrigation on 40 ha of the Manawatu silt loam soil for a night rotation on pasture over the summer period
- Irrigation on the whole of the lower terrace which included all of the Manawatu silt loam and the sandy soil (approximately 60 ha).

The profitability and financial feasibility of both irrigation investments was quantified, and a recommendation to be made for the most suitable option and application system for the Jackson's dairy operation. The financial risk associated with each investment was also assessed. Overall, this study aimed to look at irrigation from an economic point of view for dairy production, so farmers could be more aware of the issues that they face when considering irrigation to improve profitability.

Resources on the Jackson property (an artesian well, power and a pump shed for irrigation) favoured irrigation. Therefore, it was necessary to complete a second evaluation on a Manawatu property similar to the case farm but without the key resources for irrigation.

The limitations of this research were that assumptions had to be made in order to complete the study. The following assumptions were made:

- Pasture growth rates were estimated using data from a simulation growth model (i.e. 'GROW' model (Butler, 1987)).
- The farmer's ability to adapt to managing an irrigated farm will not limit the potential production under irrigation.

The limitations will mean that the exact figure on the extra pasture production that can be expected under irrigation on this property will be unknown. Also, the profitability of irrigation is heavily reliant on the farmers ability to lift management skills, apply greater attention to detail, and have commitment to good timing, in all aspects of farm management (Engelbrecht, 1995).

METHODOLOGY

To assess the profitability and financial feasibility of an investment in irrigation an Irrigation Simulation (IS) model was constructed on a spreadsheet. It was designed to help quantify the income risk involved in an investment in irrigation. The IS model was constructed using simulated pasture growth rates (PGR's) from the 'GROW' model and a technique called beta analysis (Dake, 1996) in conjunction with sensitivity analysis to examine the feasibility of an investment in irrigation with differing levels of debt. The IS model looks only at the irrigation investment as a partial budget of the additional net income and costs that result from irrigation.

The IS model is shown diagrammatically in Figure 1 and Figure 2. In simple terms, the model takes account of soil and historical climatic factors from 50 years of climate data to predict pasture growth. As a result of irrigation, additional pasture growth and quality measured in megajoules of metabolisable energy (MJME) is used to estimate additional cows and milksolid production. Operating costs (electricity, fertiliser and labour) associated with the irrigation system are calculated from the soil moisture deficits. Profits, after deducting associated costs, are calculated using both a variable and mean historical milksolid price. Taxation is also calculated and deducted from the profits. Possible outcomes (250) are completed for both a mean and variable milksolid price. These outcomes were used to calculate beta variables, then, a profitability and financial feasibility analysis was completed. Fifty post-tax possible outcomes resulting from irrigation were graphically illustrated against an expected fixed cost of funding (McFetridge, 1997).

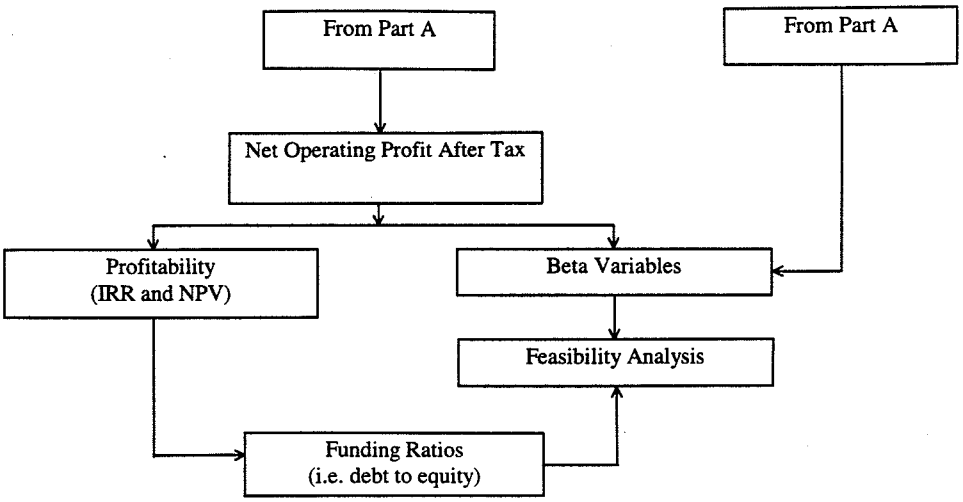

Figure 2: **Flow diagram illustrating "Part B" of the irrigation simulation (IS) model.**

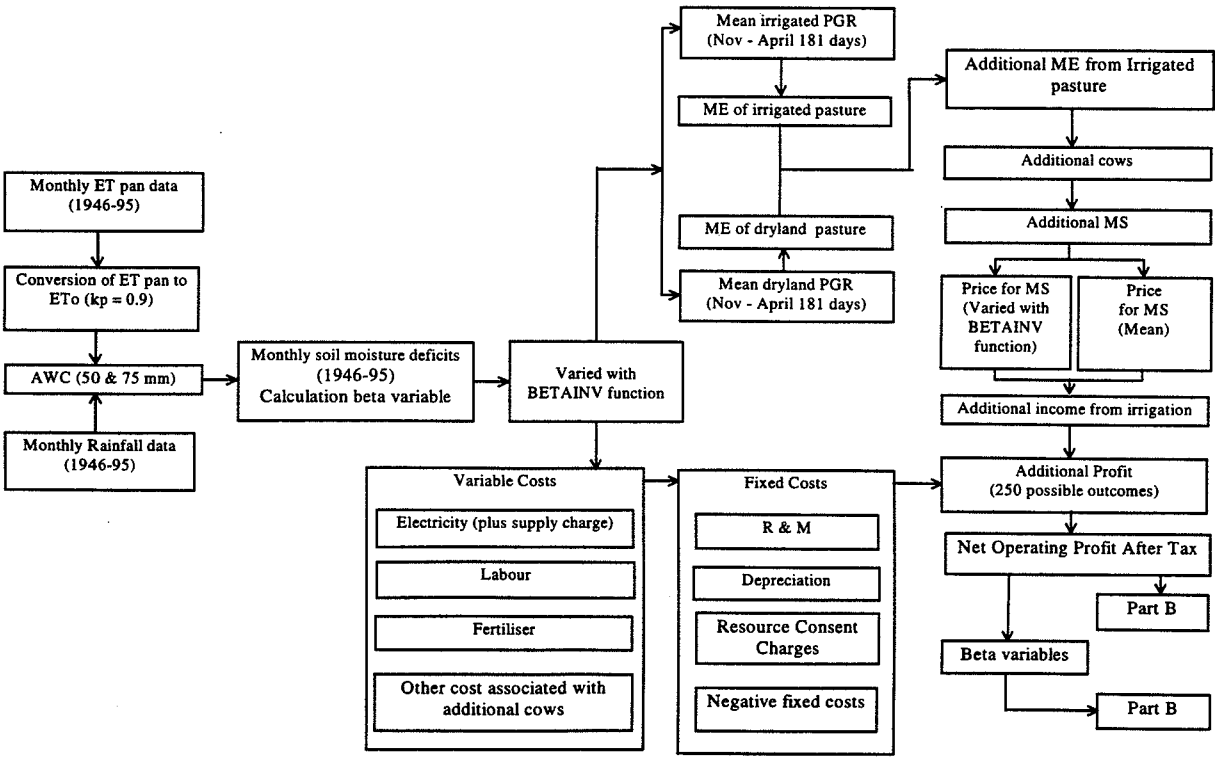

Figure 1: **Flow diagram illustrating "Part A" of the irrigation simulation (IS) model.**

RESULTS AND DISCUSSION

Soil moisture

The mean soil moisture deficits calculated from Palmerston North climatic data for the 50 year period (i.e. 1946-95) on two different soils (i.e. 50 and 75 mm AWC) were 193 and 174 mm for the two soils, respectively. The results from the monthly climatic water balance worksheet (WB worksheet) compared well with those reported in literature. Kerr et al, (1986) used Ohakea climatic data over a ten year period (1972-84) to calculate the average soil moisture deficit for soils with varying AWC's (Table 1). This data compared well with the WB worksheet used in this study. To illustrate this, soils with the same AWC's were used, along with Palmerston North climatic data over the same 10 year period (1972-84) to calculate soil moisture deficits. The results showed that the WB worksheet calculated slightly lower soil moisture deficits, however it should be noted that the average annual rainfall over this period in Palmerston North was higher than that recorded in Ohakea (Table 1).

Table 1: Comparison of soil moisture deficits between Ohakea and Palmerston North between 1972-84.

	soil water deficit (mm)			Annual rainfall (mm)
Available soil water capacity (mm)	50	100	200	
Kerr et al., (1986) - Ohakea	307	256	182	888
WB Worksheet - P. North	285	240	177	936

The trend in soil moisture deficits over the 50 year period analysed should be considered before investing in irrigation. McFetridge (1997) found that there was a noticeable increase in the size of the total soil moisture deficits for the periods 1969-90 than that for 1950-68. The calculated mean deficits for these two periods using an AWC of 50 mm were 274 and 104 mm, respectively. This was a significant difference in the soil moisture deficits, and was taken into account in the profitability and feasibility analysis.

Financial Analysis

The profitability and feasibility analysis focuses primarily on the Long lateral and Big Gun irrigation systems as they are the most suited to the Jackson property. The Hard Hose system is unsuitable because of the higher capital cost involved in the installation and the higher operating costs, and the Boom system is not considered because it is unable to irrigate undulating ground effectively.

Using the IS model the profitability of irrigation for both the Jackson's and a Manawatu property could be calculated (Table 2). Four systems have been evaluated and the financial difference between each system can be seen. The results show that there was little difference in profitability when irrigating pasture with a Boom, Big Gun or Long Lateral system. However, the IS model found that for both the Jackson's and a Manawatu property the Boom system was most profitable showing a post-tax internal rate of return (IRR) of 9.07% and 6.92%, respectively. This was followed closely by the Big Gun and Long Lateral systems (Table 2). The profitability of the Boom system was greater as a result of the lower capital cost and low annual running costs. The Hard Hose system was significantly less viable as an investment when compared to the other systems. The post-tax IRR was approximately half that of other systems. These results agree with findings by Rhodes (1972), Bell (1975) and Hutton (1978) who concluded that high costs (capital and running) associated with irrigation would have a significant impact on an investment in irrigation.

Table 2 illustrates the profitability of irrigating 40 ha of pasture on the Jackson property with a long lateral irrigation system. The total investment in this situation was $124,000, of which; $90,000 was for the irrigation system, $20,000 for the additional 25 cows (required to eat the extra pasture) and $14,000 for additional milksolid shares. The post-tax IRR was calculated over a 15 year period to be 8.17%. The post-tax NPV's

ranged from $20,640 to ($13,349) with discount rates of 6% and 10% respectively. Table 2 also illustrates the profitability of irrigating 40 ha of pasture on the Jackson property with a Big Gun system. The total investment in this situation was $120,000, of which; $86,000 was for the irrigation system, $20,000 for the additional 25 cows and $14,000 for the additional milksolid shares. The post-tax IRR was calculated over a 15 year period to be 8.09%. The post-tax NPV's ranged from $18,654 to ($13,131) with discount rates of 6% and 10% respectively.

Table 2 illustrates the possible outcomes from irrigating 40 ha of pasture on a Manawatu property (without key resources for irrigation) with a long lateral irrigation system. The total cost of this investment was $151,000, of this $117,000 was for the irrigation system and $34,000 was for the additional 25 cows and milksolid shares. The post-tax IRR was calculated over a 15 year period to be 6.34%. The post-tax NPV's ranged from $3,971 to ($32,829) with discount rates of 6% and 10%, respectively. Table 2 also illustrates the profitability of irrigating 40 ha of pasture on a Manawatu property with a Big Gun system. The total investment increased to $147,000, of which $113,000 was for the irrigation system and $34,000 for the additional 25 cows and milksolid shares. The post-tax IRR was calculated over a 15 year period to be 6.21%. The post-tax NPV's ranged from $2,306 to ($32,236) with discount rates of 6% and 10% respectively.

Table 2: Profitability of irrigation for both Jackson's and a Manawatu property, evaluating different irrigation systems and possible scenarios.

Type of System	Total Investment	IRR		Post-tax NPV		
		Pre-tax	Post-tax	6%	8%	10%
Jackson Property (AWC 75 mm):						
Boom	$117,729	12.99%	9.07%	$26,153	$7,974	($6,187)
Big Gun	$120,620	11.45%	8.09%	$18,654	$732	($13,131)
Long Lateral (Control for Scenarios)	$123,966	11.62%	8.17%	$20,640	$1,403	($13,349)
Hard Hose	$148,630	6.51%	4.31%	($17,166)	($33,020)	($45,178)
Manawatu (AWC 75 mm):						
Boom	$144,504	9.72%	6.92%	$9,805	($10,021)	($25,291)
Big Gun	$147,395	8.56%	6.21%	$2,306	($17,263)	($32,236)
Long Lateral	$151,266	8.77%	6.34%	$3,971	($16,945)	($32,829)
Hard Hose	$175,938	4.71%	3.25%	($33,835)	($51,367)	($64,657)
Scenarios (Jackson Property):						
Irrigating 60 ha (AWC = 75mm)	$177,373	12.61%	8.83%	$38,483	$9,838	($12,191)
AWC 50mm (40ha)	$127,761	13.20%	9.27%	$32,075	$10,840	($5,520)
Period 1950-68	$110,387	7.45%	5.37%	($5,367)	($19,475)	($30,121)
Period 1969-90	$140,009	16.27%	11.35%	$57,516	$31,389	$11,108
Increasing ME of irrigated pasture	$128,287	15.35%	10.81%	$47,756	$24,312	$6,162

Irrigation on 60 ha was also a consideration in this study. To evaluate this option the long lateral irrigation system was used to irrigate a soil with a AWC of 75 mm. A comparison was made between the 60 ha and the 40 ha options outlined in Table 2 with the same parameters. To irrigate the extra 20 ha an increase in capital of $53,000 was required. This resulted in an increase in the post-tax IRR of 8.17% to 8.83%. The post-tax NPV also increased significantly, this ranged from $38,000 to ($12,000) at discount rates of 6% and 10% respectively.

A comparison was also made between soils irrigated with different AWC's (i.e. 50 mm versus 75 mm). The long lateral system irrigating a soil with a AWC of 75 mm was again used as a base for this comparison. The results

show that the total investment in this situation was $127,000 (an increase of $3,800 as a result of the extra cows and milksolid shares). The post-tax IRR calculated over a 15 year period increased from 8.17% to 9.27%. The post-tax NPV also increased, this ranged from $32,000 to ($5,500) at discount rates of 6% and 10% respectively. The results suggest that irrigating a soil with a lower AWC is more profitable. This may be due to drought seasons affecting production more on soils with low AWC. Furthermore, when an irrigation system is unable to supply enough water to meet the total soil moisture deficit (i.e. in bad drought years) a greater number of moisture deficit years will result, thus benefiting irrigation.

As discussed earlier, there was a noticeable difference in the size of the total soil moisture deficits between periods 1950-68 and 1969-90. The effect of this large difference has been evaluated and an assessment made of the impact this has on the profitability of an investment in irrigation. Using a mean soil moisture deficit of 104 mm (i.e. 1950-68) a comparison of the profitability for the Jackson property was made. In this situation, the investment in the irrigation system was still $90,000, however because differences in PGR's on unirrigated and irrigated land were no longer as great, fewer additional cows and milksolid shares were required. Thus, the total investment was only $110,000. The post-tax IRR over a 15 year period decreased from 8.17% to 5.37%, with the post-tax NPV's ranging from ($5,000) to ($30,000) with discount rates of 6% and 10% respectively (Table 2). Using the same method with and a mean soil moisture deficit of 274 mm (i.e. 1969-90) a similar comparison of the profitability was made. In this situation, the total investment was $140,000 of which $90,000 was for the irrigation system and $50,000 for the additional cows and milksolid shares. The post-tax IRR calculated over a 15 year period increased from 8.17% to 11.35%. The post-tax NPV's ranged from $57,500 to $11,000 with discount rates of 6% and 10% respectively.

The results from the two situations above show how the large variation in climate can effect the profitability of an investment in irrigation. The results suggest that depending on the weather patterns over a number of seasons, a farmer could expect a variation in the post-tax IRR of 5.98% (i.e. 11.35% - 5.37%). This large variation confirms that when investing in irrigation a farmer can only estimate the possible likely returns that will be seen from irrigation.

The assumption was made that the energy content of irrigated pasture would be 10.3 MJME compared with 10 MJME for dryland pasture. To evaluate the effect of further increasing the energy content of irrigated pasture, a comparison between irrigated pasture with energy content's of 10.3 and 10.5 MJME was completed on the Jackson property. The results presented in Table 2 illustrated that the post-tax IRR calculated over a 15 year period increased from 8.17% to 10.81%. The post-tax NPV's for irrigated pasture with an energy content of 10.5 ranged from $47,000 to $6,000 with discount rates of 6% and 10%, respectively. The results illustrate how uncertainty over future returns (i.e. profitability) from irrigation can result from uncertainty over the actual difference between energy content of irrigated and dryland pastures. It is recommended further research be completed in the area.

To evaluate the feasibility of an investment in irrigation an assumption was made regarding the cost of funds. The WACC used in this feasibility analysis was calculated by assuming a post-tax cost of debt (10%), and a return on equity required by the owner of 6%. In a feasibility analysis it is important the WACC is equal to or lower than the IRR of the investment. If the investment does not generate sufficient funds to meet the cost of capital it goes into deficit and the investment is infeasible. To obtain different WACC rates the debt to equity ratio for funding the investment was changed.

Figure 3 illustrates a sample of the possible outcomes from irrigating 40 ha of pasture on the Jackson property with a Big Gun irrigation system. It was calculated that the average shortfall was $3,435, and 20 of the 50 possible outcomes will not meet the cost of funding for this investment. The total sum of these negative outcomes was $68,710 and it is possible that four consecutive years post-tax income will be below income required to meet the cost of funding. However, 30 positive outcomes occurred totalling $168,000 with an average of $5,605.

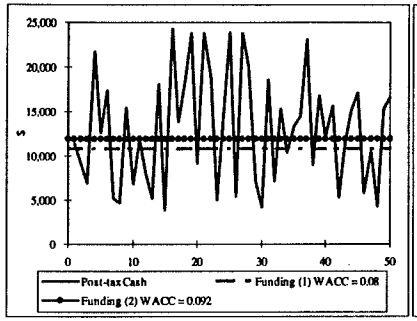

Figure 3: A sample of the possible variations in post-tax income from a Big Gun irrigation system on 40 hectares of the Jackson property.

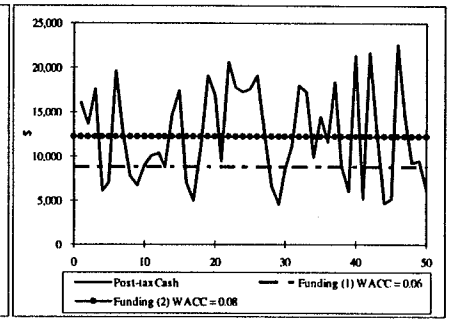

Figure 4: A sample of the possible variations in post-tax income from a Big Gun irrigation system on 40 hectares of a Manawatu property.

Figure 4 illustrates a sample of the possible outcomes from irrigating 40 ha of pasture on a Manawatu property with a Big Gun irrigation system. It was calculated that the average shortfall was $2,725, and 14 of the 50 possible outcomes will not meet the cost of funding for this investment. The total sum of these negative outcomes was $38,155 and it is possible that three consecutive years post-tax income will be below income required to meet the cost of funding. However, 36 positive outcomes occurred totalling $224,600 with an average of $6,240. The results in Figure 3 and 4 also reflect similar outcomes which could be expected when using either the Long Lateral or Boom irrigation systems (McFetridge, 1997).

As discussed in earlier, there was a noticeable difference in the size of the total soil moisture deficits between periods 1950-68 and 1969-90. The effect of this large difference has been evaluated and an assessment made of the impact this has on the profitability of an investment in irrigation. Using a mean soil moisture deficit of 104 mm (i.e. similar to that between 1950 and 1968), results suggested that an investment in irrigation may only return a post-tax IRR of 5.4%, thus indicating such an investment would be unfeasible even at a WACC of 6%. Figure 5 illustrates possible outcomes that could be expected by farmers entering such investments with high funding costs (i.e. WACC of 8 or 10%). The outcomes show that the investment is unfeasible and farmers could expect 29 out of 50 possible outcomes to be unable to meet associated funding costs. Using a WACC of 10%, a farmer could expect 10 consecutive years when post-tax income was below the income required to meet the cost of funding.

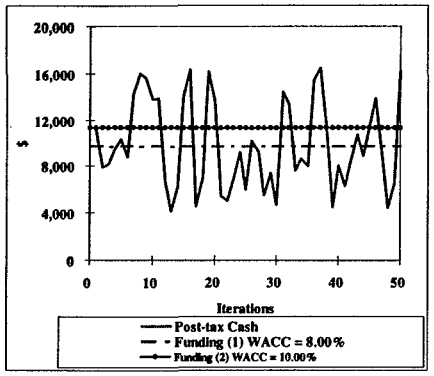

Figure 5: A sample of the possible variation in post-tax income which could be expected if the average soil moisture deficit was 104 mm and a Long Lateral irrigation system was used on 40 ha of the Jackson property.

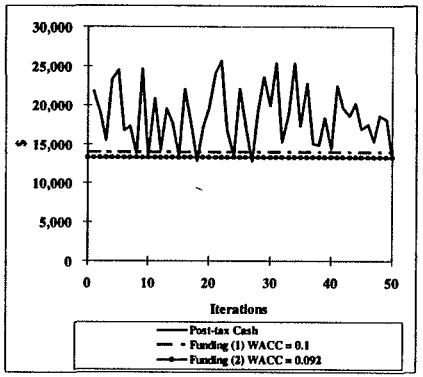

Figure 6: A sample of the possible variation in post-tax income which could be expected if the average soil moisture deficit was 274 mm and a Long Lateral irrigation system was used on 40 ha of the Jackson property.

Figure 6 illustrates a sample of the possible variation in post-tax income which could be expected if the average soil moisture deficit was 274 mm and a Long Lateral irrigation system was used on 40 ha of the Jackson property. The results showed that with a post-tax IRR of 11.4% the investment could be funded completely by borrowed capital as it would be capable of servicing a WACC of 10%. At this WACC 7 of 50 possible outcomes were unable to meet the associated cost of funds. The remaining 43 positive outcomes average a surplus of $5,400 and totalled over $230,000. The results further illustrate the importance of the soil moisture deficits when questioning whether an investment should be undertaken.

RECOMMENDATION AND CONCLUSIONS

It was only possible to irrigate 40 ha on the Jackson property as the resource consent restricted the volume of water which could be extracted. Both the Big Gun and Long Lateral irrigation system are suitable for irrigating their property. The results obtained from the IS model suggest that an investment in irrigation on 40 hectares would result in a post-tax IRR calculated over a 15 year period to be 8.09% and 8.17% for the Big Gun and Long Lateral systems respectively. The post-tax NPV's for the Long Lateral systems ranged from $20,640 to ($13,349) with discount rates of 6% and 10% respectively. Those for the Big Gun system ranged from $18,654 and ($13,131) for the same discount rates.

The feasibility of both investments with a WACC of 8% suggested that out of a possible 50 outcomes, 20 would be unable to meet the funding costs associated with the investment. In these seasons the mean negative outcome expected was approximately $3,600 with the sum of negative outcomes being approximately $72,000. It was also possible that four consecutive years post-tax income would be unable to meet the cost of funding. However, the remaining 30 seasons would result in a positive outcome, this mean was approximately $6,000 with the sum of the positive outcomes being approximately $180,000. The final decision on whether or not to proceed with irrigation would be influenced by the Jackson's attitude to the likelihood of negative outcomes, versus the "peace of mind" gained from the positives.

For a Manawatu property the total investment for irrigating 40 ha was $151,000. This generated a post-tax IRR of 6.34% and 6.21% for the Long Lateral and Big Gun irrigation systems, respectively. A reduced weighted average cost of capital of 6% was required for the project to be considered financially feasible. It is recommended however, that if resources allow, a 200 cow dairy farm should irrigate up to 60 hectares. Three application systems are recommended for consideration; these are the Boom, Big Gun and Long Lateral. The results obtained from the IS model suggest that a farmer irrigating 60 ha on a soil with a AWC of 75 mm can expect a post-tax IRR calculated over a 15 year period to be 8.80% with a Long Lateral system. The post-tax NPV's for the Long lateral system ranged from $38,163 to ($5,894) with discount rates of 6% and 10% respectively. Results from the IS Model suggest that both the Boom and Big Gun systems will have similar outcomes.

The study highlighted the key factors impacting on irrigation profitability in the Manawatu. Such factors were variation in soil moisture deficits; capital costs; running costs and feed quality for milk production.

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A STUDY OF STRATEGIES SHAREMILKERS ARE USING TO ATTAIN FARM OWNERSHIP

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INTRODUCTION

Traditionally, sharemilking has provided both an important framework for young people to gain entry into dairy farming, and a way to acquire assets for farm ownership. However, it appears that the economic climate in which farm ownership is being pursued has changed over the last 10 years (LIC, 1996a). Increases in dairy farm land prices have adversely affected the ability of sharemilkers to purchase their first farm (Rauniyar and Parker, 1996). In addition, a decrease in the real payout (on a milksolids basis) has effectively reduced a sharemilker's debt servicing ability (LIC, 1996a). Steady increases in effective farm and herd sizes have decreased the number of dairy units in New Zealand, while increasing the amount of equity a sharemilker requires for first ownership. Consequently, it has been suggested that what has traditionally been the means to build equity for farm ownership needs to change (LIC, 1996a). Despite this, many sharemilkers are still optimistic that with hard work they could still make it to farm ownership in spite of the increased obstacles and lengthened time frames (Stevenson *et al.*, 1996). Ultimately for many sharemilkers the dream of farm ownership is still their primary motivator (Martyn, 1996).

The amount of capital necessary to purchase a dairy farm is large relative to the income a sharemilker can generate in any one year and evidence suggests that the requirement may continue to increase. Many sharemilkers, however, still believe that with hard work, prudent saving, and the right investment options, farm ownership is obtainable. To attain the equity required for a farm purchase, it appears that sharemilkers are implementing various plans that could be described as strategies. To understand more about the path from sharemilking to farm ownership, it is useful to describe and analyse these strategies. This study describes and analyses strategies some sharemilkers are using to build equity to attain farm ownership.

Specifically, the aims of the study were to:

- document the strategies case study sharemilkers are using to attain farm ownership.
- identify the decisions sharemilkers face when selecting and implementing various strategies.
- document issues and decisions that relate to the path from sharemilking to farm ownership to add to industry understanding of the process.

A pilot study and three case studies were undertaken on farms in the Manawatu. All of these farmers aspire to own their own farms..

SHAREMILKING

The traditional dairy career structure has clear stages that allow farming families to progress along the dairy career 'ladder'. Early training at technical institutions and/or apprentice-like employment on farms has enabled many from farming and non-farming backgrounds to enter the industry. This initial training is often followed by a stint as a farm assistant or herd manager. A period in a contract milking or negotiable sharemilking position traditionally ensues, before progression to a 50-50 sharemilking position, and then ultimately to farm ownership.

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The linchpin of this dairy career structure has always been 50-50 sharemilking. A unique component of New Zealand dairying for more than 100 years, sharemilking involves operating a farm on behalf of the owner for an agreed share of the farm income (Stevenson, *et al*, 1996). Ultimately, however, it has offered young people a way to enter dairy farming without having to purchase land, and according to Hall and Martyn (1993) and Parker and Rauniyar (1995), it has always been considered an important step towards obtaining farm ownership.

Over recent years, the sharemilking sector of the dairy industry has been subjected to severe stress, and farm ownership has become an increasingly remote goal. Some sources of stress that have been identified include

- the decline in real prices for milksolids (Hall and Martyn, 1993; Rauniyer and Parker, 1996)
- increasing costs of production (LIC, 1996b)
- increasing herd and farm size (Parker and Rauniyar, 1995)
- increasing farm prices (Stevenson *et al*, 1996; LIC, 1996c)
- established dairy farmers purchasing more land
- risk, including:
- exposure to variations in the price of their livestock asset,
- lack of security of tenure in sharemilking position

STRATEGIC MANAGEMENT

Curtis (1994) suggests that setting *goals* establishes the pathway to positive results, and effective managers must decide what they want (goals) before they start to do it. Strategic management involves deciding what is to be achieved (goals), and then setting out to do it by implementing various strategies. The core of strategic management is *decision making;* David (1995) describes the strategic management process as an objective, logical, and systematic process of making decisions. According to Giles and Stansfield (1990) decision making could be regarded as one of the most important elements of the farm manager's job. Not only are decisions continually made, they have a lasting impact on what is achieved, and how well it is achieved. Ultimately, unless good decisions are made, goals will not be achieved (Hardaker *et al.*, 1970).

In theory, then, strategic management practices could becoming increasingly important to sharemilkers. The present economic climate appears to necessitate clear and focused goals and the implementation of equity building strategies if farm ownership is to be realised. As well, strategies and objectives need to be continually evaluated to ensure the objectives are being met and progress is being made to the goal of farm ownership. When progress is not occurring, strategies need to be evaluated and possibly replaced. Thus the formulation of strategies to attain the goal of farm ownership will not necessarily result in farm purchase.

A strategy is not always apparent to the person making the decisions. Therefore, to see what the true strategy is, an objective observer must look at the emerging pattern of goals, policies and programs to enable the strategy to be documented (Mintzberg and Quinn, 1992). This study was an attempt to document strategy from emerging patterns of goals, policies and programmes.

DESCRIBING SHAREMILKERS' CIRCUMSTANCES

In order to describe and analyse some of the strategies sharemilkers are using to attain farm ownership, four sharemilkers were interviewed, one as a pilot study, the rest as case studies. Information relating to their personal and business circumstances was collected and used as background data and is summarised in Table 1. The cases covered a range of sharemilkers' personal and farming circumstances, from one couple who were about take up their first sharemilking agreement, to one who was considering farm purchase. More detailed data are available elsewhere (Broadbent, 1997).

Table 1: Background information for case study sharemilkers

	CF 1	CF II	CF III	Pilot Study
Years farming	7	3	7	12
Current position/s	50:50	Herd Mgr	50:50 30% SM	50:50
No. of cows	300	0	200	180
Land				2 x 4 ha 1 x 32 ha
Partner income	Yes	Yes	Yes	No
1997/98 plans	29% SM	2nd 50:50 position (400 cows)		

CF 1 = case farmer 1 CF II = case farmer 2, CF III = case farmer 3

ANALYSING SHAREMILKERS' STRATEGIES

In order to document the strategies, processes used by the case farmers (or goals, policies and programs) needed to be identified. Each sharemilker (partnership) was interviewed twice, using semi-structured interviewing. A summary of the researcher's interpretation of the first interview was provided as the basis for discussion at the second interview. Data were analysed by breaking them down into databits (Dey, 1993) and classifying them (Gray, 1995) to afford comparison and the possibility of new connections. For this study, the basis for classification was the strategic management model.

Figure 1 is a simplified illustration of the list of categories and how each category contributed to farm ownership goal.

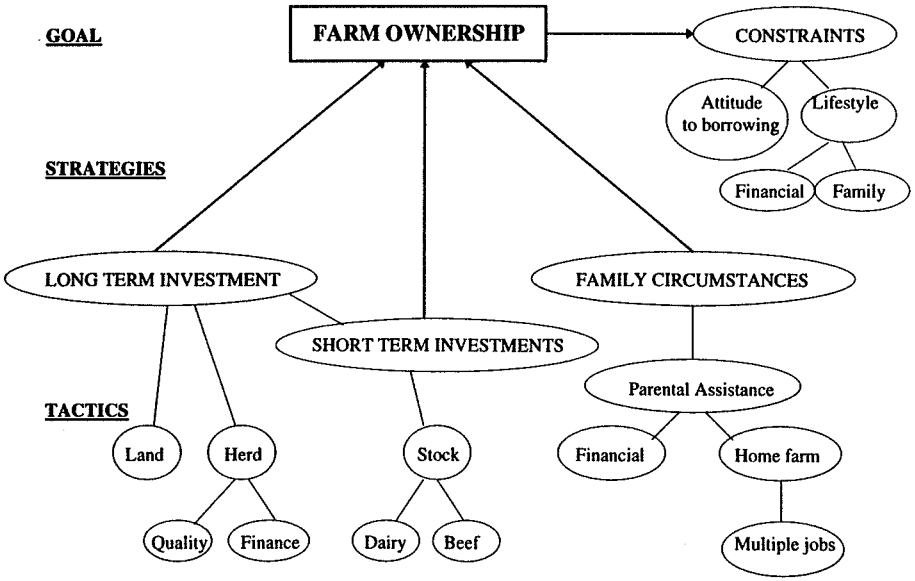

Figure 1: Categories and their contribution to the goal of farm ownership.

LONG TERM INVESTMENT

One emerging pattern was that the case sharemilkers appeared to have a planning horizon of about five years. Thus, methods of capital accumulation that occurred over a time frame that exceeded 5 years were classified as long term investments for the purpose of this study.

Investing in land (not necessarily for farming) and in a herd of livestock were the two important options for these sharemilkers. For all case study sharemilkers, the purchase of a herd of cows was a step towards farm ownership as all felt that to progress along the 'sharemilking ladder' it was important to become a 50:50 sharemilker. However, the way the herd was financed, and the input into the quality of the cows purchased varied considerably between cases.

According to Martyn (1996), sharemilkers have traditionally gained equity for farm ownership through building up stock numbers. While this was certainly true for CF III, both CF I and PS preferred to invest in land. CF I felt that land close to town would not loose its value and that livestock was more susceptible to price fluctuations.

SHORT TERM INVESTMENT

In the short term (one to four years) the sharemilkers in this study who already owned a herd of cows commonly traded in stock as a means of accumulating capital. While the returns from doing this can vary due to fluctuations in the economic climate, the preference for trading in stock as a short term means of accumulating capital could be attributed to the availability of extra young stock for rearing, or the ability of the sharemilker to source cull cows or grazing heifers. Both CF II and the PS also indicated that there was a good profit margin for selling surplus replacements. Another reason for trading in stock was that it enabled the sharemilkers to accumulate capital by doing things they are already doing, and doing well, rather than trying different things. If they invest time and money in many different things, the return may not be as high, as their time would be divided between many different investments and consequently things would not be done as well.

FAMILY CIRCUMSTANCES

The parents of all three case sharemilkers appeared to assist their offspring towards attaining farm ownership. During the course of the study, parental involvement appeared to occur either through financial backing, or through the employment of their offspring on the home farm.

Having parents who own a farm and a herd of cows has assisted CF II to progress towards farm ownership by increasing the flexibility of their herd purchase. For CF III it has meant increased job security, which is important for any sharemilker, but especially so when you have multiple herds. However both CF III and CF II admit that farm ownership for them will not be easier because their parents own a dairy farm Both suggest that their parents are business people who would not give up their own assets easily to pave the road to farm ownership for their off-spring. However the parents of CF III and CF I put up security against the loan taken out by their off-spring to purchase cows, which has certainly helped them progress, as without that financial backing, both sharemilkers would have had to remain in their previous position until such time as they could put up their own assets as security.

CONSTRAINTS

Attitudes to borrowing and lifestyle were identified as other factors affecting the realisation of the farm ownership goal. Attitudes towards borrowing money from the bank varied between case farmers, much as the literature indicated it would (O'Connor, 1973). For example CF III, with a significant amount of accumulated capital showed an inclination to take risks which the beginning sharemilker (CF II) felt they could not afford.

Lifestyle and its relationship to family and finance were important issues when considering farm purchase. Size of farm and timing of purchase were an integral part of the decision.

STRATEGIC MANAGEMENT

Currently only CF I employs formal strategic management techniques. The reason for implementing strategic planning for them was to help progress by deciding what they want to do and how they would get there. For them

strategic planning involved deciding on a long term goal and then establishing short term goals to help them achieve their long term goal.

Once goals are established, CF I then formulate 5 year plans that work towards achieving the goals. The plans consist of objectives and performance indicators to establish when the objectives are achieved, and a time frame in which they hope to accomplish each objective. However, CF I feel that while their the 5 year plans are useful to progress towards their goal, they feel they now need to focus on more year to year plans. By evaluating shorter (year long) time periods (by incorporating performance measures into their plans) CF I hope to take into account more uncertainties in their environment (such as changes to milk payout), and then implement changes to their plans sooner. By ensuring an element of flexibility is incorporated into their plans they feel changes can be made easily. This philosophy follows theory by Curtis (1994) and David (1995) that objectives need to be measurable and flexible.

By placing more emphasis on year long plans, CF I hope to incorporate more financial budgets into their planning and decision making. Currently CF I use partial budgets to work out the feasibility of making and feeding out supplements. However, they plan to do partial budgets for more of the operations on the farm to move closer towards maximising profit. They also consider being informed on new research and ideas to be very important if they are to ever achieve farm ownership. They feel that if they are informed they can better respond to changes in the environment in which they operate.

Both CF II and CF III formulate goals to give direction to their decisions. However both preferred to aim for shorter-term 4-5 year goals. Neither had any specific measures to ascertain whether or not they were achieving their objectives, however CF III indicated that he felt he was progressing if he was paying off his mortgage while still maintaining an adequate lifestyle.

While CF I is the only sharemilker practising formal strategic planning, both CF II and CF III formulate short- and medium-term goals, then make decisions to enable them to achieve these goals, which is an important part of the strategic management process. Currently both CF II and CF III are reluctant to set long term goals, as there are too many changing variables.

SUMMARY AND CONCLUSIONS

From this study it appears that the resources that are currently available to the case sharemilkers (such as land, labour and their own experience) form the basis of the strategies they are using to accumulate equity for farm ownership. When accumulating capital over short period of time the case sharemilkers indicated a preference for trading in stock. Sharemilkers indicated that this was because it was something they were good at, but also it utilises resources (time, land) at the margin and extra stock can be readily sourced.

In order to accumulate capital over a long period, the case sharemilkers indicated a preference for investing either in more cows or more land to enable them to run more stock. One of the sharemilkers with a preference for investing in land suggested that their asset value would be more secure as land that could be resold as a lifestyle block would not fluctuate in value the same way stock have done in the past.

Ultimately it appears that these sharemilkers are investing, both in the long and short term, within the boundaries of farming, in order to accumulate the equity required for a farm purchase.

Currently, all case sharemilkers set short term goals; however, there is a reluctance to set long term goals as they feel there are too many variables in farming to plan more than 4-5 years in advance. The sharemilker who practises formal strategic management sets long term goals as they feel it puts a different focus on their short term goals and decisions. By devising formal plans that help monitor progress, and that are flexible to allow for more uncertainties in the environment, the latter sharemilker feels that they can better control their progress as they have the necessary steps in place to monitor and make amendments when progress is not occurring.

If the other two case sharemilkers had had more specific measures to evaluate their performance and environment, then changes could be made early and large deviations to a long term plan would be less likely to occur. If more formal planning was undertaken by CF II and CF III they might feel more comfortable with longer term goals, as they would be monitoring changes to their environment more closely and could react earlier to unplanned changes.

Strategic management appears to have application for sharemilkers. Further research in this area could prove rewarding.

While the results from this study indicate a strong preference for sharemilkers to continue investing within farming, there is room for further studies on alternative investment strategies. The impact (on both the sharemilker and dairy industry) of using corporate or business people to help finance a farm purchase might also be useful for sharemilkers who feel that the traditional methods of capital accumulation are not sufficient.

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OLIVER TWIST DARED: The Importance of Multiple Sources of Income for Farm Families

Paper prepared for the Conference of the
New Zealand Agricultural & Resource Economics Society
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> "Oliver Twist and his companions suffered the tortures of slow starvation for three months, until at last they got so voracious and wild with hunger that ... a council was held and lots were cast to decide who should walk up to the master after supper that evening and ask for more; and it fell to Oliver Twist. Child as he was, he was desperate with hunger and reckless with misery. He rose from the table and advanced to the master, basin and spoon in hand, said, alarmed at his own temerity;
> "Please, sir, I want some more."
>
> Charles Dickens
> 1838.

Introduction

Since the early 1980s, farm families have increasingly sought to diversify their sources of income away from the core farm business operation (Benediktsson, *et al.* 1990; Le Heron 1991; Rhodes and Journeaux 1995). They do so to maintain farm household incomes, provide for retirement, and in many cases to defend farm equity and the possibility of family succession. Today therefore farm households are marked by their multiple economic activity, referred to in this paper as pluriactivity.

While there has been much popular and expert opinion devoted to farm diversification, from new sheep and cattle breeds to dairying, or even ostriches, from kiwifruit to farm forestry, farm families themselves have also chosen to seek other alternative economic 'diversifications'. These alternative enterprises can be run separately from the farm operation having no connection with or influence on land use. Equally, they can be integrated with changed forms of land use, as part of a deliberate attempt at farm diversification. Either way they frequently cater for the market demands of the wider community and non-farming sectors.

Alongside the establishment of these alternative enterprises on farms (they are not mutually exclusive) is the growth in off-farm employment by members of farm families. Off-farm employment, like the establishment of alternative enterprises, is a response to financial restructuring and agricultural adaption and, to general social and economic change for women particularly and families generally. But whereas alternative enterprises have appeared on farms as a relatively recent phenomena, off-farm employment has been evident in the New Zealand farming scene for many years as a common means for farm males to acquire capital for farm ownership, expansion or development. In the past two generations, however, young farm women have also tended to use their qualifications and skills and work off the farm. Farm women have also looked to increase their economic independence, and to pursue their own goals, in the same way as their urban peers. In this respect they have responded to social acceptance and the global change that has so dramatically influenced the lives of all women in the latter half of this century.

The two types of income earning activities discussed in this paper are, like the core activity of farming, dependent on market supply and demand. The availability of off-farm employment is governed by the local labour market and in rural areas the size of this market can be a restriction to employment. Especially as the predominant types of employment for these families are in the education and health sectors and rural schools and rural hospitals are the focus of closure and centralisation. Alternative enterprises are also market driven. However a characteristic of these enterprises is their niche nature and the ability of the entrepreneurs not only to adapt to market demands but also to command competitive marketing strategies. And while these enterprises are dependent on market supply and demand, for many of these farm families it is the first time in their lives that they have been price makers rather than price takers.

It should be noted that in neither of the two studies were off-farm investment in terms of shares or real-estate a regular feature of the financial condition of the farm families sampled. Any discretionary money has traditionally been returned to the farm business in cycles of investment and development. Alternatively, for many of the families there was no discretionary money and this was the very reason they sought off-farm employment or the establishment of alternative enterprises.

Methodology

The two research studies on which this paper is based are a study of off-farm employment (Taylor and McCrostie Little, 1995) and a study of alternative enterprise on farms (Taylor and McCrostie Little (1997). In addition, observations are drawn from ongoing research into farm succession[1]. In the course of the two complete studies 120 farm couples (where applicable) have been interviewed. In each study the interviews were in-depth, structured interviews of a purposive sample, supplemented by scoping interviews, and field observations. To complete the picture, comparative information was drawn from the international literature and other New Zealand research.

In the off-farm employment study, twenty farming couples in each of the three districts of Ashburton, eastern Southland and the Oxford ward of the Waimakariri District took part in interviews. The objectives of this research were:

- to examine the apparent trend of an increasing number of farm women and men involved in off-farm employment

[1] All three studies have been funded by MAF Policy, Wellington and we acknowledge the importance of this funding and the assistance of Dr Ann Pomeroy and other MAF staff in undertaking the research projects.

- to examine the impacts of this trend on the farming system, especially farm labour and the farm business, the farm family, and particularly farm women, and for the rural community.
- to develop the rural policy implications of the findings.

For the study of alternative enterprises twenty farm couples from districts within Mid and North Canterbury and the Manawatu/Wairarapa were interviewed. The objectives of this research were:

- examination of the character of alternative farm enterprises
- the significance of alternative enterprises to the farm and the family finances
- the significance of on-farm enterprises to the individuals most closely involved and the family members generally
- the structure of on-farm enterprises, including ownership, and interrelationships with farm business structure
- the relationships between on-farm enterprise and the local community, the labour market, financial services, and other industry sectors, such as tourism.

The farms in the studies were not unusual; they were predominately either sheep and beef or mixed cropping and livestock farms.

Some farm households share characteristics that appear to determine their alternative sources of income, essentially limited farm and household income. But the studies also found that the enterprise households exhibited characteristics that differentiated them between those seeking off-farm employment as their principle alternative source of income. This paper explores these differences and similarities.

Family Life Cycle

The interlinked cycles of farm and family provide some explanation for the extent and timing of pluriactivity by farm households. The farm cycle of succession through to full ownership, development of the farm business operation, maintaining the business and then gradual withdrawal in favour of the next generation is parallelled by the family cycle of youth and education, marriage, child rearing, ageing and preparation for retirement. The following characteristics were evident across the two studies.

Age: The families with alternative enterprises tend to be well into their farm and family cycles, their children are either following their own careers in tertiary or senior level secondary (boarding school) education. Therefore they were at the stage when they had or were facing increasing educational costs.

Families with members employed off the farm tended to be younger, and for women the cycles of life and reproduction have a marked effect on the status and intensity of their labour and employment. Women gain work experience, marry, continue using their gained skills in the labour market, withdraw during early childhood raising years and then they filter back into the labour force, often to hold part-time positions to accommodate the demands of the household and family and the continuing demands of the farm operation.

Education: Men and women from farms with alternative enterprises have relatively high levels of tertiary education, compared to the national average. Nevertheless the gender education imbalance, also apparent in the families with members working off the farm, continues to exist with a greater percentage of women than men completing a full five years of secondary education and then moving into tertiary education. This imbalance, if anything, was more marked in the off-farm employed families suggesting

either that the entrepreneurial families were generally 'better' educated or that the imbalance is righting itself under pressure from the considerable determination of farm parents (as shown in all our studies) to ensure the best education possible for their children. In terms of seeking off-farm employment, the tertiary training and qualifications gained by farm women resulted in them being the most natural members of the family to seek work away from the farm. It should be noted, however, that when the male held university qualifications, then he often took the off-farm employment option, frequently full-time. By far the greatest number of the women held qualifications in the professions of nursing and teaching.

Farming history: The eagerness of the farm families to describe their farm backgrounds was an indication of their sense of pride in their farming stock. Many men were still farming in the districts containing their generational farm history but not all of these identified their current farm as the generational farm. This may be as a result of greater mobility among the recent generation, and can usually be linked to the process of succession and retirement. But generational 'roots' are not only the birthright of farm males, farm women too shared a strong background in farming. Families described at least two generations of farming history, many identifying up to six with some of these describing farming links in Britain prior to colonial migration.

Types of enterprise

Tourism is an important enterprise option for farm households. These enterprises can provide accommodation that ranges from bed and breakfast to fully catered; they offer farm attractions like homestead gardens, farm yard activities like shearing and watching dogs working or the simple enjoyment of the ambience of the farm. Many also offer a variety of other activities like fishing, hunting, jet boating, golf and skiing. Various types of handicraft are also on sale.

The range of enterprises apart from tourism is wide and varied. For instance specialist horticulture/ nurseries; agricultural processing (non traditional and organic); food processing; viticulture and wineries; agricultural services and consultancy; light manufacturing; fashion; artwork; and handcrafts including pottery.

Parallel alternative enterprises were a frequent characteristic (McCrostie Little *et al.* 1996). For example, the majority of garden tour enterprises operated in conjunction with nursery sales and, in several cases, of specialised nursery products. Tea and gift shops, specialist food products, dried flowers and flower oils, weaving, pottery, art works, craft wool, metal work and design are further examples of parallel ventures, often run in conjunction with farm stays or garden tours. Some entrepreneurs, particularly those operating their farm/garden tours via commercial tour networks, added value to their enterprises either by providing catering (lunches, morning and afternoon teas) or providing access to their garden nurseries. The opportunity of an 'on the spot' market for a range of products has not been lost on the farm family competing in an increasingly competitive tourist market.

Nature of off-farm employment

A common perception is that farm women, with their better qualifications and wider work experience, are solely involved in off-farm employment. But farm men are also involved. The off-farm employment of males, regardless of their position in the farm business and production cycle was dominated by the agricultural sector. These men worked as shearers, agricultural contractors and truck drivers. While the majority were employed part-time off the farm, a third were employed full time.

The occupations of teaching and nursing, which dominate the off-farm employment of females attract women particularly in their mid family and farm cycles because these occupations offer the potential for part-time work that suits them when they have child rearing responsibilities. These women also work their farms. Women whose occupations required full-time application frequently pursue their work as a career option, they progress through their professions with management or upper management goals in sight and in every respect they can be described as professional career women who happen also to be farm women. Few of the men who were employed full-time had a perceived designated career path and of those who did it was interesting to find that their spouse frequently farmed the farm in their absence. These were generally the males noted above who held tertiary qualifications.

Over a third of the enterprise households (36%) had members engaged in off-farm employment. Occupations ranged across white and blue collar jobs for men. In the enterprise household off-farm employment for the males was not dominated by the agricultural sector as were the off-farm jobs of families solely dependent for secondary income on off-farm employment. For women the nursing and teaching professions still dominate but not quite to the degree that they do for off-farm employment only families. Suggesting that the enterprise families have a wider range of skills from which to draw or maybe they are just more entrepreneurial!

The relatively high level of off-farm employment is surprising given the additional income also being obtained from the non-core enterprises. These households can therefore be described as being involved in a range of activities that provide income from multiple sources, the two activities of off-farm employment and on-farm enterprises are not mutually exclusive.

Ownership of the farms and alternative enterprises

In both studies partnerships were the most common form of farm ownership, whereas companies and individual ownership (primarily by men) were relatively less common. There were also farms with more complex ownership structures, involving combinations of partnerships, trusts and companies. Our recent work on farm succession has shown that these more complex arrangements are likely to be found for land in particular, as a farm moves into the later stages of succession and retirement.

For the enterprises, partnership (50-50 equity) was also the ownership structure favoured by the majority of the enterprises followed by a handful of sole proprietorships (in several cases by women) and even fewer company structures. With few exceptions all of the partnerships were with family members, the majority being between the farm couple. As with the farms, ownership was not always straightforward, and the number of combinations reflected the diverse requirements of the entrepreneurs, the type of enterprise, the complexity of the business structure and the relationship between the farm operation and the enterprise or enterprises.

Roles and decision making

A traditional division of labour, along gender lines, was evident for farm and household for all the families studied. Men performed the major role on the farm and were nearly always identified as the major operator. Women had the major household role. Women usually shared ownership of the farm with their husbands, made financial contributions both directly and indirectly to the farm business operation, contributed labour but seldom either shared, or acknowledged sharing, responsibility for the management of the farm. Conversely there was only a minority of households where males and females accepted joint responsibility for domestic tasks. An interesting difference exists when it came to

household decisions. While women took no part in farm decisions, men either solely or jointly with their spouse made major household spending decisions underpinning the relationship between household expenditure and farm drawings.

In comparison, the picture changes dramatically for the enterprises. Here there is no gender division for roles or for decision making. Women have considerable involvement, as either major or joint operator, with the males frequently providing a secondary support role. These women had a high degree of motivation and obtained a great deal of satisfaction from their work based on their ability to utilise personal creativity and formal training. They also demonstrated an enjoyment of operating in the 'business world' as distinct from the farm. A number were developing careers through their business in a similar way to a set of women in the off-farm employment study.

Women either solely or jointly made the decisions for two thirds of the enterprises. They certainly have greater say in the enterprise than they do in the farm decisions. Enterprise jobs, especially at times of crisis, are completed regardless of gender.

Throughout all this it should be noted that these farm women engaged in multiple income earning activities carry out four distinct roles. Previous research and indeed international literature (Gasson 1980; Haney and Knowles 1988) had found that farm women carried out up to three roles - household; farm; paid employment or community work. One role was dropped when another was taken up and that usually became an exchange of paid work for community work. Our studies have shown that farm women, and indeed farm men, in New Zealand still retain a commitment to their communities which is not an 'option' but a regular and historical responsibility irrespective of family, farm, non-core enterprises or off-farm employment. For those amongst these families who run an alternative enterprise and have off-farm employment - they now carry out five roles. No wonder 'juggling time' becomes critical and the lack of time a major cause of stress, as identified in both studies.

Interrelationship enterprise/off-farm employment and farm business

The majority of the enterprises were financially and structurally independent of the farm business, being 'stand alone' business structures. Independence was the strong incentive for these entrepreneurs. For the remainder, which were integrated with the farm business operation, the structure was described as an 'accounting mechanism'. Separating the activities out, especially if there were more than one enterprise was described as 'just too complex' - and in many cases the enterprise had been set up with farm finance. The second dimension of integration was the use of farm resources, from land to buildings to equipment, frequently including the use of otherwise underutilised or redundant resources, such as a shed, tractor or extra bedrooms. The interrelationship of farm and enterprise can confuse the question of the value of farm assets used by the enterprise. With a farmstay the dual use of the farm house is inseparable as it is with those entrepreneurs who work from home in a consulting capacity or use 'space in the kitchen'. They might use the farm computer, but the intellectual property on which the enterprise is based belongs to the entrepreneur.

Nevertheless, many of the enterprises benefited greatly or would not have existed, without the use of farm buildings in particular. Having premises close at hand was also of immense and direct benefit 'access is immediate - time saved is huge'. For at least half of the entrepreneurs the proportion of the farm assets used by the enterprise were 'significant', 'essential' and 'interdependent'. The use of farm assets can be critical in the competitive advantage held by farm enterprises. Respondents readily acknowledged that in an urban setting they would be facing high building and overheads that would detract from their business edge.

The interrelationship between off-farm employment and the farm business is less distinct than the connections between enterprise and farm and relate mainly to labour and time. Whatever the extent of the woman's farm role, be it peak time, part time or full time involvement, work off the farm is frequently adjusted around seasonal pressures to ensure her involvement. The reverse was also true that specific farm work was planned around the woman's off-farm work responsibilities. Regardless of these adjustments, women with farm roles and off-farm employment would, at peak farm times such as lambing, ensure that the on-farm role dominated. They would always be available at these times, often taking annual leave then.

During the early years of their farm careers all the men reported that their primary role was the farm so that the farm dominated their secondary role in off-farm employment. Later in their farming career some men were in a position to give up off-farm employment, while others, because of their off-farm income, were able to employ labour and or change their own involvement from worker to management.

Males with no qualifications who supplement farm income by agricultural contracting, working on other peoples' farms resent having to put the farms of others ahead of their own. They work weekends, wet days and at night. They grow stressed as they watch the quality of their own farm work slip and as they try to juggle limited time and dual roles. They are criticised by their peers for not being 'proper farmers' - when all they want to do is farm their own land. They are frequently resented by other members of the shearing gang, for example, who see them as land owning farmers taking their jobs. These men feel neither farmer nor contractor.

Women described the continual balancing act required to complete all their roles. Balancing their time, energy and commitment, between their off-farm work, their farm work and their household and family needs. In terms of the effect of off-farm employment on the general environment of home and farm there were considerable differences in the responses between men and women. Given the gender division of labour, women inevitably discussed the quality of their household work, while men similarly discussed the quality of their farm work. For four times as many men as women the quality of their work, farm work, had improved. For twice as many women as men the quality of their work, household work, had declined. In this respect men benefit the most from the effects of off-farm employment and yet it is the women who are mostly employed off the farm.

Skills and training

Farm household members involved in pluriactivity are notable for the effort they make seeking out information and training relevant to their work or enterprises.

The majority of the entrepreneurs had previous business experience, other than solely farming, and the majority also report a history of entrepreneurship in their families. Generally they had learnt their skills informally - they were self taught, some gaining their early skills from family members. While their training may have been informal, entrepreneurs were aware of the necessity of keeping their skills up-to-date. They attended seminars, undertook 'lots of swot' and valued information, noting their ability to be good listeners and pursuers of information..

A large number of the women in off-farm employment had undertaken additional and/or re-training since they originally entered the workforce. They tended to retrain after a period out of paid employment for child bearing and rearing. As well, these women indicated considerable involvement in continuing or in-service training which was closely related to their occupations. In- service training was undertaken not only in the professions of nursing and teaching but also in occupations as diverse

as the travel industry, research, management, counselling and clerical. In fact it can be said that the majority of women in employment undertake continuing training to the extent that it appears that the need to update and enhance skills is as important as was their original training and retraining. They described this continual retraining as 'new skills development'. Off-farm employment be it full or part-time was a serious commitment for the majority of these women. Over half the men indicated on-going training which was farm related and informal in nature.

Deterrents to training were primarily related to access. Lack of or pressure of time; being rural based, away from places where training is usually available; childcare or family demands; clashes between training programmes and peak farm or enterprise times; and the unique nature of some enterprises and their skill requirement were identified. Training being both costly and time consuming was a persistent constraint. The women regularly found that some of the courses necessary for their continued employment were only available in the major cities or sometimes only in the capital, Wellington. As well as these deterrents, the demands of employment itself, house and farm work all made allotting time for training difficult.

Barriers to alternative incomes in farm households

The major barriers to the establishment of a non-core enterprise were of the 'red tape' variety. These were identified as, planning and 'bureaucratic' delays; signage policies; costly permits and the cross-border confusions arising from inconsistent local government tourism development policies. Lack of management skills and establishing markets were often initial barriers to the development of the enterprise. Raising of finance was not a barrier.

Limited employment opportunities and distance from the labour markets were persistent barriers to continued off-farm employment.

The amount of establishment capital commonly required for the enterprises was very small or was built up incrementally. Nevertheless a quarter of the businesses were started with over $20,000. The major source of capital for these enterprises was the farm followed by banks, commercial institutions and family and or any mix of these sources. In general, the entrepreneurs faced few problems raising capital, sometimes as a result of the strong financial position of the farm, which can play a pivotal role in facilitating the enterprise. There were also contrasting examples when the enterprise itself was financially strong but the farm was weak. In these case the banks offered farm loan facilities. Lack of faith in or understanding of the financial potential of the enterprise by banks and investors was cited by some entrepreneurs who then, with relish, reported the current good financial health and continuing expansion of their business.

Farm and enterprise finances

Financial information on farm, employment and enterprises is provided in Table 1. Even allowing for the increase in farm values in the intervening two years, the enterprise farms tended to be larger, with a stronger asset base than those in the off-farm employment study. Most importantly, the average farm surplus was clearly stronger. (Note that in some cases farm enterprise income was not differentiated from the farm accounts.)

Table 1 Financial information

	Enterprise study	Off-farm employment study
Average size of farms		202 ha
Average farm asset	$1,192,000	$654,000
Average gross farm income	$223,000	$117,000
Average farm surplus	$61,000	$21,000
Average farm long-term liability	$225,000	$160,000
Average off-farm employment income	$12,600	$28,000

Note: enterprise farm data for the 1993-4 year, off-farm employment farm data for the 1991-2 year.

The range of enterprise gross income is provided in Table 2

Table 2 Enterprise gross annual income ranges

Income ranges, $	Number
0 - 4,999	2
5,000 - 9,999	7
10,000 - 19,999	8
20,000 - 49,999	12
50,000 - 99,999	6
100,000 - 199,999	4
200,000 - 499,999	3
500,000 plus	3
no data	12

Note: Data for the 1993-4 financial year

Farmers were less forthcoming about identifying, or being able to identify enterprise pre tax surpluses, but these ranged up to $100,000 per annum.

The importance of alternative income sources

A third of the enterprises were described as either 'moderately' to 'very important' to the farm. The income either went back into the development of the enterprise or into household or individual expenditure. Entrepreneurs described the enterprise income as 'very important' to 'important' where it sustained the farm household, to 'important' where it enabled extras like holidays or even the maintenance of school or university fees. However, for the majority, the income was of greatest importance to the individual. There was no evidence of enterprises that were in any way parasitical, drawing negatively from the farm.

In comparison, for almost two thirds of the farms with off-farm employment, the additional income was considered either 'very important' or 'important' to the farm finances. Field notes from the study capture the essence of how vitally important off-farm employment income was for the viability of these farms (and households). Off-farm employment income allowed the majority of these families to protect the farm equity by avoiding drawings against the farm account for household needs and where possible enabled funds from the farm account to be allocated to farm development. However, while farm income might be ploughed back into the farm, and off-farm income used for household expenditure, each category is a component of total household income and expenditure, making assessment of the uses difficult. The bulk of off-farm income was used for general household expenses such as house improvements, furnishing and or additional education costs. It was variously described as 'family money' and 'perk money'. Nevertheless, when allocated to expenses like house improvements and children's education, off-farm income played a part more substantial than indicated by the phrase 'perk money'. At these times it shielded the farm income from sometimes essential family costs.

Furthermore the allocation of off-farm employment or enterprise income towards 'extras' obtains for women elements of both autonomy and control over the money they have earned and how it is spent. While the income distribution is not strictly personal, as it is often spent on the family, the decision how it is to be spent is made by the women.

Succession and retirement vis farm income

For farm families, the provision of a secure retirement, equitable treatment of all the children and a viable farm operation that does not financially burden the successor are the major financial concerns that must be balanced before successful succession can be said to have taken place.

Enterprise families: It was the intention of some entrepreneurs that their children be absorbed into the alternative enterprise - that the enterprise be of such financial strength that it was able to support a second generation of enterprise families. Other entrepreneurs intended that their enterprises became a full time involvement following their retirement from the farm operation. These enterprises were the 'mobile' enterprises, reliant on skills rather than their location or land base. Amongst these entrepreneurs were a number who already planned that on their death they would 'will' the enterprise to their non-successor children and so balance equity arrangements between their children and protect the farm from either sub-division or increased debt load as a result of the successor having to 'buy out' siblings. These entrepreneurs appreciated that the enterprise itself could become a very effective tool in the resolution of the dilemma of succession and the competing demands of a limited resource base.

Off-farm employed families: These families also sought to resolve the dilemma of the intergenerational transfer of the family farm. They sold off parcels of land to accommodate the financial demands of the family and the inability of the successors to 'buy out' parents and non-successor siblings. By selling off land they were able to provide parents with an off-farm house at the same reducing farm debt. The question that remains is of course how much land can be sold off without jeopardising the viable farm business operation. Working off the farm has long been a traditional method for young farmers to accumulate savings with which, in part at least, to purchase the family farm. Now, while off-farm employment income might have little direct or stated relationship with retirement strategies, it can be very important in the longer term as part of a strategy for building and protecting farm equity

Conclusions

The research on off-farm employment and alternative enterprises on farms has confirmed the importance of pluriactivity for New Zealand farm households. There are a number of implications for rural communities, and for rural researchers and policy makers.

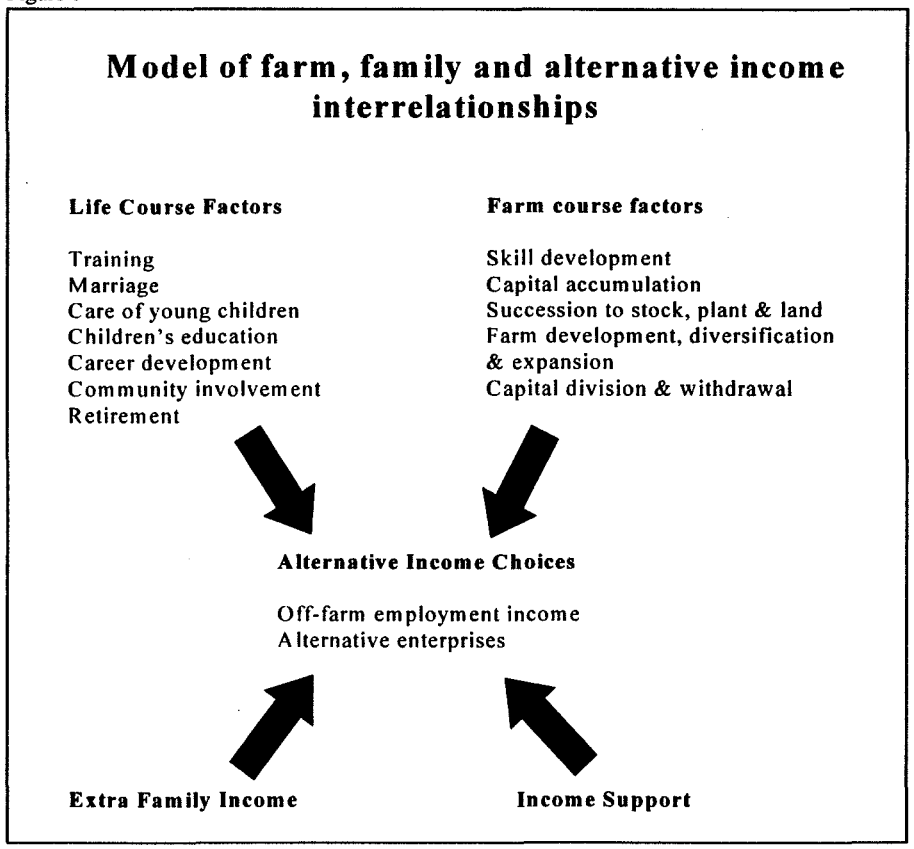
Farm social environment

The farming social environment has always supported the off-farm work of young farmers to realise the purchase their farms. It is only recently that there has been social acceptance of women working off their farms, mainly an acknowledgement that the survival of many farms through the 'bad years' of the eighties was dependent on their off-farm earning capacity. Some members of the farming community still harbour a belief that women will return to the farm kitchen once 'things come right' and it is that, and only that, understanding that allows these critics to accept the income earning power of women. Of course women will not return as one to the farm kitchen once the farm finances have stabilised - for apart from the importance of the second income they have come to enjoy the socialisation the work place offers and the challenge and fulfilment that their off-farm work provides. Male farmers will also seek work for social reasons; being the first generation to be farming largely on their own, with much less companionship from the wider family or farm workers.

Farm and family life cycles

The ability of farm women to be wage earners is regulated by the pattern of their life cycle. After initially working off the farm in her early farm years her participation in the paid employment force off the farm will be dependent on the age of her children and her child rearing responsibilities. Men work off the farm in their early years. It is the middle years when men concentrate their energies on the farm. Those men who 'have' (as a result of lack of finances) to work off the farm in these middle years do so reluctantly and resent having to spend time away from the farm. They also find that their peers are critical of their off-farm work and that they are frequently not considered 'real farmers'. Both men and women are more likely to become involved in alternative enterprises later in the farm and family cycle. A model of the interrelationships between family and farm courses and alternative farm household income is presented in Figure 1.

Figure 1



Farm entrepreneurs
Males with qualifications have been able to capitalise them in the form of regular work off the farm. They often take on a managerial role and buy in skilled farm labour, sometimes with skills in addition to their own so that one particular production aspect of the farm improves: 'he is a better stockman than I am'. They say they are frequently resented in the community because 'we refused to stay poor like everyone else'. Their farming techniques have changed, they farm for the 'top dollar' and they report that they have become more efficient in their farming methods. Their off-farm work gives them 'vision beyond the farm gate' and they believe that they are better farmers and producers. As farmers go for the 'top dollar' they are likely to develop niche markets and niche market skills, further changing the face of farming away from national marketing systems and bulk product. Some entrepreneurs reported that they had gained marketing skills in their enterprises that had influenced them in their farm product marketing strategies.

Rural labour markets
The off-farm employment of farm women is dominated by the professions of nursing and teaching. A critical aspect of their continued employment must be the regular and continuing closure of rural

schools and the centralisation of hospitals and medical services out of country areas and into regional towns and cities. Yet New Zealand, unlike most agricultural countries within the OECD, has never had a nationally encompassing rural policy. There are only weak links between relevant Ministries and no permanent mechanism for the Ministry of Agriculture or other Ministries to consider the social impact of policy decisions on the dispersed but highly productive rural sector. As a consequence there have been no links made between the closure of rural schools and hospitals, rural labour market, farming economy and the stated goal of 'sustainable agriculture'.

Training and networks
The farming economy has even greater potential for innovation, diversity and entrepreneurship, and the research has shown the importance of a wide range of skills. Farm people are active and determined in developing their skills, but they face barriers of access and costs. There is an increasing need to broaden training to include management skills well beyond the agriculture context. Also, stress and 'lack of time' put pressure on farm couples. Time management skills and communication skills may be what these farm families need most. Most importantly, farm entrepreneurs emphasise that they need to avoid 'reinventing the wheel', noting potential for improved networking and mutual support in developing business strategies.

Business environment
Farm entrepreneurs have responded strongly to the deregulated and competitive business environment in New Zealand over the past twelve years. The range of enterprises on farms bears testimony to the effect of these policies, while it also reflects the response of farmers to the effects of economic restructuring on their core business of farming. Areas in which the new economic environment has had particular effect are transport and communications, including improved land transport, air cargo, and courier services. New technology of automated telephone exchanges, the fax, cell phones and personal computer will continue to be a major part of this rapidly changing business environment. Liberal institutional changes in resource planning and liquor licensing are also having an effect, although there are still issues to be worked through.

Monitoring of farm household income
National farm monitoring should recognise a diverse range of sources of farm household income, and a comprehensive monitoring framework has been recommended (Taylor and McCrostie Little 1997). It is no longer appropriate to consider farms as 'economic' units, believing they will provide sufficient income for one family. Farm families now draw their income from a range of sources, utilising their labour and personal skills, financial and physical resources. Diversity and entrepreneurial activity will continue to expand. Like Oliver Twist, farm families are daring to challenge the status quo. We hope researchers and policy makers can keep up.

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